PRIMES

Operating Manual

Translation of the Original Instructions

BeamControlSystem BCS

Hardware and Software Interface PROFINET

Revision 01/2018 EN

Contents

PRIMES – The company

PRIMES is a manufacturer of measuring devices used for the characterization of laser beams. These devices are used for the diagnostics of high power lasers that range from CO_2 lasers to solid-state lasers or diode lasers. The wavelength range is covered from infrared to near UV. A great variety of measuring devices for the determination of the following parameters is available:

- The laser power
- The beam dimensions and beam position of an unfocussed beam
- The beam dimensions and beam position of a focussed beam
- The beam propagation ratio M^2
- The polarisation of the laser beam

Both the development and the production of the measuring devices are effected by PRIMES. This is how we ensure an optimal quality, excellent service and a short reaction time which is the basis to meet our customers' requirements fast and reliably.

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1 Basic safety instructions

Intended use

The BeamControlSystem (BCS) is exclusively intended for measurements carried out in or near the optical path of high power lasers. Other forms of usage are improper. To ensure a safe operation, the BCS must only be operated according to the terms stipulated by the manufacturer.

Improper usage of the BCS is strictly prohibited and could lead to health endangering or even deathly injuries. When operating the BCS it must be ensured that there are no potential hazards to human health.

The BCS itself does not emit any laser radiation. During the measurement, however, the laser beam is guided through the device which causes scattered radiation (Laser Class 4). That is why the applying safety regulations are to be observed and necessary protective measures need to be taken.

Observing applicable safety regulations

Please observe valid national and international safety regulations as stipulated in ISO/CEN/TR standards as well as in the IEC-60825-1 regulation, in ANSI Z 136 “Laser Safety Standards” and ANSI Z 136.1 “Safe Use of Lasers”, published by the American National Standards Institute, and additional publications, such as the “Laser Safety Basics”, the “LIA Laser Safety Guide”, the “Guide for the Selection of Laser Eye Protection” and the “Laser Safety Bulletin”, published by the Laser Institute of America, as well as the “Guide of Control of Laser Hazards” by ACGIH.

Taking necessary safety measures

If there are people present within the danger zone of visible or invisible laser radiation, for example near laser systems that are only partly covered, open beam guidance systems or laser processing areas, the following safety measures need to be taken:

- Please wear safety goggles adapted to the laser wave length that is in use.
- Please protect yourself from direct laser radiation, scattered radiation as well as from beams generated from laser radiation (for example by using appropriate shielding walls or by weakening the radiation to a harmless level).
- Please use beam guidance – or beam absorber elements which do not emit any hazardous particles as soon as they get in contact with laser radiation and which resist the beam sufficiently.
- Please install safety switches and / or emergency safety mechanisms which enable an immediate closure of the laser shutter.
- Please ensure a stable mounting of the measuring device in order to prevent a relative motion of the device to the beam axis. This reduces the risk of scattered radiation and is also necessary to ensure an optimal performance for the measurement.

Employing qualified personnel

All users must have been trained in the installation and operation of the device and they need to have a basic knowledge about the work with high power lasers, beam guidance systems as well as focussing units.

Modifications

The BCS must not be modified, neither constructional nor safety-related, without our explicit permission. Modifications of any kind will result in the exclusion of our liability for resulting damages.

Liability disclaimer

The manufacturer and the distributor of the measuring devices do not claim liability for damages or injuries of any kind resulting from an improper use or handling of the devices or the associated software. Neither the manufacturer nor the distributor can be held liable by the buyer or the user for damages to people or material or financial losses due to a direct or indirect use of the measuring devices.

2 Symbol explanations

The following symbols and signal words indicate possible residual risks:

DANGER

means that death or serious physical injuries **will** occur if necessary safety precautions are not taken.

WARNING

means that death or serious physical injuries **can** occur if necessary safety precautions are not taken.

CAUTION

means that a slight physical injury **can** occur if necessary safety precautions are not taken.

NOTICE

means that property damages **can** occur if necessary safety precautions are not taken.

On the device itself, the following symbols indicate possible dangers:

Warning of hand injuries

Read and observe the operating instructions and safety guidelines before the start-up!

Further symbols that are not security relevant:

Here you can find useful information and helpful tips.

CE With the CE marking the manufacturer guarantees that his product is in conformity with the EC guidelines.

▶ Calls for action

3 Conditions at the installation site

The BCS must not be operated in a condensing atmosphere. The ambient temperature must be above freezing. The temperature of the cooling water must not be beneath the ambient temperature. The humidity has to be taken into consideration as well in order to prevent condensates within and outside the BCS.

4 Introduction

4.1 Laser beam measurement

The production with laser beams can be observed effectively by controlling the laser beam parameters. The laser beam is basically characterized by:

- The beam power
- The beam dimensions and the beam position of the unfocussed beam
- The beam dimensions and the beam position in the focus
- The polarization of the laser beam

These basic beam parameters have a great influence on the results of laser material processing. In order to achieve a reproducible process quality it is necessary to detect all changes of the beam parameters. Changes can be caused not only by:

laser internal reasons, for example:

- the aging or pollution of optical components or
- the misalignment of the resonator

but also by:

effects in the beam guidance system or the focussing unit, for example:

- the pollution or the misalignment of mirrors or lenses
- organic trace gases in the air – thermal blooming

The processing result for the production with lasers is generally dependent on the beam power as well as the power density in the focussing range. Moreover, the position of the focussing point in relation to the processing zone must be known. Variations to these nominal sizes often lead to a reduced processing speed or processing quality.

Periodic measurements of the laser beam parameters enable a reliable control of the “tool” laser beam. This is a basic requirement for a reproducible production with the laser beam and therefore for the quality assurance.

PRIMES has developed measuring systems that are able to carry out measurements even in an industrial environment. A connection to the system control is supported and the possibility of a complete documentation of the results is therefore ensured.

5 System description

The BeamControlSystem consists of the measuring devices FocusMonitor and Compact-PowerMonitor as well as a PLC-interface-router-combination. These components are integrated in a stable aluminium housing. A pneumatic shutter protects the inlet.

The measuring devices are intended for a cyclical control of the beam parameters: power, beam position and beam dimensions as well as the beam pattern in the focus. The PLC connection ensures a smooth, automated measurement.

The enclosed instructions regarding the FocusMonitor and the CompactPowerMonitor describe the operation of the measuring devices in detail.

For the operation of the complete measuring station the safety guidelines that are applicable for the FocusMonitor and the CompactPowerMonitor apply accordingly.

Fig. 5.1: BeamControlSystem - PROFINET

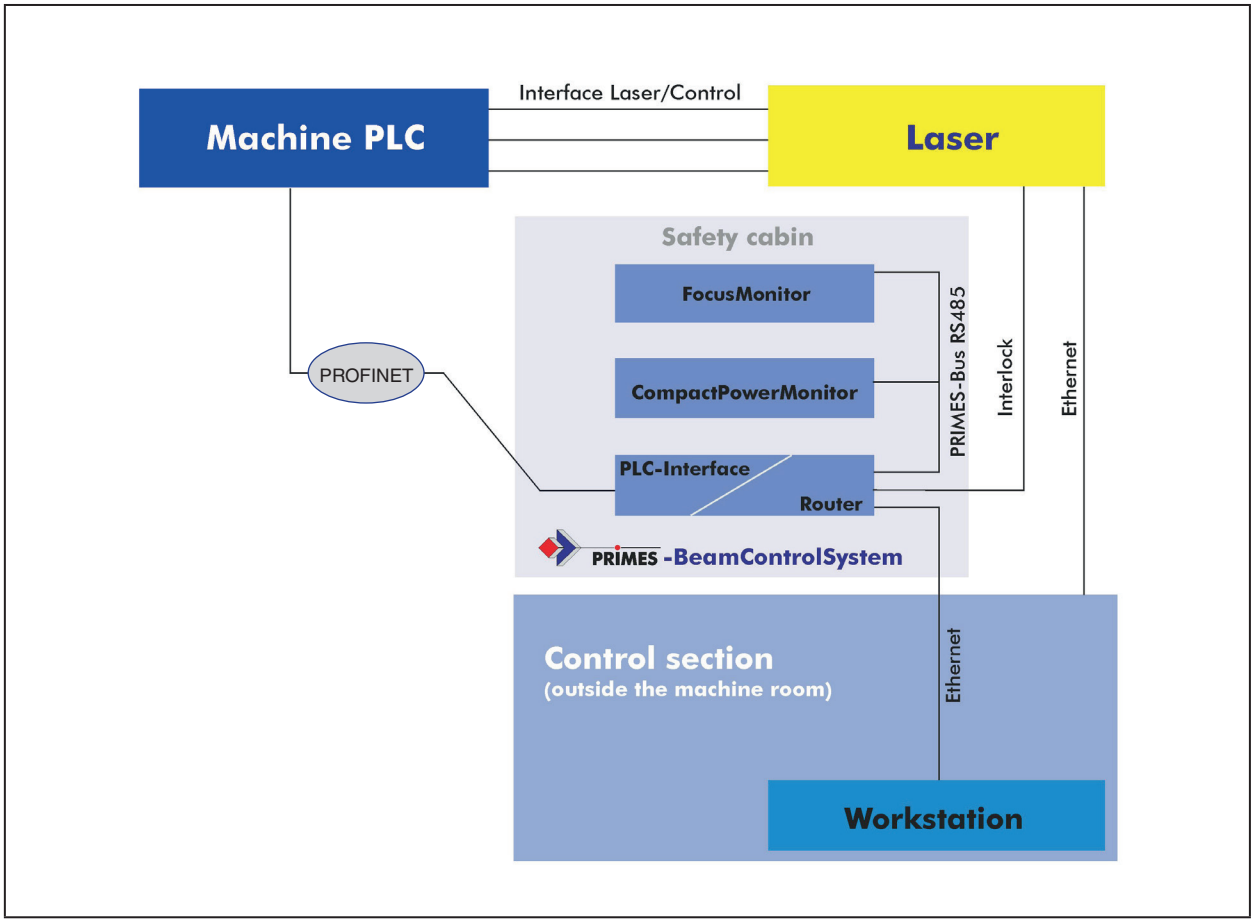


Fig. 5.2: Principle of the electrical integration of the BCS

To the outside the measuring station is connected via four electrical interfaces:

1. It is connected with the system via PROFINET. This is how the power supply as well as the communication between the measuring station and the system control is ensured.
2. The data from the BeamControlSystem to the operating computer are transferred via Ethernet.
3. The interlock signal connection to stop the laser in case of an error.
4. A further connection is the 9 pin D-Sub-connector. It can be used optionally for the communication with the operating computer by means of RS485-RS232 interface converters.

For the operation of the measuring station, the connection of cooling water as well as compressed air is necessary.

6 Connections

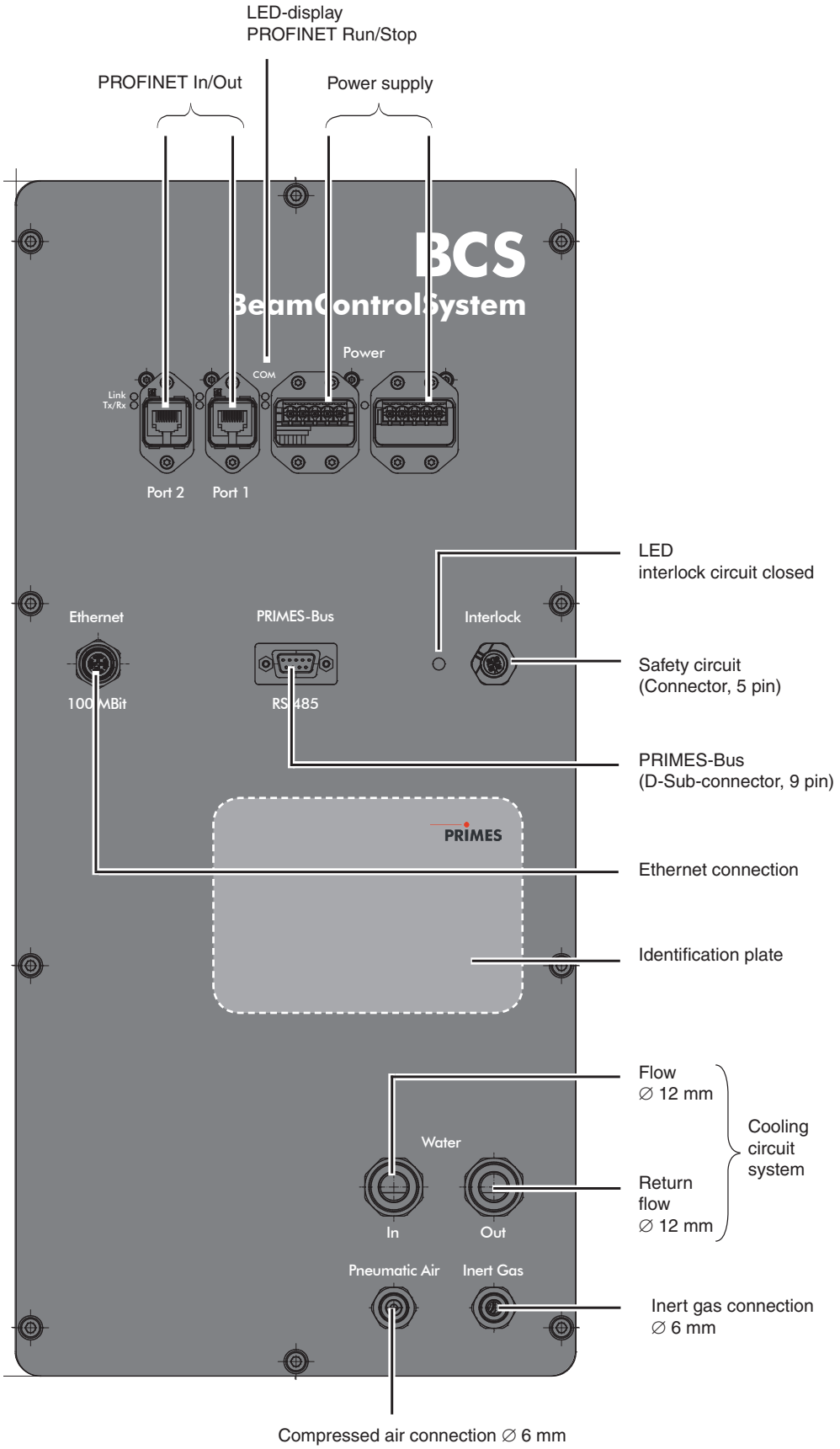


Fig. 6.1: Overview of connections

7 Installation

Before the installation, please check that there is enough space, especially for the shutter swinging out (see chapter „Dimensions“).

7.1 Alignment to the beam axis

First of all, please roughly align the housing with the four adjusting screws (for example by means of a water level).
For a precise adjustment with a dial gauge a plane groove in x- and y-directions was milled into the housing surface (please see Fig. 7.1).

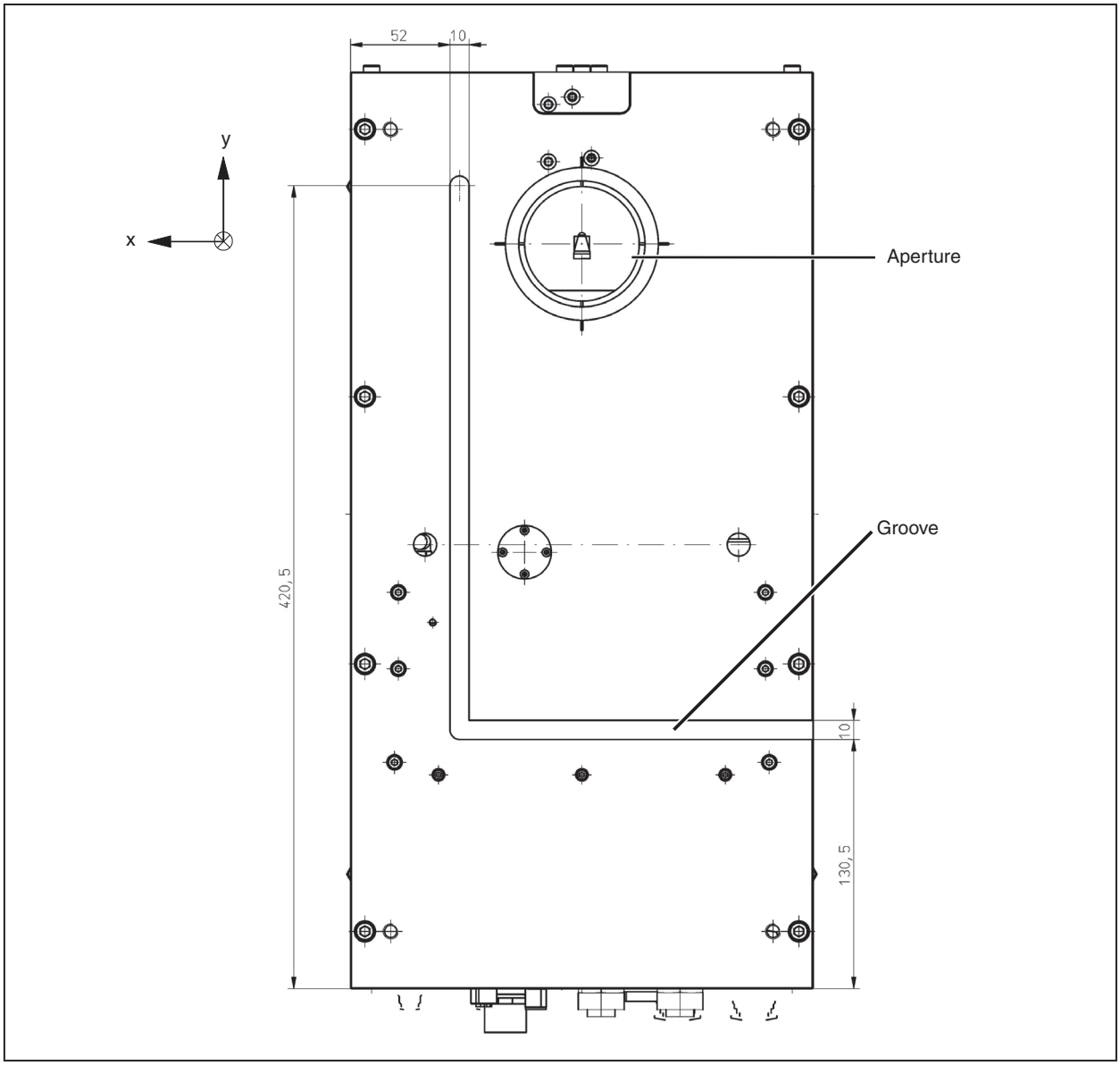


Fig. 7.1: Groove dimensions, view from above

Please align the housing so that the centres of the laser beam as well as the aperture match each other (see Fig. 7.2).
As an alignment aid four grooves are milled around the aperture[1]. The distances of the measuring window centre to the centre of the aperture (x/y – axis) as well as the distance of the measuring tip in the device (z-axis) are to be found in the document “Tool centre point-calibration” and on the identification plate. Due to the fact that the x-distance is slightly dependant on the revolution speed of the measuring tip, several x-values for the different operating speeds are stated here.

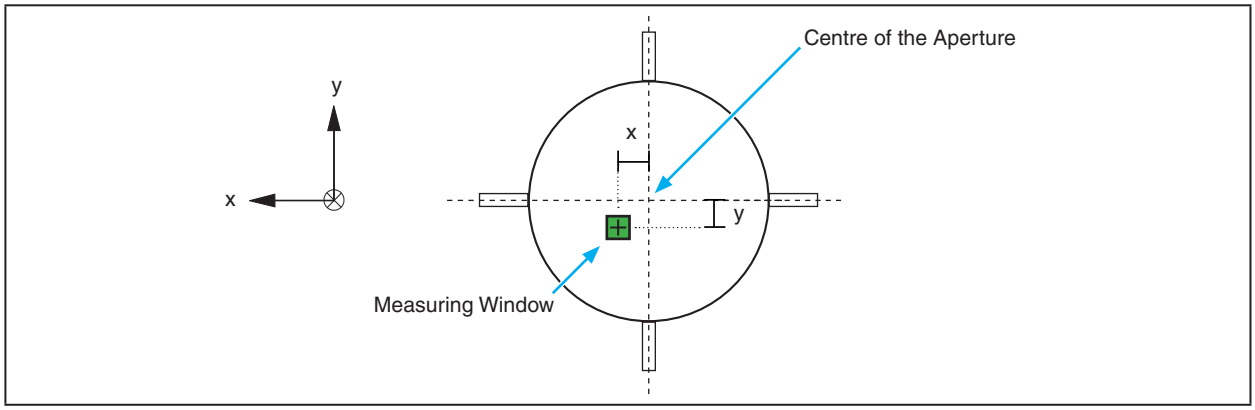


Fig. 7.2: Distances centre of the aperture – centre of the measuring window

The FocusMonitor is integrated overhead in the BCS. You therefore have to activate the check box “turned measuring tip” in the menu “Measurements → Sensor Parameters” of the operating software (LDS).

7.2 Mounting

WARNING

Danger of injury

If the appropriate position of the measuring device is changed, this could cause scattered radiation during the measurement.

- **When mounting the device, please ensure that it cannot be moved, neither due to an unintended push or a pull on the cables and hoses.**

There are eight tapped holes M6 in the base plate of the BCS-housing which are intended for the customer’s mounting. Please use at least four screws to fasten the device.
We recommend screws of the strength category 8.8 and a tightening torque of 20 N·m.

NOTICE

Danger of damage

There is a danger of damage for inner components if the screws used are too long.

- **Please do not screw the fastening screws further into the housing than 15 mm.**

The overall length of the screws depends on the customer’s mounting.

[1] Depending on customer requirements, other adjustment markings can exist.

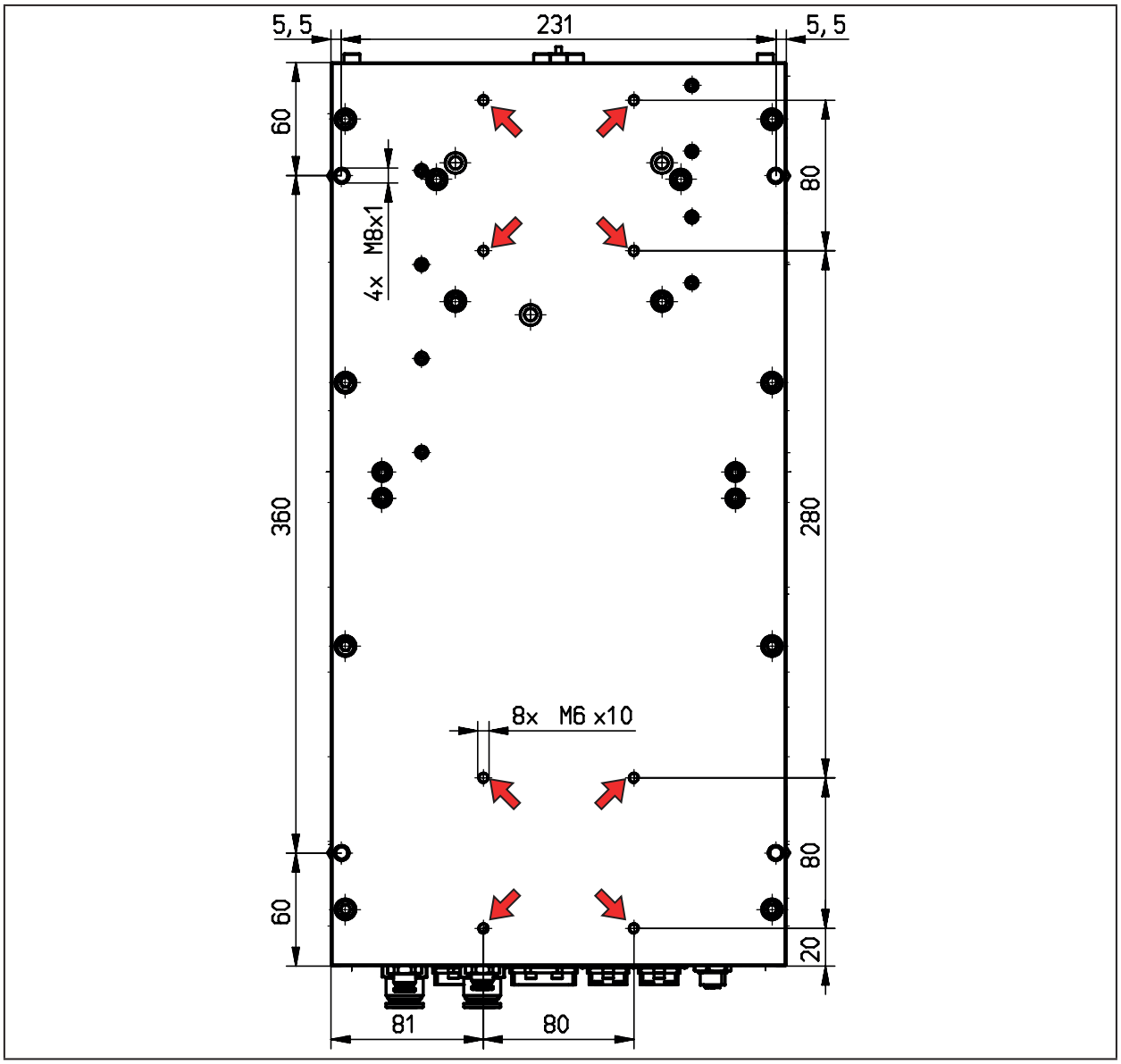


Fig. 7.3: Fixing holes, view from bottom

NOTICE

Danger of damage

There is a danger of damage caused by dirt particles

- **If you have to remove the eye bolts for reasons of space, please close the tapped holes with suitable screws (M8) or with appropriate plastic inserts.**

8 Mechanical connections

8.1 Cooling circuit system

8.1.1 Conditions

The hose connections of the BCS are intended for an outer diameter of 12 mm.
For a reliable operation a minimum water flow of 4 l/min and a maximum of 8 l/min are necessary.

There is a block valve in the cooling circuit. In order to switch the valve the compressed air needs to be connected and the supply voltage has to be turned on.

Please operate the BCS in a non – condensing atmosphere. The temperature of the cooling water may therefore not be below the ambient temperature.
Only cool the device while carrying out a measurement. We recommend to start the cooling two minutes before the measurement and to finish it one minute after the completion of the measurement.

NOTICE

Danger of damage

Concerning the water installation it must be ensured that if you work with sealing tape (e.g. teflon or hemp), no parts get into the turbine! They could constrain the flow or stop it completely.

▶ **Please rinse your line system before connecting it.**

The parts of the BCS which are in contact with the cooling water are made of copper, brass or stainless steel. The device should therefore not be connected with an aluminium cooling circuit. This could lead to corrosion of the aluminium due to the different chemical potentials. Do not add any additives to the cooling water, especially no anti-freeze agents as they could have a significant influence on the thermal conductivity and could therefore distort the measurement results.

8.1.2 Connection

1. Please remove the sealing plug of the cooling circuit and keep it save.
2. Please connect the forward (IN) and return (OUT) circuit of the device.

Operating the device with strongly de-ionized water (DI-water) is only possible if the right connection pieces are used. We would kindly ask you to inform us before buying the device.

8.2 Compressed air

The compressed air is necessary to open or to close the shutter and the block valve. The supply is effected via a plastic hose with an outer diameter of 6 mm. A pressure of 4 to 8 bar is required. User-specific modifications are possible.

As an option, a rinsing of the housing with compressed air is possible. A flow rate of typically about 10 to 20 liters per minute should be allowed for. Depending on the application it can be more.

8.3 Inert gas connection

The connections of the device are intended for hoses with an outer diameter of 6 mm.

NOTICE

There is a danger of damage for the measuring tips due to a plasma ignition or dirt particles from the environment.

When measuring great power densities[1] (YAG: 8 – 10 MW/cm²; CO_2: 20 – 30 MW/cm²) it is possible that a plasma is ignited on the surface of the measuring tip. This could destroy the measuring tip.

- **When measuring high power density please rinse the device with inert gas (nitrogen or helium). The inert gas needs to be dry and oil free.**

[1] Please also see the manual of our FocusMonitor, chapter “Selection of detectors and measuring tips”.

9 Electrical connections

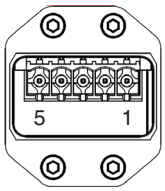
9.1 PROFINET Data

The PROFINET® connectors are AIDA compatible RJ45 connectors. Both RJ45 connectors are connected internally via an integrated switch. There are two status LED's on the left side of the connector. The green LED (Tx/Rx) glows as soon as the physical connection has been established. The yellow LED glows during data transfer.

9.2 PROFINET power supply

The power supply is realized via the AIDA compatible connectors. Both connectors are connected internally 1:1.

Power-Device connector (top view plug-in side)



Pin	Function
1	+24 V Sensor power supply
2	GND Sensor power supply
3	+24 V Actor power supply
4	GND Actor power supply
5	PE (housing)

Table 9.1: Pin assignment power supply

9.3 PROFINET Status-LEDs

There are two status LED's on the left side of the power supply. The yellow LED glows constantly if there is no physical connection to the bus. The LED flashes when there is a connection but no data transfer.
The upper green LED glows during a DCP cycle via the bus.

PROFINET® Port 1	PROFINET® Port 2	Status
Link (green)	Link (green)	DCP-signal bus transfer (green)
Tx/Rx (yellow)	Tx/Rx (yellow)	Communication indicator - Constant - no connection - Flashing - no data transfer

9.4 PRIMES Bus

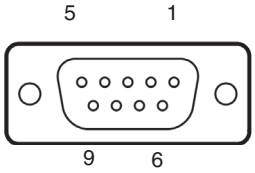
9-pole D-Sub connector (top view, plug-in side)		
	**Pin**	**Function**
	1	GND
	2	RS-485 (+)
	3	+24 V
	4	unassigned
	5	unassigned
	6	GND
	7	RS-485 (-)
	8	+24 V
	9	unassigned

Table 9.2: Pin assignment PRIMES bus

9.5 Ethernet connection

You can either connect the device with the PC via a crossover-cable or with the network via a patch cable.

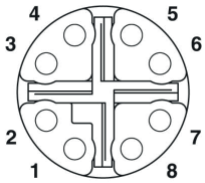
Connector, 8-pole (top view, plug-in side)		
	**Pin**	**Function**
	1	TX+
	2	TX-
	3	RX+
	4	unassigned
	5	unassigned
	6	RX-
	7	unassigned
	8	unassigned
Plug description: Phoenix-Contact 1404548 VS-BH-M12FSX-10G-RJ45-90		

Table 9.3: Pin assignment Ethernet socket

Suitable cable: Phoenix Contact 105477; Patch cable CAT6A M12 on RJ45; VS-M12MSS-IP20-94F/ 5,0/10G (1440627).

9.4 External safety circuit

The external safety circuit protects the device from damages. The device could be damaged if

- the water flow rate is too low
- the laser is turned on while the shutter is still closed.

If the water flow rate is within the normal range and the shutter is opened, Pin 1 and Pin 3 are connected.
If the device is not ready for operation, Pin 1 and Pin 2 are connected.
The pins of the safety circuit plug are potential-free.

NOTICE

Danger of damage

If the safety circuit is not connected the device could overheat or the closed shutter could be destroyed by the laser beam.

▶ **When connecting the laser control to pin 1 and 3 it has to be ensured that, in case of an interruption of the connection, the laser is turned off.**

If the safety circuit is released, the green LED next to the connector glows.

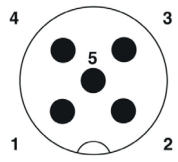
5-pole connector (top view, plug-in site)		
	**Pin**	**Function**
	1	Reference pin for pin 2 or 3
	2	If not ready for operation, connected with Pin 1
	3	If ready for operation, connected with Pin 1
	4	unassigned
	5	unassigned
Plug description	Manufacturer: Phoenix Contact SACC-E-MS-5CON-M16/0,5 SCO – 1520055	
Suitable cable	Phoenix Contact Sensor-/Actuator-cable - SAC-5P-5,0-PVC/M12FS B-L – 1431717	

Table 9.4: Pin assignment of the safety circuit connector

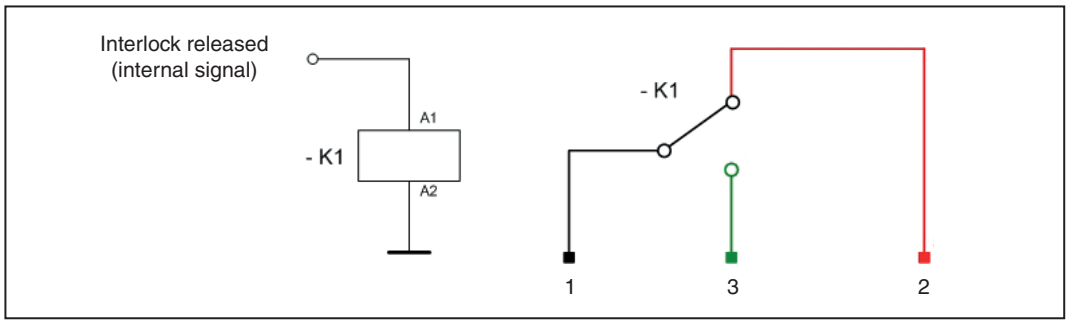


Fig. 9.1: Circuit diagram of the safety circuit

10 PROFINET

10.1 Interface description

The BCS has a PROFINET interface. To enable the integration in a line system both the bus interface and the power supply are duplicated.
All in all there are four interfaces:

- 2x PROFINET
- 2x 24 V power supply (24 V ± 5 %, a maximum of 5 ampere of power consumption)

The data is stored in the registers in **Motorola format**. This means that the highbytes are coming first, followed by lower bytes in the next registers.

10.2 Device database file (GSDML-file)

The GSDML-file for the BCS has the name *GSDML-V2.3-PRIMES-BCS-PN-20150818.xml* and can be found on the enclosed CD-ROM.
Fig. 10.1 shows the integration of the GSDML – file under step 7.

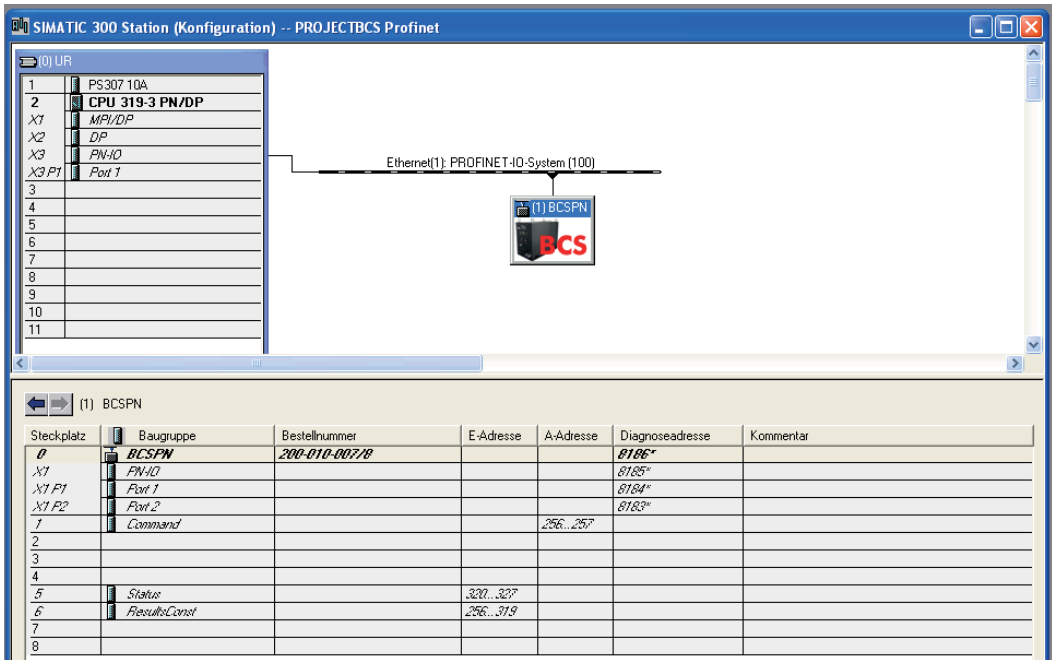


Fig. 10.1: Integration of the GSDML – file under step 7

10.3 PROFINET register structure of the BeamControlSystem

10.3.1 Output register control (Command Register)

Adr	Byte	Bit	Meaning
0			Commands or status information of the system
		0	Status flag: automatic mode [1)]
		1	Opening the shutter
		2	Closing the shutter
		3	Opening the water valve
		4	Closing the water valve
		5	Measuring programme: 1 (only power measurement)
		6	Measuring programme: 2 (caustic measurement incl. power measurement)
		7	Measuring programme: 3 (reserve)
		8	Measuring programme: 4 (reserve)
		9	Starting the measurement
		10	Cancelling the measurement (abort)
		11	Open the protective gas valve
		12	
		13	
		14	
		15	

[1)] Must be set whenever procedures or actions are controlled by the system (e.g. opening / closing shutter)

10.3.2 Input register control: status

Adr	Byte	Bit	Meaning
0	0		Status Information
		0	Shutter is open
		1	Shutter is closed
		2	Shutter is just moved
		3	Shutter error (Pos. undefined / Timeout during shutter command)
		4	Water valve is open
		5	Interlock circuit is closed (everything is ok)
		6	Interlock shutter ok (shutter is open)
		7	Interlock CPM ok (there is no CPM error relevant for the interlock)
	1	8	LDS idle (script is running, LDS is ready to receive commands)
		9	Command to device: Laser on!
		10	Measurement is running
		11	Measurement completed successfully
		12	Measurement completed with error
		13	Result ok
		14	Result not ok
		15	

10.3.3 Error register

Adr	Byte	Bit	Meaning
1			Error register FM and PM
	2	0	
		1	
		2	
		3	
		4	
		5	
		6	
		7	
	3	8	Information in register 16 to 18 and CPM error flags are not updated as the statuscollect is deactivated
		9	Data valid is set to “false” in the CPM-al-frame
		10	Flow rate is too low
		11	Temperature of the cooling water at the inlet is too high
		12	Temperature difference of the cooling water is too high
		13	Temperature of the cooling water at the outlet is too high
		14	
		15	

Adr	Byte	Bit	Meaning
2			Error register BCS and LDS
	4	0	Automatic Bit is set in case for shutter / water valve command from LDS or Automatic Bit is not set for shutter /water valve / abort command from device
		1	Simultaneous “open shutter” and “close shutter” commands from device
		2	Simultaneous “open water valve” and “close water valve” commands from device
		3	
		4	
		5	
		6	
		7	
	5	8	Fatal script error
		9	
		10	
		11	
		12	
		13	
		14	
		15	

10.3.4 Input register: results

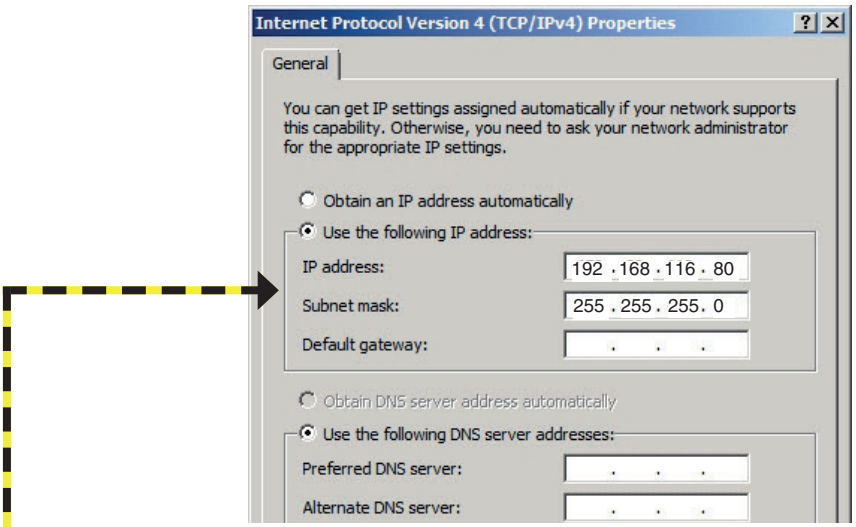
32 bit each – low address contains higher data word

Adr	Byte	Unit	Meaning
4 ... 5	8 ... 11	µm	Radius
6 ... 7	12 ... 15	µm	PosX
8 ... 9	16 ... 19	µm	PosY
10 ...11	20 ... 23	µm	PosZ
12 ... 13	24 ... 27	* 1000	M^2
14 ... 15	28 ... 31	W	Power determined
16 ... 17	32 ... 35	W	Current power
18 ... 19	36 ... 39	1/100 °C	Temperature of cooling water
20 ... 21	40 ... 43	1/100 l/min	Flow rate
22 ... 35	44 ... 71		Reserve

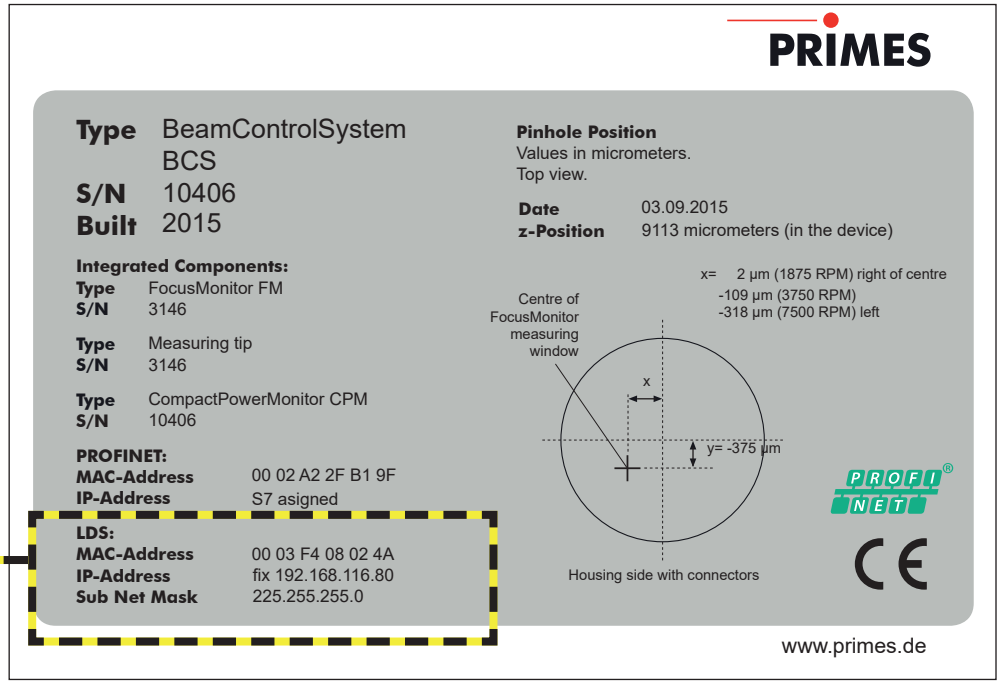
11 Ethernet Configuration

The BCS has a stipulated IP address which is given on the identification plate.

The PC must also have an IP address in the same subnet, for example:
IP-Address: 192.168.116.80
Subnet mask: 255.255.255.0



Identification plate BCS120



11.1 Establishing a connection to PC

1. Please start the PRIMES LaserDiagnosisSoftware
2. Choose the mode “TCP” in the menu “free communication” (the option “second IP” must not be activated!)
3. Enter the IP in the field “TCP”
4. Click on the “connect” button (“connected” appears in the bus monitor)
5. Click on the “save” button (the configuration is saved and does not have to be repeated after a restart)

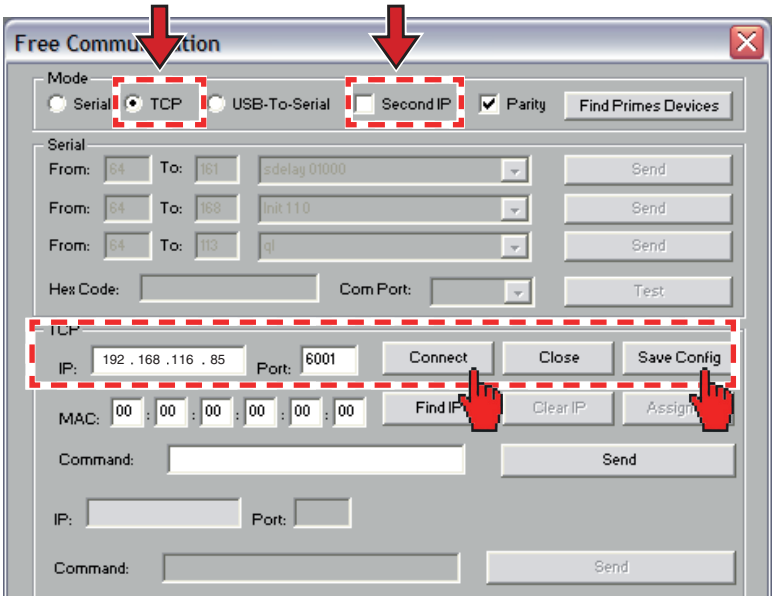


Fig. 11.1: Establishing a connection in the menu ***Free Communication***

11.2 Changing the IP address

You can change the preseted IP address in the menu ***Communication>>Free communication*** by means of the following commands:

IP-address (Sample address)	**192.**	**168.**	**116.**	**85**
	↑	↑	↑	↑
Commands	se0050✶xyz	se0051✶xyz	se0052✶xyz	se0053✶xyz

In this case **xyz** are place holders of the four IP-address bytes (values 1 - 254) which always have to be entered with three digits!
For example, the number 85 has to be entered like this: 085.
For reasons of clarity the symbol ✶ marks a space.

Example: You will change the IP address from 192.168.116.85 to 192.168.116.**86**.

1. Please start the PRIMES LaserDiagnosisSoftware.
2. Open the menu ***Communication>>Free Communication.***
3. Choose the mode “TCP” (the option “second IP” must not be activated!).
4. Enter the IP in the field “TCP”.
5. Click on the “connect” button (“connected” appears in the bus monitor).
6. Activate the checkbox ***Write bus protocol*** (the protocol can be helpful in case of problems).

7. Enter the following in the field ***Command*** (please make sure that the blank character ✶ is entered correctly):

se0053✶086

8. Click to ***Send*** and wait for the confirmation in the bus monitor (in Fig. 11.2 „-> Adr:00053 Wert: 086“)
9. Please turn off the device and turn it on again. After this restart the IP-address is updated.

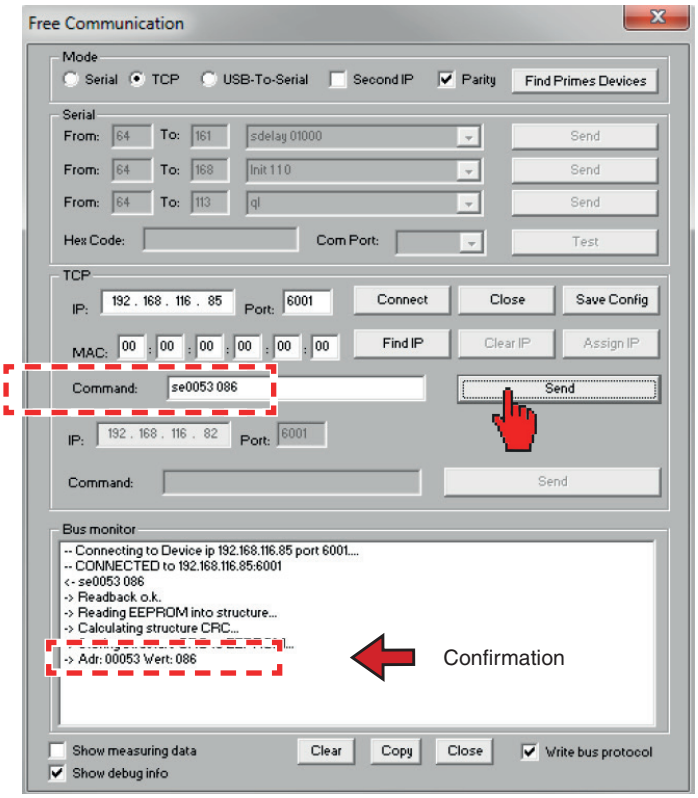


Fig. 11.2: Changing the IP address in the menu ***Free Communication***

11.3 Automatically obtain the IP-address

With DHCP (Dynamic Host Configuration Protocol) an automatic integration of a device into a present network is possible without a manual configuration.

In the LaserDiagnoseSoftware you can activate the DHCP funktion with the command:

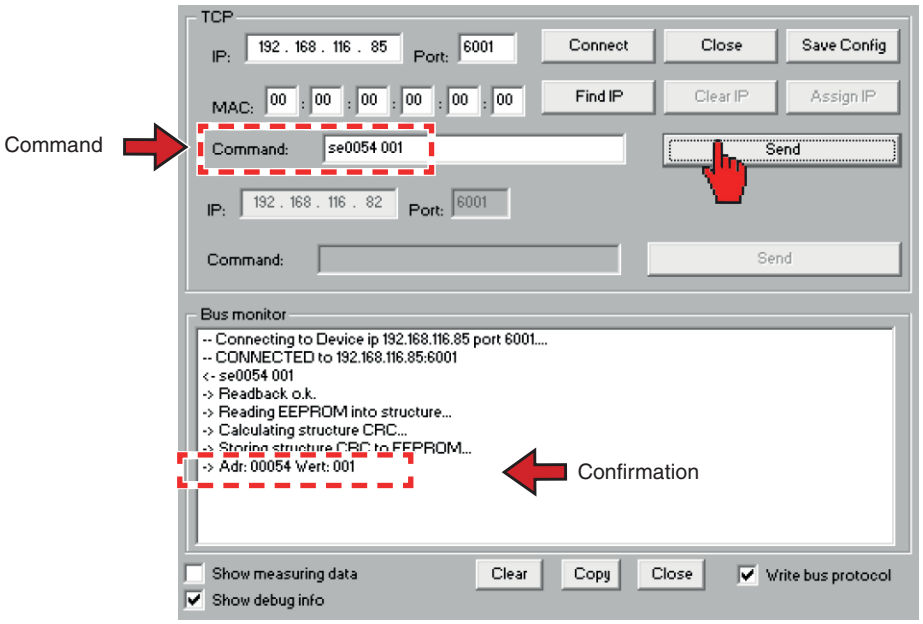
se0054✶001

1. Please install the LaserDiagnosisSoftware (LDS) on your computer which is connected with the device via the network connection.
2. Please start the software and open the menu **`Communication>>Free communication.`**
3. Select “TCP” in the field ***Mode***.
4. In the field ***TCP*** the IP address is to be entered (the IP address can be found on the type plate).
5. Please click on ***Connect.***
6. Please activate the check box ***Write bus protocol*** (the protocol can be very useful in case any problems occur).
7. Please enter the following command in the input field ***Command*** (please make sure that the blank character ✶ is entered correctly):

se0054✶001

This will activate the DHCP-function.

8. Please now turn off the BCS and turn it on again.



After a newstart of the device with the network connection now the router/server will be asked for an IP-address. Now the Server will activate a new address which needs to be requested via your router/server. The function FINDIP over the MAC address (image no.4) is not working than.
In case you turn on your equipment to the router/server with no network connection (meaning no answer from the DHCP-server), the BCS will use in the meantime the programmed static IP until you turn on and off again your machine.

The command **se0054✶000** will deactivate the DHCP function**.**

12 Measuring Operation

NOTICE

Danger of damage

Due to obstacles within the reach of the shutter it could be damaged when opening or closing.

- **First open the shutter before positioning the focusing head over the measuring unit.**

⚠ CAUTION

Danger of injuries

Danger due to moving and rotating parts.

- **Do not put your hands near the shutter while it is opening or closing.**
- **Do not put your hands near the aperture.**

The operation of the control PC with the corresponding LaserDiagnosticSoftware (LDS) is the basis for every measurement. This software can be found on the attached CD-ROM.
The control PC (not included in the delivery) is connected with the BCS via Ethernet.
The measurements can either be started manually from the PC or automatically via a script control of the software and the PROFINET connection. In both cases the LaserDiagnosticSoftware has to be installed and started beforehand. More details are given in the manual „FocusMonitor“

12.1 Measuring procedure

The measuring procedure can be divided into the following steps:

1. Ensuring the readiness for operation
2. Carrying out the measurement
3. Evaluating the measurement

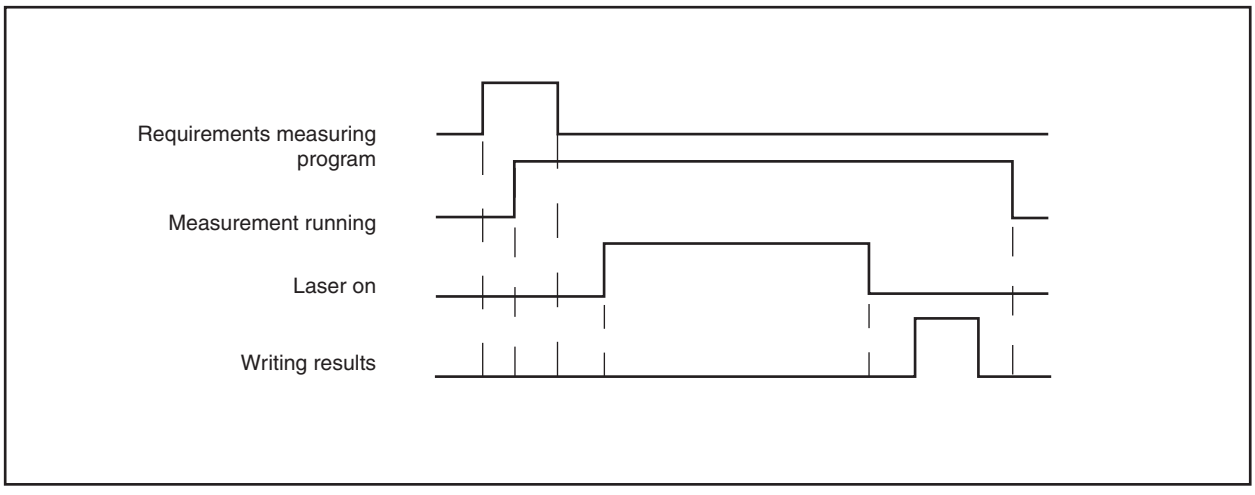


Fig. 12.1: Simplified timing diagram of the measuring procedureMeasuring procedure in detail

All signals and I/O definitions are described from the client's point of view.

	System			Script			PLC board		
Function	**I/O**	**bit**	**value**	**I/O**	**bit**	**value**	**I/O**	**bit**	**value**
Setting „LDS idle“				I	8	1			
Resetting „Measurement is running“				I	10	0			
Resetting „Laser on!“				I	9	0			
Activating automatic operation	O	0	1						
Waiting till LDS idle is set	I	8	1						
Resetting "Closing shutter"	O	2	0						
Setting "Opening shutter"	O	1	1						
Opens shutter							I	0	1
Waiting till shutter is open	I	0	1						
Setting "Opening water valve"	O	3	1						
Opens water valve							I	4	1
If shutter is open and flow rate ok, Interlock is reset							I	5 to 7	1
Waiting till all Interlocks ok	I	4 to 7	1						
Setting measuring program requirements	O	5 or 6	1						
Setting "Starting measurement"	O	9	1						
Resetting „LDS idle“				I	8	0			
Reading measuring program requirements				O	5 to 8				
Delets error flags				I	11 to 14	0			
Delets result register				Register 4 to 15		0			
Setting „Measurement is running“				I	10	1			
Waiting for the setting of „measurement is running“ (remains till „Measurement finished“ is set)	I	10	1						
Resetting measuring program requirements	O	5 or 6	0						
Resetting "Start measurement"	O	9	0						
Setting „laser on!“				I	9	1			
Waiting for „Laser on“ from BCS	I	9	1						
Turning on the laser (power is automatically identified)									
Measurement is carried out									
Resetting „Laser on!“				I	9	0			
Waiting for the resetting of „Laser on!“	E	9	0						

Table 12.1: Measuring procedure

	System			Script			PLC board		
Function	**I/O**	**bit**	**value**	**I/O**	**bit**	**value**	**I/O**	**bit**	**value**
Turning off the laser (automatic identification)									
Writing result register				Register 4 to 15		x			
Setting result o.k./n.o.k.				I	13 to 14	0 / 1			
measurement o.k./n.o.k. is set				I	11 to 12	0 / 1			
Resetting „Laser on!“				I	9	0			
Resetting „measurement is running“				I	10	0			
Waiting for the resetting of „measurement is running	I	10	0						
Resetting „opening shutter“	O	1	0						
Setting "Closing shutter"	O	2	1						
Closes shutter							I	1	1
As soon as shutter is closed, Interlock is triggered							I	5 to 6	0
Waiting for „shutter closed“	I	1	1						
Setting "Closing water valve"	O	4	1						
Closes water valve							I	4	0
Waiting for resetting "water valve open" and „ Interlock CPM OK“	I	4 and 7	0						
System can read flags and results now	Register 0 to 21		x						

Table 12.1 Measuring procedure (continuation)

13 Laser Diagnostic Software (LDS)

The BCS is operated with the PRIMES Software “LDS” or from the laser machine control. A detailed description of the software can be found in the enclosed manuals “FocusMonitor” and “CompactPowerMonitor”.
The software is extented in the following items.

13.1 User level

From version 2.9.034 on, the LaserDiagnosticSoftware is available with a user level control. There are different user levels which are activated with the corresponding password. This enables you to limit the control options in the software and to adapt them to the requirements of the operation. The following user levels are defined:

User level	Password protection	Acces to function
Operator (Op)	No	Severely limited
Controller (Co)	Yes	Limited
Expert (Ex)	Yes	Mostly unlimited
Professional (Pro)	Yes	Mostly unlimited

Table 13.1: Password protection for user levels

When starting the software you can activate the user level control in the welcoming window (Click on “Change user level”, see Fig. 13.1). If you do not use this option or if a false password is typed in, the software automatically starts with the lowest authorisation level “Operator”. This also applies for a system control start-up.

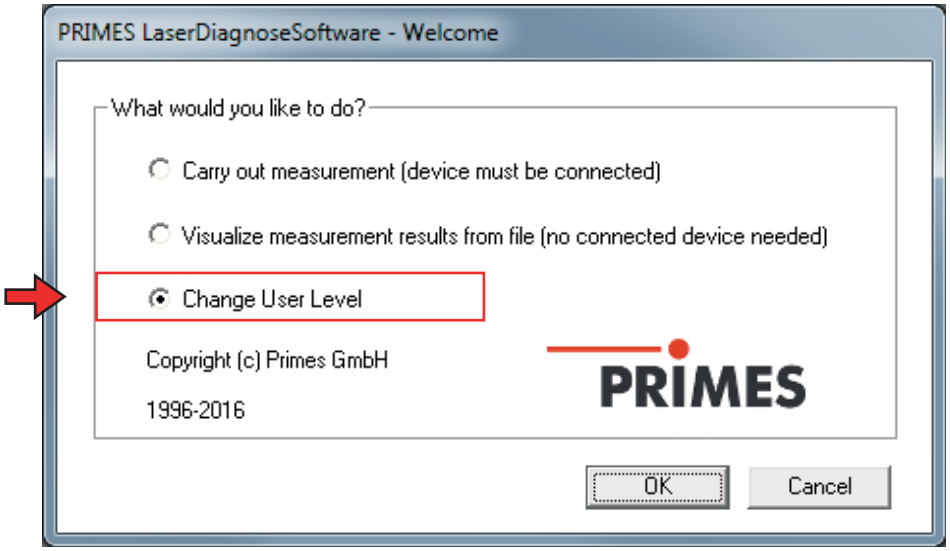


Fig. 13.1: Change user level

It is also possible to change the user level while the device is in operation (menu *„Edit → change user level...“*). If either no password or a false password is typed in, the system also starts with the user level “operator”.

The user level “operator” is, for example, intended for an application in the production.
In order to ensure an automatic process control the execution of scripts is allowed. Advanced settings for connected devices or a manual storage of measuring results is, however, not possible.

Table 13.1 shows the allocation of the allowed actions of every user level.

Op = Operator
Co = Controller
Ex = Expert
Pro = Professional

Software functions		No device connected	Device connected	Measurement	Loaded measurement
File	New	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Open…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Close				Co, Ex, Pro
	Close all				Co, Ex, Pro
	Save			Co, Ex, Pro	Co, Ex, Pro
	Save as…			Co, Ex, Pro	Co, Ex, Pro
	Export…				Ex, Pro
	Load measurement preferences...		Co, Ex, Pro	Co, Ex, Pro	
	Save measurement preferences…		Co, Ex, Pro	Co, Ex, Pro	
	Protocol…		Co, Ex, Pro	Co, Ex, Pro	
	Print…				Co, Ex, Pro
	Print preview…				Co, Ex, Pro
	Recently opened files	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Exit	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
Edit	Copy				
	Clear plane				
	Clear all planes				
	Change User Level…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
Measure-ment	Environment…	Co, Ex, Pro	Ex, Pro	Ex, Pro	Ex, Pro
	Sensor parameters		Ex, Pro	Ex, Pro	
	Beamfind settings		Ex, Pro	Ex, Pro	
	CCD info…				
	CCD Settings…				
	LQM - Adjustment…				
	Power Measurement…				
	Single ...		Co, Ex, Pro	Co, Ex, Pro	
	Caustic…		Co, Ex, Pro	Co, Ex, Pro	
	Start Adjust-Mode				
	Option…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
Presenta-tion	False colors…			Co, Ex, Pro	Co, Ex, Pro
	False colors (filtered)…			Co, Ex, Pro	Co, Ex, Pro
	Isometry…			Co, Ex, Pro	Co, Ex, Pro
	Isometry 3D…			Co, Ex, Pro	Co, Ex, Pro
	Review (86%)…			Co, Ex, Pro	Co, Ex, Pro
	Review (2.Moment)…			Co, Ex, Pro	Co, Ex, Pro
	Caustic…			Co, Ex, Pro	Co, Ex, Pro
	Raw-beam…				
	Symmetry check…			Co, Ex, Pro	Co, Ex, Pro
	Fixed Contour Lines...			Co, Ex, Pro	Co, Ex, Pro
	Variable Contour Lines.....			Co, Ex, Pro	Co, Ex, Pro
	Graphical Review…			Co, Ex, Pro	Co, Ex, Pro
	System state…				Co, Ex, Pro
	Evaluation Parameter View…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Color Tables...	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Toolbar	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Position…		Co, Ex, Pro	Co, Ex, Pro	
	Evaluation…	0	0	0	0
Commu-nication	Rescan bus	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Free Communication…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Scan device list…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
Script	Editor…	Op, Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	List…	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	Python…	Op, Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
Help	Activation…	Op, Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro
	About LaserDiagnoseSoftware…	Op, Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro	Co, Ex, Pro

Table 13.3: User access to software functions

13.2 Evaluation function

The weighting function of the LDS offers different parameters for the evaluation of the power density distribution measured. They are stored in the evaluation file (FocusCaustik.eval) and can be deactivated individually.

The following parameters can be evaluated automatically:

Parameters	Meaning
StandardFit	Deviation of the fit to the caustic (%)
PowerStable	Stability of the laser power (W)
AstigmatismRatio	Astigmatic difference (%/zr)
RadiusX	Focus radius X (mm)
RadiusY	Focus radius Y (mm)
Radius	Combinated focus radius (mm)
PositionX	Focus position X (mm)
PositionY	Focus position Y (mm)
PositionZ	Focus position Z (mm)
KValue	K
KValueX	Kx
KValueY	Ky
LaserMinPower	Minimum allowable laser power (W)
LaserMaxPower	Maximum allowable laser power (W)
LaserMeanPower	Mean laser power (W)
BeamParameterProduct	Beam parameter product (mm*mrad)
MSquare	M^2
MSquareX	M^2x
MSquareY	M^2y
BeamDirection	Combinated beam direction (°)
BeamDirectionX	Beam direction to x-axis (°)
BeamDirectionY	Beam direction to y-axis (°)
RayleightLength	Rayleigh length (mm)
Divergence	Divergence (mrad)

Table 13.4: Evaluation parameters

Additionally, you can signal the exceed of error limits and also the approach of the limit can be signalized by a warning message. Therefore, additional warning limits are added to the Eval-file (MaxWarnValue).

The BCS evaluates the measuring results and describes them only as good or bad, without the warning zone. That is why you have to state the minimum and maximum values for warning and error limits immediately. Otherwise, discrepancies within the evaluation could occur (see Table 13.5)

In order to edit the limit values please open the file “FocusCaustic.eval” with an editor which allows you to insert a line break (e.g. Notepad++). Each line in the file configures a measurement parameter.

The lines are structured as depicted in Table 13.5. For the configuration the values framed in bold can be adapted to the evaluation, the remaining values either have no influence on the assessment of a measurement with the BCS or they are only used for an automated read-out process.

Parameter name	Value	Description
bcp:ExtendedParameter		
autocalculateWarn=	„false“	
enabled=	„true“	Activation of the parameter
formatter=	„%.2f“	
id=	„StandardFit“	Designation of the parameter
maxValue=	„5.00“	Maximum value (error limit)
maxWarnValue=	„5.00“	Maximum value (warning limit)
minValue=	„0.10“	Minimum value (error limit)
minWarnValue=	„0.10“	Minimum value (warning limit)
name=	„Standard Fit“	Designation of the parameter
unit=	„%“	Unit
value=	„3.478677“	Value from the measurement
visible=	„true“	

Table 13.5: Parameter error limit / warning limit

After the measurement the data is evaluated automatically via a script control and the result is transferred via PROFINET.

13.3 Storage location of the measuring values

A measurement in an automated operating procedure with the BCS stores the measuring results in the following files:

The measuring files of caustic measurements in “foc” format.
File name: *“FocusCaustic_year_month_day_hour_minute.foc”*

For each power measurement an individual text file is created. Here, not only every single measurement for the averaging, including the date and the time, is filed but also the herewith determined average as a necessary value.
File name: *“LaserPower_year_month_day_hour_minute_second.txt”*

13.4 Automated script procedure

The LaserDiagnosisSoftware offers the possibility to edit scripts and to carry them out automatically. The following script languages are supported:

- Primes-script language
- From LDS-version 2.9.035 on: Python (version 2.6) extended by Primes-specific instruction set

For an automated script procedure, the configuration file laserds.ini in the installation directory has to be edited accordingly.

The LDS offers an editor (menu „*script → editor*“). However, as the configuration file is in ASCII-format, you can also edit it with an external editor (e.g. Notepad++).

The scripts can be created and edited by means of an external editor as they are also in ASCII-format.
The standard file-ending for scripts in the Primes language is ***.txt***, the ones in Python version ***.py.***

13.4.1 Editing the configuration file

By default, the LaserDiagnosisSoftware is installed in the directory
“C:\programs\Primes\LDS v.xxx”. Here, the configuration file “laserds.ini” can be found as well.

Open the file “laserds.ini” and search for the section “[Script]”

If you use “Primes-Script”:

In order to launch the script, please supplement the command line “start file=” with the path and the parameter “/Run;Open Editor” (see Fig. 13.2)

With “/run” the script starts immediately after the software has been started, with “Open Editor” the internal editor of the LDS is opened to display the loaded scripts

```
[Interface]
Startup=0
[Script]
Start file=C:\Programme\Primes\LDS v2.9.034c\BM_single.txt/Run;OpenEditor
Start Pythonscript=
Script libdir=
```

Fig. 13.2: Edit Primes Script

If you use “Python Script”:

In the command line “Start Pythonscript=” the path to the script file is stated without any additional parameters (see Fig. 13.3)

```
[Interface]
Startup=0
[Script]
Start file=
Start Pythonscript=C:\LaserDiagnoseSoftware\pyscript\scriptsBCS\automaticscript.py
Script libdir=C:\laserdiagnosesoftware\lib
ThreadSavePython=0
```

Fig. 13.3: Edit Python Script

The procedures written in Python can access self-created libraries. They have to be stored in the same directory as the launching script or they have to be explicitly described in the script. A further possibility is to store them in a stated directory “libdir”.

Example:

The entry in line “Script libdir=…” in Fig. 13.3 indicates the path to the library directory that is used by the LDS.

13.4.2 Global settings

Adjustable parameters are to be found in the file “GlobalSettings.py”. They are adjustable, for example in order to change the oscillation time for a power measurement.
The file can be found in the lib-directory of the LaserDiagnosisSoftware. The path to the directory has to be adapted to your computer configuration
(standard path “C:\LaserDiagnosisSoftware\pyscript\lib”).

The file “GlobalSettings.py” can be edited with any text editor. Please keep the following points in mind:

- Do not use any tabs, for instance to indent something. Any placeholders or insertions have to consist of 4 spaces.
- The order of the parameters in the file can be changed.
- Comments can be inserted from time to time. Every comment line has to start with a “#”-symbol.

The following example explains the parameters included in this file. The parameters highlighted in red with the corresponding comment line are intended for the procedures and measuring tasks of other devices. They are irrelevant for an application of the BCS.

Example:

```
#Globally valid time-out guidelines for interactions with the device (e.g. the maximum waiting
#time for the determination of laser powers); stated in s
giWaitCounter = 100

#Number of power measurements by means of which the average of the measurement
#is determined; stated in the number of desired measurements
giPowerNumVals = 2

#Below this measured laser power the laser is recognised as switched off;
#stated in W
giMaxPowerForLaserOff = 50.0

#Power difference for the detection of the switching-on process of the laser: From this
#power difference up to zero power, the laser is recognised as switched on;
#stated in W
giPowerDiffernceForLaserOn = 40.0

# irrelevant for BCS automatic process
giPlaneListForFastMeasurement = [7, 11]

# irrelevant for BCS automatic process
giFocusShiftPowerValues = [10, 20]

#irrelevant for BCS automatic process
giProtectionGlassPowerValues = [10, 100]

#irrelevant for BCS automatic process
giSaveZPosFibreMeasurement = 110000

#irrelevant for BCS automatic process
giSaveZPosProcessMeasurement = 85000
```

#Thermalization time for the oscillation process of the power measurement; after the detection
#of existing laser power this time passes until the actual measurement starts; the duration
#refers to the power measurement as well as the complete measurement of the
#caustic; stated in s
giThermalizationTime = 10

#Activation of debug outputs during the measuring procedure. This parameter is not relevant
#for the productive use of the BCS; stated binarily: 0 → no output of the debug message
#1 → output of the debug message
giDebug = 0

#irrelevant for BCS automatic process
giDebugEval = 1
giDebugEvalValue = 2

14 Maintenance

For service, maintenance and calibration it is recommendable to return the device to the manufacturer on a regular basis (every 12 to 24 months).

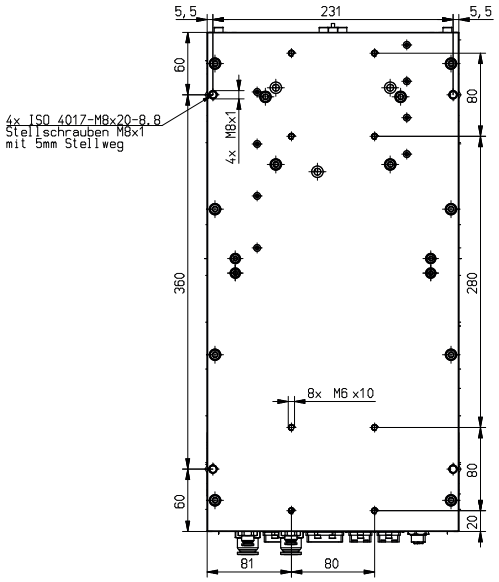
15 Measures for the product disposal

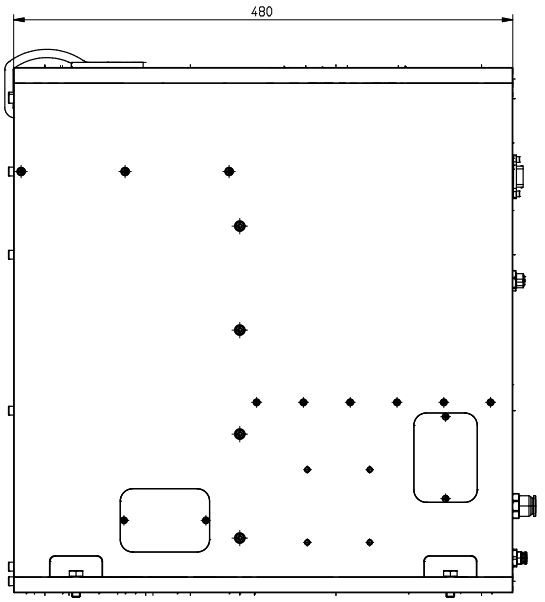
According to the Electrical and Electronic Equipment Act (ElectroG) PRIMES is obliged to dispose PRIMES measuring devices manufactured after August 2005 free of charge. PRIMES is registered as a manufacturer with the EAR foundation (German register for electronic waste). Our registry number is the following: WEEE-Reg. – Nr. DE65549202.

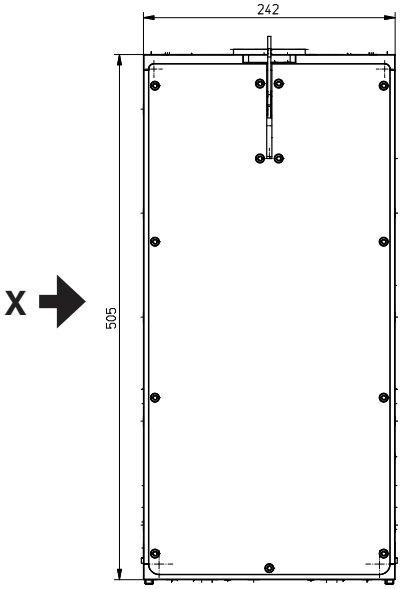
You are welcome to return PRIMES measuring devices that are to be disposed free of charge to our address (this service does not include shipping costs):

PRIMES GmbH
Max-Planck-Str. 2
D-64319 Pfungstadt
Germany

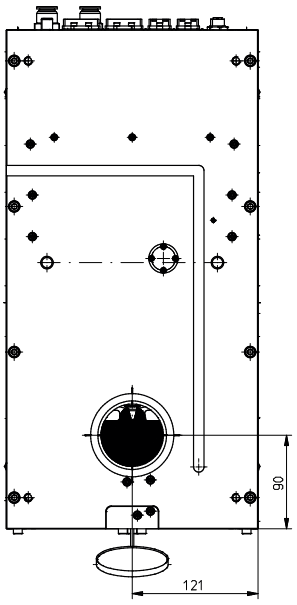
16 Dimensions



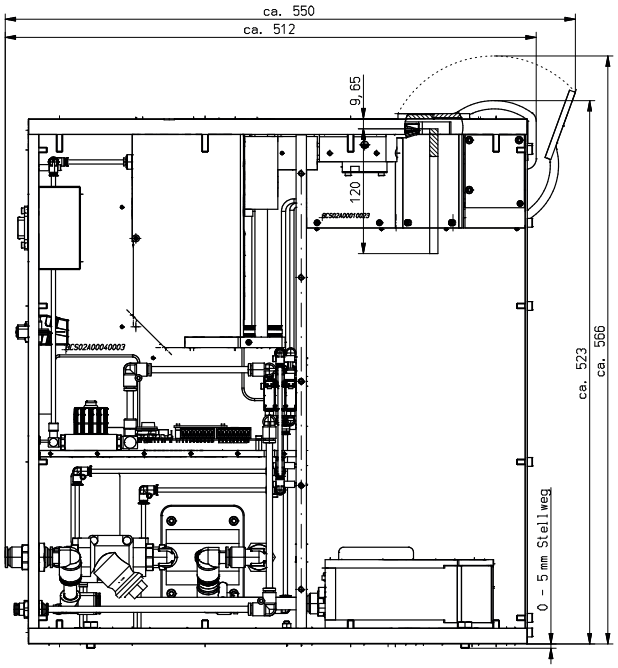




X



View X



17 Technical Data

Type		BCS
Supply data		
Supply voltage, DC	V	24 ± 5 %
Maximum power consumption	A	5
Cooling circuit		
Cooling water flow rate, min.	l/kW	0.8
Cooling water flow rate, recommended	l/min	6 ... 8
Cooling water temperature T_{in} [1]	-	dew-point temperature < T_{in} < 30 °C
Pre-pressure, typ.	bar	2 ... 4
Maximum temperature gradient	°C/min	< 0.5
Compressed air (water and oil free)		
Minimum pressure	bar	4
Maximum pressure	bar	8
Protective gas (water and oil free)		He, N_2, Ar
Maximum pressure	bar	0.5
Characteristics measurement		
Fokus diameter (FM)		
Min.	µm	150
Max.	mm	5
Wave-length range	µm	1.06
Measurement range, beneath the top of the device		
Min.	mm	10
Max.	mm	120
Peak intensity fokus at 1.06 µm, max.	MW/cm²	10
Power (CPM)		
Min.	kW	0.5
Max.	kW	10
Max. power density	kW/cm²	1
Mean power density	kW/cm²	0.5
Measuring accuracy [2]		
Power	%	± 3
Fokus position	µm	100 + 10 % of z_R
Fokus radius	%	5
Far field divergence	%	5
Rayleigh-length	%	10
Beam quality (M^2)	%	10
Repeatability [1]		
Power	%	± 1.5
Fokus position	-	5 % of z_R
Fokus radius	%	3
Far field divergence	%	3
Rayleigh-length	%	3
Beam quality (M^2)	%	3

[1] Please contact PRIMES in advance in case you intend not to work within this specification.

[2] Apart from the system-related measurement uncertainties is the measuring situation (signal-to-noise ratio, temporal stability of the laser beam strongly essential for the absolute measuring accuracy and the repeatability. The situation-related measurement uncertainty can be determined by means of the standard deviation of the hyperbolic fit calculated in the caustic evaluation. This value (multiplied by 3 for a security of 93.3%) has to be added to the measurement uncertainty as an additive contribution.

Type		BCS
Measurement duration with 64 x 64 pixel Caustic (21 planes) Power measurement	 s s	 180 10
Movement range of the z-axis	mm	120
Communication		
Ethernet PROFINET PRIMES-Bus (RS485) Safety circuit (Interlock)	Mbit - - -	100 2x 1x 1x (potential-free)
Ambient conditions		
Operating temperature range Storage temperature range	°C °C	+15 ... +40 +5 ... +50
Reference temperature	°C	+22
Permitted relative air humidity	%	80
Dimensions and weights		
l x w x h ((including the pivoting range of the shutter, without cable and plug)	mm	550 x 242 x 566
Weight, approx.	kg	50
Protection		
Degree of protection	-	IP52
Protection class	-	III

[1] Please contact PRIMES in advance in case you intend not to work within this specification.

[2] Apart from the system-related measurement uncertainties is the measuring situation (signal-to-noise ratio, temporal stability of the laser beam strongly essential for the absolute measuring accuracy and the repeatability. The situation-related measurement uncertainty can be determined by means of the standard deviation of the hyperbolic fit calculated in the caustic evaluation. This value (multiplied by 3 for a security of 93.3%) has to be added to the measurement uncertainty as an additive contribution.

18 Declaration of Incorporation of Partly Completed Machinery

Original Declaration of Incorporation of Partly Completed Machinery

according to the Machinery Directive 2006/42/EC, Annex II B

The manufacturer: PRIMES GmbH, Max-Planck-Straße 2, 64319 Pfungstadt, Germany
hereby declares, that the partly completed machine with the designation:

BeamControlSystem (BCS)

Types: BCS

is in conformity with the following relevant EC Directives:

- Machinery Directive 2006/42/EC
- EMC Directive EMC 2014/30/EU
Low voltage Directive 2014/35/EU
- Directive 2011/65/EC on the restriction of the use of certain hazardous substances (RoHS) in electrical and electronic equipment
- Directive 2004/22/EC on measuring instruments

Authorized for the documentation:
PRIMES GmbH, Max-Planck-Str. 2, 64319 Pfungstadt, Germany

The technical documentation according to Annex VII Part B of the Machinery Directive which belongs to the partly completed machinery was drawn up. The manufacturer obligates himself to provide the national authority in charge with technical documents in response to a duly substantiated request within an adequate period of time.

This partly completed machinery is intended for the integration into a laser system. An initial operation is strictly prohibited until it was ensured that the complete machine, into which the partly completed machinery was integrated, is in compliance with the requirements of the EC-Directive 2006/42/EC as well as the Laser Safety, e.g. the DIN EN ISO 12254, the DIN EN 60825 and TROS.

Pfungstadt, April 26, 2017

Dr. Reinhard Kramer, CEO

19 Appendix

19.1 LDS installation for an automated measuring mode

The LaserDiagnoseSoftware (LDS) can be configured for an automated measuring process of the BeamControlSystem. The guidance presumes a connection between the PC and the BCS.

In the setup the program permits everyone a full access, so dedicated administrator rights are not mandatory. If this is changed afterwards, please make sure the software still has full access rights (otherwise you won't get an error when working with Windows®7 but the changed files will be stored in virtual folders of Windows and will not have any effect on the software).

Operating system requirements : Windows® 7 (64 bit) or Windows® XP

For Windows® XP please replace the directory „Program files (x86)“ with „Program files“.

19.1.1 Installation process

The installation of the software is menu driven and is effected by means of the enclosed medium. Please start the installation by double-clicking the file

“Setup LDS v.2.97.exe”

and follow the instructions.

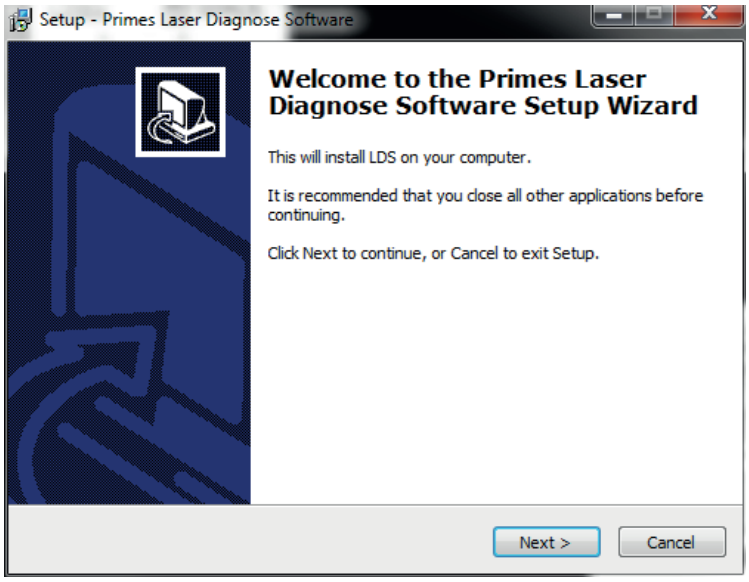


Fig. 19.1: Setup window 1

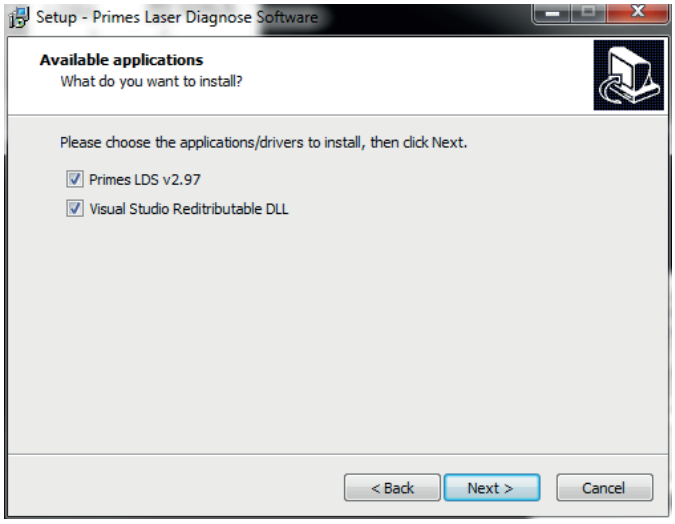


Fig. 19.2: Setup window 2

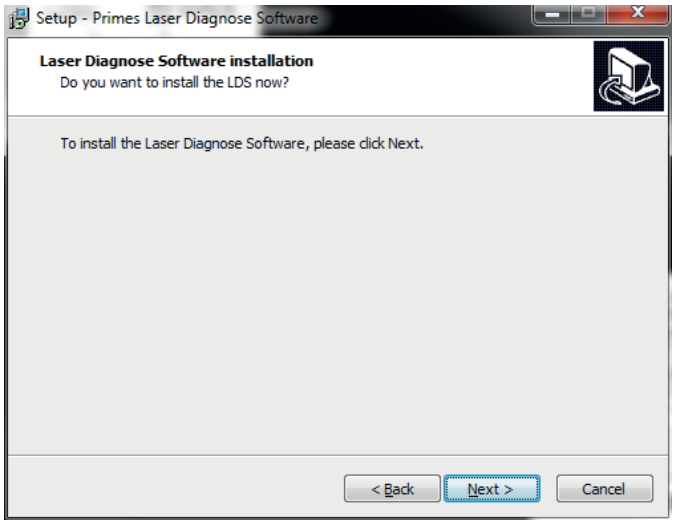


Fig. 19.3: Setup window 3

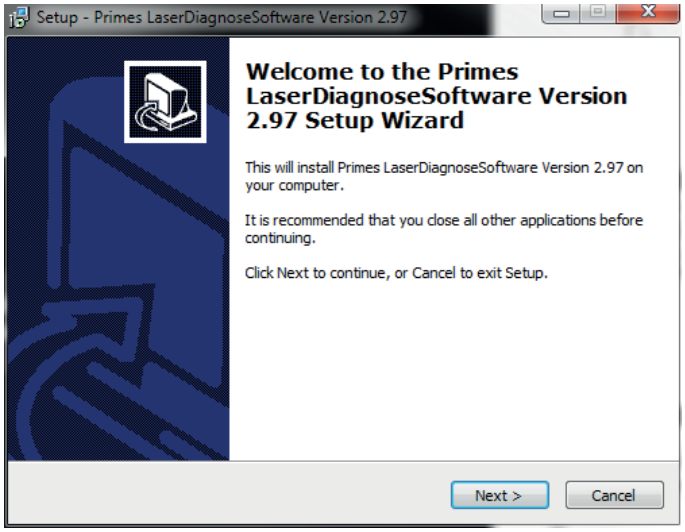


Fig. 19.4: Setup window 4

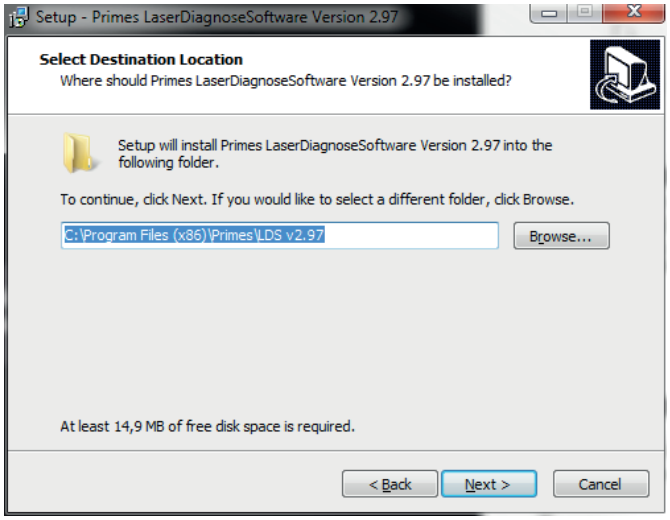


Fig. 19.5: Setup window 5

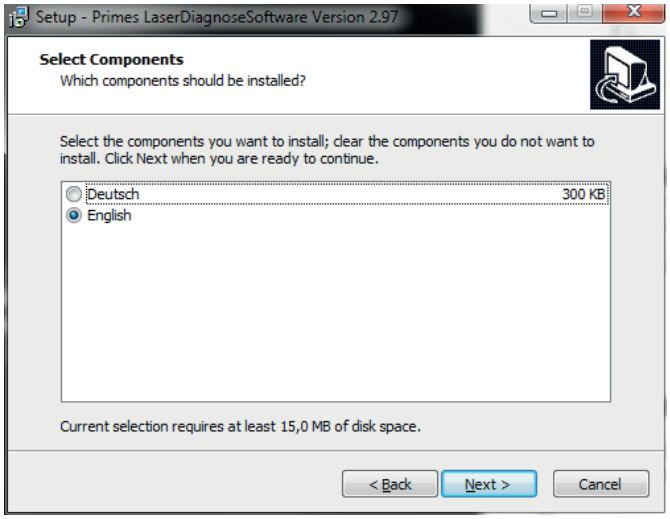


Fig. 19.6: Setup window 6

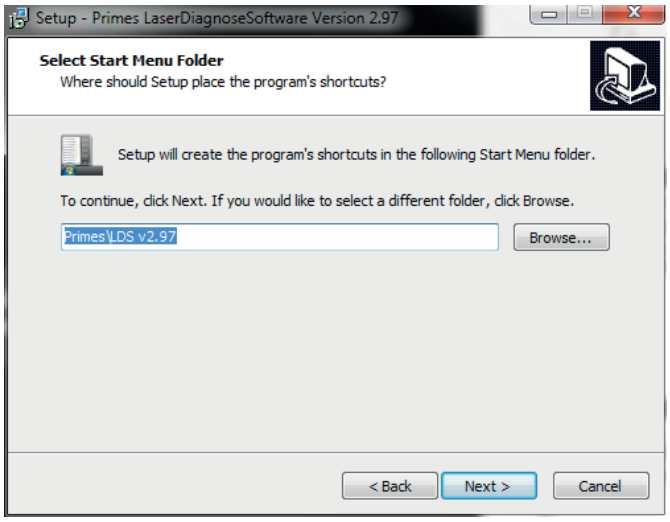


Fig. 19.7: Setup window 7

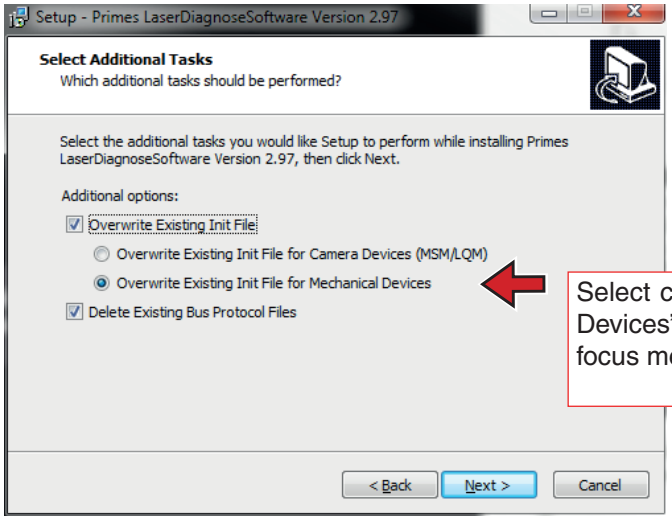


Fig. 19.8: Setup window 8

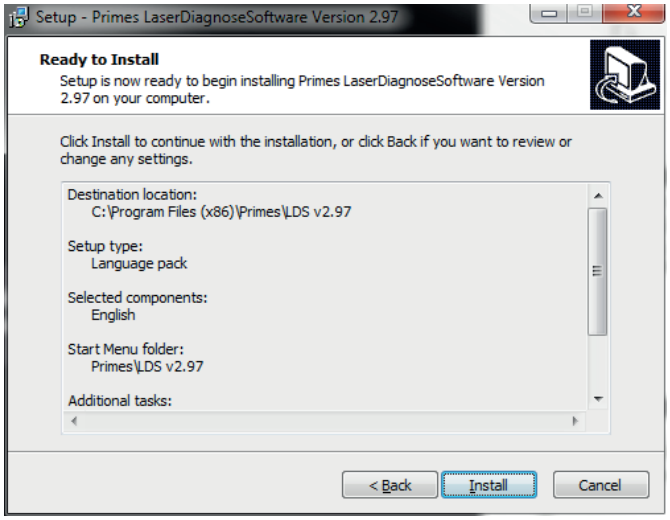


Fig. 19.9: Setup window 9

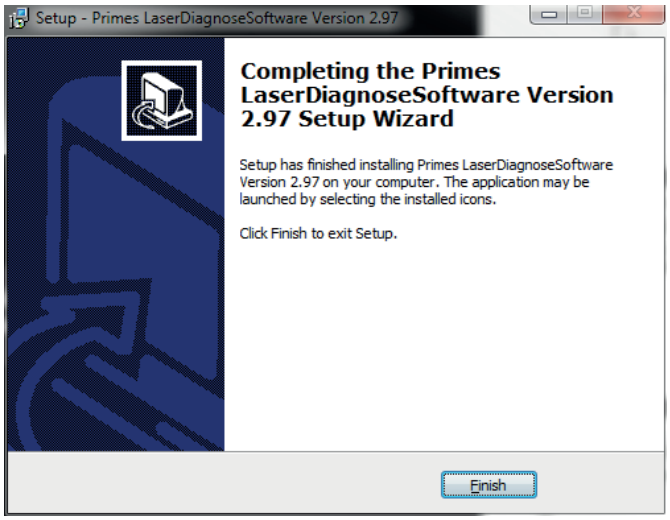


Fig. 19.10: Setup window 10

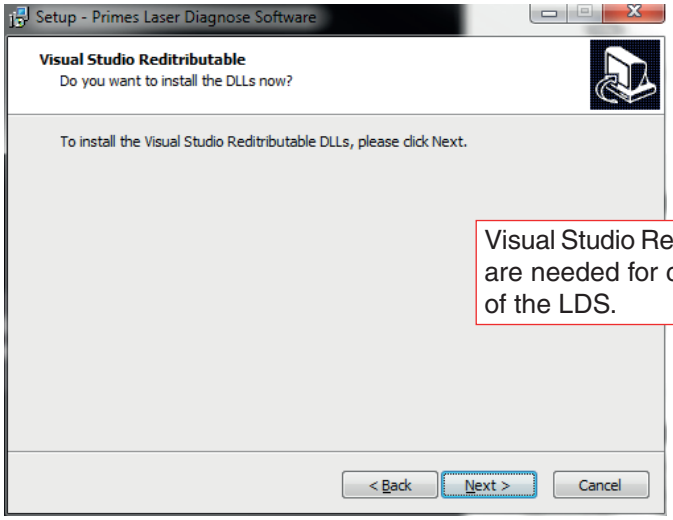


Fig. 19.11: Setup window 11

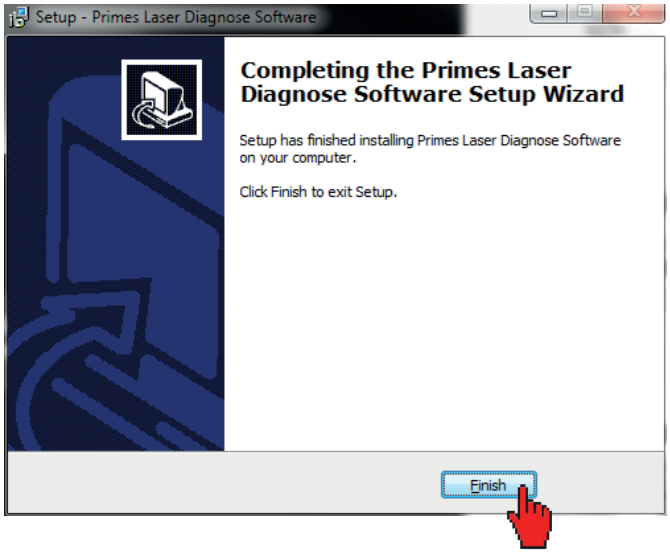


Fig. 19.12: Setup window 12

19.1.2 Configuration of the LDS for the communication with the device

Once started, the LDS standard configuration is updated.

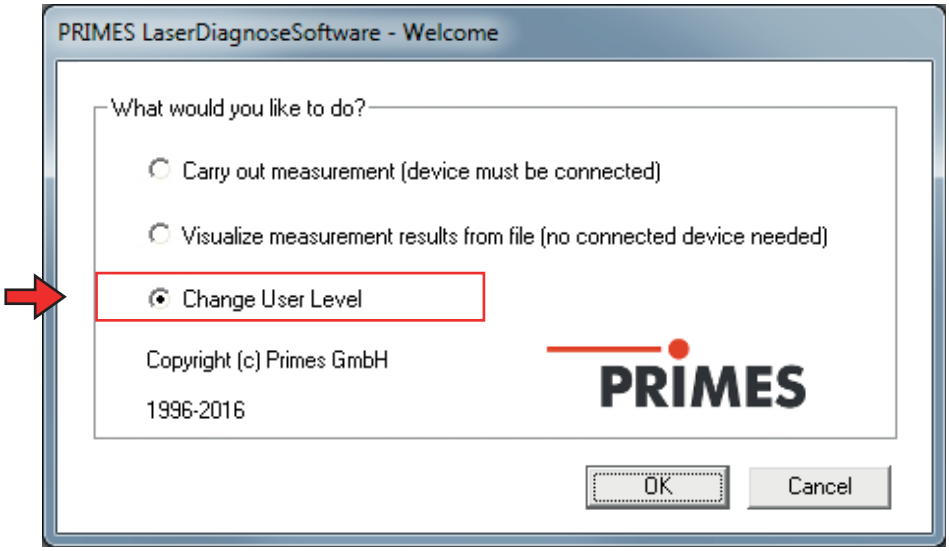


Fig. 19.13: Welcome window

1. Select “Change User Level” as shown in Fig. 19.13, type in the password for the user level ***Expert*** and click on ***OK***.
2. Select the menu ***`Communication>>FreeCommunication`***.

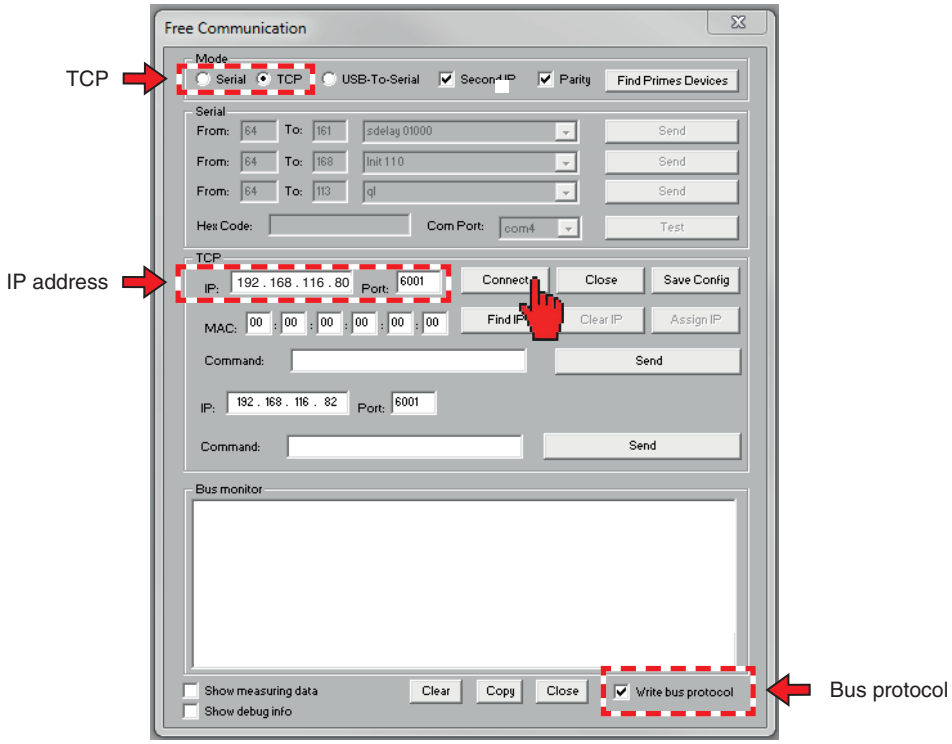


Fig. 19.14: Dialogue window ***`Free Communication`***

3. Select “***TCP***” as the communication interface (see Fig. 19.14), activate ***Write bus protocol*** (bottom right corner) and type in the IP-address (standard is 192.168.116.80, please check the IP given on the type plate of your device).
4. Click on ***Connect***.

5. If the BCS is connected to the computer you are using, a “CONNECTED to x.x.x.x” message appears (see Fig. 19.15). Click on ***Safe Config***.

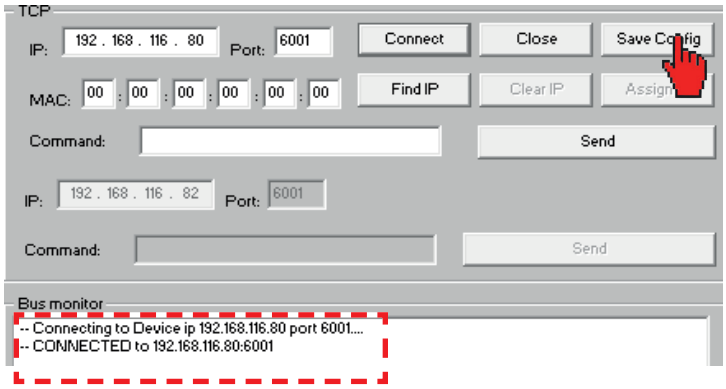


Fig. 19.15: Saving the configuration

A click on ***Find Primes Devices*** (see Fig. 19.16) searches the bus for the connected devices. When the search is successful, the windows for measurement settings are shown.

Fig. 19.16: Button for searching connected devices

19.2 Presettings for the measurement programs

The script offers 4 measurement programs. For the programs 2-4 preferences are required:

Program	Description	Required files
1	Measure power only	None
2	Measure a whole focus caustic	Preferences *FocusCaustic1.ptx* Evaluation file *FocusCaustic1.eval*
3*)	a) Verify just one plane of an existing measurement (fast caustic) b) Measure a whole focus caustic with parameters different to program 2	Preferences *FastCaustic.ptx* Evaluation file *FastCaustic.eval* Template measurement *FastCaustic.foc* Preferences *FocusCaustic2.ptx* Evaluation file *FocusCaustic2.eval*
4	Measure a single plane of an existing measurement	Preferences *OnePlane.ptx*

*) a or b on customers request

1. When a measurement according to ISO11146 is completed select the menu ***`Presentation>>Caustic`*** and click on the button ***Review...***

When all terms have green checks in the `Presentation>>Caustic>>Review` dialogue window, save it as a master for the automatic mode.

2. Select `File>>Save measurement preferences` (see Fig. 19.17)

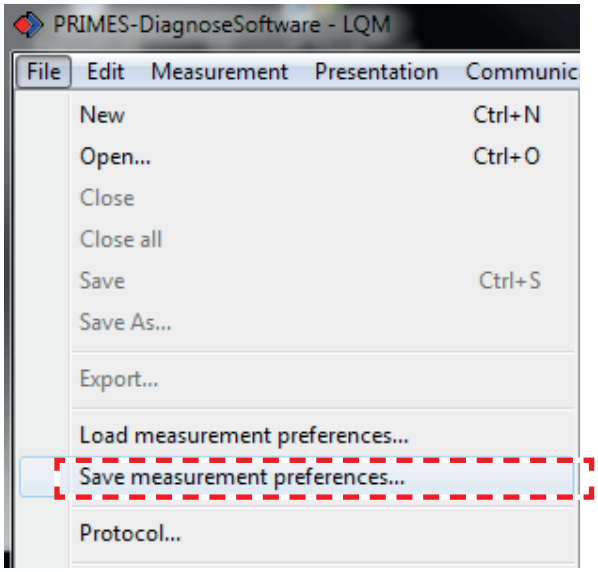


Fig. 19.17: Menu ***`File>>Save measurement preferences`***

3. Choose the directory of the scripts (in this case c:\Program Files (x86)\Primes\LDS\scripts) and save the preference files named as shown in Fig. 19.18 on page 53 to Fig. 19.20 on page 53.

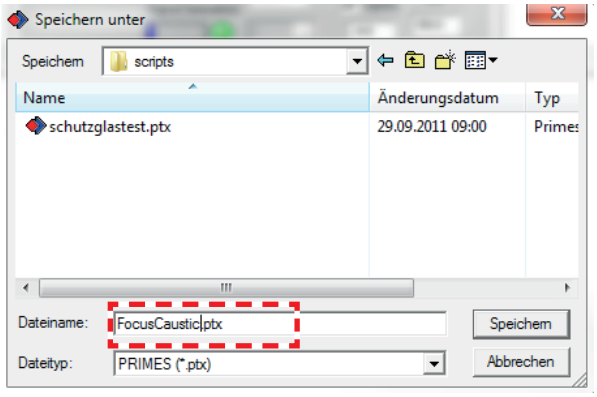


Fig. 19.18: Menu ***File>>Save as ...***

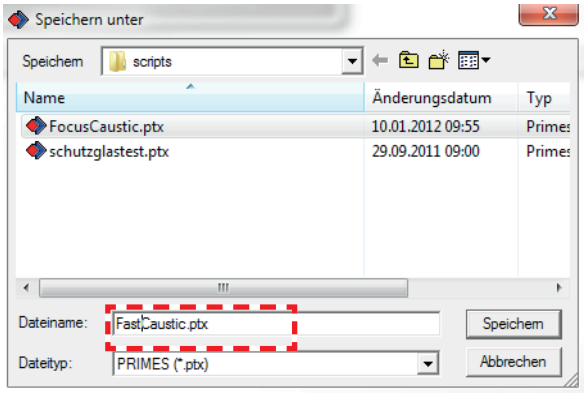


Fig. 19.19: File name ***FastCaustic.ptx***

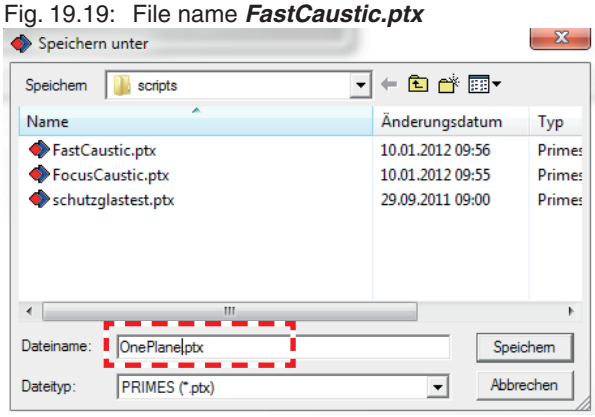


Fig. 19.20: File name ***One plane.ptx***

The preference files for program 2 and 3b are the same (except of the file name). Program 4 uses the configuration for plane 0 of its ptx-file. Basically, all 3 different ptx-files can be generated from one (good) measurement.

Also save the measurement as a master foc-file for the program “FastCaustic” (see Fig. 19.21); this is not necessary for another complete caustic measurement.

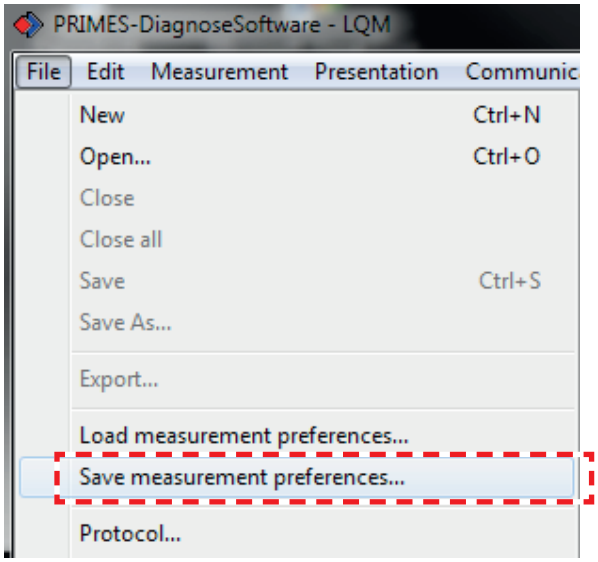


Fig. 19.21: Menu ***File>>Save measurement preferences...***

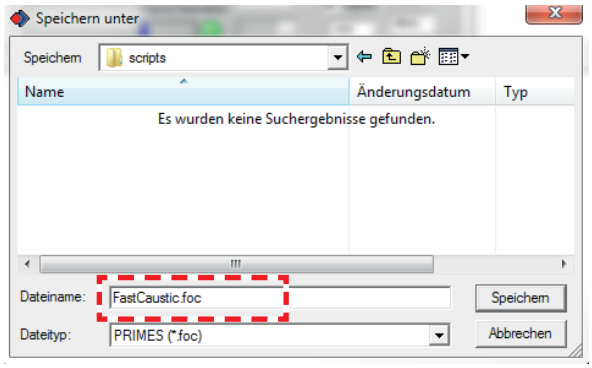


Fig. 19.22: File name ***FastCaustic.foc***

After this, close the LDS to be able to edit the configuration files, especially the “laserds.ini”.

The script controlled LDS offers the possibility to evaluate several beam parameters to qualify the measurement. The evaluation is controlled by files with the extension “ *.eval ”. One of these files is installed with the LDS in the script folder (see Fig. 19.23).

1. Using Windows Explorer, go to the directory ***scripts*** (“*c:\Program Files (x86)\Primes\LDS v2.97\scripts*”)
2. Copy the file ***schutzglastest.eval*** three times inside the directory.
3. Rename the files to:

   FocusCaustic1.eval
   FastCaustic.eval or ***FocusCaustic2.eval***
   OnePlane.eval

Fig. 19.23: Script directory

To configure the evaluation files, please refer to the accordant documentation in chapter 13.2 on page 34 and 19.5 on page 60.

4. Open the preference file for the program 4 (*OnePlane.ptx)* with an editor. Make sure that in line 5 “Start-ebene=” the value is 0.
5. Save and close the file (this will be the measuring plane and will otherwise not work correctly).

19.3 Configuration of the laserds.ini

First you have to copy the required script to the right directory, if it is not installed already.

1. Please save the script file ***automaticscript.py*** in
   c:\Program Files (x86)\Primes\LDS v2.97\Scripts

This will be the script that is started automatically.

2. Open the ***laserds.ini*** file (marked file in Fig. 19.24) with an editor.
3. Please register this file, as shown in Fig. 19.25 (line 170).

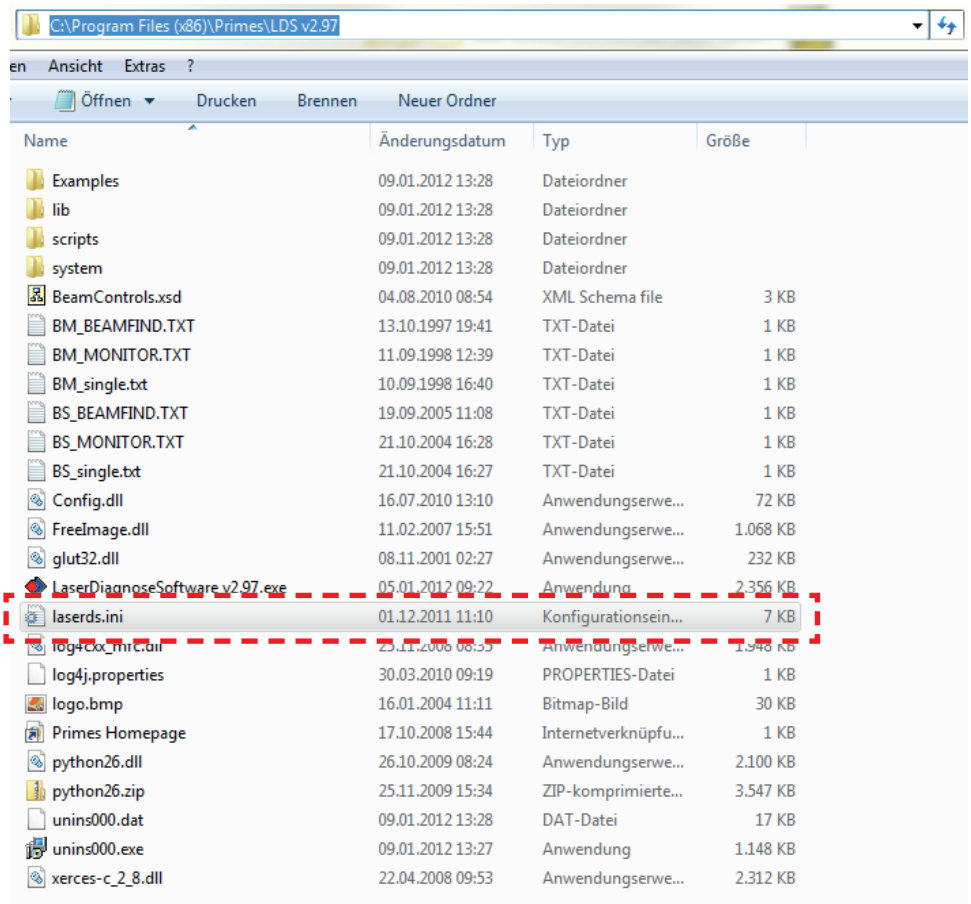


Fig. 19.24: File Laserds.ini

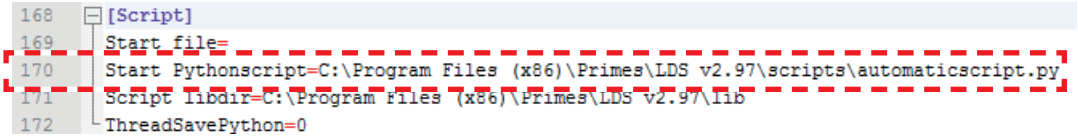


Fig. 19.25: Registration in the laserds.ini

4. In line 43 of Fig. 19.26 you can insert an arbitrary path (make sure, the LDS has the permission to write).

```
38  [File]
39  Default=
40  Beam Evaluation=\system\beamparams.eval
41  Protection Glass Beam Evaluation=\system\schutzglasstest.eval
42  Protection Glass Beam Measurement=\system\schutzglasstest.ptx
43  MSMI Save Path=MSMI Save Path=C:\BCS_Saves
44  MSMI Script Save Path=C:\Program Files (x86)\Primes\LDS v2.97\scripts
45  MSMI Selected Script=
```

Fig. 19.26: Save path for automatic measurement

5. Save and close the ini-file.
6. Copy the file ***BeamControls.xsd*** in the explorer from the script path (Fig. 19.23 on page 55) to the save directory (BCS_Saves).
7. Start the LDS.

19.4 Configuration of measuring programs

Before you start the automated measurement some environment variables have to be configured in the file ***globalsettings.py*** in the directory c:\Program Files (x86)\Primes\LDS v2.97\lib (Fig. 19.27).

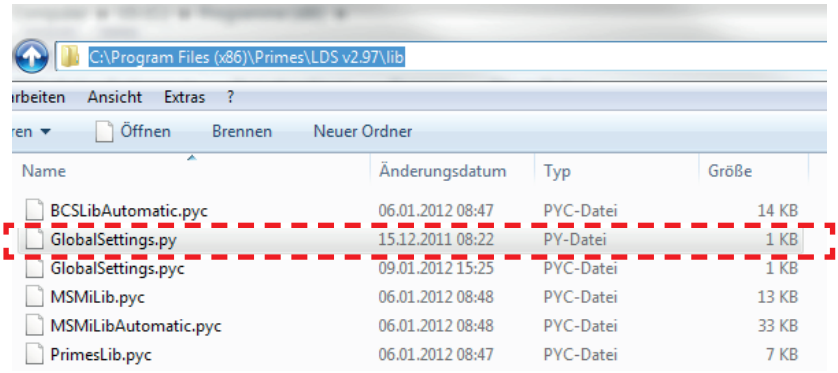


Fig. 19.27: Storage location of the *globalsettings.py* file

1. Open the file with an editor (e. g. Notepad++) as shown in Fig. 19.28.

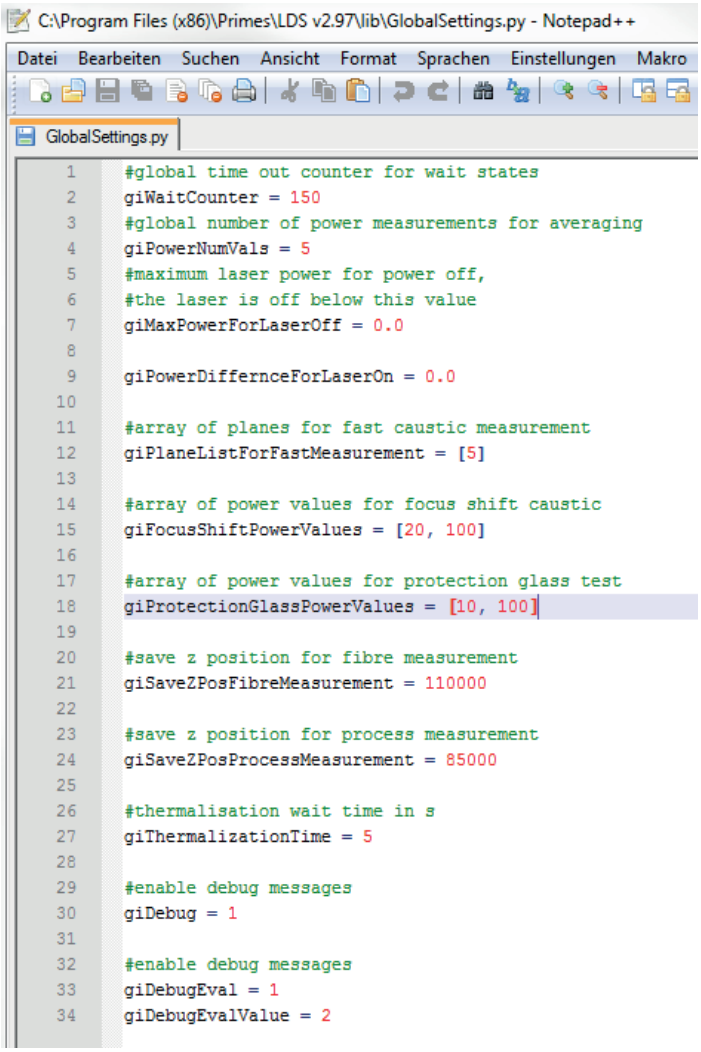


Fig. 19.28: Editing the file ***GlobalSettings.py***

In the following passages only the relevant parameters for the BCS in ***GlobalSettings.py*** are described.

The variable ***giWaitCounter*** (line 2) is a global timeout for actions like the communication with the robot. The default value 150 s is reasonable for most cases.

giPowerNumVals (line 4) sets the number of power measurements which are averaged for the program “power measurement only”. A reasonable value would be 15-20. The default is 5 which is a good value for debugging (fast but not accurate).

The script automatically detects whether the laser is powered on or off after the accordant signal. Both levels can be declared separately:

giMaxPowerForLaserOff (line 7) is the power level the program will wait for after a measurement is done and the laser is switched off.

giPowerDifferenceForLaserOn (line 9) is the power level the program will wait for after it set the “laser on” signal.

Both actions can take several seconds because of the thermalization of the system.
The designation has to be made in watts. Reasonable values would be 50. Default 0.0 watts is only for debugging without laser.

giThermalizationTime (line 27) declares the time in seconds before a measurement which will be waited so the CompactPowerMonitor (CPM) as part of the BCS is thermalized.
A reasonable value would be 60-90 seconds (5 seconds for debugging in turn).

The program ***FastCaustic*** offers the possibility of measuring just some planes of the complete laser focus (not available for another whole focus measurement).

The plane(s) can be set by the variable ***giPlaneListForFastMeasurement***. Here you can type in the planes separated by a comma and a space (-> [5, 7] will measure planes 5 and 7).
An example for a reasonable application can be the measurement of one or two planes of the master caustic again and evaluate the standard deviation (line 12).

2. After customizing the variables for your application save and close the file ***GlobalSettings.py***.

19.5 Configuration of the evaluation parameters

This chapter describes the usage of an “evaluation file” in conjunction with the automated measuring mode.

1. To use the evaluation files first open the directory (“c:\Program Files(x86)\Primes\LDS v2.97\scripts”)

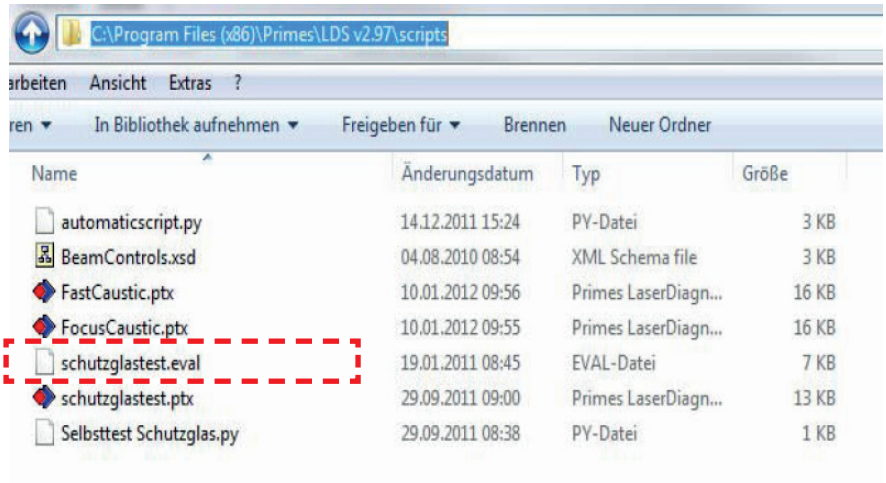


Fig. 19.29: Script directory

2. Copy the file “Schutzglastest.eval” twice inside the directory.
3. Rename the files as
   FocusCaustic.eval and ***FastCaustic.eval***.
4. Start the program “EvalEditor.exe” stored in the directory (“c:\Program Files(x86)\Primes\LDS v2.97”).
5. Load the file ***FastCaustic.eval*** as shown in Fig. 19.30.

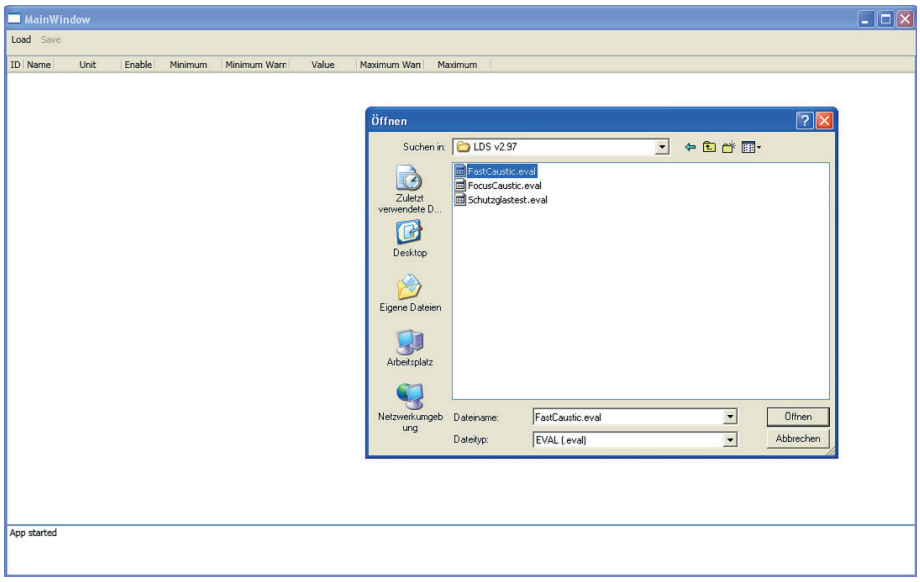


Fig. 19.30: File *FastCaustic.eval*

In Fig. 19.31 a possible configuration of the evaluation file is shown.

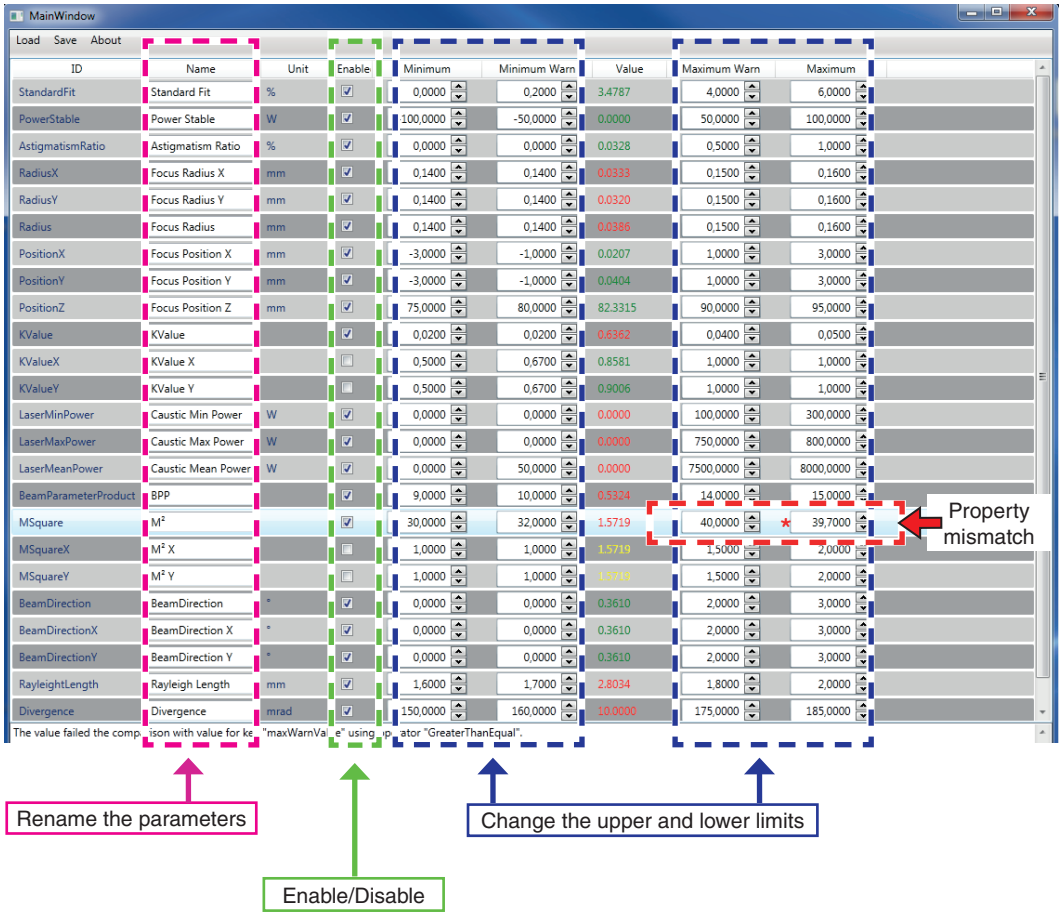


Fig. 19.31: Main window of the Evaluation Editor

Name

The name of the parameter can be changed. The selected name will be shown in the LaserDiagnoseSoftware (LDS).

Enable

The required parameters can be selected.

Minimum/Maximum

The upper and lower limits for each selected parameter can be chosen.

Minimum Warn/Maximum Warn

The columns named with “Minimum Warn” and “Maximum Warn” can be used as the limits for the evaluation test, because there is no warning level implemented in the BCS. Therefore the parameters combined in the two blue boxes (see Fig. 19.31) should be the same. A property mismatch is announced by a red square or asterisk.

6. Save the evaluation file after editing.

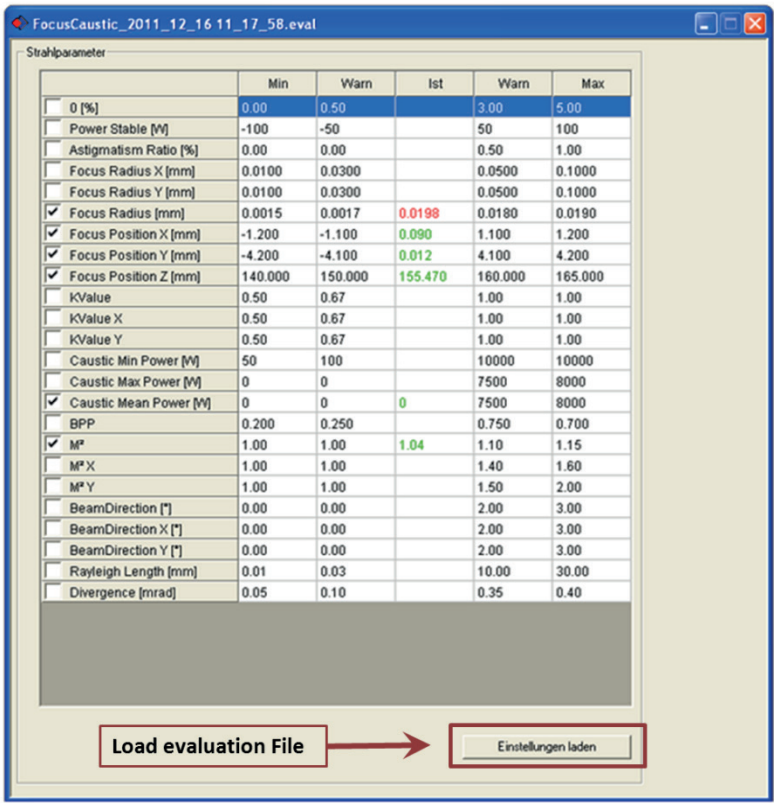
19.5.1 Show the evaluation file

For each measurement the system runs, certain documents including the timestamp are saved.

Example:

- FastCaustic _2011_12_16 11_17_58.foc
- FastCaustic_2011_12_16 11_17_58.eval
- FastCaustic_2011_12_16 11_17_58.ptx
- FastCaustic_2011_12_16 11_17_58.txt

1. Start the LDS and open the actual “*foc” file.
2. Open the menu ***Presentation*** → ***Evaluation Parameter View***...
3. Load the corresponding “ *.eval ” file.



	Min	Warn	Ist	Warn	Max
0 [%]	0.00	0.50		3.00	5.00
Power Stable [W]	-100	-50		50	100
Astigmatism Ratio [%]	0.00	0.00		0.50	1.00
Focus Radius X [mm]	0.0100	0.0300		0.0500	0.1000
Focus Radius Y [mm]	0.0100	0.0300		0.0500	0.1000
Focus Radius [mm]	0.0015	0.0017	0.0198	0.0180	0.0190
Focus Position X [mm]	-1.200	-1.100	0.090	1.100	1.200
Focus Position Y [mm]	-4.200	-4.100	0.012	4.100	4.200
Focus Position Z [mm]	140.000	150.000	155.470	160.000	165.000
KValue	0.50	0.67		1.00	1.00
KValue X	0.50	0.67		1.00	1.00
KValue Y	0.50	0.67		1.00	1.00
Caustic Min Power [W]	50	100		10000	10000
Caustic Max Power [W]	0	0		7500	8000
Caustic Mean Power [W]	0	0	0	7500	8000
BPP	0.200	0.250		0.750	0.700
M²	1.00	1.00	1.04	1.10	1.15
M² X	1.00	1.00		1.40	1.60
M² Y	1.00	1.00		1.50	2.00
BeamDirection [°]	0.00	0.00		2.00	3.00
BeamDirection X [°]	0.00	0.00		2.00	3.00
BeamDirection Y [°]	0.00	0.00		2.00	3.00
Rayleigh Length [mm]	0.01	0.03		10.00	30.00
Divergence [mrad]	0.05	0.10		0.35	0.40

Fig. 19.32: Evaluation results

Measured parameters out of the given range are marked red.

19.6 Automatic run

1. Start the LDS.

The welcome dialog is disabled and a text editor with the script appears (script is running automatically). While the script is already running, the software searches for the devices. For this preparation there is a sleep timer in the script. If the BCS is found after this timer, the “BCS idle” signal on the PROFINET is set and a measuring program can be requested (BCS idle is also notified in the lower part of the script editor; see Fig. 19.33).

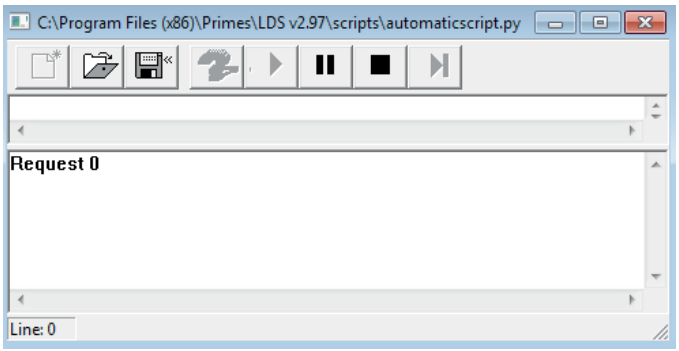


Fig. 19.33: Script editor

If the BCS isn’t found correctly after the timer has run out, the script will end with an error message like “Kein FM gefunden” (“no FM found”) (Fig. 19.34).

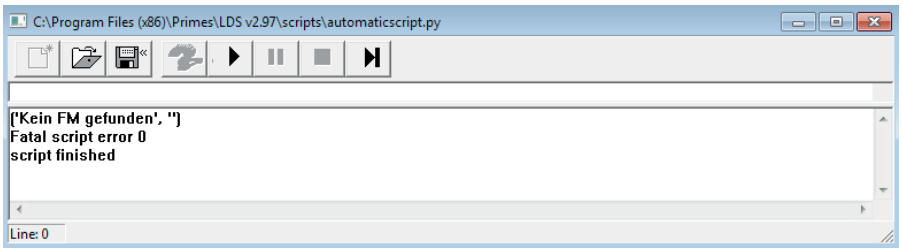


Fig. 19.34: Error message

If this happens, increase the timer setting.

1. Go to the editor in the LDS and open the ***automaticscript.py*** file.
2. Search for the line “primes.WaitFor[22000]” (see Fig. 19.35)
3. Set it to 60,000 ms tentatively (default is 22,000 ms).
4. Save the script and restart the software.

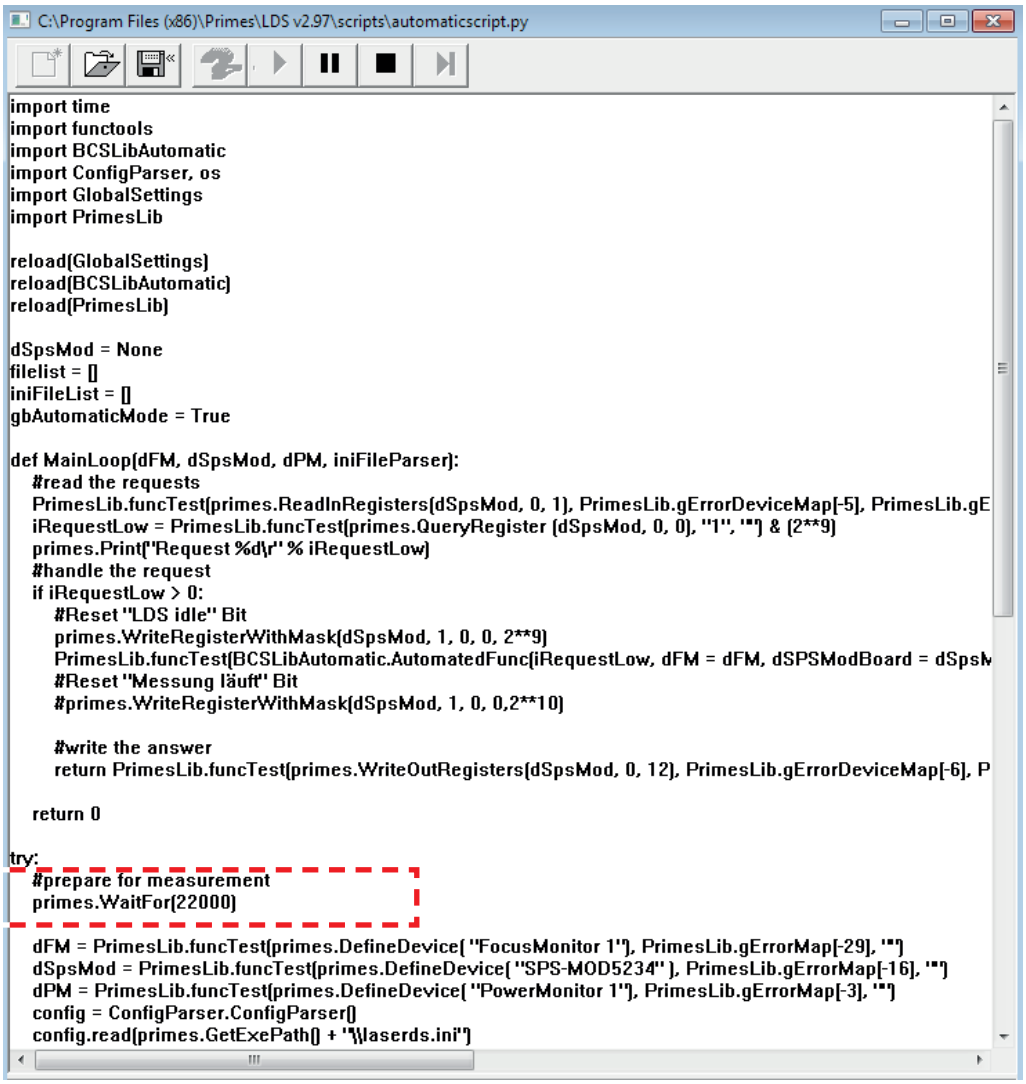


Fig. 19.35: Wait timer setting

If you still do not get the idle signal after the holding time, there is perhaps an error

1. Check all electrical connections.
2. Check the power supply (device is switched on?).
3. Check the directory path of the software.
4. Close the software and double check all steps described in this manual.