

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

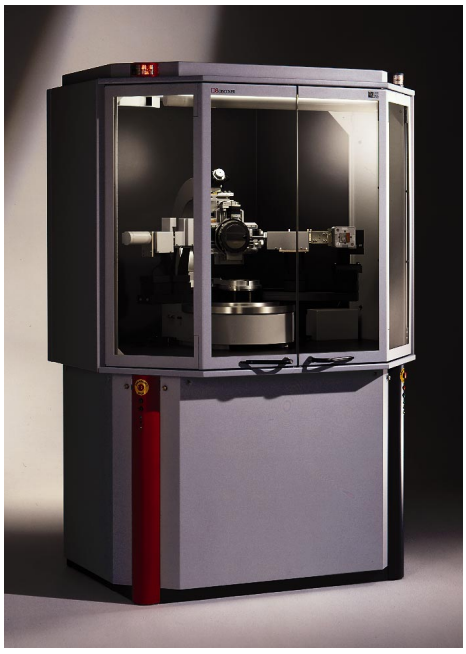
Visit our website - *Click HERE*

D8 X-ray Diffractometer Vol. I

D8 ADVANCE



D8 DISCOVER



D8 X-ray Diffractometer

Table of Contents

1 Room Planning and Preinstallation 1-1
Room planning 1-1
Area of installation 1-1
Dimensions 1-2
Weight 1-3
Room temperature and humidity 1-3
Heat dissipation 1-3
Preinstallation 1-4
Mains connection and earthing 1-4
Teleservice Modem 1-12
Cooling-water supply 1-12
Installation of the ion exchanger 1-13
Maintenance of the ion exchanger 1-13
Counter tube gas supply 1-15

2 Introduction 2-1
Safety Guidelines 2-1
About This Manual 2-1
General Safety Precautions 2-2
Warnings and Symbols 2-4
Illuminated Warning Displays 2-4
Servicing Precautions 2-5
Cleaning the Diffraction System 2-5

Maintenance of the Diffractometer Measuring Equipment 2-5
Goniometer 2-5
Sample Changer 2-5
Power Supply of Accessories Components 2-6
System Control 2-6
System Control Buttons 2-6
Illuminated Status Displays 2-7
Protection against Radiation 2-8
Tube Stand 2-9
X-Ray Safety Circuits 2-9
Control of the X-Ray Shutter 2-12
Interlock 2-14
Technical Specifications 2-15
General Diffraction System 2-15
Electrical Specifications 2-17
Diffraction Components 2-18

3 Operating Instructions 3-1
Application 3-1
Method of Operation 3-2
Design of the Diffractometer 3-4
Goniometer 3-5
X-ray Tube and Tube Stand 3-8
X-ray Tube 3-8
Tube Stand 3-8
Cable protection cover 3-9
Slit Systems 3-10
Aperture Slit System 3-10
Detector Slit System 3-12
Fixed Slits 3-13
Micro Diaphragms 3-14
Slit Changer 3-14
Variable Slit 3-14
Divergence Slit Next to the Sample 3-15
Scattered-Radiation Slit Next to the Sample 3-15
Kβ Filter 3-15

Absorber ... 3-15
Sample Carrier ... 3-16
Standard Sample Carrier ... 3-16
Rotating Sample Carrier ... 3-22
Scintillation Counter ... 3-26
Optional Detectors ... 3-27
Si(Li) Semiconductor Detector ... 3-27
Position Sensitive Detector ... 3-28
Control Electronics ... 3-30
Circuit Diagrams ... 3-30
Mains Distribution Board ... 3-31
Control Rack ... 3-32
Control Electronics Modules ... 3-33
Main Processor - Slot CPU Board (C79298-A3220-B106) ... 3-33
Universal I/O-Board (C79298-A3220-B103) ... 3-34
Detector Interface Board (C79298-A3220-B102) ... 3-38
Indexer/Driver 2 Axis / 4 Amps (419-306500) ... 3-43
Indexer/Driver 4 Axis / 2 Amps (419-306600) ... 3-47
Box Distribution Board (C79298-A3220-B200) ... 3-51
X-ray Shutter Status Display (C79298-A3220-B202/B203) ... 3-52
Control Panel (C79298-A3242-B43) ... 3-52
External X-ray Warning Display (C79298-A3220-A2) ... 3-53
Manual Control Box (SXI-472037000) ... 3-54
Hardware Setup ... 3-54
Firmware ... 3-55
Configuration ... 3-55
Keyboard setup ... 3-58
Short Description of Functions ... 3-58
Additional Information about Functions ... 3-62
Mounting ... 3-68
Connection to the X-ray Generator ... 3-68
Connection of the High-voltage Cable ... 3-68
Connection of the Cooling Water Hoses ... 3-68
Shutter Control Cable ... 3-69
Fitting and Removal of the X-ray Tube ... 3-69
Instrument Initialisation ... 3-71
Format of file DEVICE.INI ... 3-71
Sections of DEVICE.INI ... 3-72

[DEVICE] section 3-72
[UIOBx] section 3-72
[DIBx] section 3-74
[2AIBx] section 3-75
[4AIBx] section 3-75
[COMx] sections 3-76
[DRIVEx] section 3-78
[CHANNELx] section 3-84
[SCB] section 3-87
[IK121-x] section 3-87
[RS]-section 3-88
[SHUTTERx] section 3-88
[DETECTOR] section 3-91
Interfaces to External Computers 3-93
Transmission Protocol 3-94
Data transfer without software handshake 3-94
Data transfer with software handshake 3-94
Cable Wiring of RS 232 C Serial Connectors 3-95
Remote Control by an External Computer 3-95
Description of Remote Control Commands 3-96
Commands for operating mode switchover 3-96
Commands for device parameterization 3-98
Commands for measuring channel parameterization 3-106
Control commands 3-111
Commands for parameterizing and starting measuring functions and reading results 3-127
Commands for reading instrument status 3-145
Miscellaneous Commands 3-150
Measuring Function Status 3-152
Status Flags 3-154
Error Flags 3-160
Remote Control Command Set (Overview) 3-162
Commands for mode switchover 3-162
Commands for instrument parameterization 3-162
Commands for channel parameterization 3-162
Control commands 3-163
Commands for parameterizing and starting measuring functions and reading results 3-163
Commands for reading instrument status and instrument registers 3-164
Miscellaneous Commands 3-164

Remote Control Command Set (alphabetical order) 3-165
Command Macros 3-167
Macro Definition 3-167
Macro Execution 3-168
Assignment of the I/O Ports 3-169
Universal I/O Boards 3-169
Detector Interface Boards 3-176
2-Axis Indexer Boards 3-179
4-Axis Indexer Boards 3-182
Alignment of the diffractometer 3-187
Alignment of the fixed slit assembly 3-189
Zero point definition of the θ scale 3-189
Zero point definition of the 2θ scale 3-190
Centering the anti-scatter slit to the zero beam 3-191
Centering the aperture slit to the zero beam 3-192
Centering the radiation outlet flange 3-193
Alignment of the variable slit assembly 3-194
Zero definition of the θ scale 3-194
Zero definition of the 2θ scale 3-195
Centering the variable anti-scatter slit to the zero beam 3-196
Centering the variable aperture slit to the zero beam 3-197
Centering the fixed aperture slit to the zero beam 3-198
Aligning the receiving slit changer 3-199
Aligning the Parameters of the Measurement Electronics 3-200

4 KRISTALLOFLEX 760 X-ray Generator K760-A21 4-1
Description 4-1
Application 4-1
Control 4-1
Design 4-2
Method of Operation 4-4
High-Voltage Generation and Regulation 4-4
Regulation of Tube Current 4-4
Protection Circuits 4-4
Radiation Protection 4-5
Technical Data 4-6

Installation **4-7**
Set-up 4-7
Mains Connection 4-7
Terminal Block X3 4-7
Connection of High-Voltage Cable 4-7
External Warning Lamps (in Connection with a Window Control) 4-10
Commissioning and Start-up **4-10**
Operation **4-11**
Local Operation and Display 4-11
Setpoints for High-Voltage and Tube Current 4-13
Maximum Values for High-Voltage, Tube Current and Power 4-13
Baud Rate 4-13
Explanation of Status and Diagnostic Information 4-14
Start-up Routine for New X-ray Tubes 4-14
Generator Stand-by 4-15
Interface between X-ray Generator and External Computer **4-15**
Hardware 4-15
Data Transmission 4-15
Data transmission from external computer to X-ray generator 4-16
Data transmission from X-ray generator to external computer 4-16
Description of interface commands RC to X-ray generator 4-17
Maintenance and Repair **4-20**
Routine Maintenance 4-20
Troubleshooting 4-20
Spare Parts List **4-25**

5 Diffracted Beam Monochromator **5-1**
Description **5-1**
Application 5-1
Design and Mode of Operation 5-1
Technical Data 5-3
Installation 5-3
Adjustment 5-4
Preliminary Work 5-4
Pre-adjustment 5-5
Final Adjustment 5-8

Radiation Protection 5-9

6 Grazing Incidence Attachment 6-1
Application 6-1
Design and Operation 6-1
Design 6-1
Operation 6-1
Operation without Monochromator 6-2
Operation with Monochromator in Non-dispersive Arrangement 6-2
Operation with Monochromator in Dispersive Arrangement 6-3
Installation 6-3
Adjustments 6-4
Adjustment of Attachment with Monochromator 6-4
Preadjustment 6-4
Adjustment without Monochromator 6-8
Crystal Change 6-8
Radiation Protection 6-9
Technical Data 6-9
Figures 6-11

7 Reflectometer Sample Stage 7-1
Alignment of the Reflectometer Sample Stage 7-1
Introduction 7-1
Calibrating the Edge Diaphragm 7-2
Mounting Instructions 7-2
Alignment of the Edge Diaphragm 7-2
The Alignment of the Reflectometer Sample Stage 7-4
Introduction 7-4
Alignment of the Angular Scales 7-4
The Alignment of the Sample 7-8
The Mounting of the Sample 7-8
The Alignment of the Distance between Edge and Sample Surface 7-8
The ϑ-Alignment with a Mounted Sample 7-9

Example for a Sensible Reflectivity Measurement 7-10
Introduction 7-10
The Standard Experimental Set-Up 7-11
Alignment 7-11
Creating Measurement Instructions for a Reflectivity Measurement 7-12
Creating Measurement Instructions for a Reflectivity Measurement using DIFFRAC^{plus} 7-13
Instruction for the alignment of the edge diaphragm 7-18
Alignment of Reflectometry for Theta-Theta 7-19
Differences compared to theta-2theta 7-19
First alignment after installation of reflectometry stage (especially Temperature chamber "TC-Reflectometry") 7-19
Alignment of sample (use appropriate Cu absorber) 7-20

8 Special Instructions 8-1
D8TOOLS Software 8-1
D8TOOLS Overview 8-2
Instrument status 8-2
Instrument status overview 8-2
ONLINE / OFFLINE instrument status 8-3
Instrument Status Data File 8-4
Instrument Status Errorlog Data File 8-4
Instrument Status View 8-5
Instrument View 8-5
Instrument Components Status Views 8-10
Slit Changer Status 8-17
Control Boards 8-23
Control Boards Overview 8-23
Instrument Setup 8-28
Instrument Setup Overview 8-28
Instrument Online Setup Data 8-28
Instrument Setup Data File 8-29
Manual Instrument Control 8-29
Manual Instrument Control Overview 8-29
Manual Instrument Control Dialog 8-29

Communication interface configuration 8-31
Overview of the communication interface configuration 8-31
Comm Port Configuration Dialog 8-31
Instrument and user information 8-32
Overview of the instrument and user information 8-32
Instrument and Customer Info Dialog 8-32
Terms and Definitions 8-33
Conversion manual for ϑ - 2ϑ systems into ϑ - ϑ systems 8-34
Conversion manual for ϑ - ϑ systems into ϑ - 2ϑ systems 8-38
Maintenance of the Quarter Circle Eulerian Cradle 8-41
Installation / Transportation 8-41
Lubrication 8-41
Collision Switch for the Eulerian Quarter Cradles 8-44
Collision switch for open Eulerian Cradles 8-46

9 Appendix 9-2
Spare parts list 9-2
Spare Part Package 9-6
Basic Package C79298-A3242-D10 9-6
Advanced Package C79298-A3242-D11 9-8
Spare Parts Package D85 (Extended Package) C79298A3244D120 9-9

10 Index 10-1

List of Illustrations

Fig. 1-1: Dimension drawing (dimensions in mm) ... 1-3
Fig. 1-2a: Mains connection and earthing - One phase 240 VAC/50/60 Hz ... 1-6
Fig. 1-2b: Mains connection and earthing - 3 x 240 VAC/50/60Hz ... 1-7
Fig. 1-2c: Mains connection and earthing - One phase supply 230 VAC/50/60Hz ... 1-8
Fig. 1-2d: Mains connection and earthing - 3 x 230 VAC/50/60Hz ... 1-9
Fig. 1-2e: Mains connection and earthing - One phase 208 VAC ... 1-10
Fig. 1-2f: Mains connection and earthing - 3 x 120 VAC/50/60Hz ... 1-11
Fig. 1-3: Cooling water connection ... 1-12
Fig. 1-4: Rear view of the cooling water supply ... 1-14

Fig. 2-1: The interlock safety system (1) ... 2-14
Fig. 2-2: The interlock safety system (2) ... 2-14

Fig. 3-1: Beam path of the diffractometer ... 3-2
Fig. 3-2: D8 diffractometer, vertical installation ... 3-4
Fig. 3-3: Goniometer ... 3-5
Fig. 3-4: Predefined measuring circle diameter ... 3-7
Fig. 3-5: KF...4KE X-ray diffraction tube (ceramic tube type) ... 3-8
Fig. 3-6: Tube stand with aperture slit system ... 3-9
Fig. 3-7: Cable protection cover ... 3-9
Fig. 3-8: Aperture slit system for fixed slit (upper view without screening cover) ... 3-10
Fig. 3-9: Aperture slit system with variable slit ... 3-11
Fig. 3-10: Detector slit system for fixed slits (without cover) ... 3-12
Fig. 3-11: Detector slit system for a variable slit and a fixed slit ... 3-13
Fig. 3-13: Standard sample carrier ... 3-17
Fig. 3-14: Insertion aid and pressure unit ... 3-18
Fig. 3-15: Standard sample carrier with front stop bracket ... 3-19
Fig. 3-16: Standard sample carrier ... 3-20
Fig. 3-17: Rotating/transmission sample carrier ... 3-22
Fig. 3-18: Design of the rotating/transmission and the 0° rotating sample carrier ... 3-24
Fig. 3-19: Universal cup ... 3-25
Fig. 3-20: Intermediate ring, 50 mm diameter ... 3-25
Fig. 3-21: Transmission cup ... 3-25

Fig. 3-22: Sample holder 3-25
Fig. 3-23: Sample holder 3-26
Fig. 3-24: Scintillation counter 3-26
Fig. 3-25: Tensile stress relief of the detector cable 3-26
Fig. 3-26: Quantum yield of the scintillation counter 3-27
Fig. 3-27: Si(Li) semiconductor detector with Peltier cooling 3-27
Fig. 3-28: Quantum yield of a typical Si(Li) semiconductor detector (3 mm detector thickness; 25 mm beryllium window thickness) 3-28
Fig. 3-29: Position sensitive detector 3-28
Fig. 3-30: Quantum yield of the position sensitive detector 3-29
Fig. 3-31: Manual Control Box 3-54
Fig. 3-32: Configuration of D8 manual control box, part 1 3-56
Fig. 3-33: Konfiguration D8 manual control box, part 2 3-57
Fig. 3-34: High-voltage plug tube side 3-68
Fig. 3-35: Tube housing 3-70
Fig. 3-36: Beam direction according to the maximum 3-188
Fig. 3-37: Beam direction according to mean value of the 80 % edges 3-188
Fig. 3-38: Diffracted beam fixed slit assembly 3-191
Fig. 3-39: Fixed aperture slit assembly 3-192
Fig. 3-40: Diffracted beam variable slit assembly 3-196
Fig. 3-41: Variable aperture slit assembly 3-197
Fig. 3-42: Variable slit assembly with receiving slit changer 3-199
Fig. 3-43: Detector Settings Menu of DIFFRAC^{plus} ADJUST 3-200
Fig. 3-44: High-voltage measurement using Cu radiation at 40 kV and 35 mA 3-201
Fig. 3-45: High-voltage measurement using Cu radiation at 35 kV and 40 mA 3-202
Fig. 3-46: High-voltage measurement using Cr radiation at 35 kV and 45 mA 3-202
Fig. 3-47: Pulse height analysis scan using Cu radiation at 40 kV and 35 mA 3-203
Fig. 3-48: Pulse height analysis scan using Cr radiation at 35 kV and 40 mA 3-203

Fig. 4-1: X-ray generator KRISTALLOFLEX® K760-A21 4-1
Fig. 4-2: Control panel 4-2
Fig. 4-3: Top view 4-3
Fig. 4-4: High-voltage plug 4-7
Fig. 4-5: Connection of the high-voltage cable 4-8
Fig. 4-6: Rear view 4-9

Fig. 5-1: Diffracted-Beam Monochromator 5-1
Fig. 5-2: Beam path of the diffractometer with diffracted-beam monochromator 5-2
Fig. 5-3: Secondary fixed slit assembly 5-4
Fig. 5-4: Fixed slit assembly and diffracted-beam monochromator with adjustment template 5-5
Fig. 5-5: Diffracted beam monochrometer without protective cover 5-6
Fig. 5-6: Pre-adjustment of angle 5-6
Fig. 5-7: Adjustment to center of radiation 5-7

Fig. 6-1: Operation without monochromator 6-2
Fig. 6-2: Monochromator in non-dispersive arrangement 6-2
Fig. 6-3: Monochromator in dispersive arrangement 6-3
Fig. 6-5: Adjustment of 2θ angle 6-5
Fig. 6-6: Grazing incidence attachment with and without monochromator 6-11
Fig. 6-7: Attachment with the monochromator uncovered (front of crystal holder) 6-12
Fig. 6-8: Measuring attachment (rear of crystal holder) 6-13
Fig. 6-9: Monochromator (top view) 6-14
Fig. 6-10: Removing the Soller slit 6-15

Fig 7-1: A side view (from the reflected beam side) of the reflectometer sample stage. 7-1
Fig. 7-2: A side view of the RSS. 7-2
Fig. 7-3: Side view of the RSS (from the incident beam side). 7-3
Fig. 7-4: A sketch of the glass slit. 7-5
Fig. 7-5: Rocking curve measurements 7-6
Fig. 7-6: Measurement results obtained during the alignment of the zero point of the 2ϑ-scale. 7-7
Fig. 7-7: Two rocking curves obtained during the alignment of the ϑ-circle 7-10
Fig. 7-8: Complete reflectometry measurement with 5 ranges 7-13
Fig. 7-9: The extended input form of EditDQL 7-14
Fig. 7-10: The range entries form showing a typical set of ranges for a reflectivity measurement 7-16
Fig. 7-11: The measurement results (displayed by DIFFRAC^{plus} *EVA)* 7-17
Fig. 7-12: The result of the reflectivity measurement defined above. 7-17

Fig. 8-1: D8TOOLS: The Starting Window 8-1
Fig. 8-2: D8TOOLS: Communication error message 8-3
Fig. 8-3: D8TOOLS: The Instrument Status View 8-5
Fig. 8-4: D8TOOLS: The Instrument Status Flags View 8-6

Fig. 8-5: D8TOOLS: The Ready Flags View....8-7
Fig. 8-6: D8TOOLS: The Warnings View....8-8
Fig. 8-7: D8TOOLS: The Alarms View....8-9
Fig. 8-8: D8TOOLS: The Measuring Function View....8-9
Fig. 8-9: D8TOOLS: The Power Supply View....8-10
Fig. 8-10: D8TOOLS: The Drives View....8-10
Fig. 8-11: D8TOOLS: The Drive Status View....8-11
Fig. 8-12: D8TOOLS: Slide control unit for the drive speed....8-13
Fig. 8-13: D8TOOLS: The Drive Settings View....8-13
Fig. 8-14: D8TOOLS: The Chipset Status View....8-14
Fig. 8-15: D8TOOLS: The Chipset Axis Mode of Drive View....8-14
Fig. 8-16: D8TOOLS: The Channels Status View....8-15
Fig. 8-17: D8TOOLS: The Measuring Channel Status View....8-16
Fig. 8-18: D8TOOLS: The Channel Settings View....8-17
Fig. 8-19: D8TOOLS: The Slit Changer Status View....8-17
Fig. 8-20: D8TOOLS: The Tube Window Status View....8-18
Fig. 8-21: D8TOOLS: The X-ray Generator Status View....8-19
Fig. 8-22: D8TOOLS: The X-ray Generator More View....8-21
Fig. 8-23: D8TOOLS: The X-RAY Generator Settings View....8-22
Fig. 8-24: D8TOOLS: The X-ray Channel Register View....8-23
Fig. 8-25: D8TOOLS: The I/O Registers of Universal I/O Board View....8-24
Fig. 8-26: D8TOOLS: The I/O Registers of Detector Interface Board View....8-25
Fig. 8-27: D8TOOLS: The I/O Registers of 2-Axis Indexer Board View....8-26
Fig. 8-28: D8TOOLS: The I/O Registers of 4-Axis Indexer Board View....8-27
Fig. 8-29: D8TOOLS: The Manual Control Commands View....8-30
Fig. 8-30: D8TOOLS: The Communication error message....8-30
Fig. 8-31: D8TOOLS: The Communication Port Configuration View....8-31
Fig. 8-32: D8TOOLS: The Instrument and Customer Infos View....8-32
Fig. 8-33: Conversion into ϑ-ϑ configuration....8-34
Fig. 8-34: Measuring attachment to adjust the spacer ring....8-35
Fig. 8-35: Vertical goniometer in ϑ - ϑ configuration....8-36
Fig. 8-36: Counterbalance for inner and outer circle....8-37
Fig. 8-37: Conversion into ϑ-2ϑ configuration....8-38
Fig. 8-38: Measuring attachment to adjust the spacer ring....8-39
Fig. 8-39: Vertical goniometer in ϑ-2ϑ configuration....8-40

Fig. 8-40: Counterbalance for diffracted beam side 8-40
Fig. 8-41: Handle the cradle with care 8-42
Fig. 8-42: Lubricating the guiding tracks 8-43
Fig. 8-43: Switch mounting to the Eulerian cradle 8-44
Fig. 8-44: Switch connection to the goniometer sockets 8-45
Fig. 8-45: Adjusting the collision switch 8-45
Fig. 8-46: Mounting the collision switch 8-47
Fig. 8-47: Adjusting the collision switch 8-48

List of Tables

Tab. 1-1: Electrical requirements (including X-ray generator and control electronics but without accessories) 1-4
Tab. 1-2: Cooling water supply of the X-ray generator 1-12

Tab. 2-1: Technical Specifications: General Diffraction System 2-15
Tab. 2-2: Technical Specifications: Electrical Specifications 2-17
Tab. 2-3: Technical Specifications: Diffraction Components 2-18

Tab. 3-1: Width and opening angle for the fixed slits 3-14
Tab. 3-2: Verschiedene Kβ-Filter 3-15
Tab. 3-3: Accessories for the standard sample carrier 3-21
Tab. 3-4: List of schematics 3-30
Tab. 3-5: Keyboard of D8 manual control box 3-59
Tab. 3-6: Function Key F1 - Simplified manual control mode 3-60
Tab. 3-7: Meaning of values reported to host computer (D8 with GADDS) 3-61
Tab. 3-8: Nominal Θ– and 2Θ -values for the 100% reflection of Quartz 3-201

Tab. 4-1: Connection of the terminal block X3 4-7
Tab. 4-3: Entering the parameters using the local control panel 4-12
Tab. 4-4: Status and Diagnostic Information (1) 4-14
Tab. 4-5: High voltage generator error codes 4-16
Tab. 4-6: Status and diagnosis information (2) 4-21

Tab. 5-1: Intensity yield with a diffracted-beam monochromator compared to a measurement with unfiltered radiation 5-3

Tab. 9-1: Spare parts list 9-2
Tab. 9-2: Spare Parts Package: Basic Package 9-6
Tab. 9-3: Spare Parts Package: Advanced Package 9-8
Tab. 9-4: Spare Parts Package: Extended Package D85 9-9

1 Room Planning and Preinstallation

Table of Contents

1 Room Planning and Preinstallation 1-1

Room planning 1-1

Area of installation 1-1

Dimensions 1-2

Weight 1-3

Room temperature and humidity 1-3

Heat dissipation 1-3

Preinstallation 1-4

Mains connection and earthing 1-4

Teleservice Modem 1-12

Cooling-water supply 1-12

Installation of the ion exchanger 1-13

Maintenance of the ion exchanger 1-13

Counter tube gas supply 1-15

1 Room Planning and Preinstallation

Room planning

Careful room planning and the completed preinstallation are prerequisites for rapid final assembly and commissioning of the D8 X-ray diffractometer by a Bruker AXS specialist. Room planning and preinstallation should be carried out with the assistance of the appropriate Bruker AXS office after suitable consultation.

Area of installation

The installation of the devices must be planned such that the diffractometer is accessible from all sides and that the cooling air can flow without restrictions. A minimum of 70 cm free space must be provided behind the diffractometer and on both sides.

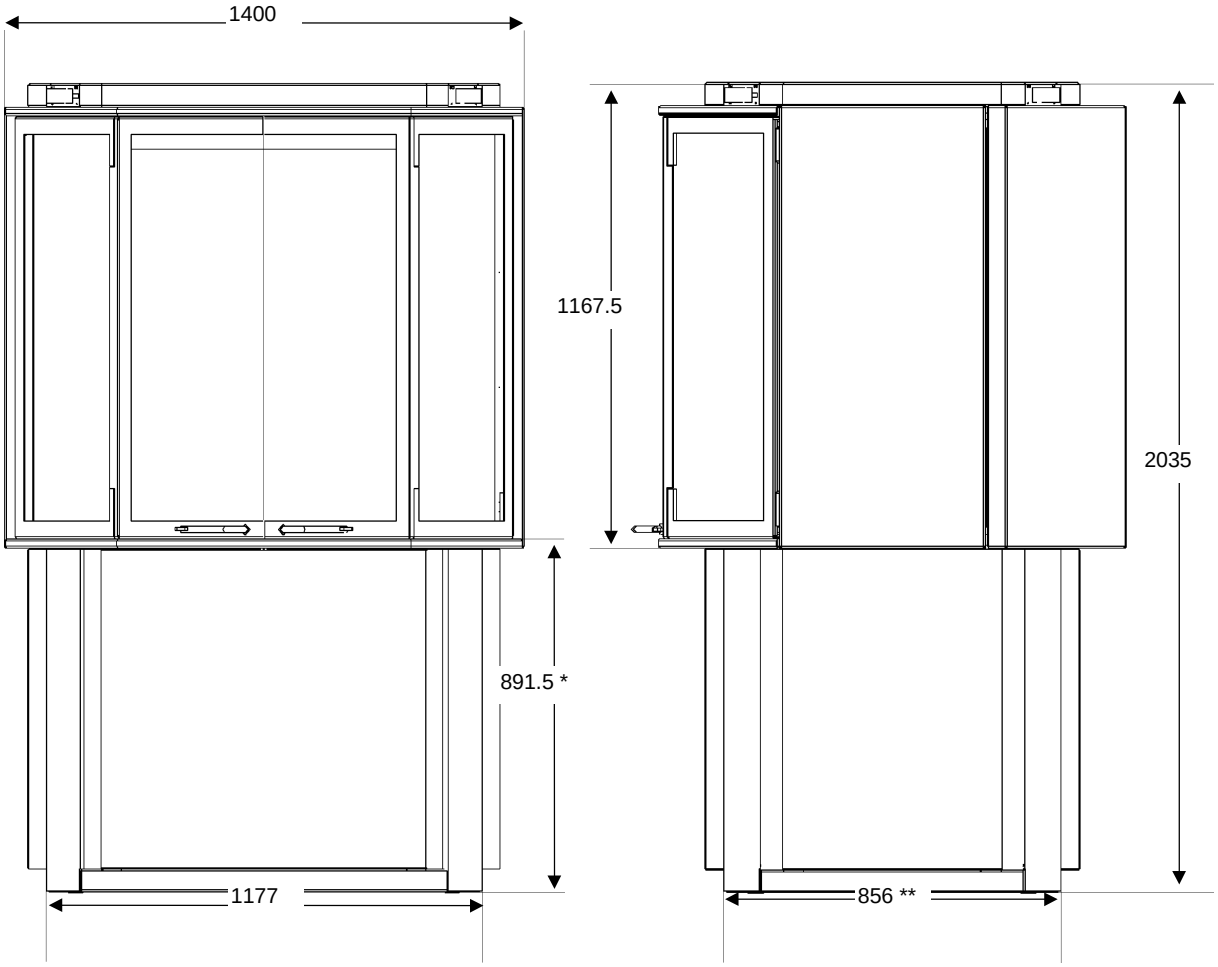
The floor should be level and with a suitable supporting capacity.

Avoid direct solar radiation.

To avoid heat near the diffractometer, the external cooling-water unit, if provided, should be installed in a separate room.

If the external cooling-water unit is installed in a closed room, make sure that the waste heat is carried off and fresh air is admitted.

Dimensions



* Console without radiation protection box

** Without side panels (for transportation)

*** Without rear panel (for transportation)

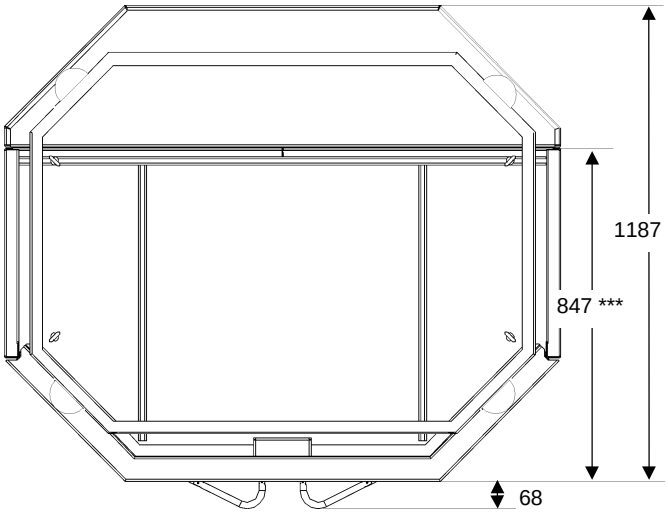


Fig. 1-1: Dimension drawing (dimensions in mm)

Weight

Console with X-ray generator and control and measuring electronics	220 kg
Radiation protection box with goniometer, tube stand, tube and standard mounts	320 kg
D8 box with console and goniometer	550 kg
Load per m^2	717 kg/m^2
Clear door width for transportation	min. 860 mm for box and console, if mounted parts are removed

Room temperature and humidity

Optimum room temperature	24 °C
Max. temperature fluctation	±10 °C
Optimum temperature gradiant	< 1 °C/h
Relative humidity	20 to 80 %, (no condensation)

Heat dissipation

If necessary, the heat dissipated must be removed by a ventilation or air conditioning system.

The maximum heat dissipation from the diffractometer (including measuring and control electronics and X-ray generator) to the air is 1 kW.

Preinstallation

Mains connection and earthing

The D8 diffraction system can be connected to almost all common AC power networks worldwide which provide the required power.

The systems can be ordered factory pre-set for the nominal mains supply voltages listed in table 1-1.

Tab. 1-1: Electrical requirements (including X-ray generator and control electronics but without accessories)

Mains supply	Technical Data
Mains supply voltage (Actual nominal voltage will be factory-preset according ordering form.)	One phase supply: 208 VAC (+/- 10%) 230 VAC (+/- 10%) 240 VAC (+/- 10%) Three phases supply: 3 x 120 VAC (+/- 10%) 3 x 230 VAC (+/- 10%) 3 x 240 VAC (+/- 10%)
Frequency range	47-63 Hz
Maximum power consumption D8 diffraction system without internal water cooling unit (C79298-A3179-A11) D8 diffraction system with internal cooling water unit (C79298-A3179-A11)	max. 6 kVA max. 6.5 kVA
Overvoltage category according to IEC 664	II

☞ The power consumption of the optional external water cooling unit is not included in table 1-1. Refer to the technical specifications of the specific device being installed on your site.

By default the diffractometer system contains a 10 m long power cable (5 x 6 mm^2) for connection to a three-phase AC network. That cable can be connected either directly to the switchboard of the inhouse mains system or it can be equipped with an approved plug connector (shrouded plug and socket outlet to DIN 49462, VDE 0623, IEC 309-1).

Fig. 1-2a - 1-2f show how to implement the mains connection.

The electrical connection of the instrument to the inhouse network must be provided via fuses or automatic circuit breakers for all phases. It must be possible to disconnect the diffraction system completely from the power supply using either a labelled switch or an labelled automatic circuit-breaker which is located nearby the diffraction system.

Warning! ⚠
In some specific local mains networks the so-called „neutral“ power line (marked with „N“) is not connected to earth potential. In this case the neutral power line N and the three phases L1, L2 and L3 must be controlled by a four-phase automatic circuit breaker. In case of an error on either the neutral power line N or on one of the phases L1, L2 or L3 that circuit breaker must disconnect all power lines (i.e. N, L1, L2 and L3) from the mains network.

As an option a residual current circuit-breaker can be added. It must be rated for a maximum current of 3 x 40 A and have a fault current of 30 mA.

The host computer will be powered directly from the inhouse mains system.

Moreover, an additional external earth terminal in accordance with the local regulations must be provided. It will be connected with earth bar X601 of the D8 diffraction system using the special earth cable supplied with the instrument.

If necessary the computer must be connected to the mains via an **interference filter**.

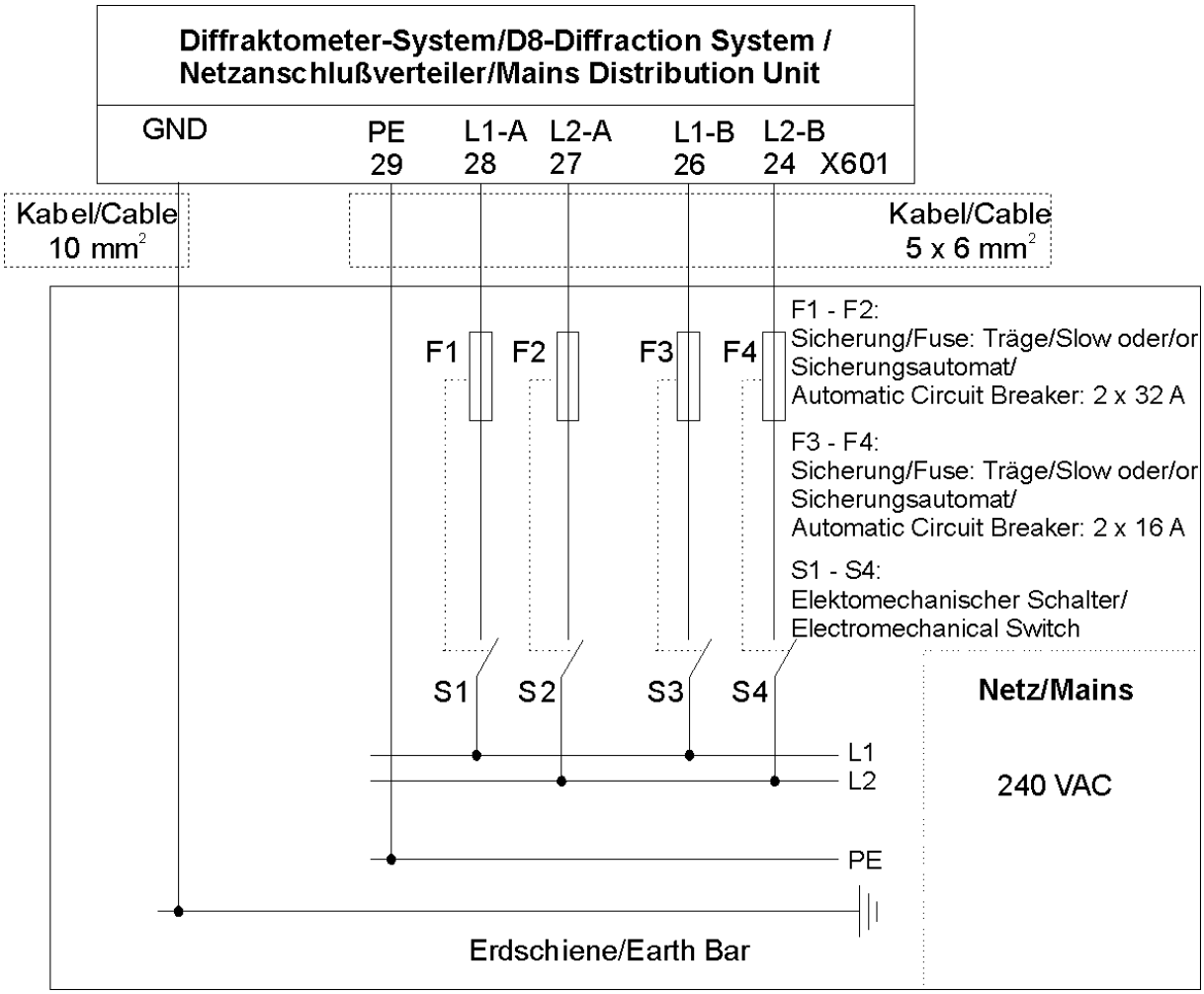


Fig. 1-2a: Mains connection and earthing - One phase 240 VAC/50/60 Hz

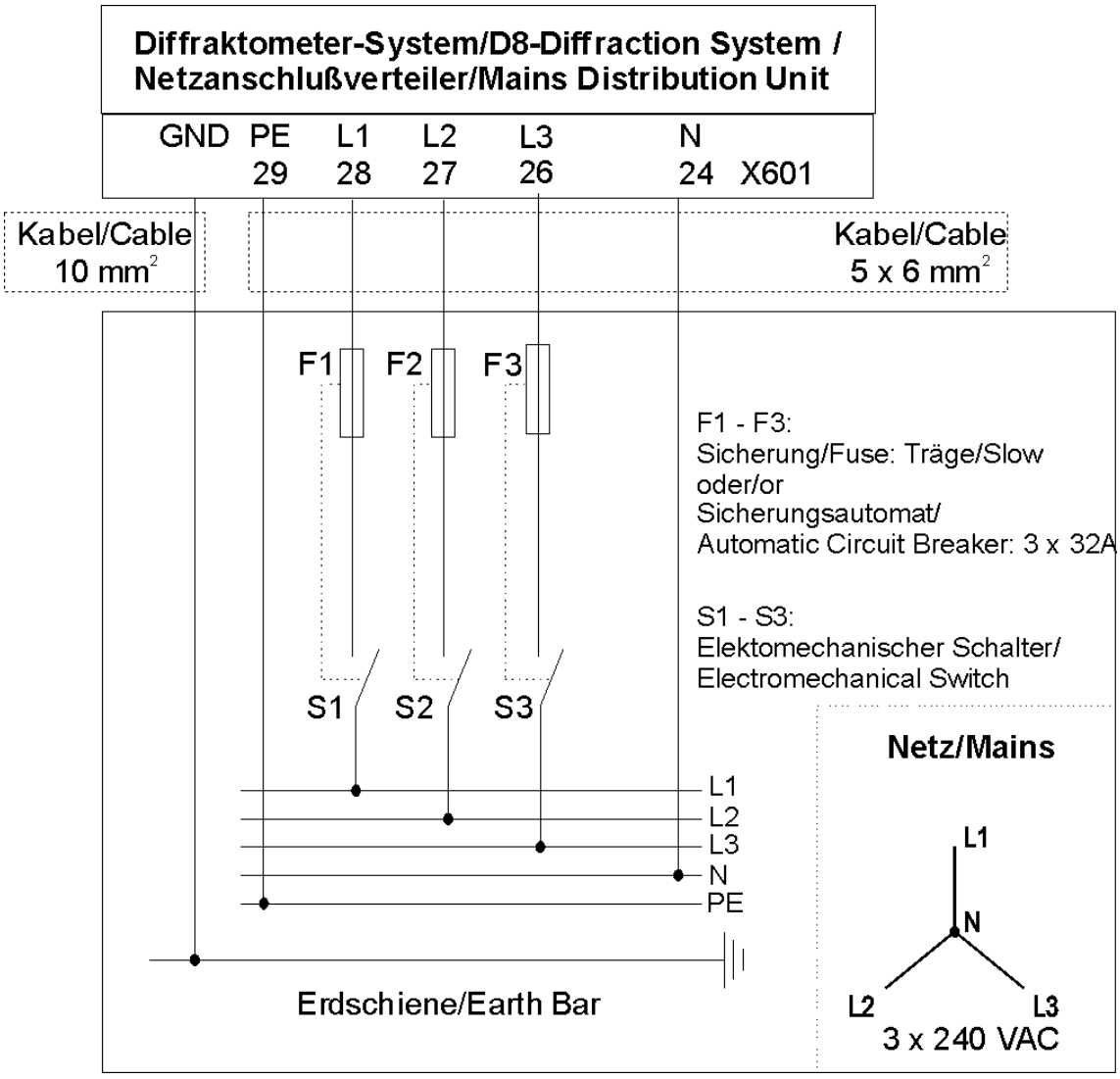


Fig. 1-2b: Mains connection and earthing - 3 x 240 VAC/50/60Hz

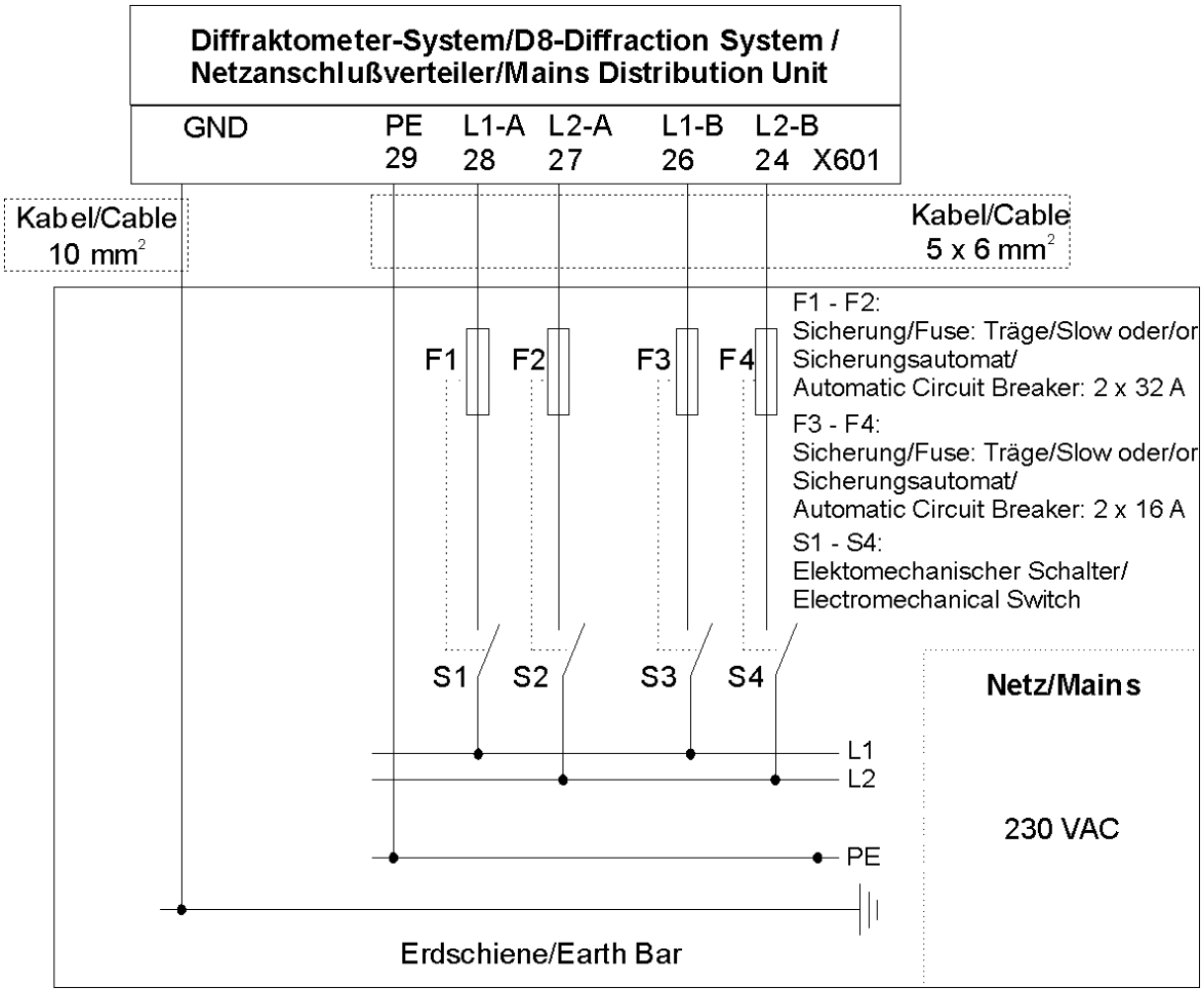


Fig. 1-2c: Mains connection and earthing - One phase supply 230 VAC/50/60Hz

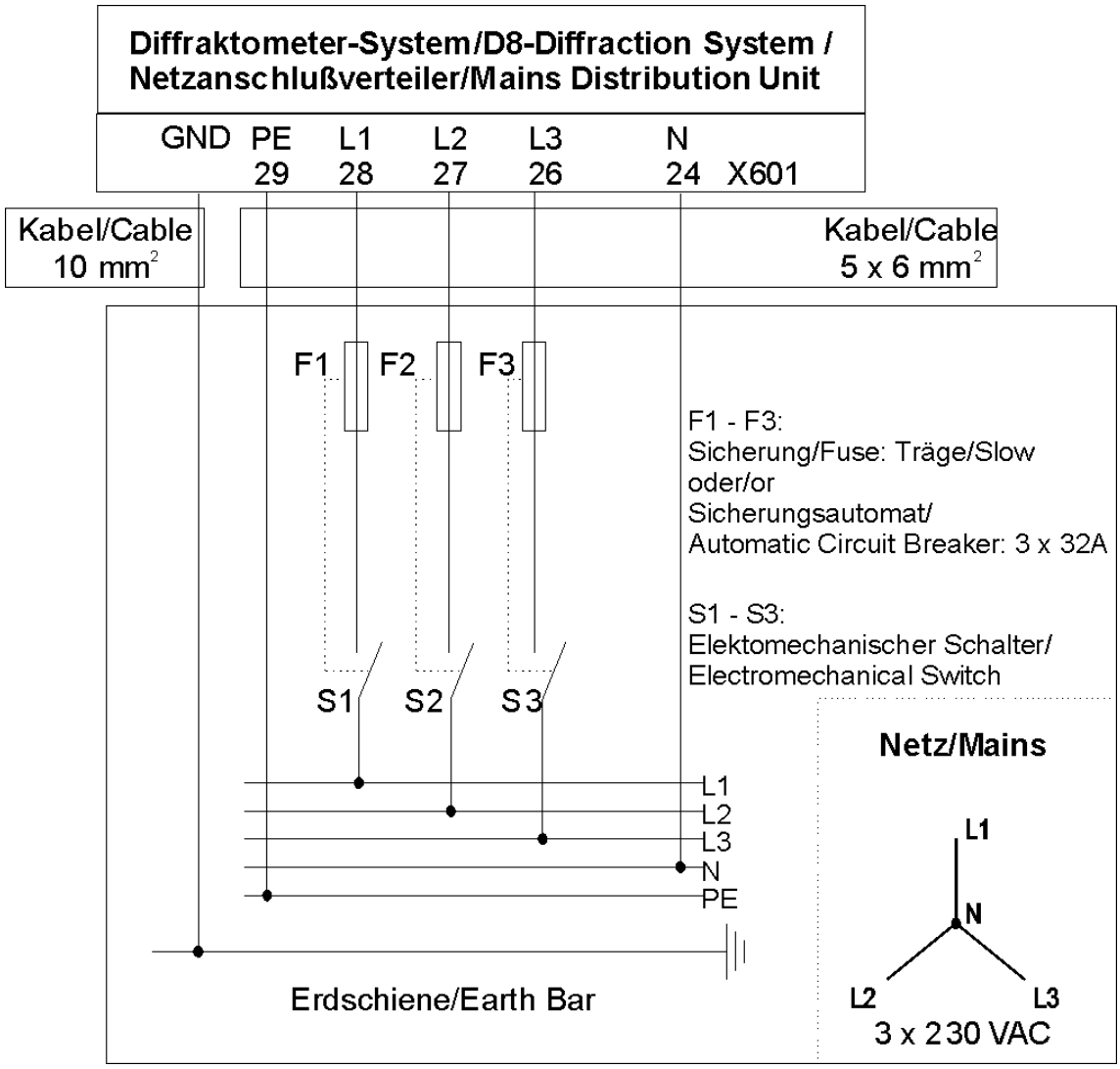


Fig. 1-2d: Mains connection and earthing - 3 x 230 VAC/50/60Hz

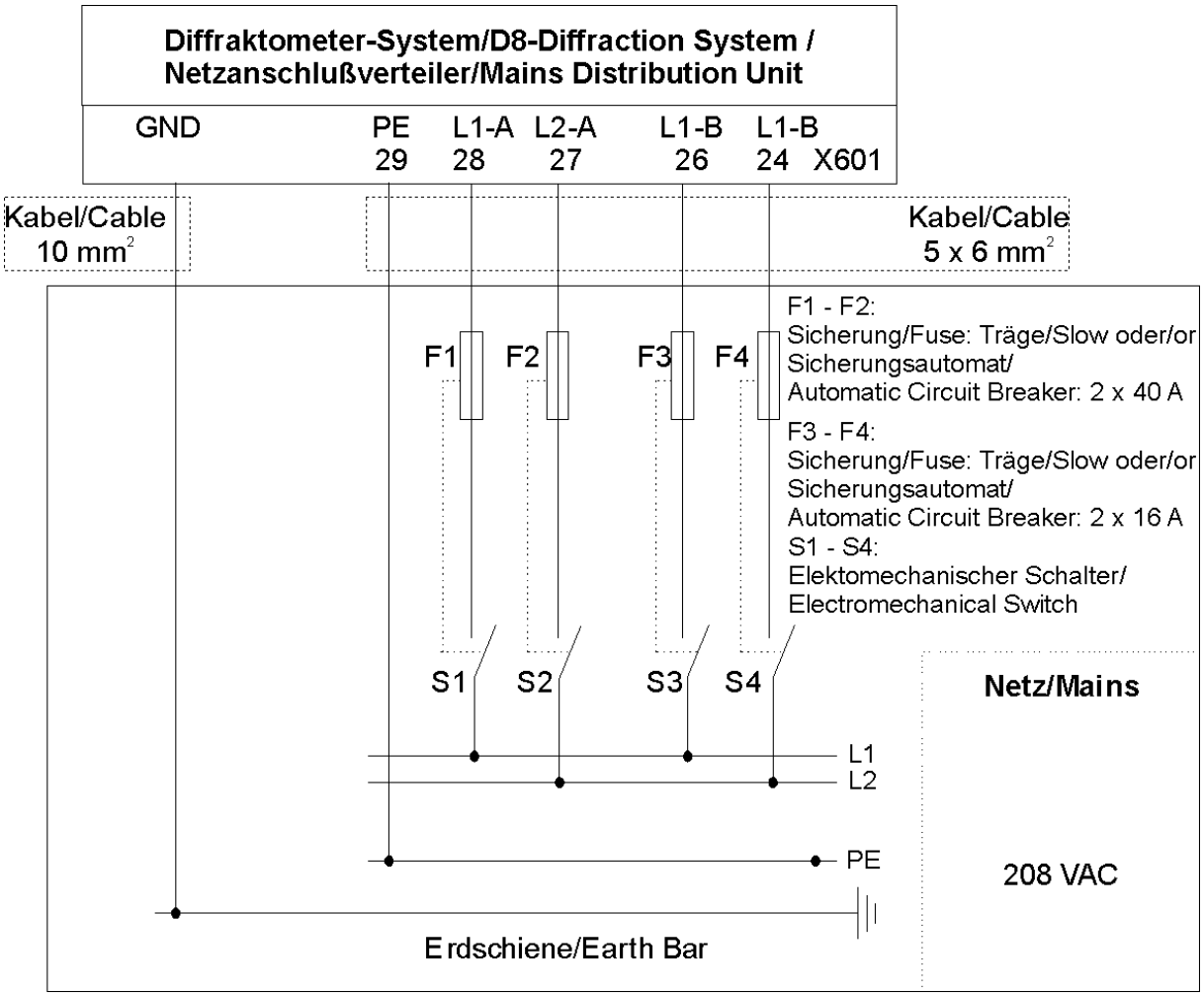


Fig. 1-2e: Mains connection and earthing - One phase 208 VAC

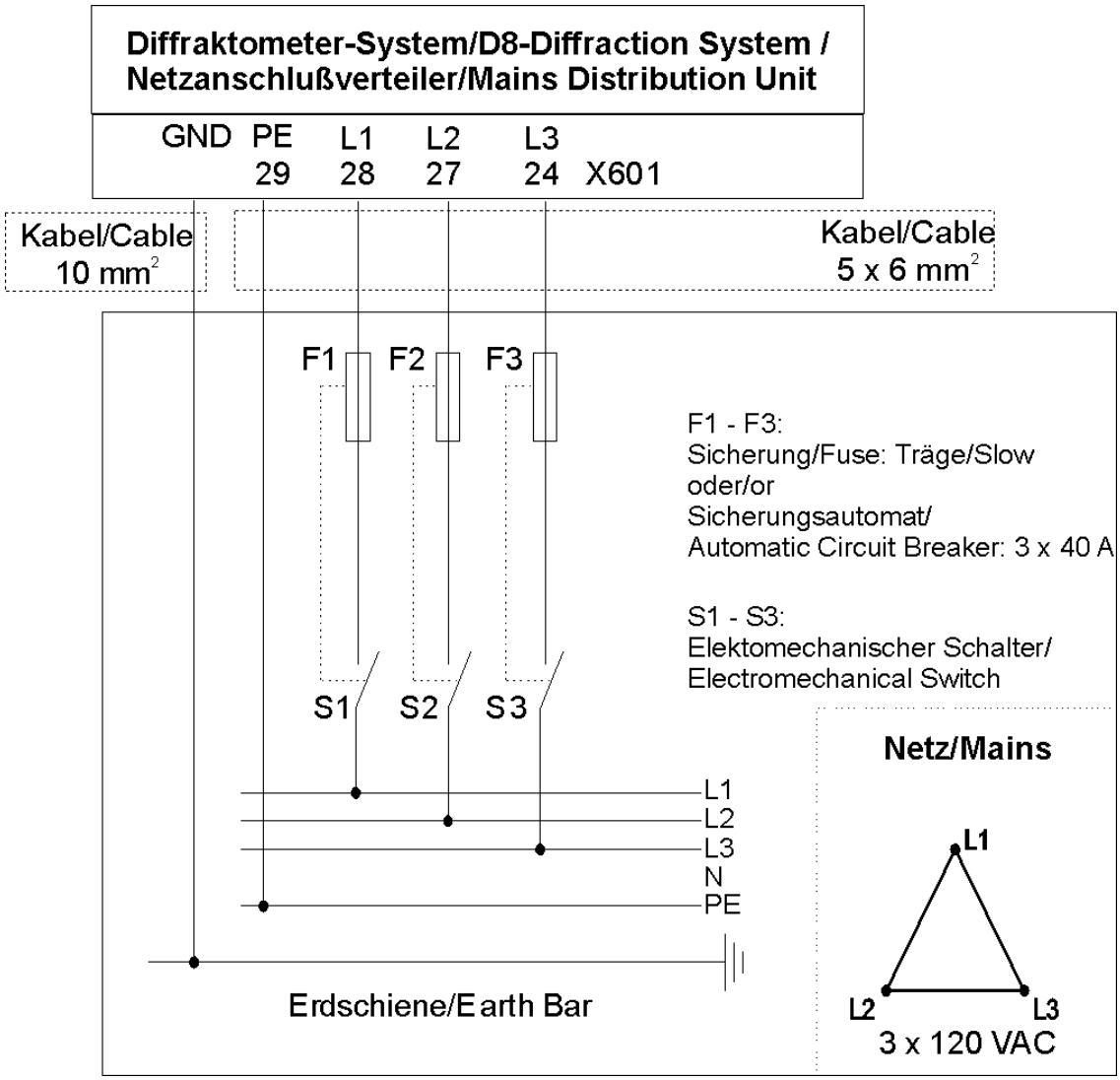


Fig. 1-2f: Mains connection and earthing - 3 x 120 VAC/50/60Hz

Teleservice Modem

The diffractometer is equipped with a modem for hardware and software diagnosis through the Bruker AXS Teleservice Centers. For this purpose a telephone socket (preferably Western connector) near the diffractometer is required.

Cooling-water supply

In order to supply the X-ray generator with cooling water, a connection must be made to the mains water supply with a pressure-free discharge.

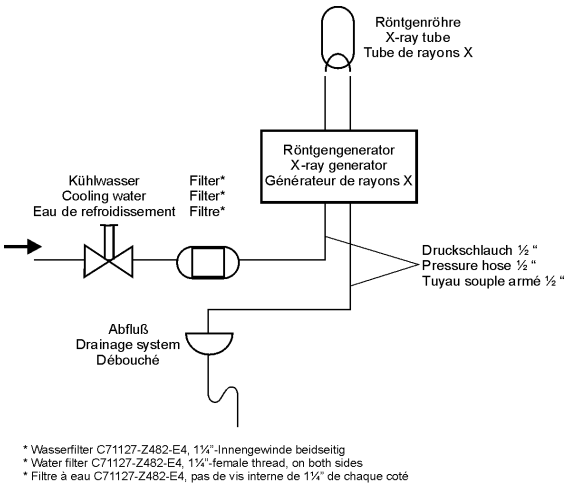


Fig. 1-3: Cooling water connection

The diffractometer is supplied with cooling-water hoses (2 x 5 m, NW 1/2“, with screw connections for the X-ray generator).

Depending on humidity and room temperature, the cooling-water temperature must be so high that condensation is impossible.

Tab. 1-2: Cooling water supply of the X-ray generator

Cooling water supply	Technical Data
Flow rate	min. 3.6 l/min
Difference pressure (= difference between input and output pressure)	4 to 8 bar
Water temperature	10 to 20 °C

The cooling water should be low in suspended matter. A suitable filter must be installed in the inlet line. It is recommendable to connect two water filters in parallel if the water is highly contaminated. The devices then need not to be switched off in order to clean one of the filters.

The hardness of the water should not exceed 30° on the German scale (300 mg CaO in 1 l water); this correspondends to 53.7° on the French scale and 37.5° on the English scale.

If a sufficient tap-water supply is not available an external cooling-water unit with a closed water circulation can be used. In this case it must be considered that the water flow is not continuous. It can be necessary to install a bypass.

To avoid corrosion and the appearance of algae, it is recommended to add an anticorrosion agent to the cooling water of the closed circulation.

Two hoses of NW 1/2“ must be used for connecting the cooling-water unit to the X-ray generator. The maximum permissible length of the hoses is 10 m each. They must be fixed using hose clamps.

3/4“ piping of copper or galvanized steel must be used in the case of larger distances. The maximum length is 15 m per pipe. The ends must be provided with hose unions. Short hoses NW 1/2” are used to connect the X-ray generator and the cooling-water unit. The maximum permissible difference in height between the cooling-water unit and the X-ray generator is 6 m.

Installation of the ion exchanger

The ion filter K120-C7 is shown in figure 1-4 with the short side of the bracket C79298-A3179-C135 hanging over the axis C79298-A3179-C119. In addition to this, the filter has to be secured with a cable binder (C72195-C122-K7) when being transported to avoid slippage. The cable binder is simply wrapped around the bracket C79298-A3179-C135 and the bow C79298-A3179-B106 and securely tied.

Maintenance of the ion exchanger

In order to ensure that the ion exchanger functions safely, it is recommended to check the conductivity of the cooling water regularly (approx. every 2 weeks). The conductivity can be read:

- when using a D8:
  in the menu of D8 Tools under the function *conduct* or
- when using a D5000matic:
  in the menu of Service Tools under the function *conduct* or
- when using a D5000:
  directly on the generator display (*conduct*)

and should never be larger than 7 µS. In case this threshold value is exceeded, remove the aperture C79298-A3179-C136 and clean it with compressed air. If this procedure proves ineffective, replace the ion filter element K120-C8.

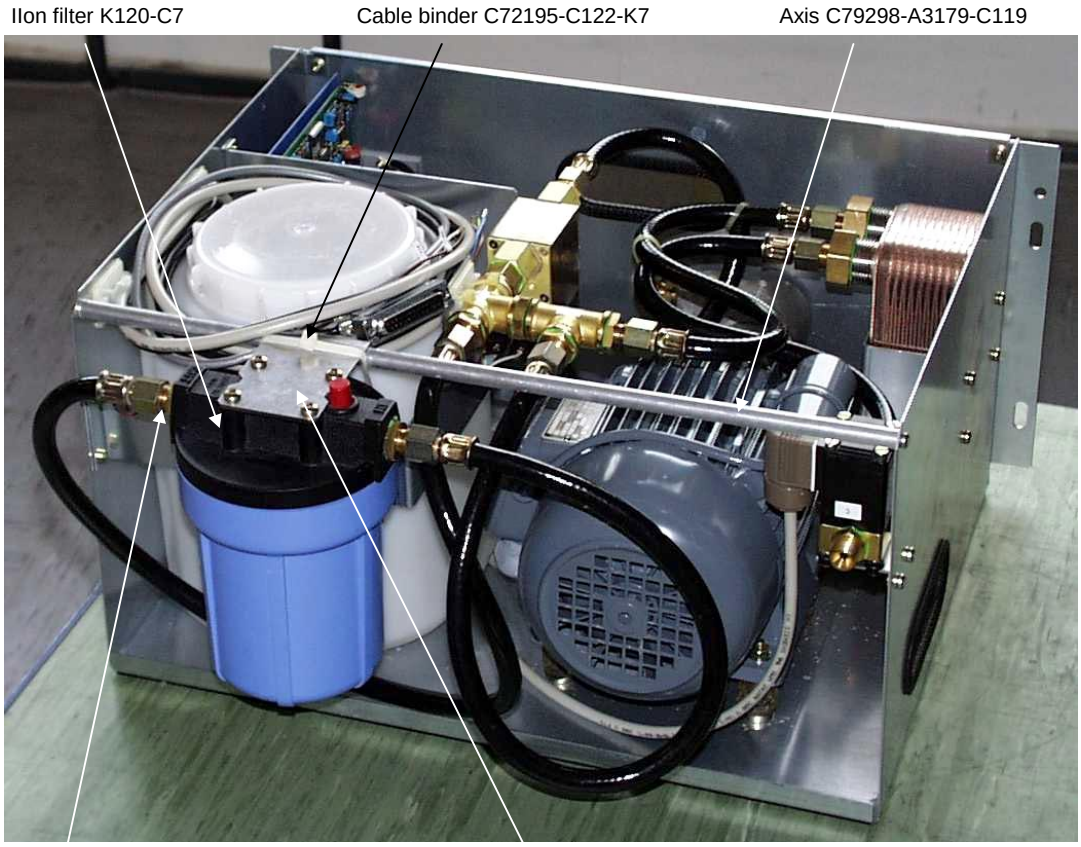


Fig. 1-4: Rear view of the cooling water supply

Counter tube gas supply

(for position sensitive detector, if supplied)

A counter tube gas cylinder with pressure reducer must be provided for the supply of a position sensitive detector. It is expedient to provide an additional location for a spare cylinder.

The line from the counter tube gas cylinder to the diffractometer should be as short as possible. Only Viton hoses may be used.

In the case of longer gas lines, copper or stainless steel piping can be laid up to the vicinity of the diffractometer. The piping must be clean and free from water and solvents and must not contain any solids such as scale or sand.

The counter tube gas lines must not be laid in the vicinity of radiators to ensure that the counter tube gas is not heated.

In order to stabilize the gas flow, a fine regulator for test gases, e.g. type D 14425-16-06 of Messrs. Dräger, should be provided after the pressure reducer (inlet pressure 200 bar, control range 50 to 10.000 mbar).

The flow counter tube is usually operated with a commercial counter tube gas mixture of 90 % argon and 10 % methane.

The counter tube gas must be technically clean (max. impurity 0.5 % v/v). It is recommendable to use compressed-gas cylinders with 50 l contents and 200 bar filling pressure. The cylinders must be suitable supported to prevent them from falling over. The safety regulations for flammable gases must be observed.

A separate outlet to open air must be provided for the used counter tube gas.

2 Safety Guidelines and Technical Specifications

Table of Contents

2 Introduction 2-1

Safety Guidelines 2-1

About This Manual 2-1

General Safety Precautions 2-2

Warnings and Symbols 2-4

Illuminated Warning Displays 2-4

Servicing Precautions 2-5

Cleaning the Diffraction System 2-5

Maintenance of the Diffractometer Measuring Equipment 2-5

Goniometer 2-5

Sample Changer 2-5

Power Supply of Accessories Components 2-6

System Control 2-6

System Control Buttons 2-6

Illuminated Status Displays 2-7

Protection against Radiation 2-8

Tube Stand 2-9

X-Ray Safety Circuits 2-9

Control of the X-Ray Shutter 2-12

Interlock 2-14

Technical Specifications 2-15

General Diffraction System 2-15

Electrical Specifications 2-17

Diffraction Components 2-18

2 Introduction

Safety Guidelines

About This Manual

This manual contains notices which you should observe to ensure your own personal safety, as well as to protect the product and connected equipment. These notices are highlighted in the manual by a warning triangle and are marked as follows according to the level of danger:

⚠ **'Danger'**
The word 'Danger' indicates that death, severe personal injury or substantial property damage will result if proper precautions are not taken.

⚠ **'Warning'**
The word 'Warning' indicates that death, severe personal injury or substantial property damage can result if proper precautions are not taken.

⚠ **'Caution'**
The word 'Caution' indicates that minor personal injury or property damage can result if proper precautions are not taken.

☜ **'Note'**
The word 'Note' draws your attention to particularly important information on the product, handling the product, or to a particular part of the documentation.

Qualified Personnel
The D8 Diffraction System or its parts may only be set up and operated in conjunction with this manual. Only qualified personnel should be allowed to work on this equipment.

The primary installation, maintenance and repair of the diffraction system may be carried out only by personnel who are authorized by Bruker AXS.

All repairs, adjustments and alignments performed at any components of the diffraction system (incl. host computer) must be carried out strictly in accordance with the established safety practices and standards of the country where the equipment is installed.

Correct Usage
This device and its components may only be used for the applications described in the catalog or the technical description, and only in

connection with devices or components from other manufacturers which have been approved or recommended by Bruker AXS.

This product can only function correctly and safely if it is transported, stored, set up, and installed correctly, and operated and maintained as recommended by Bruker AXS.

Disclaimer and Liability
We have checked the contents of this manual for agreement with the hardware, firmware and software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual are reviewed regularly and any necessary corrections included in subsequent editions. Suggestions for improvements are welcome.

General Safety Precautions

⚠ **Caution:**
The D8 Diffraction System is an analytical instrument with a strong X-ray source. Shielding and safety equipment guarantee that the emitted radiation does not exceed 7.5 µSv/h during operation. The enclosure of the diffraction experiment serves as the radiation protection box. It must always be ensured that the radiation protection box and the setup of the goniometer corresponds to one of the specified configurations and that the safety system is always in operation. Read chapter 'Protection Against Radiation' before turning on the diffraction system.

If it seems that the safety system does not work correctly or the radiation protection is impaired by any reason you must switch off the system immediately and contact your local Bruker AXS Service Organisation.

Manipulations and modifications of the safety systems are strictly forbidden!

Warning: ⚠
Danger of injury! The rear panel of the radiation safety enclosure is designed for radiation shielding and is extremely heavy. It is only used to access the goniometer during installation and maintenance. The panel must be mechanically secured by two screws located at the bottom left and right corner.

Warning: ⚠
Danger of injury! Be aware that the components attached to the goniometer will move during operation.

Warning: ⚠
When modifying the mechanical setup of the diffraction experiment the power of the diffraction system must be turned off completely. Be aware that the 'Power off' button sets the high voltage generator to standby mode only. In order to switch it off you must use the key switch located at the control panel of the high voltage generator.

⚠ **Warning:**
In order to prevent substantial damages in the system you must turn off the power of the diffraction system completely before connecting or disconnecting any cables attached to the X-ray tube, the radiation detectors, motors or to the various accessory components.

⚠ **Warning:**
The system's mains distribution unit is located underneath the left side panel of the cabinet. Usually the mains distribution unit will be accessed by authorized service personnel only. But, some of the optional accessories of diffraction experiments get their electrical power out of the switched power sockets which are part of the mains distribution unit. If the power line of such an component needs to be connected or removed the left side panel can be opened by the user.

Be aware! When the equipment is connected to the mains supply, some terminals of the mains distribution unit may be live. Therefore it is absolutely necessary to switch off the external mains supply before opening the side panel. It is **not** sufficient to just press the D8's 'Power OFF' button. The mains supply must be switched off externally on the customer's side (wall socket or external switch). After the side panel is attached again it must be secured using two screws. (See chapter 'Control Electronics - Mains Distribution Board' in this manual.)

Warning: ⚠
The interior of the radiation protection box is illuminated by a standard fluorescent light tube located on the ceiling. Turn off the system's wer supply before removing/inserting the light tube.

Warning: ⚠
Do not touch the front window of X-ray detectors as it contains Beryllium.

Fumes or the dust from Beryllium and its compounds can be hazardous if inhaled! During use corrosion of beryllium may occur. Beryllium must not be cut, machined or handled in any way.

Warning: ⚠
Some of the electronic boards are equipped with batteries. Disposal of batteries must comply with all applicable national regulations.

Warning: ⚠
Sometimes complex D8 systems will be supplied by several power supply lines. The system and its components will be live until **all** power lines connected to the system are disconnected from the mains power supply.

Warnings and Symbols

The following indicators and symbols are displayed on the D8 Diffraction System. Strictly obey all instructions and warning text printed on the labels which are attached to the various parts of the equipment.

Symbols



Radiation Danger!
This symbol is fixed at the front panel of the high voltage generator and also on each of the four orange warning displays.



Live Part! Risk of Electric Shock!



Caution! Read the Operating Instructions!



Protective Ground/Earth Terminal



Emergency Stop!
Switch off the High Voltage Generator and the control electronics immediately!

Illuminated Warning Displays

'X-rays On'
Illuminated orange warning display on top of the radiation protection box signals that the X-ray tube is radiating. Radiation Danger!



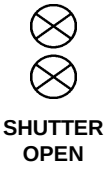
'X-rays On'
Illuminated orange warning display located at the High Voltage Generator's front panel signals that the X-ray tube is radiating. Radiation Danger!



'Service Operation Mode Activated'
Flashing red warning display indicates that the D8 system is in the unprotected service operation mode. Radiation Danger!



'X-ray Shutter Open - Radiation Danger!'
The two red warning displays located at the tube mount indicate that the X-ray shutter is open. Radiation Danger!



'X-ray Shutter Safely Closed'
The single green display indicates that the X-ray shutter is in the safe position, i.e. the radiation window is closed.



For detailed information see section 'Protection Against Radiation' appearing on page 2-8.

Servicing Precautions

All repairs, adjustments and alignments performed at any components of the diffraction system (incl. host computer) must be carried out strictly in accordance with the approved works practices of the country where the equipment is installed.

The electronic modules contain electrostatically sensitive devices. Before any components or modules are touched, the service person should discharge hisself by touching an earthed object.

The physical components must only be connected to the front plugs of the modules provided for them. The block diagram C79298-A3240-A1 provides information. The front plugs of the modules are not protected against the insertion of incorrect components.

⚠ **Warning:**
The incorrect connection of modules or components may result in substantial damage in the system. Therefore thoroughly check all such operations before switching on the power supply.

Cleaning the Diffraction System

For cleaning the interior of the radiation protection box use dry cleaning utensils only. Do not use water or aggressive cleansing agents. The front doors can be cleaned with any standard household-type window detergent.

Caution: ⚠
Before starting cleaning you must turn off the power of the complete diffraction system, i.e. both control electronics, accessory components and high voltage generator!

Maintenance of the Diffractometer Measuring Equipment

The components of the diffractometer measuring equipment are mainly maintenance-free.

It is recommended to regularly check and maintain the following components by Bruker AXS service people.

Goniometer

Clean or replace and relubricate the lubricating brushes (parts list item No. 4.1.4) at the worm drives for theta and 2theta.

Only use the lubricant "Molymagnus NT-3" which is supplied by Wiho-Chemie, Virchowstr. 7, D-90409 Nürnberg and manufactured by Strub & Co. AG, Ch-6260 Reiden.

Sample Changer

Clean the gear meshing and lubricate using commercial grease.

Power Supply of Accessories Components

Inside the Mains Distribution Unit there are six shockproof sockets which are mainly used internally for powering the control electronics and fans of the cabinet. These sockets are switched on/off by the system's Power ON and Power OFF button. In addition to that they are switched off by the emergency stops in case of danger.

If desired the power lines of accessory components can be attached to these shockproof sockets. In that case it must be secured that the total power consumption of all attached accessory components does not exceed 800VA.

⚠ **Danger!**
When the equipment is connected to the mains supply, some terminals of the mains distribution unit may be live. Therefore it is absolutely necessary to switch off the external mains supply before opening the side panel. It is **not** sufficient to just press the D8's 'Power OFF' button. The mains supply must be switched off externally on the customer's side (wall socket or external switch). After the side panel is attached again it must be secured using two screws. (See chapter 'Control Electronics-Mains Distribution Board' in this manual).

System Control

System Control Buttons



Emergency Stop Button
This button is located on both the left and right operation panel of the cabinet. If hit it switches off the control electronics and all accessories attached to the mains sockets of the mains distribution unit immediately, i.e. stops the movement of all drives and also turns off the high voltage for the X-ray tube.

The High Voltage Generator is not turned off by that button but just set to standby mode.



Turn On Power of the Diffraction System
This button switches on the control electronics and all accessories attached to the mains sockets of the mains distribution unit.

The High Voltage Generator is not controlled by that button. The High Voltage Generator must be switched ON separately using the key switch located at its front panel.



Turn Off Power of the Diffraction System
This button switches off the control electronics and all accessories attached to the mains sockets of the mains distribution unit.

The High Voltage Generator is not turned off by that button but just set to standby mode. The High Voltage Generator must be switched OFF separately using the key switch located at its front panel.



Turn On/Off Fan
This button turns ON/OFF the fan located on top of the radiation protection box.



Turn On/Off Illumination
This button turns ON/OFF the fluorescent tube located at the ceiling of the radiation protection box.

For more information about how to turn ON the High Voltage Generator see chapter 4 'High Voltage Generator' in this manual.

Illuminated Status Displays



Power of Diffraction System 'Turned On'
This display indicates that the control electronics and all accessories attached to the mains sockets of the mains distribution unit are powered on or off.

The power status of the High Voltage Generator is not displayed by that lamp. The High Voltage Generator must be switched ON/OFF separately using the key switch located at its front panel.



Fan Activated
This display indicates the status of the fan located on top of the radiation protection box.



Illumination Turned ON
This display indicates the status of the fluorescent tube located at the ceiling of the radiation protection box.



Control Electronics 'Turned On'
(Left and right operation panel of the cabinet)
Illuminated green display indicates that the control electonics rack is powered on.

Run



Display for System Alarms and Warnings
(Left and right operation panel of the cabinet)
Illuminated red display indicates a system alarm, flashing red light indicates a warning.

Alarm



Measurement Running/Suspended
(Left and right operation panel of the cabinet)
Illuminated yellow display indicates that a measurement is in progress, flashing yellow display means that the measurement has been suspended because any physical component is not ready.

Busy

Protection against Radiation

The D8 Diffraction System is an analytical instrument with a strong X-ray source. Shielding and safety equipment guarantee that the emitted radiation does not exceed 7.5 μSv/h during operation. The enclosure of the diffraction experiment serves as the radiation protection box. It must always be ensured that the radiation protection box and the setup of the goniometer corresponds to one of the specified configurations and that the safety system is always in operation.

The following is necessary to guarantee a radiation-safe design of the x-ray setup:

- The tube mount must be attached to the track provided on the goniometer, and the goniometer must be located at one of the pre-defined and monitored positions located on the bottom part of the radiation protection box.
- The primary optics must be mounted.
- The radiation protection box must be installed completely. This guarantees that the scattered radiation produced during the measurement is shielded.

There are several warning displays which have the following meanings:

On top of the radiation protection box the orange warning displays signal that the X-ray tube is radiating (“X-rays on”). The flashing red display indicates that the D8 system is in the unprotected service operation mode.

The two red warning displays located at the tube mount means that the X-ray window is open (“Shutter open”). The green display indicates that the X-ray shutter is in the safe position, i.e. the radiation window is closed.

The function of all these warning lamps is monitored.

The rear panel can be removed for servicing and installation. In this case the X-ray generator will be disabled by the safety system since the radiation protection could not be guaranteed.

The D8 diffraction system has been aligned prior to delivery. A new alignment, even following a tube replacement, is generally possible with the radiation protection housing closed.

If it is necessary to align under radiation with the radiation protection housing open, the safety switches of the panel elements of the radiation protection housing can be bypassed using a key switch. It is forbidden to override the safety functions in any way other than using the key switch. The red service warning displays on top of the radiation protection box are flashing when the key switch has been activated. Only the person responsible for radiation protection measures or other authorized persons have the permission to use the safety key. The key must be safely guarded by them to prevent abuse.

When the key switch is activated, the generation and release of X-rays is exclusively the responsibility of the current user: The operating

data of the X-ray tube (high-voltage and current) can only be selected manually directly at the X-ray generator. The X-ray shutter can only be activated using the buttons located at the service operation panel.

⚠ **Caution:**
Working with an unprotected diffractometer is dangerous. Alignment work with an unprotected unit must only be carried out by persons who are subject to personal dose measurements and medical surveillance. Only the lowest values for the high-voltage and tube current are allowed to be used. Use long alignment tools! Never hold your hand in the primary beam! Only remove those parts of the shielding whose removal is essential for the alignment. Generally it is sufficient to remove only the rear panel.

Tube Stand

The tube stand is an essential part of the radiation protection facilities. It has an outlet window for the working beam which can be closed by a 4 mm thick W/Cu shutter. It is forbidden to manipulate the shutter and the surrounding flange plate. The switches S3 and S4 located in the tube mount are only closed when the tube mount is installed correctly. Only then the shutter can be opened.

X-Ray Safety Circuits

See schematics C79298-A3242-A11-*-11 and C79298-A3244-A1-*-11.

D8 diffraction systems have two totally independent safety circuits. Both safety circuits are directly connected with the safety control unit (implemented with contactors) located inside the X-ray generator. Generation of the high-voltage is only enabled in the X-ray generator when both safety circuit are closed i.e. both signal safe conditions.

Safety Circuit #1:
Safety Circuit #1 consists of the shutdown relays K1, K2, K4 and K5 (part of C79298-A3220-B200), the circuit-breakers S651(left goniometer position switch) and S653 (right rear panel switch), the top front door switches S657 (left front door) and S659 (right front door) , the X-ray shutter position switch S1 (part of the tube mount) and the rip cord which connects to ground potential and monitors the correct installation of the high-voltage cable. If all switches are closed ground potential will be conducted from the rip cord's end through the whole line of switches and applied to the X-ray generator's safety control unit. The ground level switches a relay which enables the generation of the high-voltage.

Safety Circuit #2:
Safety Circuit #2 consists of the shutdown relays K1, K2, K4 and K5 (part of C79298-A3220-B200), the circuit-breakers S652(right goniometer position switch) and S654 (left rear panel switch), the bottom front door switches

S658 (left front door) and S660 (right front door) and the X-ray shutter position switch S2 (part of the tube mount). If all switches are closed the X-ray generator will apply a potential of +24V to the terminating pin of S2. That positive +24V potential will be conducted starting from the shutter position switch S2 through the whole line of switches and applied to the X-ray generator's safety control unit. There the positive voltage will switch a further relay which enables the generation of the high-voltage.

The various components of the safety circuit work as follows:

S651/S652:
The switches S651 and S652 monitor the position of the goniometer and are mounted at the right and left side panel of the goniometer. They secure that the goniometer is located exactly at one of the permissible positions. The switches are circuit-breakers with positive opening contacts. Each switch has a second contact which is wired to digital inputs of the control electronics. Thus the status of these switches can be verified by the host or service computer.

S653/S654:
The switches S651 and S652 check if the rear panel of the X-ray protection box is installed. They secure that the X-ray generator cannot generate any high-voltage if the rear panel is not mounted correctly (during non-service operation mode). The switches are circuit-breakers with positive opening contacts. Each switch has a second contact which is wired to digital inputs of the control electronics. Thus the status of these switches can be verified by the host or service computer.

S657-S660:
The switches S657 and S658 check if the left front door is closed correctly, switches S659 and S660 check the right front door. While the X-ray generator's high-voltage is turned on all these switches secure that the front doors can only be opened when the X-ray shutter is closed (during non-service operation mode).

Each switch is controlled individually by a special control logic located on the Universal IO-Board. The control logic which is implemented by hardware compares the states of S657 and S658 and also of S659 and S660 by pairs. If the state of any switch pairs differ the control logic will immediately open the safety circuit via the relays K1 and K2 and thus disable the generation of high-voltage.

Rip Cord:
The rip cord connects the safety circuit 1 to ground potential and monitors correct installation of the high-voltage cable. In safety circuit 1 at the connection point of the rip cord a resistor (R2, 6.8 Ohm) is inserted. The current flowing through safety circuit 1 generates a voltage drop in this resistor which serves to monitor the safety circuit for an impermissible ground connection prior to the rip cord contact.

In 'Double Diffraction Systems' there is only one rip cord which must be connected with the shutter control electronics of shutter 1.

S1/S2:
The X-ray shutter position switches S1 and S2 are part of the shutter control electronics which is located directly at the tube mount. S1 and S2 open together with the X-ray radiation shutter and signal the emission of X-rays. If the X-ray generator is turned on and the X-ray shutter is closed S1 and S2 will bypass the upper and lower switches of the right and left front door. Thus in that case the user can open and close the front doors without turning off the X-ray generator.

In 'Single D8 Diffraction Systems' the X-ray shutter position switch S1 is part of the safety circuit 1 and is connected in parallel to the upper front door switches S657 and S659 (simulation key C79298-A3242-B104 must be installed!). Switch S2 is part of safety circuit 2 and is wired in parallel to the lower front door switches S658 and S660.

In 'Double Diffraction Systems' there are two different X-ray shutters each having a separate pair of position switches. Position switch S1 of shutter 1 is connected in series to switch S1 of shutter 2. Both switches are connected in parallel to the upper front door switches S657 and S659. Corresponding position switch S2 of shutter 1 is connected in series to switch S2 of shutter 2. These two switches are connected in parallel to the lower front door switches S658 and S660 (The simulation key C79298-A3242-B104 is not necessary for double diffraction systems!).

K1,K2,K4,K5:
The so-called shutdown relays K1 and K2 are driven by the safety control unit which is implemented by hardware and is located on the Universal IO-board of control electronics 1. The contacts of K1 and K2 are inserted as well as in safety circuit 1 and safety circuit 2.

The so-called shutdown relays K4 and K5 are driven by the safety control unit which is implemented by hardware and is located on the Universal IO-board of control electronics 2. The contacts of K4 and K5 are inserted both in safety circuit 1 and safety circuit 2, too. In single diffraction systems K4 and K5 will be activated all time.

If the safety control units of control electronics 1 and 2 do not detect any errors then K1, K2, K4 and K5 will close and both safety circuits will be closed.

K1 and K2 or K4 and K5 respectively will open the safety circuit and thus shut down the X-ray generator if one or more of the following error conditions occur:

- the internal or external X-ray warning display is not OK
- the service warning display is not OK
- the internal or external 'Shutter Open' / 'Shutter Closed' displays are not OK
- the X-ray shutter sticks and does not close completely
- the status of the front door switches S657 and S658 or S659 and S660 does not match

- the status of the shutter position switches S1 and S2 (located at tube mount) does not match
- the readback contacts of the shutdown relays K1 and K2 (K4 and K5) detect different states
- the service relay K3 sticks

K3:
With the so-called service relais K3 portions of the safety circuit can be bypassed by authorized persons for servicing purposes. This status is indicated by the flashing of the red service warning lamp which is located on top of the X-ray protection box.

After turning on service mode using the key switch S624 which is part of the service operation panel the service relay K3 will be activated and close its contacts. Then K3 will bypass the rear panel switches S653/S654 and the front door switches S657-S660, i.e. during service mode the X-ray shutter can be opened even if the front doors are open and the rear panel is removed.

The contacts of key switch S624 and of service relay K3 as well as the function of the red service warning lamp are monitored by the Universal IO-Board. In the event of an error, the generator high-voltage is switched off via the shutdown relays K1, K2 or K4 and K5.

In double goniometer systems the service key switch and the service warning lamps are controlled and monitored by control electronics 1 only. Control electronics 2 is not involved.

Caution:
During service operation mode the system is unprotected! Working on an unprotected instrument is dangerous! In this case the radiation protection requirements must be strictly observed!

Control of the X-Ray Shutter

See schematics C79298-A3244-A1-*-11.

The X-ray shutter (tube mount) is connected directly with the shutter control unit which is implemented on the Universal IO-Board. If the shutter shall open the control unit provides the X-ray shutter magnet first with an opening voltage pulse and then with a hold current which keeps the shutter window open.

The X-ray shutter will only open if the following four conditions are fulfilled:

1. The whole tube mount is installed correctly (controlled by switches S3 and S4).
2. The primary optics is attached (controlled by switches S5 and S6).
3. The generator high-voltage is switched on.
4. The shutter control logic detects that the shutter displays are OK.

If one of the conditions (1) to (3) fails, the current through the X-ray shutter's coil will be switched off and the shutter will close immediately driven by a mechanical spring.

If the shutter control logic detects an error (current throuth the shutter displays is not OK or the X-ray shutter position switches S1 and S2 do not detect the same state) the shutdown relays K1/K2 or K4/K5 will open. Consequently the X-ray generator's high-voltage will be turned off and the X-ray shutter will close.

The shutter contol electronics differ between two operating modes dependent of key switch S624 located at the service operating panel.

Standard Operation Mode
The X-ray shutter is controlled remotely by the host computer using the firmware commands 'Open Shutter' and 'Close Shutter'. The buttons located at the service operation panel are disabled completely.

Service Operation Mode

In this mode any pending 'Open Shutter' commands sent by the host computer are deleted and new 'Open Shutter' commands are not accepted any longer. Thus the X-ray shutter cannot be controlled by the host computer any more (not even using direct commands).

During Service Operation Mode the buttons of the service operation panel are enabled. The shutter can be opened and closed manually by pressing the 'Open Shutter' and 'Close Shutter' buttons. For more information see chapter 'Service Control Panel' in this manual.

Caution:
During service operation mode the system is unprotected! Working on an unprotected instrument is dangerous! In this case the radiation protection requirements must be strictly observed!

Shutter Warning Displays

Warning display located at the tube mount:

Green LED:
The green LED display indicates that the X-ray shutter is closed, i.e. the X-ray shutter is in the safe position with the radiation outlet window being closed.

The current through the green LED is permantly measured. If an error of the display is detected the X-ray generator will be switched off immediately via the safety circuit (shutdown relays K1/K2 or K4/K5 will open the two **safety circuits).**

Red LEDs:
The red LED display indicates that the X-ray shutter is not closed, i.e. the X-ray shutter is at least partially open and X-ray radiation is emitted through the radiation outlet window into the interior of the X-ray protection box.

The current through the two red LEDs is permanently measured. If an error of the display is detected the X-ray generator will be switched off immediately via the safety circuit (shutdown relays K1/K2 or K4/K5 will open the two safety circuits).

Interlock

The interlock is an important safety device to protect against X-ray pollution. The interlock ensures, that the X-ray source can only be mounted and run in certain positions within the radiation protection enclosure.

⚠ **Danger:**
Only service people from Bruker AXS or specially educated personnel are allowed to set up the interlock.

Any manipulation could cause injury due to X-rays. If a forced or irregular interlock manipulation is detected, your licence for full radiation protection systems will be revoked.

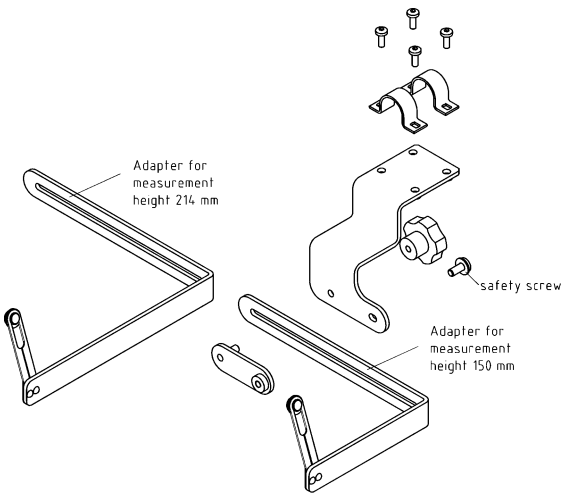


Fig. 2-1: The interlock safety system (1)

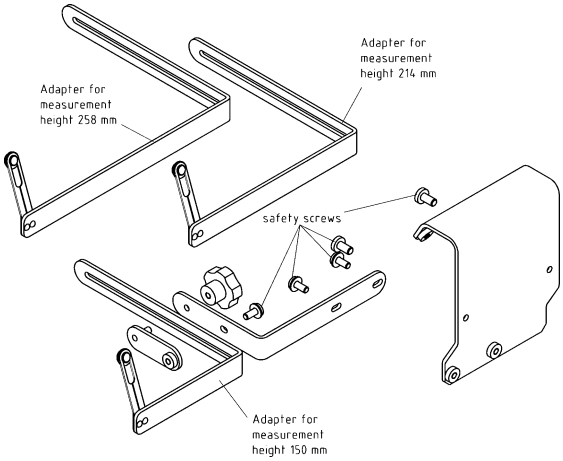


Fig. 2-2: The interlock safety system (2)

Technical Specifications

General Diffraction System

Tab. 2-1: Technical Specifications: General Diffraction System

Mechanical Specifications	
Weight of the cabinet including X-ray generator and control electronics	220 kg
Weight of the radiation protection Box including goniometer, tubestand, tube and standard mounts	320 kg
Area load per m^2 of the floor (standard system including goniometer, tubestand, tube and standard mounts)	720 kg/m^2
Height (Cabinet and Radiation Protection Box)	2035 mm
Width	1400 mm
Depth	1255 mm

Environmental Specifications	
Temperature operation range	14 - 34° Celcius
Maximum temperature gradient	0.5° Celcius per hour
Relative humidity	20%-80%, condensation not allowed
Atmospheric pressure	Diffraction system applicable at all terrestic locations under atmospheric air pressure conditions

Cooling Water Requirements	
Minimum Flow Rate	3.5 l/min
Water Pressure	5 to 8 bar
Operating Water Temperature	10 to 35° Celcius
Diameter of Cooling Water Supply	1/2“

Safety Specifications	
Electrical Safety	DIN EN 61010-1 IEC 1010-1
Electromagnetic Compatibility:	EN50081-1 und EN50081-2 EN50082-1 und EN 50082-2
Radiation Safety	• Recommendations of ICRP (International Commission on Radiological Protection) • Recommendations of IAEA (International Atomic Energy Association) • Instructions of EURATOM (Europäische Atomgemeinschaft) • German Law ‘Atomgesetz’ • German Law ‘Roentgenverordnung’ • DIN (Deutsches Institut für Normung) 54113 • ‘Bauartzulassung’: PTB (Physikalisch Technische Bundesanstalt) certificated as ‘Vollschutzgeraet nach Roentgenverordnung’ • Each D8 System runs through an individual radiation safety test.
Protection Classification according IEC 536	Class I
Protection Degree according IEC 529	IP 2 0

Electrical Specifications

Tab. 2-2: Technical Specifications: Electrical Specifications

Diffractometer including X-ray Generator and Control Electronics but without accessories	
Mains Supply Voltage (Actual nominal voltage is factory-preset and printed on the system label located at the cabinet's rear panel.)	One Phase Supply: 208VAC (+/- 10%) 230VAC (+/- 10%) 240VAC (+/- 10%) Three Phases Supply: 3 x 120VAC (+/- 10%) 3 x 230VAC (+/- 10%) 3 x 240VAC (+/- 10%) (For details see schematics 'D8-Mains Distribution')
Frequency Range	47Hz - 63Hz
Maximum Power Consumption	max. 6 kVA Generator: max. 5.5 kVA at 3kW tube power Control Electronics: max 0.5 kVA
Overvoltage Category according IEC 664	II

Optional Internal Water Cooling Unit (C79298-A3179-A11)	
Mains Supply Voltage and Frequency	AC230V (+/- 10%)
Frequency Range	47Hz - 63Hz
Maximum Power Consumption	460 VA

Diffraction Components

Tab. 2-3: Technical Specifications: Diffraction Components

Goniometer	
Measuring Circle Diameters	435 mm 500 mm 600 mm all intervening settings possible
Operating Position	Horizontal or vertical
Angular Range of Theta and 2-Theta	360° (depending on mountings)
Step Width	0.0001 degree
Angular Range with Standard Mounts All angular values are given for measurement circle diameter of 435 mm. All angular values may be smaller in respect to the used tube mount type. The angular values may be different if a different measurement circle diameter is used. - with fixed slit assembly long - with fixed slit assembly short - with variable divergence diaphragms and fixed diffracted beam assembly - with variable divergency assembly - with fixed divergence diaphragm and gracing incidence soller slit - with variable divergence diaphragm and gracing incidence soller slit	 2-Theta <= 169° 2-Theta <= 166° 2-Theta <= 163° 2-Theta <= 158° 2-Theta <= 163° 2-Theta <= 158°
Reproducibility of the Angle Setting (Theta and 2-Theta)	<= +/- 0.0005°
Absolute Accuracy (Theta and 2-Theta)	<= +/- 0.005°
Central Clearance in Theta ring	100 mm
Theta and 2-Theta drive	controlled by two independent stepper motors
Velocity	max. 2000°/min (dependent on hardware setup)
Scanning Velocity	max. 200°/min (dependent on hardware setup)
Rotating Ring Stress Capacity Axial Thrust Torque Perpending Axis	 500N 1000 Ncm

3 Operating Instructions

Table of Contents

3 Operating Instructions 3-1
Application 3-1
Method of Operation 3-2
Design of the Diffractometer 3-4
Goniometer 3-5
X-ray Tube and Tube Stand 3-8
X-ray Tube 3-8
Tube Stand 3-8
Cable protection cover 3-9
Slit Systems 3-10
Aperture Slit System 3-10
Detector Slit System 3-12
Fixed Slits 3-13
Micro Diaphragms 3-14
Slit Changer 3-14
Variable Slit 3-14
Divergence Slit Next to the Sample 3-15
Scattered-Radiation Slit Next to the Sample 3-15
Kβ Filter 3-15
Absorber 3-15
Sample Carrier 3-16
Standard Sample Carrier 3-16
Rotating Sample Carrier 3-22
Scintillation Counter 3-26

Optional Detectors 3-27
Si(Li) Semiconductor Detector 3-27
Position Sensitive Detector 3-28
Control Electronics 3-30
Circuit Diagrams 3-30
Mains Distribution Board 3-31
Control Rack 3-32
Control Electronics Modules 3-33
Main Processor - Slot CPU Board (C79298-A3220-B106) 3-33
Universal I/O-Board (C79298-A3220-B103) 3-34
Detector Interface Board (C79298-A3220-B102) 3-38
Indexer/Driver 2 Axis / 4 Amps (419-306500) 3-43
Indexer/Driver 4 Axis / 2 Amps (419-306600) 3-47
Box Distribution Board (C79298-A3220-B200) 3-51
X-ray Shutter Status Display (C79298-A3220-B202/B203) 3-52
Control Panel (C79298-A3242-B43) 3-52
External X-ray Warning Display (C79298-A3220-A2) 3-53
Manual Control Box (SXI-472037000) 3-54
Hardware Setup 3-54
Firmware 3-55
Configuration 3-55
Keyboard setup 3-58
Short Description of Functions 3-58
Additional Information about Functions 3-62
Mounting 3-68
Connection to the X-ray Generator 3-68
Connection of the High-voltage Cable 3-68
Connection of the Cooling Water Hoses 3-68
Shutter Control Cable 3-69
Fitting and Removal of the X-ray Tube 3-69
Instrument Initialisation 3-71
Format of file DEVICE.INI 3-71
Sections of DEVICE.INI 3-72
[DEVICE] section 3-72
[UIOBx] section 3-72
[DIBx] section 3-74
[2AIBx] section 3-75
[4AIBx] section 3-75

[COMx] sections ... 3-76
[DRIVEx] section ... 3-78
[CHANNELx] section ... 3-84
[SCB] section ... 3-87
[IK121-x] section ... 3-87
[RS]-section ... 3-88
[SHUTTERx] section ... 3-88
[DETECTOR] section ... 3-91
Interfaces to External Computers ... 3-93
Transmission Protocol ... 3-94
Data transfer without software handshake ... 3-94
Data transfer with software handshake ... 3-94
Cable Wiring of RS 232 C Serial Connectors ... 3-95
Remote Control by an External Computer ... 3-95
Description of Remote Control Commands ... 3-96
Commands for operating mode switchover ... 3-96
Commands for device parameterization ... 3-98
Commands for measuring channel parameterization ... 3-106
Control commands ... 3-111
Commands for parameterizing and starting measuring functions and reading results ... 3-127
Commands for reading instrument status ... 3-145
Miscellaneous Commands ... 3-150
Measuring Function Status ... 3-152
Status Flags ... 3-154
Error Flags ... 3-160
Remote Control Command Set (Overview) ... 3-162
Commands for mode switchover ... 3-162
Commands for instrument parameterization ... 3-162
Commands for channel parameterization ... 3-162
Control commands ... 3-163
Commands for parameterizing and starting measuring functions and reading results 3-163
Commands for reading instrument status and instrument registers ... 3-164
Miscellaneous Commands ... 3-164
Remote Control Command Set (alphabetical order) ... 3-165
Command Macros ... 3-167
Macro Definition ... 3-167
Macro Execution ... 3-168

Assignment of the I/O Ports 3-169
Universal I/O Boards 3-169
Detector Interface Boards 3-176
2-Axis Indexer Boards 3-179
4-Axis Indexer Boards 3-182
Alignment of the diffractometer 3-187
Alignment of the fixed slit assembly 3-189
Zero point definition of the θ scale 3-189
Zero point definition of the 2θ scale 3-190
Centering the anti-scatter slit to the zero beam 3-191
Centering the aperture slit to the zero beam 3-192
Centering the radiation outlet flange 3-193
Alignment of the variable slit assembly 3-194
Zero definition of the θ scale 3-194
Zero definition of the 2θ scale 3-195
Centering the variable anti-scatter slit to the zero beam 3-196
Centering the variable aperture slit to the zero beam 3-197
Centering the fixed aperture slit to the zero beam 3-198
Aligning the receiving slit changer 3-199
Aligning the Parameters of the Measurement Electronics 3-200

3 Operating Instructions

Application

The D8 X-ray diffractometer can be used for nearly all X-ray diffraction applications, such as structure research, phase analysis, stress and texture measurements.

Various supplements may be used together with the diffractometer; these include

- extended mask systems
- primary and diffracted beam monochromators
- sample carrier and center gauge
- detectors (scintillation counter, position sensitive detector, Si(Li) semiconductor detector)
- texture
- flux analysis
- grazing incidence
- high and low temperature chambers.

The standard model of the diffractometer is used for powder examinations.

The diffractometer can be computer-controlled and thus used for automatic operation.

The diffractometer is equipped with separate drives which may be coupled electronically or used independently from one another.

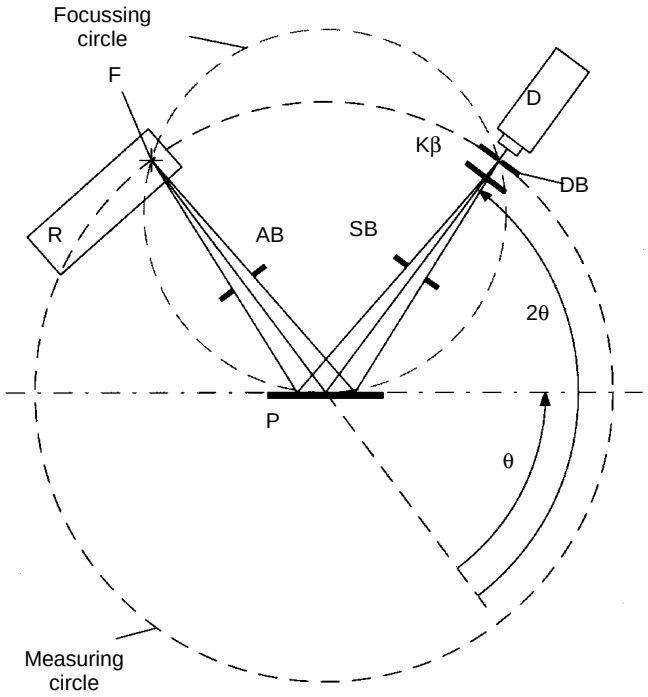
Method of Operation

The radiation emanating from the line focus of the X-ray tube is diffracted at the sample and recorded by the detector. The sample rotates at a constant angular velocity such that the angle of incidence of the primary beam changes whilst the detector rotates at double angular velocity around the sample (Bragg-Brentano geometry). The diffraction angle (2θ) is thus always equal to twice the glancing angle (θ). The diffractometer beam path is shown in Fig. 3-1.

Each time the Bragg condition is satisfied, the primary beam is reflected from the sample to the detector. The detector and the connected measuring electronics measure the intensity of the reflected radiation; the angular position of the reflections is displayed at the controller.

Pulse counts or diffraction patterns are obtained in this way.

For clearer representation, the Kβ reflections may be suppressed using a filter or a monochromator.



θ *Glancing angle*
2θ *Diffraction angle*
AB *Aperture slit*
D *Detector*
DB *Detector slit*
F *Focus*
Kβ *Kb filter*
P *Sample*
R *X-ray tube*
SB *Scattered-radiation slit*

Fig. 3-1: Beam path of the diffractometer

The Bragg-Brentano law is used for focussing. Focus, sample and detector slit are on the focussing circle; focus and detector slit are also located on the measuring circle. In order that the diffracted radiation can be focused when it hits the detector, the whole effective sample surface should actually be on the focussing circle. In a practical system, however, it is sufficient to place the surface of the plane sample tangentially at the focussing circle.

An aperture slit between tube and sample delimits the irradiated sample area.

Undesired scattered radiation is suppressed by the scattered radiation slit.

Design of the Diffractometer

The diffractometer (Fig. 3-2) consists of the goniometer (1), the tube, the tube stand (2), the slit system (3 and 5) required for the measurement, the sample carrier (4) and the detector (6).

The unit is installed horizontally or vertically in a radiation protection housing or on a separate table. When installed in a radiation protection housing, the unit meets the requirements for fully protected instruments, as laid down in the German X-ray regulations of 1.3.1973. A lead glass window at the front of the radiation protection housing enables the samples to be changed or the diffractometer mounts to be modified. The window shutter of the tube stand closes automatically when this window is opened.



1 Goniometer
2 Tube stand
3 Aperture slit system
4 Sample carrier
5 Detector slit system
6 Detector (scintillation counter)

Fig. 3-2: D8 diffractometer, vertical installation

Goniometer

The goniometer (Fig. 3-3) consists of a housing which accepts the inner ring (2), the outer ring (1) and the drive.

Inner ring (2) and outer ring (1) are driven by a stepper motor each.

A foot (3) is provided for vertical installation.

The goniometer contains opto-electronic definitions of the reference position for θ circle at 30° and 2θ circle at 60°.

θ/2θ goniometer
The track (4) for detector and detector slit system is mounted on the outer ring (1). The sample carrier is mounted on the inner ring (2). The track (5) for tube stand and aperture slit system is mounted on the goniometer housing.

θ/θ goniometer
The track (4) for detector and detector slit system is mounted on the inner ring (2). The sample carrier is in a fixed position. The track (5) for tube stand and aperture slit system is mounted on the outer ring (1).



1 Outer ring
2 Inner ring
3 Foot for vertical installation
4 Track for detector and detector slit system
5 Track for tube stand and aperture slit system

Fig. 3-3: Goniometer

Within the D8 diffractometer there are 3 useful predefined measuring circle diameters:

- 435 mm
- 500 mm
- 600 mm

Different optical components can now be used absolutely easy and reproducible without having to measure distances actively.

This is realised using hard pin stops on the tracks put into the according positions (fig. 3-4). Therefore there are 3 holes on the incident beam track as well as 3 especially highlighted holes on the diffracted beam side as shown in the picture. The remaining holes on the secondary side are used for different special applications.

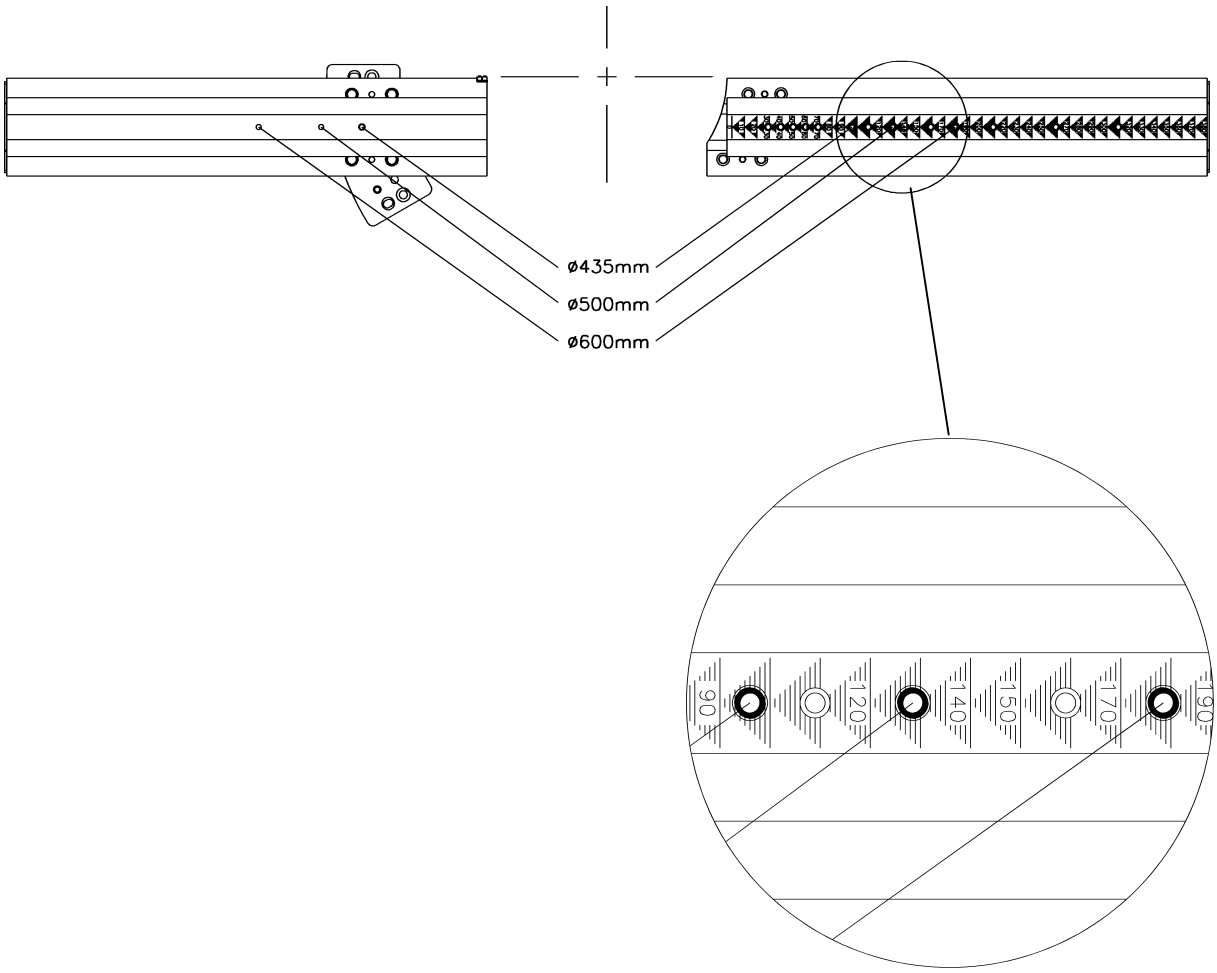


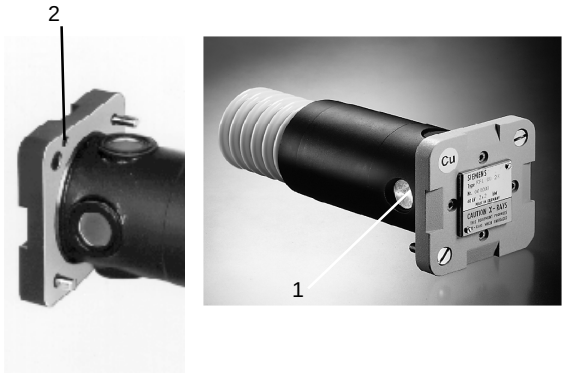
Fig. 3-4: Predefined measuring circle diameter

X-ray Tube and Tube Stand

An X-ray tube with lateral radiation outlet window is used in the D8 diffractometer. This X-ray tube with earthed anode is supplied by a KRISTALLOFLEX 760 X-ray generator which is installed in a console-type housing.

X-ray Tube

An KF...4KE air-insulated X-ray diffraction tube is available with Cr, Fe, Co, Cu, Mo, Ag or W anode. The optical focus can be modified by changing the emission angle. A normal emission angle of 5° reduces the projection of the focus to 1/10 of its length.



1 Radiation outlet window
2 Bore hole for positioning the tube in the tube stand

Fig. 3-5: KF...4KE X-ray diffraction tube (ceramic tube type)

Tube Stand

Radiation protection requires that the X-ray tube be housed in a tube stand (Fig. 3-2.2 und Fig 3-6).

The air-insulated X-ray diffraction tubes (Fig. 3-5) used in the diffractometer feature two line focuses or two square focuses or one line focus and one square focus respectively, the radiation outlet windows (Fig. 3-5.1) of which are closed by the tube stand.

An electro-mechanically operated shutter can be opened in a window with line focus, used for the powder diffractometer. The other three windows are firmly closed.

Two red LEDs light up when the window shutter is open. A green LED lights up when the window shutter is closed. Two safety switches for the window shutter are pressed down by a safety bracket, mounted on the goniometer.



Fig. 3-6: Tube stand with aperture slit system

Cable protection cover

The cable protection cover consists of a special technical fabric with a zipper and is used for cable protection and cable guidance respectively. This is important especially in the case of theta-theta systems.

All cables and hoses coming from the tube housing are wrapped together by the cover. Begin zipping the zipper next to the tube housing. During installation make sure that the cable package runs underneath the control cables for the goniometer in order not to damage them during operation.

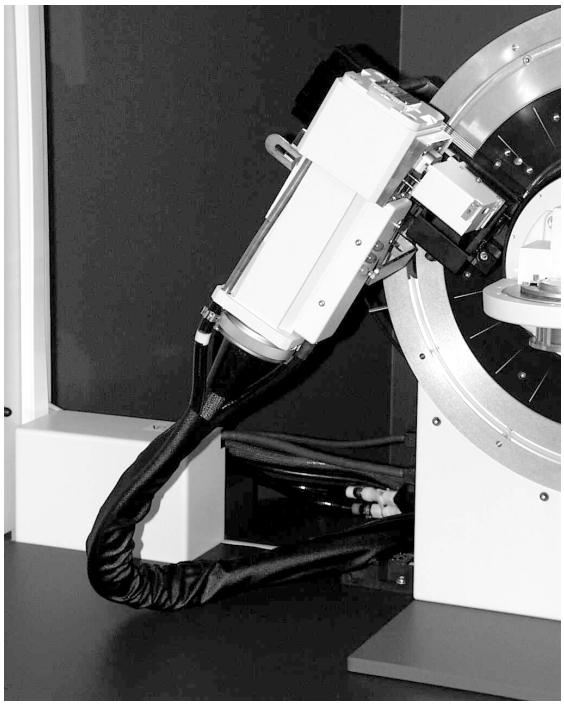


Fig. 3-7: Cable protection cover

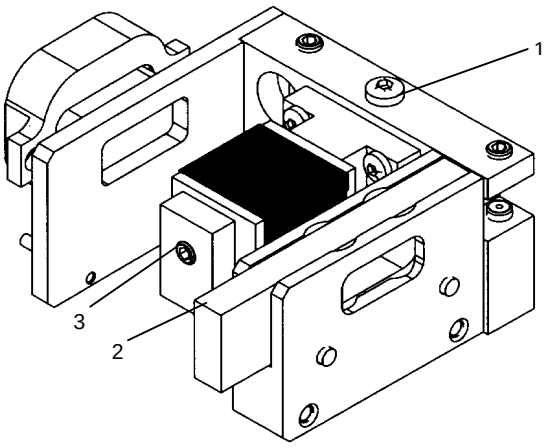
Slit Systems

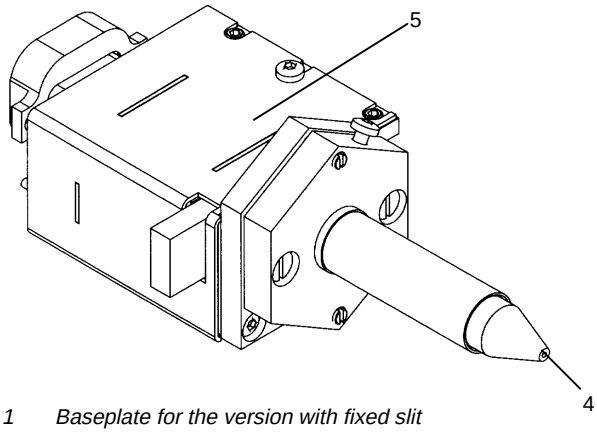
Aperture Slit System

The aperture slits are perpendicular to the goniometer level.

Version with a Fixed Slit

The aperture slit system (Fig. 3-8) contains a fixed divergence slit (2).





1 Baseplate for the version with fixed slit
2 Divergence slit
3 Primary Soller slit
4 Pinhole next to the sample
5 Cover

Fig. 3-8: Aperture slit system for fixed slit (upper view without screening cover)

A primary Soller slit (3) may be installed before the divergence slit.

A Kβ filter, an absorber or a micro slit may be installed instead of the divergence slit (2). 4

A pinhole (4) next to the sample may be installed.

A cover is installed in order to screen off the scattered radiation.

Version with a Variable Slit

The aperture slit system with variable slit (Fig. 3-9) contains a variable divergence (1) slit and a fixed divergence slit (2).

A Kβ filter, an absorber, a soller slit or a micro slit may be installed instead of the fixed divergence slit.

A pinhole (Fig. 3-8.4) next to the sample may be installed.

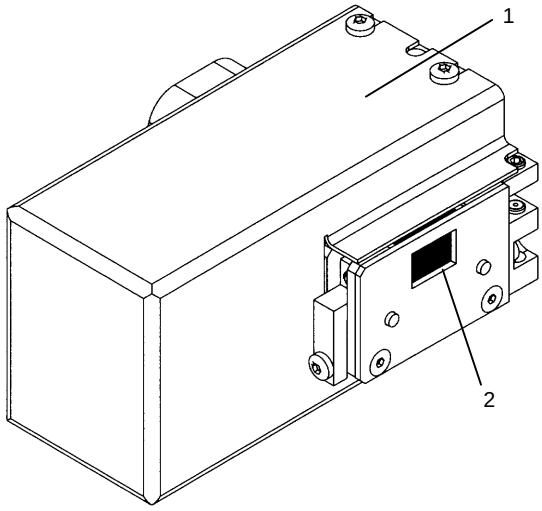
A cover is provided in order to screen off the scattered radiation.

The variable slit has a range of 1000 steps corresponding to one rotation of the patented controller. The slit is fitted such that it is wide open at the reference point and that the control range commences with the 172nd step following the reference point. With –172 as the reference value, the following relationship thus applies to the slit width w over 860 micro steps:

$$wi = 0.1° \cdot 1.01^{i}$$

where i = number of steps

⚠ **Caution:**
The variable slit is oriented according to its mounting on the base plate. The position and orientation of the slit must remain the same for all manipulations.



1 Variable aperture slit with cover
2 Fixed divergence slit

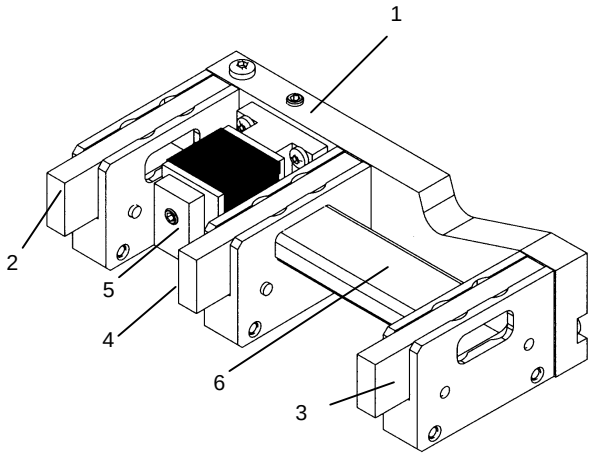
Fig. 3-9: Aperture slit system with variable slit

Detector Slit System

The detector slits are perpendicular to the goniometer level.

Version with Fixed Slits

The detector slit system (Fig. 3-10) accepts a scattered-radiation slit (2) and a detector slit (3).



1 Baseplate for the version without slit changer
2 Scattered-radiation slit
3 Detector slit
4 Kβ filter or absorber
5 Secondary Soller slit
6 Screening tube

Fig. 3-10: Detector slit system for fixed slits (without cover)

Two set-pins fix the position of the detector slit system on the detector ring.

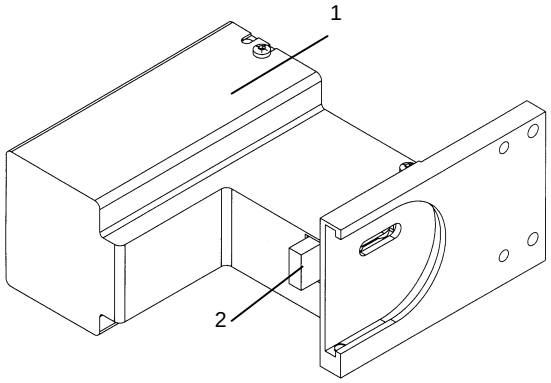
A secondary Soller slit (5) may be installed between the two slit positions (2) and (3).

A Kβ filter or an absorber (4) may be inserted.

A cover is installed in order to screen off the scattered radiation.

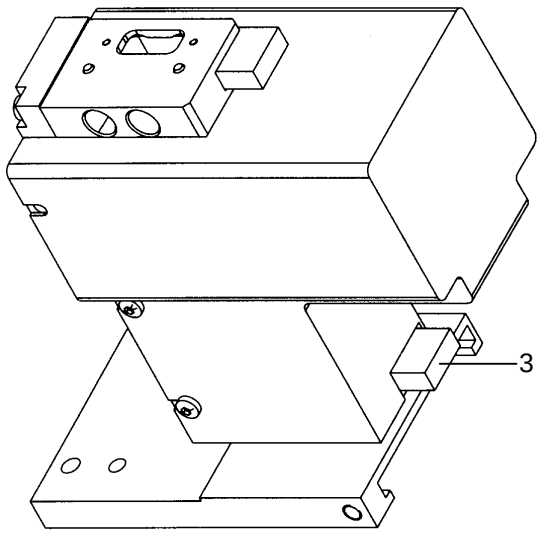
Version with a Variable Slit and a Fixed Slit

The detector slit system for variable slits (Fig. 3-11) contains a variable scattered-radiation slit (1) and a detector slit (2). A Kβ filter or an absorber (3) may be inserted.



1 Variable scattered-radiation slit with cover
2 Detector slit

>> continued on next page



3 Kβ filter or absorber

Fig. 3-11: Detector slit system for a variable slit and a fixed slit

A secondary Soller slit may be inserted between the variable scattered-radiation slit and the detector slit.

A cover is provided in order to screen off the scattered radiation.

The variable slit has a range of 1000 micro steps corresponding to one rotation of the patented controller. The slit is fitted such that it is wide open at the reference point and that the control range commences with the 172nd step following the reference point. With –172 as the reference value, the following relationship thus applies to the slit width w over 860 micro steps:

$w_i = 0.1° \cdot 1.01^i$ where i = number of steps

Caution:
The variable slit is oriented according to its mounting on the base plate. The position and orientation of the slit must remain the same for all manipulations.

Fixed Slits

The slit width is marked in millimeters on the fixed slits.

The slits are held magnetically.

Always insert the fixed slits such that the bevelled surface is inside (towards the holding magnets). The inscription must be visible.

The diffractometer is supplied together with two 1 mm wide slit slits used as divergence and as scattered-radiation slit (opening angle 0.5°) and a 0.1 mm slit slit used as detector slit (opening angle 0.03°).

Width and opening angle for the various fixed slit positions are specified in Table 3-1.

Tab. 3-1: Width and opening angle for the fixed slits

	Opening angle for	
Diaphragm width	**aperture and scattered-radiation slits**	**detector slits**
0.05 mm	0.025°	0.015°
0.1 mm	0.05°	0.03°
0.2 mm	0.1°	0.06°
0.6 mm	0.3°	0.18°
1 mm	0.5°	0.3°
2 mm	1°	0.6°
6 mm	3°	1.8°

Approximate values are: aperture and scattered radiation angle (in degrees) are equal to 1/2 diaphragm width (in mm); detector angle (in degrees) is equal to 1/3 diaphragm width (in mm) (measuring circle diameter 401/435 mm).

Micro Diaphragms

Micro diaphragms with a diameter of 0.3, 0.5 or 1 mm may be inserted into the aperture slit position for irradiating small sample surfaces.

A stop screw is used for vertical adjustment. A 1 mm wide diagonal diaphragm in the detector slit position is used for adjustment.

Slit Changer

A controllable detector slit changer facilitates automatic selection of a fine slit slit (0.06 mm wide, opening angle 0.018°) for high resolution and any plug-in slit as required.

Variable Slit

The variable divergence slit (Fig. 3-9.2), which is controlled via a stepping motor, facilitates selection of the optimum aperture angle. A patented controller permits the slit to be adjusted in 860 micro steps between 0.1° and 3° in steps smaller than 1 %. Here the aperture angle follows the equation

$\alpha_i = 0.1° \cdot 1.01^i$

with i = number of steps.

Using a second variable slit as scattered radiation slit (Fig. 3-11.2) provides optimum scattered radiation suppression, in particular in the range of small angles, and facilitates automatic measurements from $2\theta = 0.3°$ to larger angles, always ensuring a maximum sample irradiation.

Apart from a selective adjustment of a specific slit width, a microprocessor control command can be used for creating a sinusoidal forced coupling between angle of incidence and slit width or between angle of reflection and scattered radiation slit width respectively. This means that the same sample length up to approx. 20 mm is irradiated at any angle of incidence.

Divergence Slit Next to the Sample

For measuring small surfaces, we recommend installing the divergence slit next to the sample to the tube holder flange. The radiation height is delimited by slit slits set to a width of 0.25 mm. This width may be increased up to 0.8 mm. Two pulling and two pressing screws are used for aligning the divergence slit which bears the slit and lies next to the sample to the beam center. A pinhole diaphragm of 0.5 mm diameter may be used instead of the slit in order to delimit the irradiated sample height to approximately 0.5 mm. Two different versions of the divergence slit next to the sample are provided: one for the 401 mm and one for the 500 mm measuring circle (texture).

Scattered-Radiation Slit Next to the Sample

The scattered-radiation slit next to the sample (Fig. 3-8.4) is a simple aid for measuring in the range of small angles, in particular when a position sensitive detector is used. This slit is fixed to the tube stand and screens out scattered radiation of the primary radiation beam.

The distance between the diaphragm edge and the sample surface can be adjusted. The distance between diaphragm edge and sample center can be adjusted for measurements up to a higher angular range.

Kβ Filter

A Kβ filter may be used for suppressing the characteristic Kβ radiation.

Tab. 3-2 lists the various filter values used for attenuating the Kβ line intensity to 1% of the intensity of the Kα doublet. The Kα line intensity is thus attenuated to a value between half and two thirds of the original value.

Tab. 3-2: Verschiedene Kβ-Filter

Radiation (Kα, Kβ)	Filter material	Thickness
Cu	Ni	12 µm
Cr	V	10 µm
Fe	Mn[1]	10 µm
Co	Fe	10 µm
Mo	Zr	65 µm

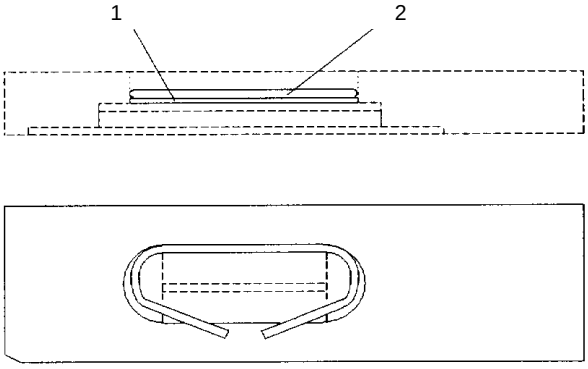
Absorber

One or two Cu absorbers of 0.1 mm thickness may be inserted into a slit in order to delimit the pulse rate at the detector during adjustment (to 10^5 pulses/second for a scintillation counter, for example).

The Cu absorber can be inserted in any plug-in slit of the aperture or detector slit system.

[1] Manganese in compound (150 µm thickness)

Plate (1) and clasp (2) are inserted in the slot of the plug-in slit, as shown in Fig. 3-12.



1 Plate
2 Clasp

Fig. 3-12: Plug-in slit with Cu absorber

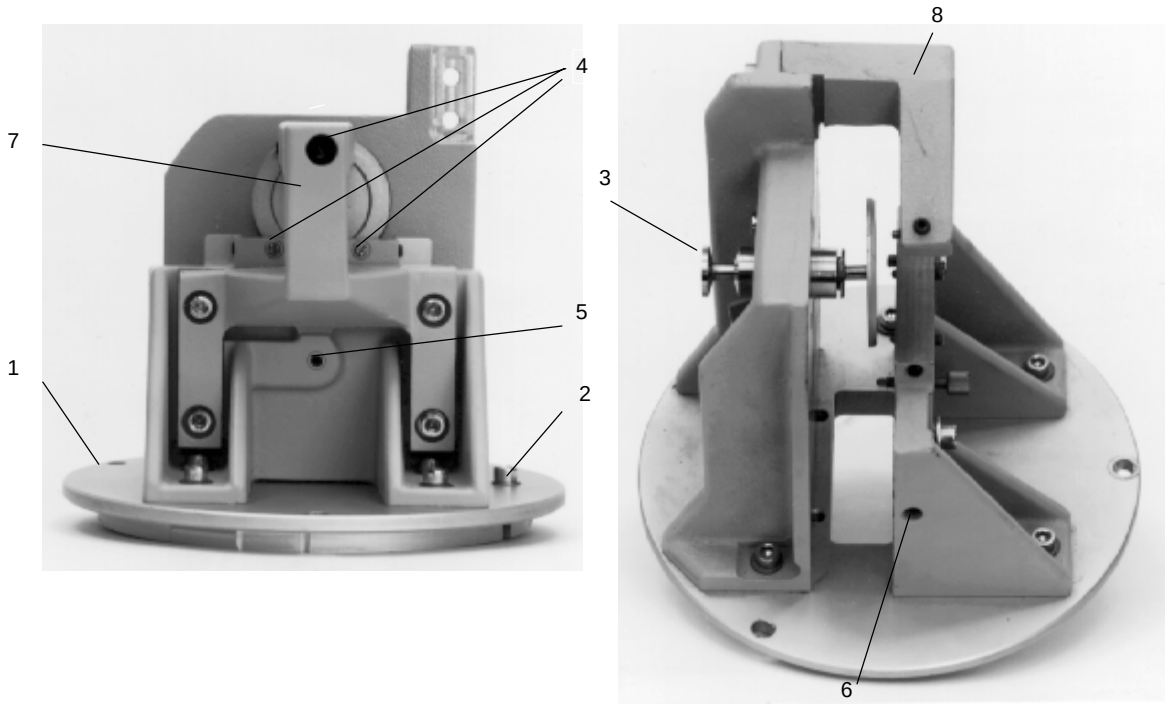
Sample Carrier

The sample carrier (Fig. 3-2.4) is adjusted in the factory such that the goniometer rotary axis is on the sample surface. Together with a play compensating disk (Fig. 3-13.1) it is mounted on the sample carrier ring (Abb.3-3.1) and accepts the sample to be examined. The play compensating disk permits sample carrier replacement without play and thus ensures reproducibility. Tightening the play compensating screw (2) reduces the fit play between play compensating disk (Fig. 3-13.2) and sample carrier ring to zero. Once the play compensating disk (1) has been tightened to the goniometer, the play compensating screw should be loosened and only re-tightened slightly.

Caution:
The play compensating screw (2) may not be tightened once the equipment has been removed.

Standard Sample Carrier

A pressure unit (3) with quick-release lock presses the sample in the standard sample carrier (Fig. 3-13) against the stop screw, which can be adjusted without play. The three stop screws (5) are factory-adjusted and secured. The screw (6) may be carefully tightened and adjusted without play.



1 Flange
2 Play compensating screw
3 Pressure unit
4 Set screws, factory-adjusted
5 Set screw
6 Lock Screw for [5]
7 Standard bracket
8 Front stop bracket

Fig. 3-13: Standard sample carrier

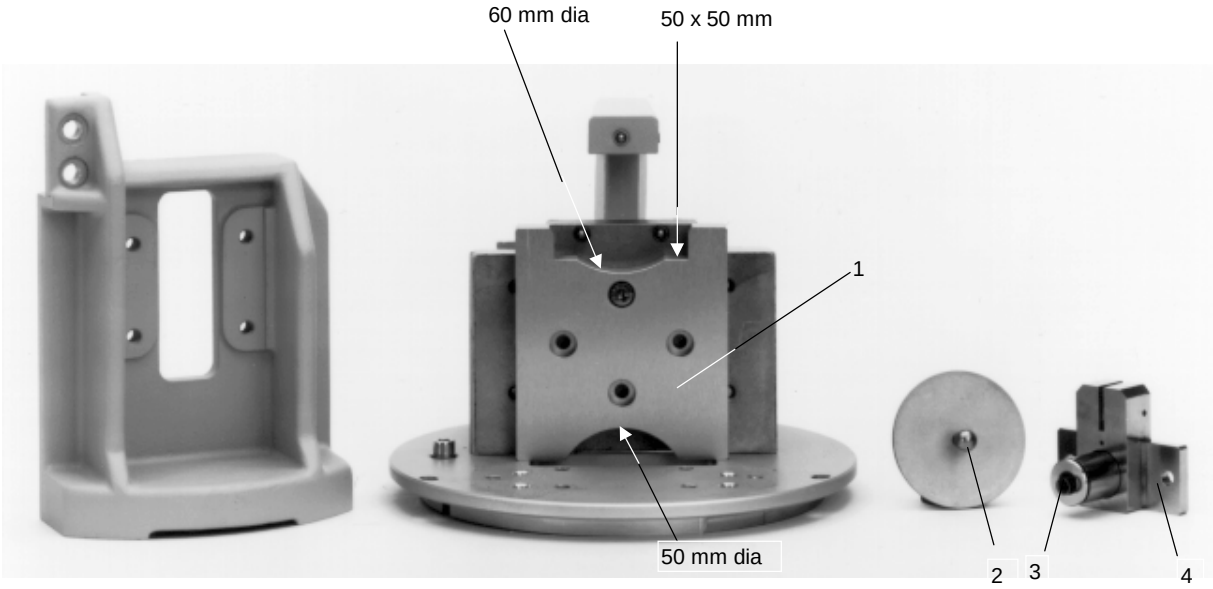
Samples up to a thickness of 20 mm may be inserted. An insertion aid (Fig. 3-14.1) is available for samples of 50 x 50 mm and with 50 or 60 mm diameter.

The pressure disk (Fig. 3-14.2) permits unshaped samples to be held tight. It may be removed from the pressure pin (Fig. 3-14.3) and replaced by a sample-specific disk shape.

Setting the pressure unit (Fig. 3-14.4) to the lower position enables alignment of large and uneven samples to the goniometer center using the fourth stop screw (Fig. 3-13.5). The insertion aid (Fig. 3-14.1) must be removed in this case.

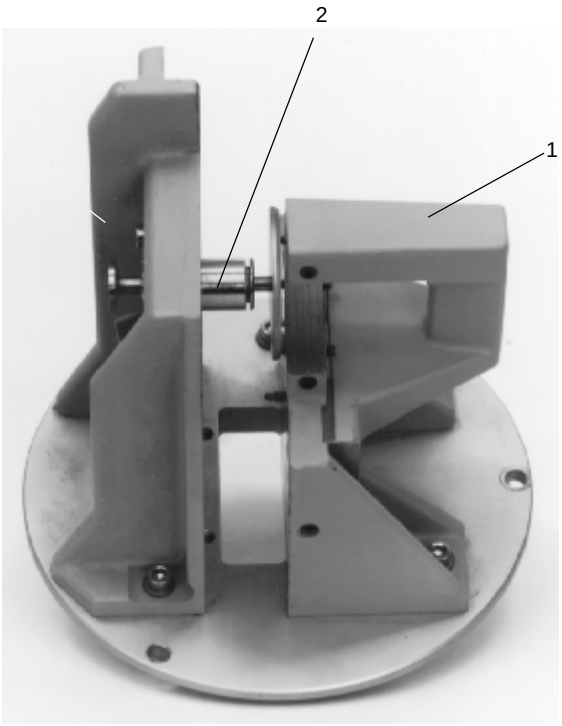
The front stop bracket (Fig. 3-13.8 and 3-15.1) permits large-surface insertion of samples; angle 2θ is then limited to 150.

Standard bracket (Fig. 3-13.7) and front stop bracket (Fig. 3-13.8 und 3-15.1) may be removed and re-installed in a reproducible manner.



1 Insertion aid
2 Pressure disk
3 Pressure pin
4 Pressure unit

Fig. 3-14: Insertion aid and pressure unit

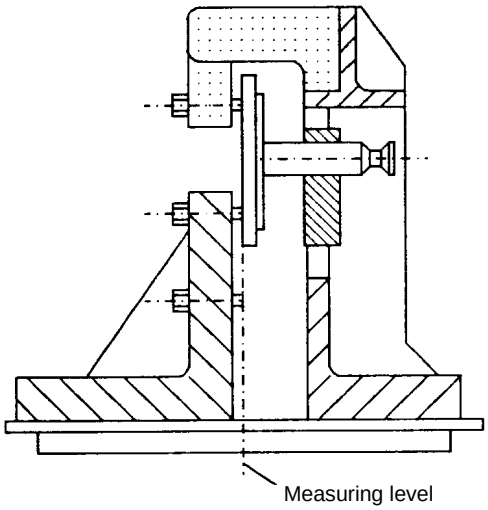


1 Front stop bracket
2 Pressure unit

Fig. 3-15: Standard sample carrier with front stop bracket

Fig. 3-16 shows the two possible installations for the standard sample carrier.

With standard bracket
preferably for samples:
50 mm dia, 60 mm dia or 50 x 50 mm,
max. 20 mm thick



With front stop bracket
(optional)
preferably for big samples,
max. 20 mm thick

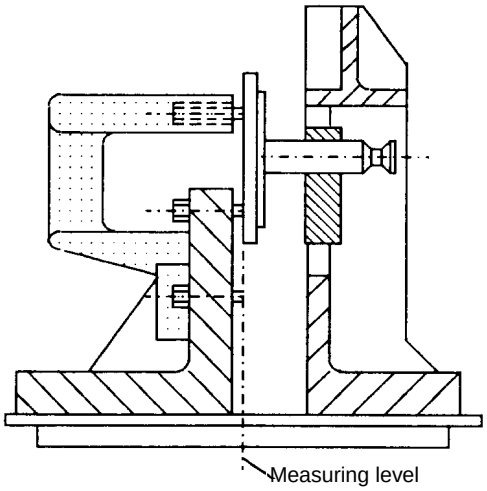
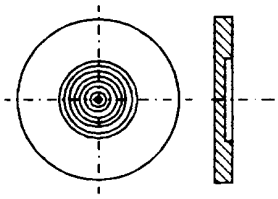
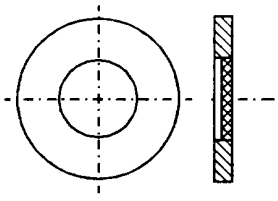
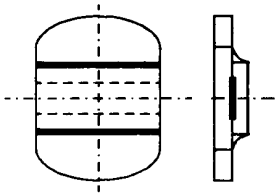
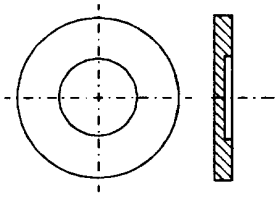


Fig. 3-16: Standard sample carrier

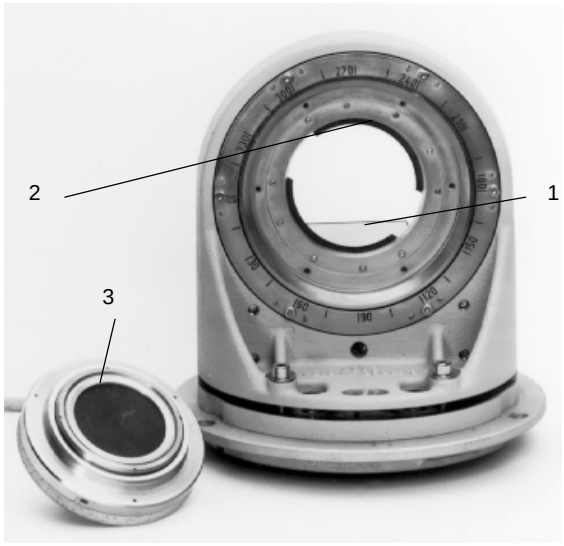
Accessories:
Sample holders for powder measurements, quartz sample for test measurements, calibration slit for 0° adjustment and a silicon single crystal holder for examination of very small samples (Tab. 3-3) are provided for use with the standard sample carrier. These accessories are also used with the standard cup for the rotating and transmission sample carriers.

Tab. 3-3: Accessories for the standard sample carrier

		Used with	Application
Sample holder 50 mm dia		Standard sample carrier Rotating sample carrier	Powder measurement
Quartz sample 50 mm dia		Standard sample carrier Rotating sample carrier	Test measurement
Calibration slit 50 mm dia 38 mm long		Standard sample carrier Standard cup (with mask cap 20°/0° or mask ring 20°/0°) for rotating sample carrier	0° adjustment
Silicon single crystal holder 50 mm dia		Standard sample carrier Standard cup (for rotating sample carrier	Very small samples

Rotating Sample Carrier

Instead of the standard sample carrier, sample carriers with stepper motor drive (Fig. 3-17) may be used in one of two designs: rotating/transmission sample carrier or 0° rotating sample carrier.



1 Drive motor
2 Seating ring for sample cup
3 Transmission sample cup

Fig. 3-17: Rotating/transmission sample carrier

The sample is inserted in a sample cup which is held by permanent magnets on a pivotable seating ring. A spring in the cup lid presses the sample against the cup mask.

The sample cup's design guarantees that the sample surface is in the cup seat level; different mask thicknesses are thus not significant for the measuring result. Masks of 42 mm diameter are available.

The maximum sample thickness is 50 mm. Plastic centering rings may be used for centering small samples.

The maximum sample thickness for rotating sample carriers is 40 mm and 4 mm for transmission sample carriers.

Rotating/Transmission Sample Carrier

The requirements for preparation are drastically reduced if the sample carrier is used as rotating sample carrier. Rotating the sample around its surface normal eliminates the influence of particle size and orientation to a great extent.

The sample carrier is used as a transmission sample carrier if the crystallite orientation of transmittable objects is to be obtained.

The sample may be rotated around its surface normal.

A scale ring with 15° division is applied to the rotary seat and to the sample cup.

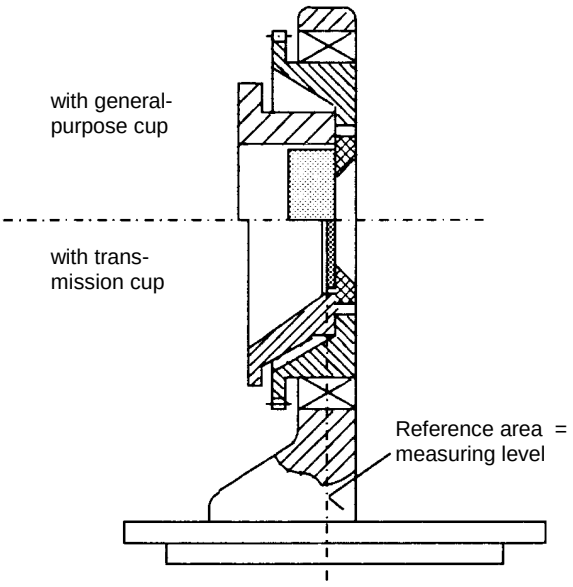
In reflection measurements, measurement of a rotating sample is possible from $2\theta = 20°$. If the sample cup is still, measurement is possible from $2\theta = 0°$. Transmission technique permits measurement up to $2\theta = 120°$ (in case of Bragg-Brentano geometry). Rotational speed can be adjusted continuously between 15 and 120 rpm.

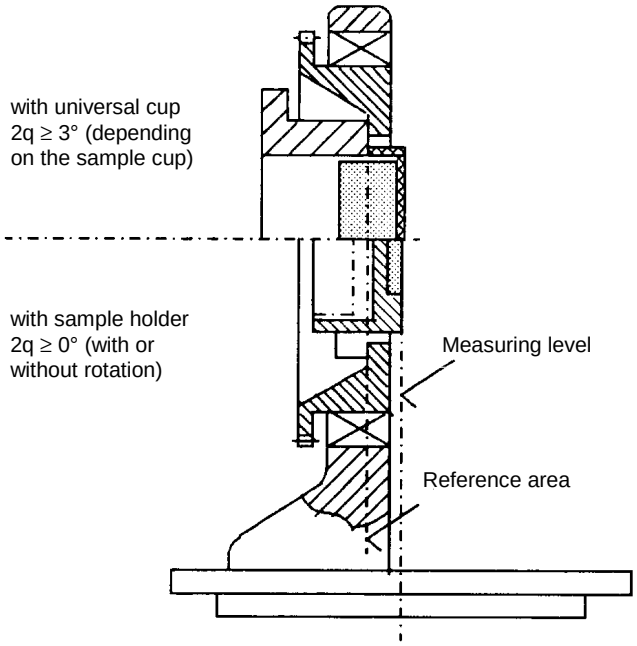
The angular positions can be selected in steps of 0.28°. Reference marks at 0° (mechanical) permit electronic angle correction.

0° Rotating Sample Carrier

Compared with the rotating/transmission sample carrier, the 0° rotating sample carrier features a sample carrier contact surface which is offset by 6 mm from the goniometer center. The measuring level remains in the goniometer center. With or without rotation, the 0° sample carrier permits measurements from $2\theta = 0°$. Transmission measurements are not possible (in case of Bragg-Brentano geometry).

Rotating/transmission sample carrier





0° rotating sample carrier

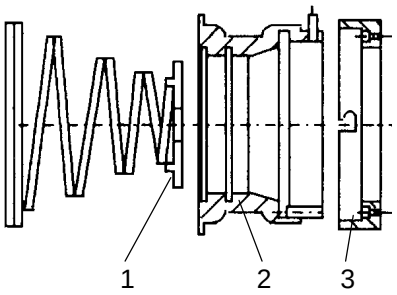
Fig. 3-18: Design of the rotating/transmission and the 0° rotating sample carrier

Accessories

A universal cup permits measurement of samples up to 50 mm diameter and 40 mm thickness (Fig. 3-19)).

Smaller samples may be supported using an intermediate ring (Fig. 3-20) in the universal cup.

The accessories for the standard sample carrier (sample holders, quartz sample, calibration slit and silicon single crystal sample) may also be used with the universal cup.



1 Pressure unit
2 Upper part
3 Lower part

Fig. 3-19: Universal cup

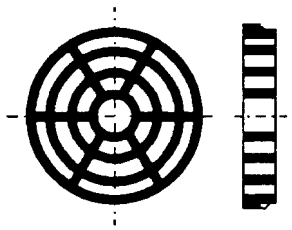


Fig. 3-20: Intermediate ring, 50 mm diameter

A transmission cup (Fig. 3-21) for samples of up to 50 mm diameter and 4 mm thickness is provided for transmission measurements.

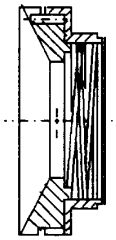


Fig. 3-21: Transmission cup

A sample holder (Fig. 3-22) which may be used at both sides permits measurements with rotating samples from $2\theta = 0°$. Powder samples can be inserted in one side, while samples of up to 50 mm diameter and 15 mm thickness can be accepted in the other side. A rupture joint permits the sample holder to be broken easily in order to remove the thick sample. The sample holder may be reused for thick samples.

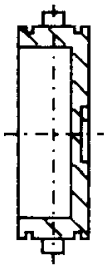


Fig. 3-22: Sample holder

Further accessories are sample holders (Fig. 3-23) for measuring fibres and threads.

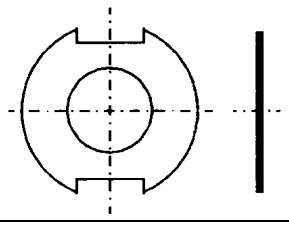
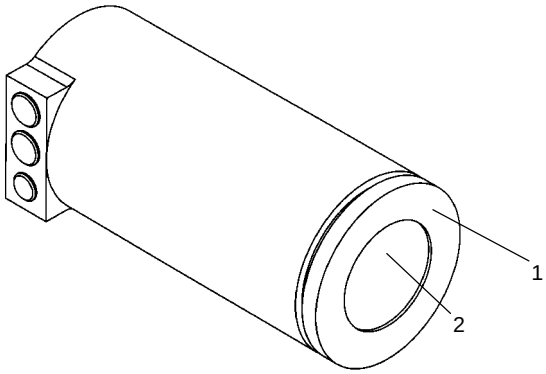
		Used with	Application
Sample holder, 50 mm dia		Universal cup for rotating sample changer Transmission cup for rotating sample changer	Examination of fibres and threads

Fig. 3-23: Sample holder

Scintillation Counter

Normally, a scintillation counter (Fig. 3-2.6 und Fig. 3-24) which enables X-ray measurement in the wavelength range between 0.05 and 0.3 nm is used as a detector (Fig. 3-26).



1 Socket for inserting the scintillation counter into the detector holder
2 Radiation inlet window (Beryllium)

Fig. 3-24: Scintillation counter

Detector cable – Tensile stress relief

Fix the cable to the detector as shown in fig. 3-25, to release the plugs from their tensile load. Use the supplied black binding straps.

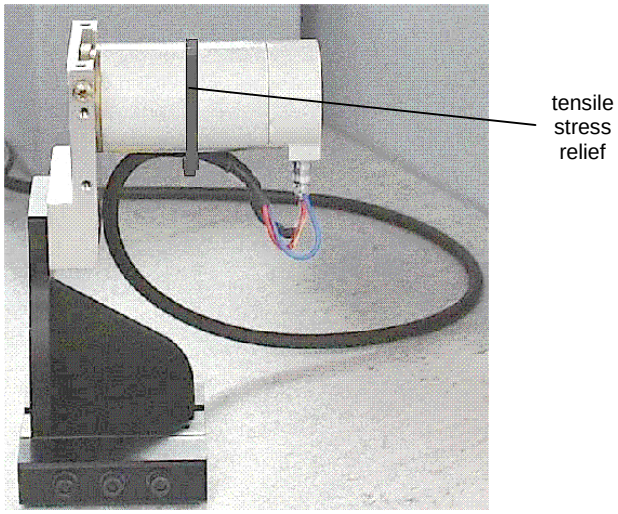


Fig. 3-25: Tensile stress relief of the detector cable

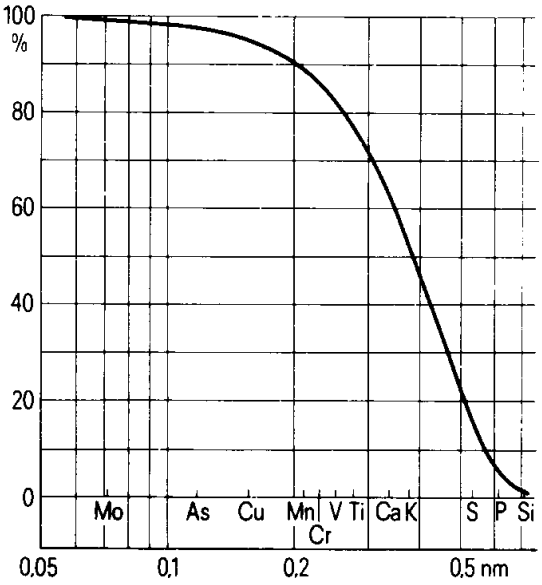


Fig. 3-26: Quantum yield of the scintillation counter

Optional Detectors

Si(Li) Semiconductor Detector

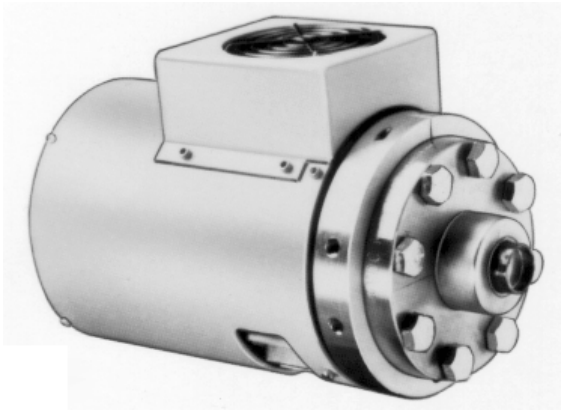


Fig. 3-27: Si(Li) semiconductor detector with Peltier cooling

A Si(Li) semiconductor detector with Peltier cooling can be set up (Fig. 3-27) using the standard detector slit holder.

The Si(Li) semiconductor detector is an X-ray detector with a high energy resolution. It is suitable for a wavelength range between 0.05 and 0.3 nm (Fig. 3-28).

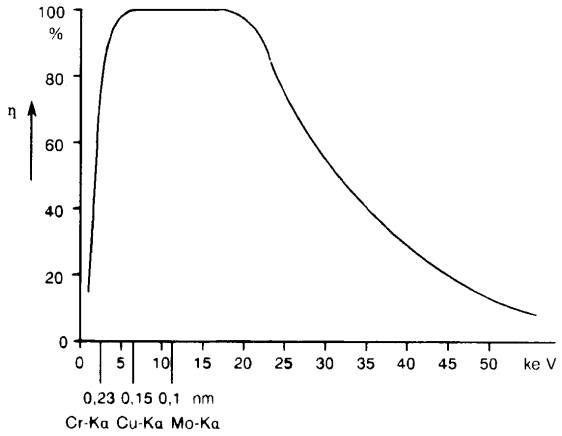
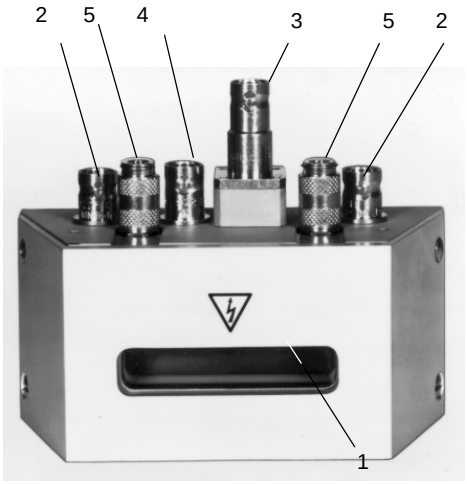


Fig. 3-28: Quantum yield of a typical Si(Li) semiconductor detector (3 mm detector thickness; 25 mm beryllium window thickness)

In contrast to a conventional wavelength-dispersive diffraction arrangement this detector permits an energy-dispersive diffraction arrangement where sample and detector remain stationary. An X-ray source with continuous radiation is used as excitation. The active area size of the Si(Li) crystal is about 2 x 12 mm.

Position Sensitive Detector

The position sensitive detector (Fig. 3-29) is a special flow counter which detects all reflections within a specific angular range. The angular positions of the detected reflections are determined from the X-ray quanta impact points.



1 Radiation inlet window
2 Signal line
3 High-voltage connector
4 Pre-amplifier connector
5 Gas connector

Fig. 3-29: Position sensitive detector

The position sensitive detector is especially suitable for stress measurements, tracking of phase transformations and quick recording of voluminous diffraction patterns.

The position sensitive detector is available in two different versions: with a metal or a quartz counter tube wire. The service life of the metal wire is 100 times greater than that of the quartz wire; the quartz wire has a better position resolution.

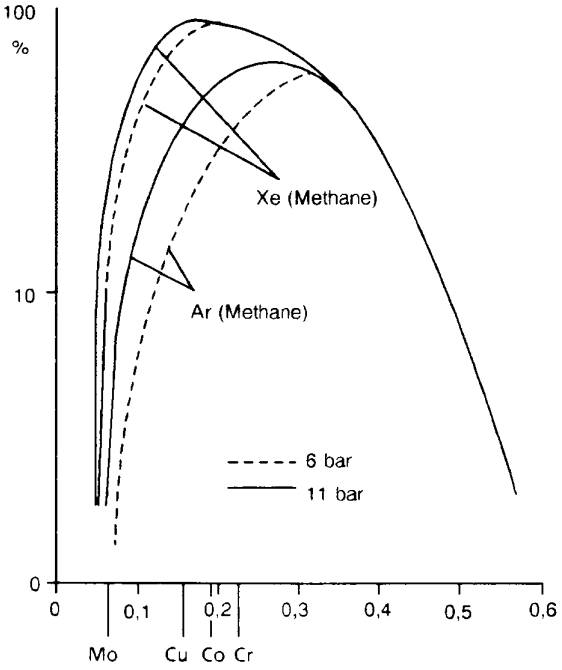


Fig. 3-30: Quantum yield of the position sensitive detector

The position sensitive detector is suitable for measuring in a wavelength range between 0.05 and 0.5 nm (Fig. 3-30).

Control Electronics

Circuit Diagrams

Tab. 3-4: List of schematics

Block Diagram	
C79298-A3240-A1-*-12	D8 Control Electronics
C79298-A3242-A1-*-12	Safety System Diffractometer D8
Wiring Plans	
C79279.A3242-A10-*-11	Goniometer
C79298-A3240-A1-*-11	Wiring of Control Rack
C79298-A3242-A1-*-11	Wiring of Radiation Safety Box
C79298-A3242-A11-*-11	Wiring of Status Display, Service Control Panel, Safety Circuit, Warning Displays
C79298-A3242-A12-*-11	Wiring of Mains Distribution
C79298-A3242-B43-*-11	Wiring of Service Operation Panel
C79298-A3242-B101-*-11	Wiring of System's Status Display
C79298-A3244-A1-*-11	Wiring of X-ray Shutter Control
C79298-A3158-B19-*-11	Wiring of Variable Slit
C79298-A3158-B18-*-11	Wiring of Two-Position Slit Changer
Cables	
C79298-A3240-B21-*-6	Connecting Cable B200/X2/X4 to B103/X7
C79298-A3240-B22-*-6	Connecting Cable B200/X3/X5 to B103/X8
C79298-A3244-B10-*-6	Connecting Cable X-ray Shutter to B103/X9
C79298-A3242-B103-*-6	Connecting Cable K760/X541 to B200/X1
C79298-A3130-A72-*-6	Connecting Cable B200/X13 to AC-controlled capillary rotation stage
C79298-A3130-A73-*-11	D8-Scintillation Detector Cable (NaJ and YAP)
C79298-A3130-A76-*-6	RS 232 Interface Cable (D8 to Host or Service Computer)
C79298-A3130-A61-*-11	RS 232 Interface Cable (D8 to X-ray Generator)
Hose Diagram	
C79298-A3242-A102-*-98	Hose Diagram (Water)
C79298-A3179-D120-*-98	Hose Diagram (Water) K760 + Internal water cooling unit

Mains Distribution Board

The mains distribution board is located on the lower left side of the cabinet and consists of the following parts (see schematic C79298-A3242-A12-*-11):

- contactors for turning on/off the mains power supply
- terminals for the supply of the X-ray-Generator, cooling units and water valves
- sechs shock proof sockets for mains supply of any kind of user specific external devices
- mains supply for the fluorescent tube, cabinet fans and fans of the radiation enclosure
- adaption of all supply voltages other than 230 VAC to the internally used supply voltage level
- earth bar for grounding all components of the system

Fuses:

F601	16 A slow-blow fuse for mains supply voltage (for all components except the X-ray generator)
F602	6.3A slow-blow fuse for mains supply voltage (for all components except the X-ray generator)

Pushbuttons:

S601	Turn off power
S602	Turn on power
S603	Emergency Stop located at the right front panel of the D8's cabinet
S604	Emergency Stop located at the left front panel of the D8's cabinet

Important Note:
The pushbuttons S601-S604 do not turn on/off the X-ray generator. In order to switch it on/off the key switch located at the X-ray generator's front panel must be used. If pushbutton S601 or the emergency stop button is pressed the X-ray generator will immediately stop generating any high voltages and will be set to the so-called standby-mode.

S605	Turn on/off fan inside the radiation protection enclosure
S606	Turn on/off the light inside the the radiation protection enclosure

⚠ **Caution:**
In order to prevent any life threatening electrical shocks the D8's mains power supply must be turned off by all means before

- touching any components of the mains distribution board;
- any fuse is inserted or removed;
- the fluorescent tube (illumination) is exchanged by another one;
- the fans of the cabinet's rear panel are attached/removed to the shock proof connectors;
- any electrical device is connected / disconnected to the shock proof connectors;
- an internal or external cooling unit is installed or removed;
- an external water valve is connected or disconnected.

⚠ **Important note:**
It is **not** sufficient to turn off just the D8's power supply. The whole D8 system has to be separated completely from the user's mains net by an external switch or an automatic circuit breaker located nearby the D8 system!

Control Rack

The control rack is an independent unit which contains all major printed circuit boards and which is loacted in the cabinet. It consists of the following parts (see block diagram C79298-A3240-A1-*-12 and schematic C79298-A3240-A1-*-11):

- Switching mode power supply (input: 230 VAC/output: +12 V,+5 V,-5 V,-12 V)
- Unregulated power supply (input: 230 VAC/output:+80 VDC,+24 VDC, 24 VAC, 42 VAC)
- Power Bus Board with 14 slots (see schematic C79298-A3220-B205-*-11)
- ISA/AT Passive Backplane with 14 slots (see schematic C79298-A3220-B206-*-11)
- Floppy disk drive (1.44 MB)
- Harddisk drive (as option only)
- Ventilators for cooling all printed circuit boards

Fuses:

F1/F8	6.3A slow-blow fuse for the mains supply
F2	6.3A slow-blow fuse for +80 VDC supply voltage
F3	6.3A slow-blow fuse for +24 VDC supply voltage
F4	1.6A medium-slow-blow fuse for +24 VAC supply voltage
F5	1.6A medium-slow-blow fuse for +42 VAC supply voltage
F6	1.6A medium-slow-blow fuse for +5 VDC supply voltage (used by the X-ray shutter)

⚠ **Caution:**
In order to prevent any life threatening electrical shocks the rack's mains power supply must be turned off by all means before any fuse is inserted or removed!

⚠ **Caution:**
In order to prevent severe damages of the control electronics the rack's mains power supply must be turned off by all means before any printed circuit board is inserted or removed!

Control Electronics Modules

The modules described below control the various components of the analysis system. In order to fulfill the demands for high flexibility and easy extendability the control electronics is based on the ISA-AT industry standard.

Main Processor - Slot CPU Board (C79298-A3220-B106)

The slot CPU is the system's main processor. After power-up it loads and starts the operating system including the control software from a floppy disk drive or optionally from a harddisk drive. The control software initializes the parameters of all functional units as defined in the file DEVICE.INI, supervises and diagnoses the system, runs measurement tasks and communicates with the outside world (i.e. host computer, service computer and manual control box via RS232 interfaces).

Features

- BIOS with extensions for keyboardless and videoless operation
- 4 MB main memory
- 2 serial ports (COM1 and COM2)
- 1 parallel bidirectional port
- keyboard interface
- IDE harddisk and FDD floppy controller
- loud speaker

Assignments of connectors (side panel)

COM1	Serial Port #1 (Connected to the host computer)
COM2	Serial Port #2 (Connected to the service computer)

Assignments of connectors (on board)

IDE	Interface for harddisk drive
FDC	Interface for floppy disk drive

Universal I/O-Board (C79298-A3220-B103)

The Universal IO-Board implements the main interface between the control electronics and various components located inside the cabinet and the radiation protection box. Furthermore it communicates with the HV-Generator and the manual control box and also supervises the D8's radiation safety system.

Features

- Supervisor of the X-ray safety system (plausibility check of switches and warn lamps)
- Control of the X-ray shutter
- 2 serial ports interfacing with the X-ray Generator and an optional manual control box
- Control of one two-position slit changer
- Control of a rotating sample stage driven by an AC-motor
- Control of the sample changer
- Control of an externally used X-ray warning display
- CAN-bus interface
- System's watchdog
- Check of all supply voltages available inside the control rack
- Battery backed RAM for system setup parameters (3-V coin type Lithium battery on board)
- One 32 bit and one 16 bit wide quartz based timer
- Mains synchronization unit
- Digital inputs and outputs (standard logic levels, partially with open collector or relays outputs)
- LED status display

Status Display

Green LED "RUN"	The green LED lights up when the control rack's power is switched on. It indicates that the +5-V supply voltage is OK and the watchdog of the master processor does not detect any error conditions.
Red LED:"ALARM"	The red LED lights up if there are any instrument faults which lead to an alarm. The LED will flash when an instrument warning occurs.
Yellow LED:"BUSY"	The yellow LED lights up when a measurement is in progress. It flashes when a measurement has been started but cannot be performed because any physical component is not ready.

⚠ **Note:**
There are additional status LEDs mounted at the cabinet's left and right front panels. These LEDs have the same meaning as the ones located on the Universal IO-Board.

Assignments of Connectors (Front Panel)

X7	Diffraction System Cable #1
X8	Diffraction System Cable #2
X9	Tube Mount Cable (X-ray Shutter Control)
X10	CAN Interface
X11	Serial Interface to HV-Generator (RS232)
X12	Serial Interface to Manual Control Box (RS232)
X13	2-Position Slit Changer/AC Controlled Rotating Sample Stage

Side Panel

X14	External Warning Display
X15	Reserved Digital Input/Output Lines

On Board

X16	Reset System (Relay Output)
X17	Sample Changer Control Lines
X18	Reserved Relay Outputs
X19	External Battery

Jumper Switches

IO-Board Number

X22	1-16	A10	(A10 = 0 if switch in ON position)
	2-15	A11	
	3-14	A12	
	4-13	A13	
	5-12	A14	
	6-11	A15	

IO Base Address

X23	1-16	A9	(A9 = 0 if switch in ON position)
	2-15	A8	
	3-14	A7	
	4-13	A6	

Interupt Select

X22	7-10	IRQ 5 (IRQ 5 selected if switch in ON position)
	8-9	IRQ 10

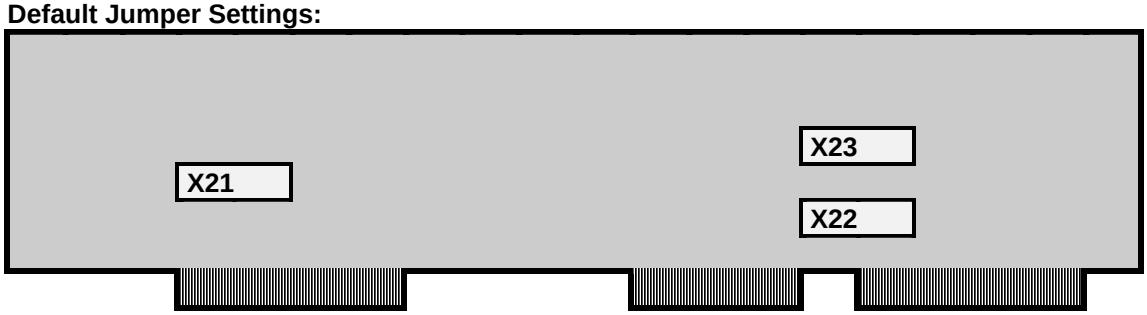
X23	5-12	IRQ 7
	6-11	IRQ 11
	7-10	IRQ 12
	8-9	IRQ 15

⚠ **Note:**
Only one interrupt line may be selected at one time.

Battery Operation

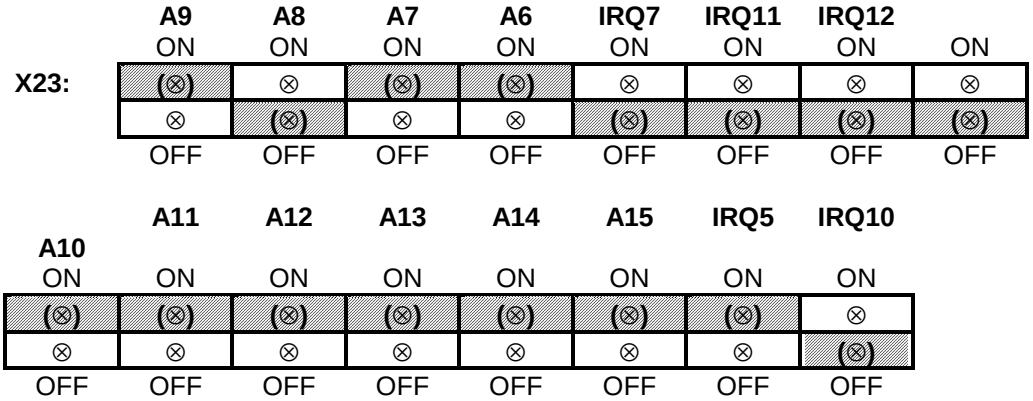
X21	In order to activate the internal 3-V coin type battery pin 2 and pin 3 of X19 must be shorted using the attached jumper.

Default Jumper Settings:



Default settings: (1) Internal Battery activated
(2) Base Address: 100H
(3) Selected Interrupt Source: IRQ 5





Detector Interface Board (C79298-A3220-B102)

The Detector Interface Board generates the high-voltage required for the operation of scintillation and proportional counters. It contains a high speed pulse amplifier with a pulse shaping stage, line shift correction and baseline restoration unit and furthermore two discriminator windows including complete pulse counting unit. In addition there is a digital count input for all various kind of detectors which have a digital pulse output.

Features

Dectector High-Voltage Supply

- Highly stabilized DC voltage in the range from 250 V to 2250 V (digitally controlled in steps of 0.25 V)
- Automatic detection of the attached detector type
- Normal operation range: scintillation counters 400 V to 1250 V, proportional counters 1250 V to 2250 V
- Output protected against short circuits
- Superior stabilility of the high-voltage (temperature coefficient is less than 30 ppm/K)
- Green status LED for displaying the state "Detector High Voltage ON"

Pulse Amplifier

- Amplification gain can be controlled digitally with a resolution of 12 bits
- 4 selectable shaping time constants
- Baseline restoration stage which minimizes the baseline shift at high count rates
- Lineshift correction unit to compensate any shifts of the pulse amplitudes at high count rates
- High stability of the amplification gain (overall temperature coefficient is less than 200 ppm/k)
- Analog output on board

Discriminator and Counting Unit

- Quartz based measurement timer (32 bit)
- Three 32-bit scalers for counting the pulse events
- Two totally independent window discriminators (resolution of the lower and upper window levels is 8 bit)
- Pile-up detection unit
- Count input for digital detector pulses (TTL level)

Miscellaneous

- Power supply for the detector preamplifier (+12 V and -12 V))
- Built-in self-test capability to check all functional units via remote control

Assignments of Connectors

Front Panel

X7	Detector signal input 1 (proportional or NaJ/YAP scintillation counter)
X8	Detector signal input 2 (count input for detectors with TTL logic level outputs like Kevex detector or fast scintillation counter)
X8	Detector supply voltages (+12 V and –12 V)
X10	Detector high-voltage (250 V to 2250 V)

On Board

X11	Analog output 1 – amplified and shaped analog pulses measured directly at the discriminator
X12	Analog output 2 – test pulses generated on board

Jumper Settings

Number of Detector Interface Board

X21	1-16	A10 (A10 = 0 if switch in ON position)
	2-15	A11
	3-14	A12
	4-13	A13
	5-12	A14
	6-11	A15

IO Base Address

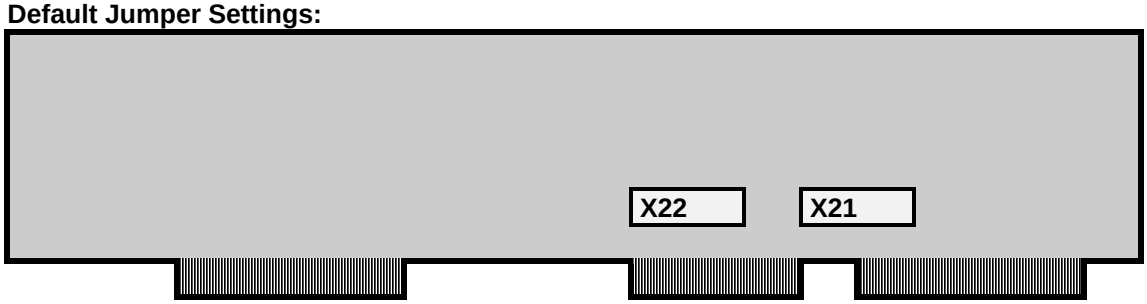
X22	1-16	A9 (A9 = 0 if switch in ON position)
	2-15	A8
	3-14	A7
	4-13	A6
	5-12	A5

Interrupt Select

X21	7-10	IRQ 5 (IRQ 5 selected if switch in ON position)
	8-9	IRQ 10
X22	6-11	IRQ 11
	7-10	IRQ 12
	8-9	IRQ 15

☞ **Note:**
Only one interrupt line may be selected at one time.

Default Jumper Settings:



Default settings: (1) Base Address: 140H
(2) Selected Interrupt Source: IRQ 5

X22:

A9	**A8**	**A7**	**A6**	**A5**	**IRQ11**	**IRQ12**	**IRQ15**
ON	ON	ON	ON	ON	ON	ON	ON
(⊗)	⊗	(⊗)	⊗	(⊗)	⊗	⊗	⊗
⊗	(⊗)	⊗	(⊗)	⊗	(⊗)	(⊗)	(⊗)
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

X21:

A10	**A11**	**A12**	**A13**	**A14**	**A15**	**IRQ5**	**IRQ10**
ON	ON	ON	ON	ON	ON	ON	ON
(⊗)	(⊗)	(⊗)	(⊗)	(⊗)	(⊗)	(⊗)	⊗
⊗	⊗	⊗	⊗	⊗	⊗	⊗	(⊗)
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

Optional Settings #1: Base Address: 540H

X22:

A9	**A8**	**A7**	**A6**	**A5**	**IRQ11**	**IRQ12**	**IRQ15**
ON	ON	ON	ON	ON	ON	ON	ON
(⊗)	⊗	(⊗)	⊗	(⊗)	⊗	⊗	⊗
⊗	(⊗)	⊗	(⊗)	⊗	(⊗)	(⊗)	(⊗)
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

	A10	A11	A12	A13	A14	A15	IRQ5	IRQ10
X21:	⊗	(⊗)	(⊗)	(⊗)	(⊗)	(⊗)	(⊗)	⊗
	(⊗)	⊗	⊗	⊗	⊗	⊗	⊗	(⊗)
	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

(⊗)
(⊗) = Jumpers inserted

(⊗)
(⊗) = Jumpers removed

Potentiometers at the Front Panel:

R12	Adjust amplification gain of the pulse amplifier
R36	Adjust efficiency of the line shift correction

⚠ **Caution:**
The potentiometers at the front are set in the factory and sealed by lacquer. They must not be subsequently changed!

Important Notes

⚠ **Caution:**
The connection cable to the radiation detector may only be connected or disconnected if the control electronics is turned off completely! The radiation detector could be damaged. Be aware that the generated high-voltage at connector X10 can reach voltages up to 2250 V.

Caution: ⚠
In order to prevent any electrical shocks (up to 2250 V on board) the detector interface board must not be operated if the metal shields above and below the high-voltage section on that board are removed.

Indexer/Driver 2 Axis / 4 Amps (419-306500)

The D8 indexer boards use the latest DSP technology tightly integrated with on-board motor drivers. With this level of integration, the user has complete software control of all step motor controlling parameters.

The DSP chipset provides the following features:

- Advanced control of 2 step motors per board
- High speed step and direction output
- S-curve, trapezoidal, velocity contouring and electronic gearing trajectory modes
- Incremental encoder feedback
- 32-bit position, velocity, acceleration and jerk trajectory profile registers
- Step output rates up to 1.5 MHz
- On-the-fly stall detection
- Two limit switch inputs per axis

The on-board motor drivers provide the following features:

- Synchronized fixed-frequency chop-mode motor current control
- 80-V/4-A control of up to 2 motors
- Software selected current setting for each axis
- Drivers electrically isolated from the ISA bus interface and DSP logic for noise reduction
- Software selectable 5, 10, 20, 25, 50, 100, 200 and 250 microsteps/step modes for each axis
- Software selectable step correction tables to improve microstepping accuracy for each axis
- Drivers can be individually enabled and disabled under software control
- Software selectable standby current mode to reduce motor heating for each axis
- Software selectable minimum ON-time to control the minimum winding duty cycle for each axis
- Software selectable high speed full-step mode to improve high speed performance of each axis

Additional on-board features:

- Outputs for step and direction signals with software polarity-reversal control
- Software selectable support for 1 pulse/degree position markers instead of incremental encoders
- Software selectable polarity-reversal for all home and limit switch inputs
- Software selection of external home switch or encoder index mark for all DSP home inputs
- Software selection of limit switch sensing direction for each axis
- Software selection of motor movement direction and encoder readout direction for each axis

Front Plug Assignments

X1	Stepper motor, home switch and CW/CCW limit switches of axis #2
X2	Stepper motor, home switch and CW/CCW limit switches of axis #1
X3	Incremental Encoder of axis #2
X4	Incremental Encoder of axis #1
X5	Direction and step output for axis #1 and #2

Jumper Settings

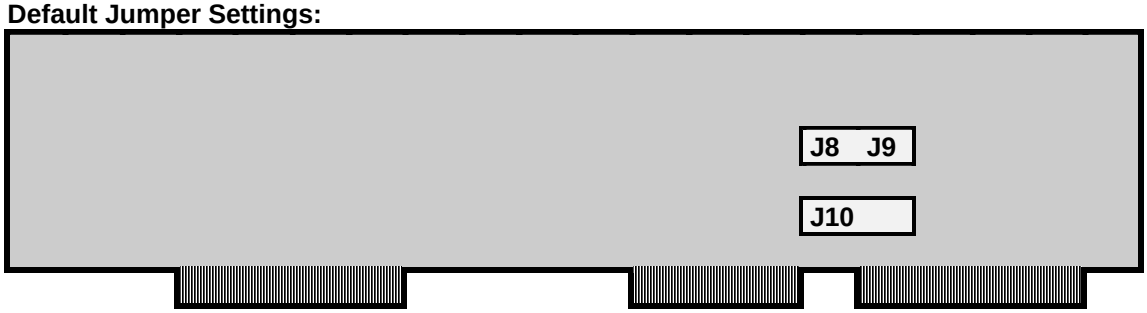
J8/J9 Base Address:	1-1	A4 (A4 = 0 if jumper set; A4 = 1 if jumper removed)
	3-4	A5
	5-6	A6
	1-2	A7
	3-4	A8
	5-6	A9
	7-8	A10
	9-10	A11
	11-12	A12

Interupt Select

J10 Interupt Select:	1-1	IRQ 2 (IRQ 2 selected if jumper set)
	3-4	IRQ 5
	5-6	IRQ 7
	7-8	IRQ 10
	9-10	IRQ 11
	11-12	IRQ 12
	13-14	IRQ 14
	15-16	IRQ 15

⚠ **Note:**
Only one interrupt line may be selected at one time.

Default Jumper Settings:



Default settings: (1) Base Address: 160H
(2) Selected Interrupt Source: None

J8:

A10	A11	A12
(⊗)	(⊗)	(⊗)
(⊗)	(⊗)	(⊗)

J9:

A4	A5	A6	A7	A8	A9
(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

J10:

IRQ 15	IRQ 14	IRQ 12	IRQ 11	IRQ 10	IRQ 7	IRQ 5	IRQ 2
⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
⊗	⊗	⊗	⊗	⊗	⊗	(⊗)	(⊗)

Optional Settings #1: Base Address: 560H

J8:

A10	A11	A12
⊗	(⊗)	(⊗)
⊗	(⊗)	(⊗)

J9:

A4	A5	A6	A7	A8	A9
(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #2: Base Address: 960H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J8:	(⊗)	⊗	(⊗)	J9:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	⊗	(⊗)		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #3: Base Address: 0D60H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J8:	⊗	⊗	(⊗)	J9:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	⊗	⊗	(⊗)		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #4: Base Address: 01160H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J8:	(⊗)	(⊗)	⊗	J9:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	(⊗)	⊗		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

(⊗)
(⊗)

= Jumpers inserted

(⊗)
(⊗)

= Jumpers removed

Important Notes

⚠ **Caution:**
In order to prevent any life threatening electrical shocks (voltage at pins of connector X1/X2 can reach values up to about 80 VDC!) the rack's mains power supply must be turned off by all means before any cable attached to X1 or X2 is installed or removed.

Also the indexer board could be damaged if a plug connected to X1-X4 is removed while the motor is activated.

Indexer/Driver 4 Axis / 2 Amps (419-306600)

The D8 indexers use the latest DSP technology tightly integrated with on-board motor drivers. With this level of integration, the user has complete software control of all step motor controlling parameters.

The DSP chipset provides the following features:

- Advanced control of 4 step motors per board
- High speed step and direction output
- S-curve, trapezoidal, velocity contouring and electronic gearing trajectory modes
- Incremental encoder feedback
- 32-bit position, velocity, acceleration and jerk trajectory profile registers
- Step output rates up to 1.5 MHz
- On-the-fly stall detection
- Two limit switch inputs per axis

The on-board motor drivers provide the following features:

- Synchronized fixed-frequency chop-mode motor current control
- 24-V/2-A control of up to 4 motors
- Software selected current setting for each axis
- Drivers are electrically isolated from the ISA bus interface and DSP logic for noise reduction
- Software selectable 5, 10, 20, 25, 50, 100, 200 and 250 microsteps/step modes for each axis
- Software selectable step correction tables to improve microstepping accuracy for each axis
- Drivers can be individually enabled and disabled under software control
- Software selectable standby current mode to reduce motor heating for each axis
- Software selectable minimum ON-time to control the minimum winding duty cycle for each axis
- Software selectable high speed full-step mode to improve high speed performance of each axis

Additional on-board features:

- Software selectable support for 1 pulse/degree position markers instead of incremental encoders
- Software selectable polarity-reversal for all home and limit switch inputs
- Software selection of external home switch or encoder index mark for all DSP home inputs
- Software selection of limit switch sensing direction for each axis
- Software selection of motor movement direction and encoder readout direction for each axis

Front Plug Assignments

X1	Stepper motor, home switch and CW/CCW limit switches of axis #4
X2	Stepper motor, home switch and CW/CCW limit switches of axis #3
X3	Stepper motor, home switch and CW/CCW limit switches of axis #2
X4	Stepper motor, home switch and CW/CCW limit switches of axis #1
X5	Incremental Encoder of axis #4
X6	Incremental Encoder of axis #3
X7	Incremental Encoder of axis #2
X8	Incremental Encoder of axis #1

Jumper Settings:

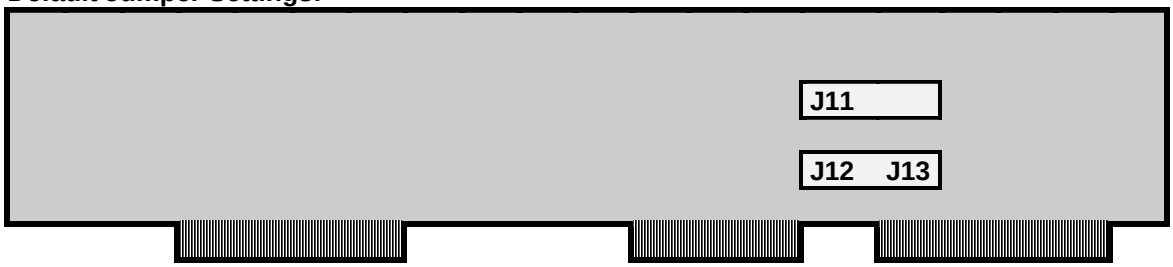
J12/J13 Base Address:	1-1	A4 (A4 = 0 if jumper set; A4 = 1 if jumper removed)
	3-4	A5
	5-6	A6
	1-2	A7
	3-4	A8
	5-6	A9
	7-8	A10
	9-10	A11
	11-12	A12

Interupt Select

J11 Interupt Select:	1-1	IRQ 2 (IRQ 2 selected if jumper set)
	3-4	IRQ 5
	5-6	IRQ 7
	7-8	IRQ 10
	9-10	IRQ 11
	11-12	IRQ 12
	13-14	IRQ 14
	15-16	IRQ 15

☞ **Note:**
Only one interrupt line may be selected at one time.

Default Jumper Settings:



Default settings: (1) Base Address: 560H
(2) Selected Interrupt Source: None

	IRQ 15	IRQ 14	IRQ 12	IRQ 11	IRQ 10	IRQ 7	IRQ 5	IRQ 2
J11:	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
	⊗	⊗	⊗	⊗	⊗	⊗	(⊗)	(⊗)

	A10	A11	A12
J12:	⊗	(⊗)	(⊗)
	⊗	(⊗)	(⊗)

	A4	A5	A6	A7	A8	A9
J13:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #1: Base Address: 160H

	A10	A11	A12
J12:	(⊗)	(⊗)	(⊗)
	(⊗)	(⊗)	(⊗)

	A4	A5	A6	A7	A8	A9
J13:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #2: Base Address: 960H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J12:	(⊗)	⊗	(⊗)	J13:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	⊗	(⊗)		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #3: Base Address: 0D60H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J12:	⊗	⊗	(⊗)	J13:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	⊗	⊗	(⊗)		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

Optional Settings #4: Base Address: 01160H

	A10	A11	A12		A4	A5	A6	A7	A8	A9
J12:	(⊗)	(⊗)	⊗	J13:	(⊗)	⊗	⊗	(⊗)	⊗	(⊗)
	(⊗)	(⊗)	⊗		(⊗)	⊗	⊗	(⊗)	⊗	(⊗)

(⊗)
(⊗)

= jumpers inserted

(⊗)
(⊗)

= jumpers removed

Important Notes:

⚠ **Caution:**
In order to prevent severe damages of the indexer board the rack's mains power supply must be turned off by all means before any connector attached to X1-X4 or X5-X8 is removed or installed.

Box Distribution Board (C79298-A3220-B200)

The Box Distribution Board is located at the left side of the D8's base cabinet. It is connected to the various components of the safety circuit, the X-ray generator, the service control panel, the status and X-ray warning displays. It concentrates all signals and wires them with the Universal I/O-Board via two cables.

Single diffraction system
The connectors X2 und X3 of the Box Distribution Board are connected with X7 and X8 of the Universal IO-Board located inside the control rack. The so-called "Control Rack #2 Simulator Key" (C79298-A3242-B104) must be plugged into connector X4. Connector X5 of the Box Distribution Board must be left free.

Double diffraction system (One X-ray source and two independently controlled goniometers)
The connectors X2 und X3 of the Box Distribution Board are connected with X7 and X8 of the Universal IO-Board located inside control rack #1, the connectors X4 und X5 of the Box Distribution Board are connected with X7 and X8 of the Universal IO-Board located inside control rack #2.

Note:
In case of a double diffraction system the check of the proper function of all X-ray and service warning lamps is performed only by electronic rack #1. Control rack #1 is the master, control rack #2 is the slave.

X-ray Shutter Status Display (C79298-A3220-B202/B203)

The X-ray Shutter Status Display (see schematic C79298-A3220-B202/B203-*-11) is part of the shutter control unit which is located directly at the tube mount. The three LEDs indicate the current status of the X-ray shutter.

Red Display "Shutter Open"
The two red LEDs light up whenever the X-ray shutter is not closed.

⚠ **Caution:**
X-ray radiation inside the X-ray protection box!)

Whenever the red light is on X-ray radiation will be emitted from the X-ray tube towards the diffraction experiment setup.

Green Display "Shutter Closed"
The green LED lights up if the shutter is closed (safe condition). Even if the X-ray generator's high-voltage in on there will be no X-ray radiation inside the X-ray protection box.

For more details about X-ray protection and implemented X-ray safety precautions see chapter 'Protection Against X-ray Radiation' in Chapter 2.

Control Panel (C79298-A3242-B43)

The Service Control Panel (see schematic C79298-A3242-B43-*-11) is mounted at the top left corner of the base cabinet. It contains the 'Clear Alarm Flags' button S620 which is used to reset any captured safety error condition. Furthermore there are several shutter control components which are activated only during 'Service Operation Mode'.

Button 'Clear Alarm Flags' (S620)
The control circuit of the X-ray safety system which is located on the Universal IO-Board sets the alarm flag if one or more error conditions affecting the radiation safety occur. As long as the error flag is set the safety circuit will be kept open and the X-ray generator is prevented from producing any high-voltage. After reparation of the error condition the button 'Clear Alarm Flag' must be pressed one time in order to reset the error flag. Then the safety circuit will close again and the X-ray generator can continue generating high-voltage.

Service Operation Mode:

S624 Key switch to enable/disable 'Service Operation Mode'
For safety reasons each time key S624 is toggled the safety circuit will be opened and the X-ray generator will be turned off. In order to continue the user has to turn on the high-voltage again by pressing the X-ray generator's high-voltage button.

S621 Open Shutter Button
This button is activated only during Service Operation Mode. As soon as it is pressed an audible warning signal will be generated and about two seconds later the shutter will open.

☞ **Note:**
For safety reasons during Service Operation mode the shutter cannot be opened / closed by the host computer or service computer!

S622 Close Shutter Button
This button is activated only during Service Operation Mode. If it is pressed the X-ray shutter will be closed immediately. (Note: During Service Operation mode the shutter cannot be opened/closed by the host computer or service computer.)

S623 Select Shutter electronics #2
This switch must be in position 'SHUTTER #1' if the X-ray shutter associated with control electronics #1 shall be controlled manually. It must be in position 'SHUTTER#2' if the shutter connected to control electronics #2 has to be controlled.

External X-ray Warning Display (C79298-A3220-A2)

The optional External Warning Display (see schematic C79298-A3220-B204-*-11) which consists of three LED displays can be positioned anywhere inside or outside the X-ray protection box. It will be connected with connector X14 of the Universal IO-Board.

Red Display "Shutter Open"
The red LEDs light up whenever the X-ray shutter is not closed.

Caution: ⚠
X-ray radiation on.

Green Display: "Shutter Closed"
The green LEDs light up if the shutter is closed (safe condition).

Orange Display: "X-ray ON"
The orange LEDs light up as soon as the X-ray Generator's high-voltage is turned on.

Manual Control Box (SXI-472037000)

The optional manual control box enables the user to control the various components/drives of the diffraction system individually and to read back their current status. It is a very helpful tool used during setup and alignment of the diffraction experiment. It consists of a numeric keypad, several function keys and a LCD display. The Manual Control Box is connected to connector X12 of the Universal IO-Board via an EIA-232 interface cable which also includes a power supply line.



Fig. 3-31: Manual Control Box

The D8 manual control box is meant for easy alignment of D8 and samples with direct view on the instrument.

Hardware Setup

The Manual Control Box must be connected to connector X12 of the Universal IO-Board (C79298-A3220-B103) via an EIA-232 interface cable which also includes a power supply line. This interface cable is shipped together with the Manual Control Box.

Steps for Installation:

1. Turn off the power of the whole D8 Diffraction System.
2. Remove the front panel of the cabinet and the control electronics.
3. Connect the interface cable of the Manual Control Box to connector X12 of the printed circuit board labelled B103 (Universal IO-Board, C79298-A3220-B103)
4. Attach the front panels again.
5. Turn on the power of the D8 Diffraction System.

⚠ **Caution:**

In order to prevent severe damages of the Universal IO-Board and the Manual Control Box the D8's mains power supply must be turned off by all means before the interface cable attached to X12 is removed or installed.

Firmware

To operate the D8 manual control box it might be necessary to update the firmware. The floppy inside the D8 control rack must contain the three files listed below.

1. Phoenix.exe	1. version 15.June 1999 or newer
2. QDataAXS.v30	2. version 3. December 1998 or newer
3. QCodeAXS.v30	3. version 28.January 97or newer

They must be updated if only older or no versions of these files exist.

⚠ **Caution:**
Create a backup floppy before overwriting or deleting any file on your D8 boot floppy!

Configuration

The D8 manual control box must be added to the configuration to be enabled. Before changing the configuration create a backup file of the configuration (diff_in1.cnf). Afterwards start the configuration program and go to section "Advanced Diffractometer Setup" (Fig. 3-32). Accept the warning that only experienced users should advance. In the section "Diffractometer Ports" activate Port 2 and choose "Manual Control" (Fig. 3-32). In section "Internal Control Boards" activate the "Connected Terminal" "QTERM2". Finally download the new configuration.

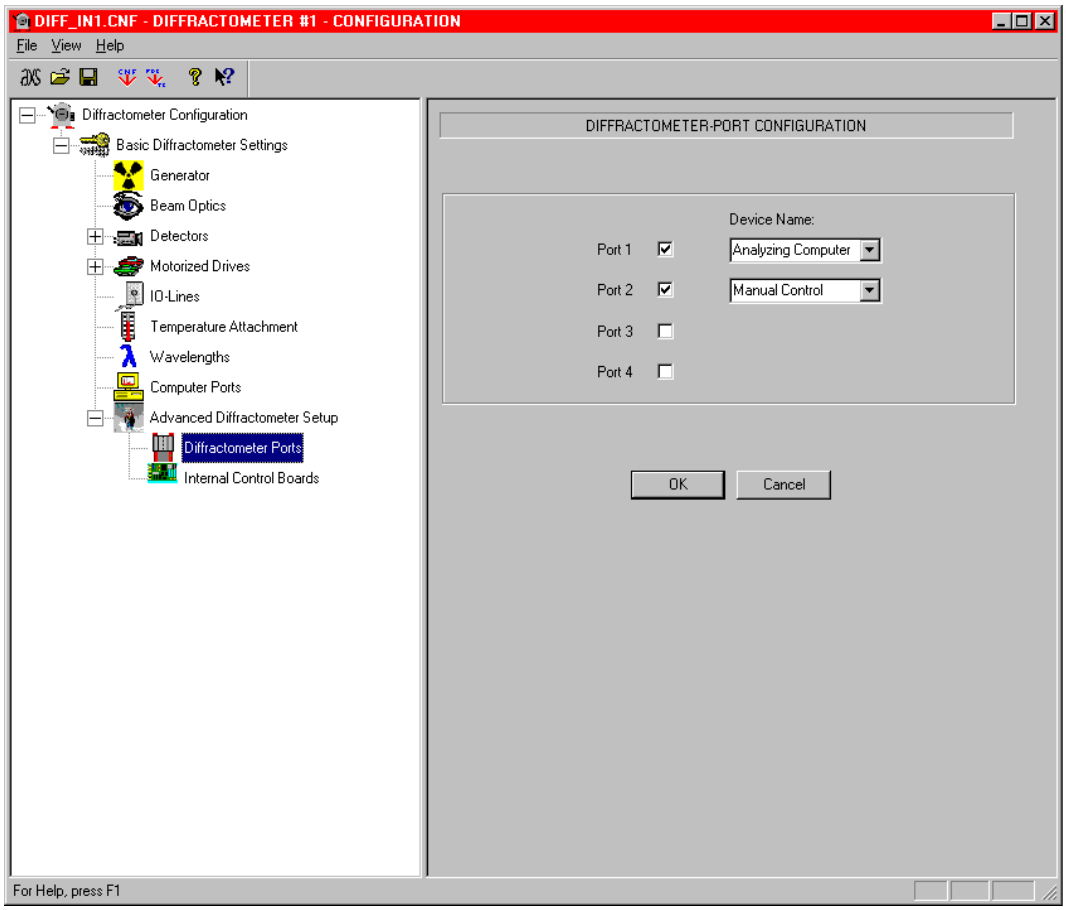


Fig. 3-32: Configuration of D8 manual control box, part 1

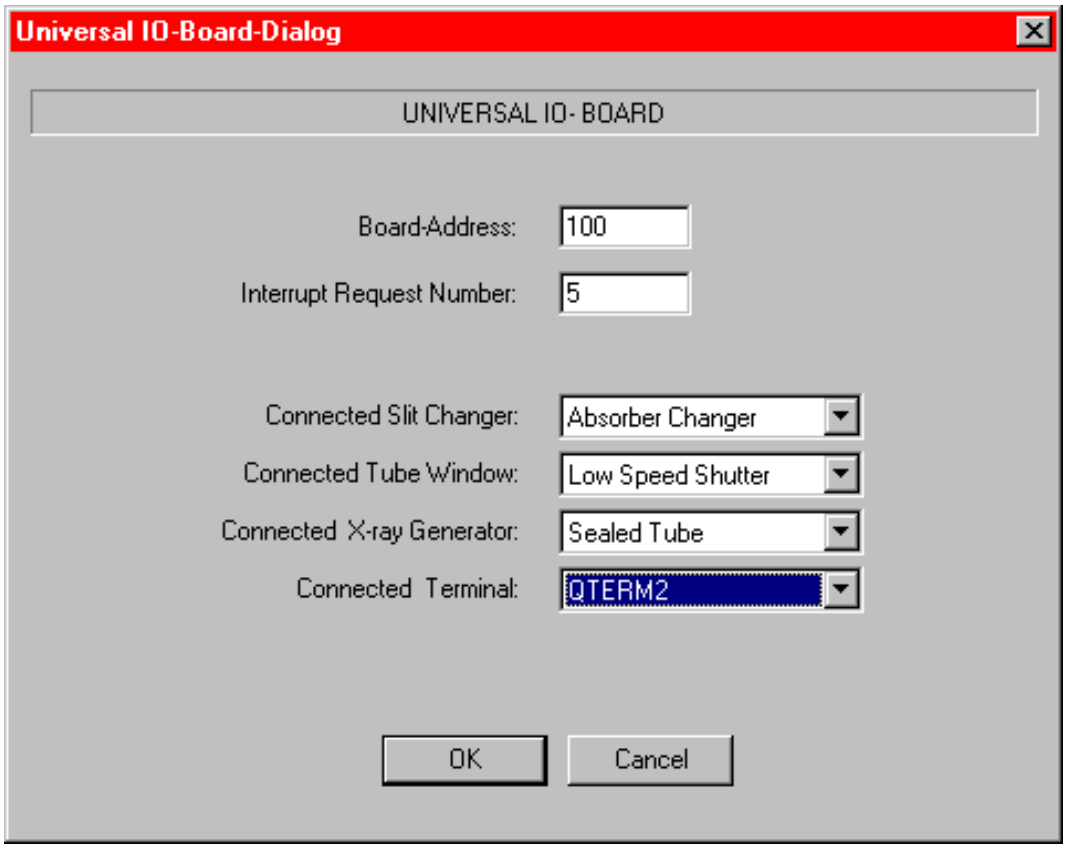


Fig. 3-33: Konfiguration D8 manual control box, part 2

Keyboard setup

If the D8 manual control box is installed the first time on a D8 the keyboard of the D8 manual control box must be set up. Therefore, use the remote control commands of the D8 (see below page 3-96).

⚠ **Caution:**
Be careful because the Set up Mode (SU) of the D8 must be used. By this the configuration of the instrument will be changed. Any mistake might lead to malfunction of the D8!

The command sequence for setting up the keyboard is as following

1. SU
2. QTLD
3. QU

Afterward the remote control mode can be left.The QTLD needs some time (something in the order of 1 minute). During this time the files QDataAXS.v30 and QCodeAXS.v30 will be read from the D8 boot floppy. In case of proper operation the R/W LED of the floppy drive in the D8 control rack is on.

Short Description of Functions

The functionality of the D8 manual control box is rather self explaining in most functions. Therefore, table 3-5 and 3-6 summarise the functions. For further information refer to the explanation of the corresponding remote control commands in chapter 'Description of Remote Control Commands' (see page 3-96).

Tab. 3-5: Keyboard of D8 manual control box

Hot-Key	**Function**
ACVAL	Display "Actual Values"
CHAN	Display "Channel Values"
STATUS	Display "Component Status and Errors"
I/O-REG	Display "I/O Register Bitmap"
DRVC	Manual Drive Control Mode
TWC	Manual Tube-window Control Mode
SHIFT + ACVAL	Display Programming Mode "Actual Values"
SHIFT + CHAN	Display Programming Mode "Channel Values"
SHIFT + STATUS	Display Programming Mode "Component Status and Errors"
SHIFT + I/O-REG	Display Programming Mode "I/O Register Bitmap"
F1	Simplified Manual Drive Control Mode
F2	reserved
F3	reserved
F4	reserved
↑	Move drive upward (Manual Drive Control Mode)
↓	Move drive downward (Manual Drive Control Mode)
STOP	Stop
ESC	Delete input line
DEL	Delete last character
ENTER	Quit input

Tab. 3-6: Function Key F1 - Simplified manual control mode

Key	Function
1	Select axis 1, display axis name and position
2	Select axis 2, display axis name and position
3	Select axis 3, display axis name and position
4	Select axis 4, display axis name and position
5	Select axis 5, display axis name and position
6	Select axis 6, display axis name and position
7	Select axis 7, display axis name and position
8	Select axis 8, display axis name and position
9	Select axis 9, display axis name and position
A	Select axis 10, display axis name and position
B	Select axis 11, display axis name and position
C	Select axis 12, display axis name and position
D	Select axis 13, display axis name and position
E	Select axis 14, display axis name and position
F	Select axis 15, display axis name and position
0	Select axis 16, display axis name and position
+	Select fast speed, display will show FAST
-	Select slow speed, display will show SLOW
↑	Move forward (press to start, release to stop)
↓	Move reverse (press to start, release to stop)
ENTER	Report keys pressed for optical alignment (D8 with GADDS)

☞ **Note for D8 with GADDS:**
The equivalent GGCS manual control axis select key combination is shown on the display as (ABCD), where A, B, C and D are displayed depending on the axis selected. This is shown to assist the user during the optical alignment procedure.

Table 3-7 indicates the values reported to the host computer in the form 'STx' when the ENTER key is pressed. The value 'x' is the accumulated values of all status information. The letters in parentheses indicates the equivalent GGCS axis select keys that are pressed for this function.

Tab. 3-7: Meaning of values reported to host computer (D8 with GADDS)

Value	Meaning
1	Hardware collision on selected axis
4098	Default status value (always set)
4	Attenuator IN
8	Attenuator OUT
256	Omega selected (D)
512	2theta selected (C)
1024	Chi selected (B)
2048	Phi selected (A)
3072	X selected (AB)
2560	Y selected (A C)
2304	Z selected (A D)
768	Zoom selected (CD)
1536	Linear stage selected (BC)
32768	Shutter open

Additional Information about Functions

Shift ACVAL

Define content of display "Actual Values" (ACVAL). The user can define the drives which shall be displayed on the D8 manual control box after pressing **ACVAL.** The positions of up to 4 drives can be displayed. The drives are identified by the number defined in the configuration program, i.e. 1, 2, ... 16.

Example for a common set up:

Drive number	Meaning
1	Theta
2	2Theta
3	Phi
4	Chi
5	X
6	Y
7	Z

According to this example “Shift ACVAL, 1,7,5,3, Enter” would lead to display of theta in line 1, z in line 2, x in line 3, and Phi in line 4 after pressing of ACVAL.

Input Format: <drive in line1>(,<drive in line 2>(,<drive in line 3>(,<drive in line 4>)))

av_id	Meaning
1 ... 16	Positioning Drive #1 ... #16

Display Formats:

```
Drive name = --       ; drive not referenced and adjusted
Drive name = 1234.--  ; drive not adjusted
Drive     name     = ; drive referenced and adjusted
1234.5678
```

Shift CHAN

Define content of display "Channel Values" (CHAN). The user can define a detector which actual values will be displayed. The channel number which is associated with a detector by the D8 is defined in the configuration program. In most cases the channel number will be “1”. Each detector can have up to three different counters. For reference compare description of the detectors and the detector interface board.

Example: “Shift CHAN, 1,2” will display in line 1 the counts per second in the first discriminator of the detector connected to detector interface board 1 if CHAN is pressed.

Input Format: <channel number>,<cv-id#1>(,<cv-id#2>(,<cv-id#3>))

cv-id	Meaning
1	Measuring channel status register
2	Counting rate of counter 1 (discriminator 1)
3	Counting rate of counter 2 (discriminator 2)
4	Counting rate of counter 3
5	Measuring time
6	Count of counter 1 (discriminator 1)
7	Count of counter 2 (discriminator 2)
8	Count of counter 3
9	Number of stored measured values

Display Formats:

```
CHANNEL_NAME
STATUS          = xx            ; xx = Bitmap |hex
RATEx           = 12345678
TIME            = 123456.789
CNTRx           = 1234567890
NUM MV          = 12345
```

Shift STATUS

Define content of display “Status” (STATUS). Compare section “Status Flags” on page 3-154of this manual.

Input Format: <st-id#1>(,<st-id#2>(,<st-id#3>(,<st-id#4>)))

st-id	Meaning
1	Control register of instrument
2	Ready messages
3	Warnings
4	Alarms
5	(Generator) shutdown circuit capture register
6 ... 21	positioning drive #1 ... #16
22	(standard) slit changer
23	(standard) tube window
24	(standard) X-RAY Generator

Display Formats:

```
INSTR           = xxxx
READY           = xxxx
WARN            = xxxxxxxx
ALARM           = xxxx
GSCL            = xxxxxxxx
DRV_NAME        = xx
SLIT            = xx
TUBEWIN         = xx
XRAY-GEN        = xx
(xx... = Bitmap |hex )
```

Shift I/O-REG

Define content of display "I/O Register Bitmap" (I/O-REG)

Input Format: <io_adr#1>(,<io_adr#2>(,<io_adr#3>(,<io_adr #4>)))

<io_adr#x> = I/O-Address **|hex**

Display Format:
`aaaa = xx  ; aaaa = I/O-Address |hex , ; xx = I/O Register Bitmap |hex`

⚠ **Caution:**
Not readable I/O Registers addressed by <io_adr#x> can cause system errors!

DRVC

Manual Drive Control Commands. This command can be used to move the drives.

Examples (configuration as in example “Shift ACVAL”):
“DRVC, 1,2, 20” moves theta to 20°.
“DRVC,5,1” initialises the x translation

Input Format: <drive-id> <cmd_id> (<parm1> <parm2> ...)

drive-id	Meaning
1 ... 16	Positioning Drive #1 ... #16

cmd_id	Meaning
0	Stop
1	Adjust
2	Go
3	Rotate
4	Oscillate
5	Move
6	Find Reference
7	Follow-up
8	Couple Drives
"Stop"-command parameters:	none
"Adjust"-command parameters:	none
"Go"-command parameters:	<parm1> = Target Position <parm2> = Moving Speed
"Rotate"-command parameters:	<parm1> = Moving Speed, 0 = Off > 0 = positive Moving Direction < 0 = negative Moving Direction
"Oscillate"-command parameters:	<parm1> = Amplitude (>1 = positive, <1 = negative) <parm2> = Moving Speed
"Move"-command parameters:	<parm1> = Moving Speed 0 = Off > 0 = positive Moving Direction < 0 = negative Moving Direction

Note:
If <parm2> = 0 the specified drive starts moving by operating the ARROW UP ↑ or ARROW DOWN ↓ key with one clock per sec. Each time you operate the same arrow key again the speed is increased by a factor of 10. The speed is limited to the start-stop-speed (see configuration entry SLOW=<slow-speed>). If the opposite arrow key is operated the moving direction changes.

cmd_id	Meaning
"Find Reference"-command parameters:	<parm1> = Moving Direction (1 = positive, -1 = negative)
"Follow-up"-command parameters:	<parm1> = Master Drive <parm2> = Sample Length
"Couple"-command parameters:	<parm1> = Slave Drive <parm2> = Coupling Factor

TWC

Manual Tube Window Control Commands. Each time you operate the TWC-key the Tube-window toggles its position (closed -> open, opened.-> close)

Input Format: <cmd_id>

cmd_id	Meaning
0	Close Tube Window
1	Open Tube Window

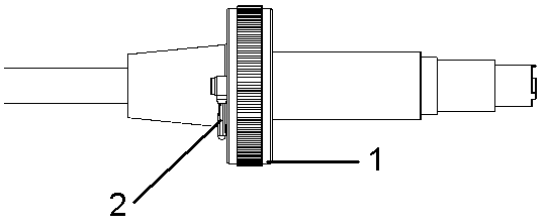
Mounting

Connection to the X-ray Generator

The tube housing is connected to the X-ray generator via the high-voltage cable and the cooling water hoses. The shutter control cable connects the tube housing with the multi I/O-board plugged into the D8 controller rack.

Connection of the High-voltage Cable

⚠ **Danger:**
Before the high-voltage cable is connected or the X-ray tube is inserted, switch off the X-ray generator to avoid high-voltage accidents. Remove the key switch from the X-ray generator and pull the rip line (Fig. 3-34.2), to prevent a restart of the X-ray generator. First fasten the cable to the tube stand, then to the generator.



1 Union nut
2 Ground connector

Fig. 3-34: High-voltage plug tube side

Insert the plug of the high-voltage cable (Fig. 3-34) into the tube stand and fasten it by tightening the union nut (1). The plug must not be greased. Connect the high-voltage cable to the X-ray generator (see Instructions for the X-ray generator).

Connection of the Cooling Water Hoses

The cooling water hoses connecting tube housing and X-ray generator are splitted into two pieces. The two pieces can be connected respectively disconnected by clips. The hose for the cold water supply is marked by a yellow loop, the hose for the warm water return is marked by a red loop. Connect the yellow marked hose with the union nut to the middle connecting piece found on the back side of the generator. The red marked hose is connected to the upper connecting piece. Wire the hoses through the labyrinth, so that the clips are accessible from withing the radiation enclosure.

Push the open end of the yellow marked hose over the shaft 5 (Fig. 3-35) and the end of the red marked hose over shaft 6 (Fig. 3-35). Fix the hoses on the shaft with the shipped clamps.

To enable the water flow the clips must be connected and an X-reay tube must be mounted in the tube housing.

⚠ **Caution:**
The switch-off delay upon water failure must not exceed 2 s. This must be checked in the "Heating" position when the equipment is first put into operation (bend the water supply hose).

Shutter Control Cable

The shutter control cable is plugged into the connection X9 of board B103 in the D8 controller. The cable supplies the safety circuit and the window control.

Fitting and Removal of the X-ray Tube

Caution: ⚠
The windows of the X-ray tube are made of thin beryllium and must not be touched.

Fitting
Before fitting the X-ray tube make sure that the X-ray generator is switched off and the rip line is pulled.

Check that the seals on the water pipes fit properly.

Insert the X-ray tube in the tube housing; the pin (Fig. 3-35.1) at the tube housing must then engage in the bore hole of the X-ray tube.

Tighten the fastening screws of the X-ray tube alternately, taking care not to misalign the X-ray tube.

Removal
Switch off the X-ray generator.

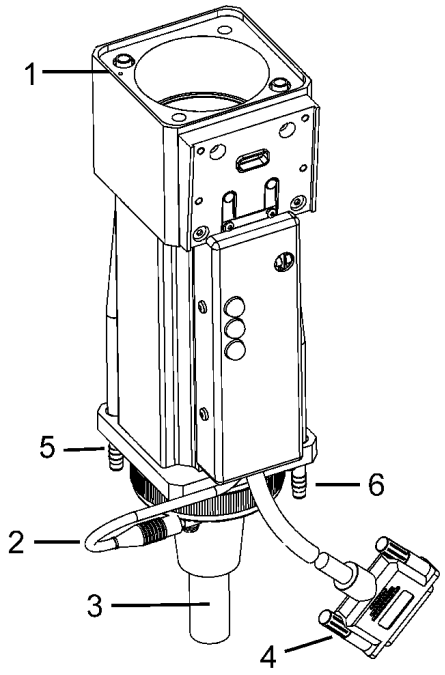
Block off the cooling water flow.

If possible, blow out the cooling water hoses with compressed air. This prevents the cooling water from getting into the tube stand when removing the X-ray tube. Otherwise disconnect both clips in the water hose lines.

Alternately loosen the fastening screws of the X-ray tube and make sure that the X-ray tube is not misaligned.

Remove the X-ray tube; make sure that no water running out gets to the tube or into the tube stand. Wipe off any remaining drops of water.

Take the handling hints of the tube vendor into account. You may find the hints in the manual shipped with the tube.



1 Pin
2 Rip line
3 High-voltage plug
4 Shutter control cable
5 Connection cooling water inflow
6 Connection cooling water outlet

Fig. 3-35: Tube housing

Instrument Initialisation

After start of the instrument control program the instrument configuration and also initialisation and operating parameters will be read from file DEVICE.INI.

The instrument control program starts when the power of the controller is switched on. After switching the power on the operating system is initialised (like a personal computer is booted). Then the instrument control program starts. This can be recognised because the **busy** LED at the base cabinet switches off.

The DEVICE.INI file on the storage of the controller contains all the parameters which are needed to set-up the electronic boards in the controller. The DEVICE.INI file is written respectively modified by the configuration program of DIFFRAC*plus*. It is not necessary to modify the DEVICE.INI file by using an ASCII editor. Only during the installation qualified personal is allowed to create a DEVICE.INI file without using the configuration program.

⚠ **Caution:**
Entering wrong entries in the DEVICE.INI file may damage electronic boards! It is strongly recommended to use the configurations program of the users software DIFFRAC*plus* to initialise the hardware properly.

Format of file DEVICE.INI

The file DEVICE.INI consists of a number of different sections. Each of the sections has several entries. Each entry corresponds to an instrument parameter and specifies its value. The format of a section is like

```
[section_name]
p1_name=p1_def
p2_name=p2_def
   .   =   .
   .   =   .
   .   =   .
   .   =   .
   .   =   .
```

Meaning:
section_name is the name of the section. The brackets ([]) are used to identify a section name. The opening bracket ([) must be the first character of the line. No space is allowed between the opening and closing bracket and section name.

The entry **px_name=px_def** defines the parameter named px_name. No spaces are allowed between the parameter name and '=' character and also between the '=' character and parameter definition. if px_def is missing then that parameter is not defined or a default is used.

In the file DEVICE.INI comments can be inserted. The first character of a comment line has to be a semicolon (;).

⚠ **Caution:**
If the format of the DEVICE.INI is not correct, the instrument control program may not start or will initialise the hardware incorrect.

Sections of DEVICE.INI

[DEVICE] section

This section consists of entries which define the instrument name and the instrument parameters.

The [DEVICE] section consists of following entries:

NAME=<instrument-name>
This entry defines the instrument name e.g. D8 for the D8 diffraction system.

Pre-defined names:

`NAME=D8`	for standard D8 instruments
`NAME=D8-GADDS`	for D8 GADDS instruments
`NAME=D8-SMART`	for D8 SMART instruments

IRQ=<irq-number>
This entry defines the interrupt request number of all installed interrupt driven boards. The number has to be set during the installation.

⚠ **Warning:**
If the interrupt request number is defined incorrect, the system will not work. There is no need to ever change this number.

SETUPTIME=<time>
This entry defines the maximum instrument set-up time. The instrument set-up time is used only while a measuring function is running. If the instrument is not ready for measurement after the set-up time passed the measuring function is aborted by the instrument control software.

[UIOBx] section

This section consists of entries which define the hardware settings and the interface of the universal I/O board (universal I/O board C79298-A3220-B103).

The number x is the logical universal I/O board number (valid numbers x are 1 or 2). That means that up to two universal I/O boards can be mounted into the controller.

The [**UIOBx**] section consists of following entries:

BASEADR=< hex-value >
This entry defines the base address of the universal I/O board. The exchange of commands, data and status register information's will be based on this address.

Warning: ⚠
If the base address does not correspond to the hardware address defined by jumpers on the board, the whole system will not work.

SLIT=< string >
For the control program this entry defines whether the slit changer or the absorber changer or even no changer is connected to output X13 of the I/O board. Leave this entry empty means no changer is connected. If a <string > (SlitChanger or AbsorberChanger) is entered the control software handles the changer.

< string > = Name of the (standard-) 2-position slit changer.

☞ **Note:**
If a name is entered but no changer is connected the control program will miss position signals from the changer and will not execute measurements.

TUBEWIN=< string >
For the control program this entry defines whether a tube window is connected to output X9. Missing < string > (e.g. LowSpeedShutter) means that no tube window is connected.

< string > = Name of the (standard) 2-position (open, closed) tube window:

XRAYGEN=< string >
For the control program this entry defines whether an X-RAY generator is connected to output X11 of the I/O board or not. If < string > (e.g. SealedTube) is missing the control program does not try to control the X-RAY generator.

< string > = Name of the (standard) X-RAY-Generator:

TERMINAL=< string >
For the control program this entry defines whether a hand held terminal (Manual Control Box) is connected to output X12 of the I/O board or not. If < string > (e.g. QTerm2) is missing the control program does not try to communicate with the terminal.

< string > = Name of the Manual Control Box

Pre-defined names:

`TERMINAL=QTERMII`	for standard D8 instruments
`TERMINAL =QTERMII-GADDS`	for D8 GADDS instruments
`TERMINAL =QTERMII-SMART`	for D8 SMART instruments

☞ **Note:**
Tthe number x of the [UIOBx] sections in the DEVICE.INI file has to correspond to the number of installed I/O boards.

Example of a [UI0Bx] section:

```
[UIOB1]
BASEADR=100
SLIT=SlitChanger
TUBEWIN=LowSpeedShutter
XRAYGEN=SealedTube
TERMINAL=QTERM2
```

Meaning
A motorised slit changer and a QTERM hand held terminal is connected to the universal I/O board. The safety shutter and the sealed tube generator is controlled via the I/O board.

[DIBx] section

This section consists of entries which define the hardware settings and the interface of the detector interface board (detector interface C79298-A3220-B102). The number x is the logical detector interface board number.

The [**DIBx**] section consists of following entries:

BASEADR=< hex-value >
This entry defines the base address of the detector interface board. The control program uses this address to exchange commands, data and status registers information's with the board.

⚠ **Warning:**
If the base address does not correspond to the hardware address defined by jumpers on the board, the detector interface board will not work.

DETECTOR=< string >
This entry defines the detector which is wired to the board. Missing < string > (e.g. Scintillation for a scintillation counter) means that no detector is connected to the corresponding board.

The parameters for the detector <detector-name> must be defined in the corresponding [CHANNELx] (see below) section of the file DEVICE.INI.

TTLIN=< string >
This entry defines the TTL-pulse generator (e.g. a detection system with a TTL output) which is connected to the TTL-input of the board. Missing < string > means that no TTL-pulse generator is connected to the corresponding board.

Note: ☜
The number x of the [DIBx] sections in the file DEVICE.INI has to correspond with the number of the installed detector interface boards.

Example of a [DIBx] section

```
[DIB1]
BASEADR=140
DETECTOR=ScintillationCounter
TTLIN=Kevex
```

Meaning:
A scintillation counter is connected to the detector interface board. The TTL input lines gets the signals from the NIM output of a Kevex type detector.

[2AIBx] section

This section consists of entries which define the hardware settings of the 2-axes motor driver board (2-Axis indexer 419-306500). The number x is the logical 2-axes driver board number. Valid numbers are 1 to 4 if up to 4 boards are installed. One board has to be installed (x=1) to drive the motors for theta and 2theta circle.

The [**2AIBx**] section consists of following entries:

BASEADR=< hex-value >
This entry defines the base address of the 2-axis driver board. The control program uses this address to exchange commands, data and status registers information's with the board.

⚠ **Warning:**
If the base address does not correspond to the hardware address defined by jumpers on the board, the driver board will not work.

DRIVER1=< string >
DRIVER2=< string >
These entries define the drives which are connected to the driver board outputs. Missing <string> means no drive is connected to the corresponding driver board output. The parameters of the drive < string > must be defined in the corresponding [DRIVEx] section of the file DEVICE.INI.

Note:
The number x of the [2AIBx] sections in the file DEVICE.INI has to correspond with the number of the installed 2-axes driver boards.

Example of a [2AIBx] section

```
[2AIB1]
BASEADR=160
DRIVER1=Theta
DRIVER2=2Theta
```

Meaning:
The motors for Theta and 2theta drive of the goniometer are connected to DRIVER1 output respectively DRIVER2 output.

[4AIBx] section

This section consists of entries which define the hardware settings of the 4-axes motor driver board (4-axis indexer 419-306600). The number x is the logical 4-axes driver board number. Valid numbers are 1 to 4 if up to 4 boards are installed.

The [**4AIBx**] section consists of following entries:

BASEADR=< hex-value >
This entry defines the base address of the 4-axis motor driver board. The control program uses this address to exchange commands, data and status registers information's with the board.

⚠ **Warning:**
If the base address does not correspond to the hardware address defined by jumpers on the board, the driver board will not work.

DRIVER1=< string >
DRIVER2=< string >
DRIVER3=< string >
DRIVER4=< string >
These entries define the drives which are connected to the driver outputs X1 trough X4. Missing < string > means that no drive is connected to the corresponding driver output. The parameters of the drive < string > must be defined in the corresponding [DRIVEx] section of the file DEVICE.INI.

☞ **Note:**
The number x of the [4AIBx] sections in the file DEVICE.INI has to correspond with the number of the installed 4-axes driver boards.

POWER=<int-value>
This (optional) entry defines the power-supply of the board. Missing the enty or missing < int-value > means the default power-supply is used.

☞ **Note:**
The POWER-entry is only regarded with Revision01 4-Axis-Indexer-Boards.

Example of a [4AIBx] section

```
[4AIB1]
BASEADR=560
DRIVER1=
DRIVER2=Z-Drive
DRIVER3=DivergenceSlit
DRIVER4=AntiscatteringSlit
```

Meaning:
The Z-drive of an Eulerian cradle is connect to DRIVER2 output the 4-axes board, the motorised slits are connected to DRIVER3 output respectively DRIVER4 and DRIVER1 output 1 is not used.

[COMx] sections

The [COMx] sections define the name, port address, communication parameters and communication protocol of the serial communication ports of the controller. The number x is the logical comport number (valid numbers: 1 <= x <= 4).

The [COMx] sections consist of following entries:

NAME=< string >
This entry defines the name of the serial communication port. Recommended names are:

Recommended names are:
NAME=AnalyzingComputer
NAME=ServiceComputer

PORT=< hex-value >
This entry defines the base address of the UART (Universal Asynchronous Receiver Transmitter) which controls the specified serial communication port. The exchange of all commands, data sets and status registers will be based on this address.

MODE=<baud>,<dbits>,<parity>,<sbits>
This entry defines baudrate (<baud>), character length (<dbits>), parity (<parity>) and number of stopbits (<sbits>).

Standard parameters:

```
<baud> = 9600
<dbits> = 8
<parity> = N
<sbits> = 1
```

HANDSHAKE= <rts>, <cts>, <stx>, <etx>, <ack>, <nak>, <check>
This entry defines ASCII control characters and sumcheck for software handshake mode of the serial communication port x. The parameter list consists of

```
Request to Send character (<rts>)
Clear to Send character (<cts>)
Start of Text character (<stx>)
End of Text character (<etx>)
Acknowledge character (<ack>)
Negative Acknowledge character (<nak>)
Sumcheck (<check>), <check> = Y means with sumcheck, <check> = N means without sumcheck
```

Standard parameters:

Setting	ASCII control character
Request to Send character (<rts>):	ENQ = 05_{hex}
Clear to Send character (<cts>):	DLE = 10_{hex}
Start of Text character (<stx>):	STX = 02_{hex}
End of Text character (<etx>):	ETX = 03_{hex}
Acknowledge character (<ack>):	ACK = 06_{hex}
Negative Acknowledge character (<nak>):	NAK = 15_{hex}
Sumcheck (<check>):	N

CANCEL=<char>
This entry defines a character which will be used as a short form of a panic stop command. Only ASCII control characters are permissible.

Standard character: ASCII control character CAN = 18_{hex}

After reception of a cancel character all drives, measuring functions and command macro execution will be stopped immediately and the command and reply buffer cleared.

COMMENT=<string>
This entry defines a string which will be used as a comment line identifier. Only printable characters - except ‘,’ ‘.’ ‘;’ ‘%’ characters - are permissible.

Standard string: rem

All characters following a comment identifier in a remote control command will be ignored.

AUTO=<char>
This entry enables or disables the auto transmit function of the comport.

If the auto transmit function is enabled changes of Ready Flags, Warning Flags, Alarm Flags, measuring function abort or available collected data will be transmitted to the host PC immediately.

<char> = 'N' or <char> missing means disable auto transmit function

<char> ='Y' means enable auto transmit function.

Example of a [COMx]

```
[COM1] ;no handshake
NAME=Computer
PORT=03f8
MODE=9600,N,8,1
HANDSHAKE=
CANCEL=24
COMMENT=rem
AUTO=N
```

Meaning:
COM1 is the port which connects the controller with the host computer. The hardware handshake is disabled. The communication parameters are 9600 baud, no parity, 8 data bits and 1 stop bit.

[DRIVEx] section

These sections (different x) contain the parameters which are necessary for the control program to use the individual stepping motors. The number x is the logical drive number. The control program uses the number x in several commands.

Valid numbers for x are 1 through 16.

The [DRIVEx] sections consist of following entries:

DRIVE=< string >
This entry defines the name of the drive.

The entry must correspond with an entry in one of the sections [2AIBx] or a [4AIBx] DRIVERx=<drive-name>.

Recommended names are (others are also supported):

```
THETA or 2THETA
2THETA or OMEGA
PHI or SPINNER
CHI
XTRANS
YTRANS
ZTRANS
VSLIT1
VSLIT2
CHCUT1
CHCUT2
XAXIS
YAXIS
```

CFN=< hex-value>
This entry is a six digits hex number ($\#_6\#_5\#_4\#_3\#_2\#_1$) which corresponds to a bit mask.

Overall the number determines the behaviour and the characteristic of an individual motor.

<drive-cfn> is the sum of significance's with following assignments:

Significance	Assignment	Meaning
#1	D0 - home switch	0 = not installed, 1 = installed
	D1 - number of home marks bit 0	see below
	D2 - number of home marks bit 1	see below
	D3 - number of home marks bit 2	see below
$\#_2$	D4 - degree mark on the motor axis	0 = not installed, 1 = installed
	D5 - optical encoder	0 = not installed, 1 = installed
	D6 - lower limit switch	0 = not installed, 1 = installed
	D7 - upper limit switch	0 = not installed, 1 = installed
$\#_3$	D8 - encoder direction [1]	0 = normal direction, 1 = reversed direction
	D9 - motor direction	0 = normal direction, 1 = reversed direction
	D10 - limit switch direction	0 (ccw*=ccw, cw*=cw), 1 (ccw=cw, cw=ccw) (ccw means counter clock wise; cw means clock wise)
	D11 - driver mode	0 = micro-step mode, 1 = full-step mode
$\#_4$	D12 - standby current mode	0 = standby enabled, 1 = standby disabled
	D13 - 'force on' time-constant	0 = 0.5 microseconds, 1 = 2 microseconds
	D14 – not used	always 0
	D15 – not used	always 0
$\#_5$	D16 - home switch polarity	0 = normal, 1 = inverted
	D17 - index mark polarity [2]	0 = normal, 1 = inverted
	D18 - limit switch polarity	0 = normal, 1 = inverted
	D19 - max current[3)]	0 = 150mA, 1 = 2A

Significance	Assignment	Meaning
$\#_6$	D20 - step output polarity	0 = normal, 1 = inverted
	D21 - direction output polarity	0 = normal, 1 = inverted
	D22 - unit bit 0	(coding see below)
	D23 - unit bit 1	(coding see below)
	D24 - 1 = lower limit switch used as reference switch	
	D25 - 1 = upper limit switch used as reference switch	
	D26 - homing direction	0 = normal (=downward), 1 = inverted (=upward)

Coding of D1, D2 and D3 - number of home marks:

bit 2	bit 1	bit 0	meaning
0	0	0	number of home marks = 1
0	0	1	number of home marks = 2
0	1	0	number of home marks = 3
0	1	1	number of home marks = 4
1	0	0	number of home marks = 5
1	0	1	number of home marks = 6
1	1	0	number of home marks = 7
1	1	1	number of home marks = 8

Coding of D22 and D23 – unit of the drive:

bit 1	bit 0	meaning
0	0	unit = step
0	1	unit = degree
1	0	unit = mm
1	1	not used



Note:

[1)] The encoder direction (bit D8) is for both degree mark and incremental encoder.

[2)] The index mark polarity (bit D17) is for both degree mark and index mark of the incremental encoder.

[3)] The max current (bit D19) is only valid for Revision01 4-Axis-Indexer-Boards

MTYPE=< int-value >
For the control program this parameter defines which kind of motor is connected. Valid numbers are 1 through 8. D8 standard motors are all of type 1. Contact Bruker AXS if you like to connect your own motor driven equipment to one of the motor driver boards.

FSTEPS=< int-value >
This entry gives the number of full-steps per motor revolution. Typically 2-phase stepping motors have 200 steps per revolution.

GEAR=< float-value >
This entry gives the number of motor revolutions per unit (e.g. per degree or per mm) of the defined drive (so called mechanical gear).

CUR=< float-value >
This entry gives the current for the stepping motor of the defined drive. The value is given in Ampere.

RESOL=< float-value >
This value is the size of one micro-step of the defined drive in units of the drive (e.g. deg or mm).

ECOUNTS=< int-value >
This entry gives the number of encoder counts per motor revolution.

SLOW=< float-value >
This value is the velocity with which the defined drive starts any movement to a given target position, that means < float-value > is the start velocity for the acceleration profile. If the drive approaches the target position it is decelerated to < float-value >. Then it is switched off at the target position. The units for < float-value > are degree/min, mm/sec, or steps/sec.

The < float-value > is also used for the 'Find Reference' command execution. The < float-value > defines the maximum velocity for measurements with this drive.

Note: ☜
If the drive is used to carry heavy loads then reduce the value of < float-value > if you recognise problems or unacceptable noise during movements.

FAST=< float-value >
This value is the maximum velocity of the drive. It is used as the top level of the acceleration profile. The units for < float-value > are degree/min, mm/sec, or steps/sec.

Note: ☜
If the drive is used to carry heavy loads then reduce the value of < float-value > if you recognise problems or unacceptable noise during movements.

ATIME=< float-value >
This value defines the acceleration and deceleration time during the velocity profiles (units are seconds).

☞ **Note:**
If the drive is used to carry heavy loads then reduce the value of < float-value >if you recognise problems or unacceptable noise during movements.

REF=< float-value >
This entry defines the reference position of the specific drive. The reference position of a drive is aligned by an X-Ray measurement.

LOWER=< float-value >
This entry defines the lower permissible drive position (lower software limit switch).

UPPER=< float-value >
This entry defines the upper permissible drive position (upper software limit switch).

POSERR=< int-value >
This value defines the maximum allowed difference between the approached motor position and the motor position detected by the encoder. If the position error exceeds the specified value the motion error status flag is set and the drive stops immediately. Obviously the drive has to be equipped with an angular encoder.

MODULUS=< float-value >
If a motorised rotational degree of freedom of the goniometer system has the possibility to turn endless then the actual position of this drive would increase to infinite. This senseless fact is countered by introducing the MODULUS. When a specific drive is turned from a given start position to a position start position plus the value < float-value > it approaches physically the start position again. The advantages for this type of drive is that if a modulus value ≠ 0 is specified the drive moves the shortest way to its target position. For degree based drives the <mod-value> is typically 360° or 0°.

Example of a [DRIVEx] section

```
[DRIVE1]
NAME=Theta
CFN=4223EF
MTYPE=1
CUR=2
FSTEPS=200
GEAR=1
RESOL=0.0002
ECOUNTS=5000
SLOW=100
FAST=1200
ATIME=1
REF=30.00
LOWER=-10
UPPER=175
POSERR=200
MODULUS=
```

Meaning:
The Theta drive is configured as follows:

F = 8 home marks, home switch installed;

E = optical encoder, lower and upper limit switch installed;

3 = reversed motor and encoder direction;

2 = 2 µsec force-on time constant;

2 = inverted index mark polarity;

4 = units are degree;

The motor works with 2 Ampere, has 200 steps per revolution, 1 turn per unit (degree) and a micro-step size of 0.0002°.

The encoder has 5000 steps; the speeds of the motor are 100°/min respect. 1200°/min max.

The acceleration time 1 second; the reference angle is 30°.

The software limits are at –10° and +175°; if the difference between motor and encoder read out is above 200 encoder steps, the motor will stop because of positioning error.

[CHANNELx] section

The [CHANNELx] section contains the parameters for the connected detector. The number x is the logical channel number. The control program and even the user software uses the channel number in several commands. Valid numbers are 1 through 4.

The [CHANNELx] section consists of the following entries:

DETECTOR=< string >
This entry defines the name of the connected detector. The entry must agree with a DETECTOR entry in a [DIBx] section.

Recommended names are:

```
ScintillationCounter
FlowCounter
```

DHV=< float-value >
This value is the detector high-voltage. The value is aligned by an x-ray measurement. The value is different for different detectors and for different wavelengths. Furthermore the range of values is different for different types of detectors. E.g. proportional counters use typically < float-value > above 1000V whereas scintillation counter work in the range around 800V

⚠ **Caution:**
If the system starts respectively the power is switched on the control program sets the detector high-voltage to < float-value > instantly. The high-voltage output of the detector interface board is then on **high-voltage**. **Avoid any contact!** Additionally, do not connect a detector when the system is running.

AG=< int-value >
This value defines the initially set value of the amplifier gain. The alignment is typically done be x-ray measurements. Allowed values are 1 through 200.

SHAPE=< int-value >
The allowed values for < int-value > are 1, 2, 3 or 4. The measurement electronics supports 4 different shaping times. The real shaping times are realised by hardware and cannot set individually. 1 corresponds to the longest shaping time whereas 4 corresponds to the shortest. Short shaping time means that a very high count rate (up to 1.0×10^7) can be handled by the detector/measurement electronics system but with lack of energy resolution. Typically for NaJ scintillation counters a shaping time of 2 is selected for small count rates (some thousands) or 3 for higher count rates (reflectometry or high resolution measurements). For a YAP scintillation counter always 4 is recommended, and for a proportional counter use always 3.

LS=< int-value >
The allowed values for < int-value > are 0, 1 or 2. 0 corresponds to no, 1 to weak and 2 to strong line shift correction. Line shift corrections are often enabled in case gas filled counters are used. Scintillation counters typically do not need any line shift corrections.

LLD1=<lld>
This value is the lower level of the first discriminator. The value is typically aligned by an x-ray measurement.

LLD2=<lld>
The value <lld> is the lower level of the second discriminator. The value is typically aligned by an x-ray measurement.

WIDTH1=<width>
The value <width> is the window width of the first discriminator. The value is typically aligned by an x-ray measurement.

WIDTH2=<width>
The value <width> is the window width of the second discriminator. The value is typically aligned by an x-ray measurement.

TLDSCR=<int-value>
The value <tld-sel> defines whether the top level discriminator is enabled (1) or disabled (0). Incoming pulses with a specific height (in V) are extracted from the count rate and cannot falsify the count rate which is within the discriminator window. The number of top level pulses are collected into a separate counter.

Note:
<tld-sel> must be set to 0 if a TTL detector is connected to the counts in port of the detector interface board, and if the TTL detector should be used for measurements.

DTIME=< int-value >
This entry defines whether the count rate evaluation within the measurement electronics is done with a fixed electronically generated dead time (600 nsec or 1300 nsec) or even without (minimised).

PILEUP=< int-value >
This entry defines whether the count rate evaluation within in the measurement electronics is done without pile-up detection (0) or with pile-up detection (62 nsec up 4 µsec). The pile-up corrections takes into account that after a pulse raises up, a second pulse can probably raise the signal more up, if the second comes in within a specific time (high count rates). If this happens within the with <int-value> defined pile-up detection time these pulses are separated from the count rate. The number of pile-up pulses are collected into a separate counter.

Note:
This value must be zero if an pulse generator is wired to the TTL-input of the corresponding Detector Interface Board.

Note:
Parameter ranges: see chapter „Remote Control Commands“, section „Measuring Channel Commands

Note:
< int-value > must be set to 0 if a TTL detector is connected to the counts in port of the detector interface board, and if the TTL detector should be used for measurements.

Example of a [CHANNELx] section

```
[CHANNEL1]
NAME=ScintillationCounter
DHV=912.1
SHAPE=3
AG=50
LS=0
LLD1=0.44
WIDTH1=1.1
LLD2=0
WIDTH2=0
TLDSCR=0
DTIME=minimzed
PILEUP=0
```

Meaning:
A scintillation counter is connected to the detector interface board 1. It uses a **high-voltage** of 912.1V, an amplification gain of 50 and a shaping time constant defined by 3. The lower level of the first discriminator is set to 0.44V and the window width is 1.1V. The top level discriminator, the pile-up correction and the constant dead time are disabled.

[SCB] section

This section consists of entries which define the interface to the Sample-Changer-Control-Board and the drives which are attached to the drivers of the Sample-Changer-Control-Board.

The [**SCB**] section consists of following entries:

OUTREG=< int-value >
This entry defines the 8-bit-digital-output number of the Universal-I/O-Board which is used as control-port-interface to the Sample-changer control board.

INREG=< int-value >
This entry defines the 8-bit-digital-input number of the Universal-I/O-Board which is used as status-port-interface to the Sample-changer control board.

DRIVER1=< string >
DRIVER2=< string >
DRIVER3=< string >

These entries define the Sample-changer drives which are attached to the driver outputs.

Pre-defined names are:

```
SampleMagazine
SampleLock
SampleRotation
```

[IK121-x] section

This section consists of entries which define the interface to the Encoder-Interface-Board IK121 from Heidenhain and the parameters of the attached encoders. The number x is the logical IK121-Board number (valid numbers: 1 <= x <= 4).

The [**IK121-x**] section consists of following entries:

BASEADR=< hex-value >
This entry defines the base address of the IK121-Encoder-Interface-Board. All command, data and status registers will be based on this address.

ENCODER1=< string >
ENCODER2=< string >

These entries define the encoder which are attached to the encoder interface. Missing < string > means no encoder is attached to the corresponding encoder interface. The ENCODERx-entry < string > must agree with a NAME-entry in a [DRIVEx] section.

LINES1=< int-value >
LINES2=< int-value >

These entries define the number of lines of the attached encoders.

Note:
The number of [IK121-x] sections in the file DEVICE.INI depends on the number of the attached encoders.

[RS]-section

This section consists of entries that define the hardware settings and the interface of the D8-Rotary-Shutter-Board.

The **[RS]** section consists of following entries:

BASEADR=<base_adr>
This entry defines the base address (hex value) of the D8-Rotary-Shutter-Board. All command, data and status register locations will be based on this address.

CFN=<mreg_cfn>
This entry determines the initial MREG register configuration.

<mreg_cfn> is the sum of significances with following assignments:

D0 – reserved	not used
D1 - shutter	0 close (Default)
D2 - attenuator	0 close (Default)
D3 - failoverride	0 = sync, 1 = isafailsafe signal
D4 - isafailsafe	ISA failsafe bit (should be set to 0)
D5 - mode	0 = J2 control, 1 = ISA control
D6 -xmono (time constant selector)	0 = 4 uS, 1 = 1 uS
D7- xen (driver enable)	0 = disable, 1 = enable

CUR=<phase_cur>
This entry defines the operating phase current of the stepper motor as an Ampere value.

DNLD=<download.ini>
This entry defines the name of the download file to be downloaded when the system is initialized.

[SHUTTERx] section

This section defines an attached shutters and its parameters. The number x is the logical shutter number (valid numbers: 1 <= x <= 4).

Note:
The logical number #1 is reserved for the detailed specification (e.g. open and close delay times) of the primary shutter.

If a rotary shutter control board is present the logical number #2 is reserved for the detailed specification (e.g. open and close delay times) of the attached rotary shutter.

The [SHUTTERx] sections consist of following entries:

NAME=<string>
This entry defines the name of the shutter.

Recommended names for primary shutters:

```
LowSpeedShutter for the standard tube window
RotatingAnodeShutter
Pre-defined names for secondary shutters:
RotaryShutter
```

TYPE=<int-value>
This entry defines the type of the shutter.

Shutter types:

1 = primary shutter
2 = secondary shutter

☞ **Note:**
Only one primary shutter is allowed!

OPEN=<string>
This entry defines the type, the output number (if available) and the active level of the shutter control line.

Types of the shutter control line:

OC = open collector output or an TTL output is used to control the shutter

DC = DC power output is used to control the shutter

AC = AC power output is used to control the shutter

TW = standard tube window (LowSpeedShutter)

Output numbers (open collector output or TTL output control only!):

coding 1 of 24
20 = 1 = output #1 (20)
21 = 2 = output #2
22 = 4 = output #3

223 = 8388608 = output #24

active level of the shutter control line:

0 = an active low level at the shutter control line opens the shutter

1 = an active high level at the shutter control line opens the shutter

Note: ☜
The OPEN entry is ignored if the section specifies the parameters for the standard primary shutter (tube window of the sealed tube = LowSpeedShutter)

STATUS=<string> (not yet used!)
This entry defines the type, the input number (if available) and the active level of the shutter status line.

OPENDELAY=<float-value>
This entry defines the shutter open delay time in sec.

CLOSEDELAY=<float-value>
This entry defines the shutter close delay time in sec.

Examples:
Assume: X-RAY source = sealed tube, primary shutter = Standard tube window, no secondary shutter

```
[SHUTTER1]
NAME=LowSpeedShutter
TYPE=1
OPEN=TW1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030
```

Assume: X-RAY source = rotating anode, primary shutter = rotating anode shutter opened by the active high DC power output, no secondary shutter

```
[SHUTTER1]
NAME=RotatingAnode
TYPE=1
OPEN=DC1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030
```

Assume: X-RAY source = sealed tube, primary shutter = Standard tube window, secondary shutter = rotary shutter

```
[SHUTTER1]
NAME=LowSpeedShutter
TYPE=1
OPEN=TW1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030
```

```
[SHUTTER2]
NAME=RotataryShutter
TYPE=2
OPEN=
STATUS=
OPENDELAY=0.014
CLOSEDELAY=0.007
```

Assume: X-RAY source = rotating anode, primary shutter = rotating anode shutter opened by the active high level DC power output, secondary shutter = rotary shutter

```
[SHUTTER1]
NAME=RotatingAnode
TYPE=1
OPEN=DC1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030
```

```
[SHUTTER2]
NAME=RotataryShutter
TYPE=2
OPEN=
STATUS=
OPENDELAY=0.014
CLOSEDELAY=0.007
```

Assume: X-RAY source = sealed tube, primary shutter = Standard tube window, secondary shutter = custom shutter opened by the active high level open collector digital output#1

```
[SHUTTER1]
NAME=LowSpeedShutter
TYPE=1
OPEN=TW1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030

[SHUTTER2]
NAME=CustomShutter
TYPE=2
OPEN=OC1,1
STATUS=
OPENDELAY=0.020
CLOSEDELAY=0.010
```

Assume: X-RAY source = rotating anode, primary shutter = rotating anode shutter controlled by the active high level DC power outputl, 1st secondary shutter = rotary shutter, 2nd secondary shutter = custom shutter opened by the active low TTL digital output#9

```
[SHUTTER1]
NAME=RotatingAnode
TYPE=1
OPEN=DC1
STATUS=
OPENDELAY=0.050
CLOSEDELAY=0.030
```

```
[SHUTTER2]
NAME=RotataryShutter
TYPE=2
OPEN=
STATUS=
OPENDELAY=0.014
CLOSEDELAY=0.007

[SHUTTER3]
NAME=CustomShutter
TYPE=2
OPEN=OC256,1
STATUS=
OPENDELAY=0.020
CLOSEDELAY=0.010
```

[DETECTOR] section

This section defines an attached detector and its parameters.

The [DETECTOR] section consist of following entries:

NAME=<string>
This entry defines the name of the detector.

Recommended names:
`SMART-APEX for the SMART-APEX CCD detector`
`HISTAR for the multi-wire area detector`

ENABLE=<string>
This entry defines the type, the output number (if available) and the active level of the detector control line.

Types of the detector control line:

OC = open collector output or an TTL output is used to control the detector
DC = DC power output is used to control the detector
AC = AC power output is used to control the detector

Output numbers (open collector output or TTL output control only!):

coding 1 of 24
2^0 = 1 = output #1 (2^0)
2^1 = 2 = output #2
2^2 = 4 = output #3

2^{23} = 8388608 = output #24

active level of the detector control line:
0 = an active low level at the shutter control line enables the detector
1 = an active high level at the shutter control line enables the detector

STATUS=<string> (not yet used!)
This entry defines the type, the input number (if available) and the active level of the detector status line.

Examples:
Assume: detector = SMART-APEX CCD detector, enabled by the active high level open collector digital output#2

```
[DETECTOR]
NAME=SMART-APEX
ENABLE=OC8,1
STATUS=
```

Assume: detector = HISTAR multi wire area detector, enabled by the active low level TTL digital output#10

```
[DETECTOR]
NAME=HISTAR
ENABLE=OC8,0
STATUS=
```

Interfaces to External Computers

The data transfer between the instrument and external computers is handled via asynchronous serial interfaces (RS 232 C without hardwired qualifier) in full-duplex mode. The interface parameters (baudrate, number of data bits, parity, number of stop bits) will be read from the file DEVICE.INI during instrument initialization.

Standard programming:

baudrate	9600 baud
number of data bits	8 data bits
parity	no
number of stop bits	1 stop bit

The string (including the control characters if handshake mode) at the beginning and end of a data transmission, must not be longer than 256 characters. The data transmission can be interrupted by the receiver at any time by means of the ASCII control character DC3 (X-OFF) and enabled again by the control character DC1 (X-ON).

The external computer sends a command to the instrument and immediately checks that it has been received by evaluating the reply from the instrument. If the command is rejected, an error message is sent to the computer (string code „?“ and an error code). The computer is informed of the reason for non-acceptance in the error message.

Error code	Meaning
1	Command unknown
2	Argument required
3	Incorrect argument(s)
4	Command only permissible in remote control mode
5	Command only permissible in setup mode
6	Setup mode active
7	No argument(s) permissible
8	Component not installed
9	Position of drive unknown
10	Component / Drive not initialized
11	Component / Drive at limit switch
12	Measuring function running
13	Service switch in position „SERVICE“
14	No response from X-ray generator
15	Remote control by an other serial communicatin port
16	Serial communicatin port busy
17	File not found
18	File access error
19	File read/write error
20 ... 29	Error messages of X-ray generator

Transmission Protocol

Data transfer without software handshake

The external computer sends the command to the instrument. If the command has been accepted the instrument replies with a CR (cariage return) character if no data is requested or with the requested data. If the command is rejected the instrument replies with an error message (string code „?“ and an error code).

Data transfer with software handshake

The control characters for software handshake will be read from the file DEVICE.INI during instrument initialization.

Standard programming:

Error code	ASCII control character
REQUEST TO SEND character	ENQ = 05_{hex}
CLEAR TO SEND character	DLE = 10_{hex}
START OF TEXT character	STX = 02_{hex}
END OF TEXT character	ETX = 03_{hex}
ACKNOWLEDGE character	ACK = 06_{hex}
NEGATIVE ACKNOWLEDGE character	NAK = 15_{hex}
CHECKSUM	No

The transmitter sends the REQUEST TO SEND character to the receiver and waits for the CLEAR TO SEND character. If the receiver can accept data the CLEAR TO SEND character will be send to the transmitter. After receiving the CLEAR TO SEND character from the receiver data transfer starts with START OF TEXT character followed by the data string. When sumcheck is enabled (CHECKSUM = Yes) a 3 digit number is added to the data string representing the complement of the sum of all characters from the START OF TEXT character to the last data character modulo 256. Data transfer ends by sending the END OF TEXT character. After receiving the END OF TEXT character the receiver starts data processing. A faulty string (character error, checksum error if checksum added) is replied to transmitter by the NEGATIVE ACKNOWLEDGE character. The transmitter then repeats the data transmission. If the receiver accepts the data string the receiver sends the ACKNOWLEDGE character to the transmitter.

Cable Wiring of RS 232 C Serial Connectors

The instrument controller uses 9-pin male D type serial connectors with following pin assignments:

Pin	Conductor name
1	Protective Ground
2	Transmit Data, TxD
3	Receive Data, RxD
5	Logic Ground

The connection between the instrument and the external computer is made via a screened 3-core cable. The cable screen must be connected to the metal parts of the plug housing with as large an area as possible, and connected to pin 1 (Protective Ground). If interferences occur, it is recommendable to fit an RF ground strip with a cross-section of 10 mm^2 between the instrument and the external computer.

Remote Control by an External Computer

The instrument can be controlled by a number of commands from an external computer. Each command from the external computer to the instrument consists of a command code (2 letters) and, if applicable, an argument or several arguments separated by commas. The instrument replies with the requested data if the command has been accepted or an error message (string code „?“ and an error code) if the command is rejected. The computer is informed of the reason for rejection by means of the error code in the error message.

Before accepting control commands the instrument must be set to the operating mode „Remote control“ by the RC command. Status and diagnostic commands will be executed in all operating modes.

Commands are processed in parallel.

If a command is performed before a pending command is finished (e.g. a command which refers to a moving drive or a measuring function) then the running command is aborted immediately and the last entered command executed.

The delay between a command and the commencement of its execution is about 100 ms. Correct execution can then be checked by the computer by reading the corresponding status information (e.g. ready flags).

Description of Remote Control Commands

Commands for operating mode switchover

SU	Setup Mode
QU	Quit Setup Mode
RC(<code>)	Remote Control Mode
RS(<code>)	Reset
EX	Exit to DOS Level

SU Setup Mode

Switches the instrument into setup mode (device controller switched off) as preparation of commands for instrument parameterization. This command is effective until the QU command is entered.

QU Quit Setup Mode

Terminates setup mode.

RC(<code>) Remote Control Mode

Switches the instrument to remote control mode or back into standby mode depending on the value <code>.

<code>: Integer

code	Meaning
0	Standby and manual control mode
1	Remote control mode

The **RC** command without an argument can be used to read back the instrument remote control port.

RS<code>(,<id>) Reset

This command is used to restore initial instrument parameters or to reset components or the instrument.

<code>: Integer

code	Meaning
2	Reset comports
3	Reset drive(s)
4	Reset channel(s)
5	Reset the comport of the X-RAY Generator
6	Reset the comport of the Terminal (Manual Control Box)
7	Clear buffered RAM
90	Reset Universal-I/O-Board
91	Reset 2-Axis-Indexer-Board
92	Reset 4-Axis-Indexer-Board
95	Reset Detector-Interface-Board
98	Restore initial instrument parameters
99	Reset instrument (meet power ON reset)

<id>: Integer

This argument specifies the component (e.g. drive-ID, channel-ID, ...) which will be reset.
If it is missing all available specified components will be reset.

EX Exit to DOS Level

Command to leave instrument control and exit to DOS level.

Commands for device parameterization

SE(<section>(,<list of parameters>))	Section
ZI(<drv_id>(,<ref>))	Zeros Initial
DL(<drv_id>(,<lower>,<upper>))	Drive Limits
CL(<drv1_id>,<drv2_id>,<lower>,<upper>(,<reversed>))	Collision Limits
MO<drv_id>(,<modulus>)	Modulus
DR(<drv_id>(,<info_id>)	Drive(s)
CH(<chnl_id>(,<info_id>)	Channel(s)

SE(<section>(,<list of parameters>)) Section

This command is used to write and read sections of the configuration file DEVICE.INI.

<section>: String
Name of the section to write or read.

<list of parameters>:
The optional list of parameters is used to write a section. It consist of a complete list of the section entries (see Instrument Initialization).

Special cases:

SE<section>:
This command is used to read the complete section from the file DEVICE.INI. Section entries are separated by semicolon.

SE<section>,/l:
This command is used to load the specified section from file DEVICE.INI on disk into system memory.

☞ **Note:**
After this command the respective component must be initialized using an appropriate Reset command (RS command)!

SE<section>,/s:
This command is used to save the specified section in file DEVICE.INI on disk.

SE<section>,/d:
This command is used to delete the specified section in the system memory and in file DEVICE.INI on disk.

☞ **Note:**
After this command the respective component must be initialized using the Reset command RS99!

The **SE** command without an argument is used to read the section names of the file DEVICE.INI separated by commas.

ZI(<drv_id>(,ref)) Zeros Initial
Command to set and readout of reference value(s) for the positioning drives of the instrument.
1 ... 16 positioning drive #1 ... #16

<drv_id>: Integer
Selection of positioning drive according to drive identification number.

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<ref>: Real
Reference value of drive in units (e.g. steps, degree, millimeter, ...)

☞ **Note:**
The associated drive must be initialized after changing the reference value. The reference value is used as the new reference point following initialization.

Special cases:
The **ZI<drv_id>** command is used to readout the current reference value of the specified positioning drive.
The **ZI** command is used to read the current reference values of all installed positioning drives.

DL(<drv_id>(,<lower>,<upper>)) Drive Limits

Command to set and readout of lower and upper limits for the positioning drives of the instrument
1 ... 16 positioning drive #1 ... #16

<drv_id>: Integer
Selection of positioning drive according to drive identification number.

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<lower>: Real
Lower limit of drive in units (e.g. degree, millimeter, ...)

<upper>: Real
Upper limit of drive in units (e.g. degree, millimeter, ...)

If limits are set the drive is abruptly stopped when over-traveling these limits.
If <lower> = <upper> the limits are disabled.

Special cases:
The **DL<drv_id>** command is used to read the current limits of the specified positioning drive.
The **DL** command is used to read the current limits of all installed positioning drives.

CL(<drv1_id>,<drv2_id>,<lower>,<upper>(,<reversed>)) Collision Limits

Command to set lower and upper collision limits.

Note:
Up to 4 collision limits can be set.

<drv1_id>: Integer
Selection of positioning drive#1 according to drive identification number.

drv1_id	Meaning
1 ... 16	positioning drive #1 ... #16

<drv2_id>: Integer

Selection of positioning drive#2 according to drive identification number.

drv2_id	Meaning
1 ... 16	positioning drive #1 ... #16

<lower>: Real
Lower collision limit in units (e.g. Degree, Millimeter, ...)
If the position of drive#1 minus position of drive#2 is less than the <lower> value the drives will be stopped imediately.

<upper>: Real
Upper collision limit of drive in units (e.g. Degree, Millimeter, ...)
If the position of drive#1 minus position of drive#2 is greater than the <upper> value the drives will be stopped imediately.

<reversed>: Integer
Moving direction of positioning drive#2 versus positioning drive#1.
If this argument is greater than “0” or missing the moving direction of positioning drive#2 and positioning drive#1 is reversed (e.g. both drive#1 and drive#2 move clockwise to higher positions).
If this argument is less than “0” the moving direction of positioning drive#2 versus positioning drive#1 is reversed (e.g. drive#1 moves clockwise to higher positions while drive#2 moves counter clockwise to higher positions).

How to determine the <lower> and <upper> values (assume drive#1 and drive #2 are adjusted!):
1. Move drive#2 near to the mechanical collision.
2. Compute the difference of position of drive#1 minus position of drive#2.
3. Move drive#2 in the opposite direction near to the mechanical collision.
4. Compute the difference of position of drive#1 minus position of drive#2.
5. Set <lower> = smaller value computed in step#2 and step#4
6. Set <upper> = larger value computed in step#2 and step#4

Special cases:
The **CL** command is used to read the current collision limits.
The collision limits will be replied in following order:
collision limit #1; collision limit #2; ... ; collision limit #4
separated by „;“ (semicolon)
with collision limt #n = drive#1,drive#,lower limit,upper limit,reversed

MO<drv_id>(,<modulus>) Modulus

Command to enable and disable the modulus option of the addressed drive.

<drv_id>: Integer
Selection of positioning drive according to drive identification number.

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<modulus>: Real

modulus	meaning
0	disable the modulus option
360	enable the modulus (=360 degree) option

☞ **Note:**
With modulus option enabled (MODULUS=360) the rotary drive takes the short path when positioned with a GO-command.

The **MO<drv_id>** command can be used to read back the actual modulus option.

DR(<drv_id>(,<info_id>) Drive(s)

Command to read the names, the actual settings and/or actual values of installed positioning drives.

<drv_id>: Integer
Selection of positioning drive according to drive identification number.

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

info_id	Meaning
1	Actual settings requested
2	Actual values requested

If the argument <drv_id> is missing the names of the installed drives will be transmitted to the external computer in the increasing sequence of drive identification numbers (drv_id) separated by commas.
If the argument <drv_id> is specified the actual settings and/or actual values of the specified drive will be transmitted to the external computer depending on the argument <info_id>. The requested information will be transmitted in following sequence separated by commas:

Case <info_id> = 1: actual drive settings requested
- port address
- drive configuration
- motor type
- motor phase current
- number of full-steps per motor rotation
- mechanical gear
- resolution
- encoder counts per motor rotation
- slow speed
- fast speed
- acceleration time
- reference
- lower limit
- upper limit
- position error limit
- modulus value

Case <info_id> = 2: Actual values of the specified drive requested
- actual position
- status flags
- error flags
- home mark number
- saved direction
- encoder counts
- position error in encoder counts
- chipset axis mode
- chipset axis status

Case <info_id> missing or 0
- actual drive settings [2])
- actual drive values [3])

[2]) See case <info_id> = 1.

CH(<chnl_id>(,<info_id>) Channel(s)

Command to read the names, the actual settings and/or actual values of installed measuring channels.

<chnl_id>: Integer

Selection of measuring channel according to channel identification number.

chnl_id	Meaning
1	measuring channel 1
2	measuring channel 2
3	measuring channel 3
4	measuring channel 4

info_id	Meaning
1	Actual settings requested
2	Actual values requested

If the argument <chnl_id> is missing the names of the installed channels will be transmitted to the external computer in the increasing sequence of measuring channel identification numbers (chnl_id) separated by commas.
If the argument <chnl_id> is specified the actual settings and/or actual values of the specified channel will be transmitted to the external computer depending on the argument <info_id>. The requested information will be transmitted in following sequence separated by commas:

Case <info_id> = 1: Actual channel settings requested
- port address
- detector high-voltage
- pulse shaping time constant select
- line shift select
- lower level discriminator 1
- discriminator width 1
- lower level discriminator 2
- discriminator width 2
- top-level discriminator select
- death time
- pulse discrimination pile-up time

Case <info_id> = 2: Actual values of the specified channel requested

[3]) See case <info_id> = 2.

status flags
counting rate of counter 1
counting rate of counter 2
counting rate of counter 3
measuring time
count of counter 1
count of counter 2
count of counter 3
number of stored measured values

Case <info_id> missing or 0
actual channel settings [4])
actual channel values [5])

[4]) See case <info_id> = 1.

[5]) See case <info_id> = 2.

Commands for measuring channel parameterization

HV<chnl_id>(,<dhv>)	Detector) High-voltage
DI<chnl_id>(,<lld1>,<width1>,<lld2>,<width2>)	Discriminators
LS<chnl_id>(,<code >)	Line Shift
AG<chnl_id>(,<ag >)	Amplifier Gain
TL<chnl_id>(,<code >)	Level Discriminator
DT<chnl_id>(,< dtime >)	Death Time
PT<chnl_id>(,< ptime >)	Pile-up Time
CP<chnl_id>(,<dhv,<lld1>,<width1>,<lld2>,<width2>, <ls>, <ag>, <tldscr>,<dtime>, <ptime>)	Channel Parameters
TC<chnl_id>(,<tconst >)	Time Constant

HV<chnl_id>(,<dhv>) (Detector) High-voltage
High-voltage value for the measuring channel

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<dhv>: Real
High-voltage value in volt
Range of values: 0 ≤ hv value ≤ 2400
Resolution: 0.25 V

The **HV<chnl_id>** command can be used to read the high-voltage of the measuring channel.

DI<chnl_id>(,<lld1>,<width1>,<lld2>,<width2>) Discriminators
Values of the lower discriminator threshold and the discriminator width for the measuring channel selected by <chnl_id>

<chnl_id>: Integer
Selection of measuring channel to which the following parameters apply

<lld1>, <lld2>: Real
Set value of lower discriminator threshold in volt

Range of values: 0 ≤ lld ≤ 6.25
Resolution: 8 bit (approx. 24.5 mV)

<width1>, <width2>: Real
Set value of discriminator width in volt
Range of values: 0 ≤ window ≤ 6.25, without limits: <width> > 6.25
Resolution: 8 bit (approx. 24.5 mV)

The **DI<chnl_id>** command can be used to read the discriminators of the measuring channel.

LS<chnl_id>(,<code >) **Line Shift**

Command for selecting the line shift efficiency

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<code>: Integer
Control word for for selecting the line shift efficiency

code	Meaning
0	Line shift off
1	Weak line shift
2	Strong line shift

The **LS<chnl_id>** command can be used to read the line shift selection of the measuring channel.

AG<chnl_id>(,<ag >) **Amplifier Gain**

Command for setting and reading the measuring channel gain

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<ag>: Integer
Gain value
Range of values: 1 ≤ value ≤ 200

The **AG<chnl_id>** command can be used to read the gain of the measuring channel.

TL<chnl_id>(,<code >)Top Level Discriminator

Command to enable or disable the top level discriminator

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<code>: Integer
Control word to enable or disable the top level discriminator

code	Meaning
0	disable
1	enable

The **TL<chnl_id>** command can be used to read the top level discriminator selection of the measuring channel.

DT<chnl_id>(,<dtime >) Death Time

Command to select the death time

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<dtime>: Integer
Dead-time value

dtime	Meaning
0	(constant) death time off
600	(constant) death time = 600 ns
1300	(constant) death time = 1300 ns

The **DT<chnl_id>** command can be used to read the death time selection of the measuring channel.

PT<chnl_id>(,<ptime >) Pile-up Time

Command to enable or disable the pile-up detection and to select the pile-up time

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<ptime>: Integer
Control word to select the death time

code	Meaning
0	Pile-up detection off
62 ... 4000	Pile-up time = 62 ... 4000 ns

The **PT<chnl_id>** command can be used to read the pile-up time selection of the measuring channel.

CP<chnl_id>(,<dhv,<lld1>,<width1>,<lld2>,<width2>,<ls>,<ag>,<tldscr>, <dtime>,<ptime>) Channel Parameters

Command for setting and reading measuring channel parameters

<chnl_id>: Integer
Selection of measuring channel to which the following parameters apply

<dhv>: Real
High-voltage value in volt
Range of values: 0 ≤ hv ≤ 2400
Resolution: 0.25 V

<lld1>, <lld2>: Real
Set value of lower discriminator threshold in volt
Range of values: 0 ≤ lld ≤ 6.25
Resolution: 8 bit (approx. 24.5 mV)

<width1>, <width2>: Real
Set value of discriminator width in volt
Range of values: 0 ≤ window ≤ 6.25, without limit: <width> > 6.25
Resolution: 8 bit (approx. 24.5 mV)

<ls>: Integer
Control word for switching line shift correction on/off

ls	Meaning
0	Line shift correction off
1	Weak line shift correction
2	Strong line shift correction

<ag>: Integer
Gain value
Range of values: 1 ≤ value ≤ 200

<tldscr>: Integer
Control word to enable or disable the top level discriminator

code	Meaning
0	Disable
1	Enable

<dtime>: Integer
Dead time value

code	Meaning
0	(Constant) death time off
600	(Constant) death time = 600 ns
1300	(Constant) death time = 1300 ns

<ptime>: Integer
Control word to select the death time

code	Meaning
0	Pile-up detection off
62 ... 4000	Pile-up time = 62 ... 4000 ns

The **CP<chnl_id>** command can be used to read the current values <dhv>, <lld1>, <lld2>, <width1>, <width2>, <ls> and <ag> of the measuring channel.

TC<chnl_id>(,<tconst >) Time Constant
Defines the time constant for the integrator (ratemeter).

<chnl_id>: Integer
Selection of measuring channel to which the following parameter applies

<tconst>: Real
Time constant of integrator in seconds
Range of values: $0.01 \leq \text{time} \leq 0.01*2^{32} - 1$
Resolution: 0.01 s

The **TC<chnl_id>** command can be used to read the time constant of the measuring channel.

Control commands

HT(<id>)	Halt
DS<drv_id>,<dir>(,<nsteps>)	Drive Step(s)
TU<drv_id>,<dir>,<speed>	Tuning
FR<drv_id>,<dir>	Find Reference
IN(<id>)	Initialization
CD<mdrv_id>(,<sdrv_id>,<ratio>)	Couple Drives
PD(<bitmask>)	Preset
GO(<drv_id>,<target>(,<speed>))	Go
GL(<drv_id>,<target>(,<speed>))	Go Long Path
RG<drv_id>,<distance>(,<speed>)	Relative Go
RG<drv_id>,<distance>(,<speed>)	Relative Go
OS<drv_id>,<ampl>,<speed>(,<number>)	Oscillation
RO<drv_id>,(<speed>)	Rotation
FU<sdrv_id>(,<mdrv1_id>,<length>,<radius>,<distance>(,<mdrv_id>)	Follow Up
SL(<code>)	Slit
AC(<code>)	AC-Motor
SA(<pos>)	Sample
SH(<code>(,<sh_open_time>)	Shutter
TW(<code>)	Tube-window
CC<cmd_id>(,<param>)	Sample-changer Control
TW(<code>)	Tube Window
XR(<code>)	X-RAY
DC(<code>)	DC Power Output
AC(<code>)	AC Power Output
OC(<bitmask>,<value>(,<chnl_id>))	Output Contact

HT(<id>) Halt

Stop command for drives, measuring functions and command macros

<id>: Integer
Selection of the drive/measuring function to be stopped

id	Meaning
1 ... 16	positioning drive #1 ... #16
17	Sample-changer
20	Command macro execution
21	Measuring function

DS<drv_id>,<dir>(,<nsteps>) Drive Step(s)

Command to move a positioning drive specified number of steps <nsteps> in the specified direction <dir>.

If the argument <nsteps> is missing the drives moves one step in the specified direction <dir>.

☞ **Note:**
This command can be used to move a drive out of a limit if all other commands fail!

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<dir>: ASCII
Selection of moving direction according to following coding:

dir	Meaning
U	Up
D	Down

<nsteps>: Integer
Number of steps

The command doesn't apply to coupled drives (see CD command).

TU<drv_id>,<dir>,<speed> Tuning

Activation of manual control of drive. The drive starts at the initial speed <speed> in the upward or downward direction. To stop the drive enter the command HT<drive_id>.

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<dir>: ASCII
Selection of tuning direction according to following coding:

dir	Meaning
U	Upwards direction
D	Downwards direction

<speed>: Real
Selection of initial speed

The command also applies to coupled drives. Coupled drives are tracked according to the coupling ratio (see CD command).

FR<drv_id>,<dir> Find Reference

Command for automatic tuning of coarse reference of a positioning drive in the direction <dir> at the start/stop speed

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<dir>: ASCII
Selection of tuning direction for coarse reference according to following coding:

dir	Meaning
U	Upwards direction
D	Downwards direction

IN(<id>) Initialization

Initialization of the component selected by <id>

<id>: Integer
Selection of the drive/component to be initialized

id	Meaning
1 ... 16	positioning drive #1 ... #16
17	Sample-changer

The goniometer drives 1 and 2 are always initialized together. The goniometer drives must be decoupled by the command CD2,0 prior to their initialization (IN, IN1, IN2 commands).
The selected drive/component must be present.

The **IN** command without an argument results in the initialization of all drives/components.

CD<mdrv_id>(,<sdrv_id>,<ratio>) Couple Drives

Command for electronic coupling of stepping motor drives

Essential! Command only permissible with drive stationary!

<mdrv_id>: Integer
Selection of master drive according to following coding:

<sdrv_id>: Integer
Selection of coupled drive (slave) according to following coding:

<ratio>: Real
Coupling factor

The following relationships exist between the master drive and the coupled drive:

$ratio = dx_{master} / dx_{slave}$
dx_{master}: travel of master drive
dx_{slave}: travel of coupled drive

$v_{slave} = ratio * v_{master}$
v_{master}: speed of master drive
v_{slave}: speed of coupled drive

Special cases:
CD<mdrv_id>,0:
decouple all drives coupled by <mdrv_id>

CD<mdrv_id>:
transmit all drives coupled by <mdrv_id> to the external computer

---

PD(<bitmask>) Preset Drives
This command is used to specify drives which will only be presetted for synchronized start moving only or synchronized start moving and counter enable. All following drive commands (e.g. GO<args>, RG<args>, OS<args>, RO<args>, ... commands) prepare the drive control hardware by presetting the specified parameters. Synchronized command execution of all presetted drives will start after a GO command without arguments (see GO command) or start counting in measuring functions with moving drives.

<bitmask>: Integer
Total of bit significances of presetting drives according to following table:

SignificanceDrive	
2^0 ... 2^{15}	positioning drive #1 ... #16

The **PD** command without an argument is used to read back the presetted positioning drives.

GO(<drv_id>,<target>(,<speed>)) Go
Positioning command for stepping motor drives
If the optional argument <speed> is appended the positioning command the drive moves with the specified constant speed from the current position to the target position. Without this argument the drive moves in a trapezoidal speed profile using the parameters defined in the corresponding DRIVEx section of the configuration file DEVICE.INI, i.e. SLOW (start speed)and FAST (maximal speed).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<target>: Real
Target of drive (degrees, mm, steps). Target applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

<speed>: Real

Positioning (constant) speed of drive (degrees/min, mm/sec, steps/sec). Speed applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

The selected drive (and the coupled drive if applicable) must be initalized!

The **GO** command without arguments starts drive command execution of all presetted drives.

GL(<drv_id>,<target>(,<speed>)) Go Long Path

Positioning command for stepping motor drives. A rotary drive takes the long path even if the modulus option is enabled (MODULUS=360, see entry MODULUS of section [DRIVEx] in the instrument configuration file DEVICE.INI).

If the optional parameter <speed> is missing the drive speed is ramped up in a trapezoidal speed profile from slow speed to fast speed (see entries SLOW and FAST of section [DRIVEx] in the instrument configuration file DEVICE.INI).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<target>: Real
Target of drive (degrees, mm, steps). Target applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

<speed>: Real
Positioning speed of drive according the drive unit (degrees/min, mm/sec, steps/sec).
If <speed> is less than or equal the slow speed no speed profile is used (speed = constant) .
If <speed> is greater than the slow speed the drive speed is ramped up in a trapezoidal speed profile from slow speed to the specified speed.

The selected drive (and the coupled drive if applicable) must be initalized!
The command also applies to coupled drives. Coupled drives are tracked according to the coupling ratio (see CD command).

RG<drv_id>,<distance>(,<speed>) Relative Go

Positioning command for stepping motor drives relative to the current position.
A rotary drive takes the long path even if the modulus option is enabled (MODULUS=360, see entry MODULUS of section [DRIVEx] in the instrument configuration file DEVICE.INI).

If the optional parameter <speed> is missing the drive speed is ramped up in a trapezoidal speed profile from slow speed to fast speed (see entries SLOW and FAST of section [DRIVEx] in the instrument configuration file DEVICE.INI).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<distance>: Real
Distance of drive movement (degrees, mm, steps). Distance applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

<speed>: Real
Positioning speed of drive according the drive unit (degrees/min, mm/sec, steps/sec).
If <speed> is less than or equal the slow speed no speed profile is used (speed = constant) .
If <speed> is greater than the slow speed the drive speed is ramped up in a trapezoidal speed profile from slow speed to the specified speed.

The selected drive (and the coupled drive if applicable) must be initalized!
The command also applies to coupled drives. Coupled drives are tracked according to the coupling ratio (see CD command).

RG<drv_id>,<distance>(,<speed>) Relative Go

Positioning command for stepping motor drives relative to the current position
If the optional argument <speed> is appended the positioning command the drive moves with the specified constant speed from the current position to the target position. Without this argument the drive moves in a trapezoidal speed profile using the parameters defined in the corresponding DRIVEx section of the configuration file DEVICE.INI, i.e. SLOW (start speed)and FAST (maximal speed).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<distance>: Real
Distance of drive movement (degrees, mm, steps). Distance applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

<speed>: Real
Positioning (constant) speed of drive (degrees/min, mm/sec, steps/sec). Speed applies to the master drive. Coupled drives are tracked according to the coupling ratio (see CD command).

The selected drive (and the coupled drive if applicable) must be initalized!

OS<drv_id>,<ampl>,<speed>(,<number>) Oscillation

Control command for switching on the oscillation of the stepping motor drive at the specified speed and offset <ampl> from the current position and in the direction defined by the sign of <ampl>
The optional parameter <number> defines the number of oscillations.
Oscillation is only possible if the selected drive is initialized.
The oscillation remains switched on until cancelled by another control command or the number of oscillations has been executed if specified.

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

<ampl>: Real
Offset of oscillation in drive dimension (degrees with rotational drives, millimeters with linear drives)

<speed>: Real
Oscillation speed (degrees/minute with rotational drives, millimeters/s with linear drives)

<number>: Integer

This optional parameter defines the number of oscillations.

The command also applies to coupled drives. Coupled drives are tracked according to the coupling ratio (see CD command).

RO<drv_id>,(<speed>) Rotation

Control command for switching the drive rotation on and off

<speed>: Real

speed	Meaning
0	Rotation off
≠ 0	Rotation on with spezified rotation speed

<drv_id>: Integer

1 ... 16 positioning drive #1 ... #16

The **RO<drv_id>** command can be used to read back the current drive rotation speed. A value of >0 is read if drive rotation is switched on, otherwise 0.

FU<sdrv_id>(,<mdrv_id>,<length>,<radius>,<distance>) Follow Up

Control command for switching on the follow-up of the positioning drive <sdrv_id> with the positioning drive <mdrv_id>

This command is mainly used to follow up the variable slit with the goniometer drives to ensure an irradiated, constant sample area.

A follow-up is only possible if the spezified drives have been initialized.

The follow-up remains switched on until cancelled by another control command.

<sdrv_id>: Integer

1 ... 16 positioning drive #1 ... #16

<mdrv_id>: Integer

1 ... 16 positioning drive #1 ... #16

<length>: Integer

This parameter defines in a follow-up command for a varible slit the length of irradiated, constant sample area

Refer to relationship between irradiated sample area, slit opening and position of variable slit.

<radius>: real

This parameter defines in a follow-up command for a varible slit the radius of irradiated, constant sample area
Refer to relationship between irradiated sample area, slit opening and position of variable slit.

<distance>: real
This parameter defines in a follow-up command for a varible slit the distance beween the variable slit and the irradiated, constant sample area.
Refer to relationship between irradiated sample area, slit opening and position of variable slit.

<mdrv2_id>: Integer
Selection of a second master positioning drive.

mdrv2_id	Meaning
1 ... 16	positioning drive #1 ... #16

☞ **Note:**
In case of a secondary master drive the difference of master drive 1 and master drive 2 is used to compute the set-value of the slave drive.

The FU<sdrv_id> command can be used to read back the actual command-parameters. If the drive <sdrv_id> is in follow-up mode the read parameters are transmitted in following order

<length>
<radius>
<distance>

separated by commas
If the drive <sdrv_id> is not in follow-up mode only a zero is transmitted.

SL(<code>) Slit

Control command for the (standard) 2-position slit changer

<code>: Integer

code	Meaning
1	Narrow slit changer position
2	Wide slit changer position

The **SL** command without an argument can be used to read back the current slit changer position.

SA(<pos>) Sample

Command to load a specified sample into the measuring position or to park the Sample-magazine.

Note:
The Sample-changer must be adjusted.

<pos>: Integer

pos	Meaning
> 0	sample to load into measuring position
= 0	park the Sample-magazine

The SA command without an argument is used to read back the sample in measuring position.

SR(<code> Sample Rotation

Control command for switching the sample rotation ON and OFF

<code>: Integer

code	Meaning
0	rotation OFF
+1	rotation ON (positive direction)
-1	rotation ON (negative direction)

The SR command without argument can be used to read back the current sample rotation status. A value of /= 0 is returned if sample rotation is switched ON, otherwise 0 is returned.

CC<cmd_id>(,<param>) Sample-changer Control

Commands to control the Sample-changer manually.

<cmd_id>: Integer
Command-code with the following effect:

cmd_id	Meaning

10	adjust the Sample-magazine
11	position the Sample-magazine
12	park the Sample-magazine
13	stop the Sample-magazine
14	adjust the Sample-lock
15	lock the sample
16	unlock the sample
17	stop the Sample-lock
18	adjust the Sample-rotation
19	Sample-rotation ON
20	Sample-rotation OFF

<param>: Integer
This optional parameter specifies the magazine position executing an „Position Sample-magazine“ -command.
This optional parameter specifies the moving direction executing an „Sample-rotation ON“ -command.

SH(<code>(,<sh_open_time>) Shutter

Command to control all types of secondary shutters.

<code>:Integer

code	Meaning
0	Close shutter
1	Open shutter
2	attenuator IN (only valid with the (new) rotary shutter!)

<sh_open_time>: Real, optional
Shutter open time in seconds.
Range of values: 0.001 ≤ sh_open_time ≤65.535sec
Resolution: 0.001 sec

If a rotary shutter control board is installed the **SH** command without an argument can be used to read back following informations:
SH< status>,<rs_open time>,<hardware version>,<firmware version>

<status> = readout of rotary shutter status and control register
<open time> = shutter open time in seconds
<hardware version> = shutter interface hardware version number
<firmware version> = shutter interface firmware version number

Rotary-shutter Status and Control register:

D7	D6	D5	D4	D3	D2	D1	D0
REGBW	REGAW	MODE	FAULT	ISAFAULT	ATTENUATOR	SH UTTER	SENSE

REGBW REGB write control, REGBW = 1 ISA can read data from CPU.
REGAW REGA write control, REGAW = 1 ISA can write data to CPU.
MODE MODE = 0 J2 control, MODE = 1 ISA control
FAULT FAULT = 0 no shutter FAULT detected, FAULT = 1 shutter FAULT detected
ISAFAULT ISAFAULT = 0 no ISAFAULT detected, ISAFAULT = 1 ISAFAULT detected
ATTENUATOR ATTENUATOR = 0 attenuator closed, ATTENUATOR = 1 attenuator open
SHUTTER SHUTTER = 0 shutter closed, SHUTTER = 1 open
SENSE SENSE = 0 shutter/attenuator closed, SENSE = 1 shutter/attenuator open

---

TW(<code>) Tube-window

Control command for the primary shutter (e.g. tube window of the sealed tube, rotating anode shutter, ...)

<code>: Integer
Control word to open and close primary shutter

code	Meaning
0	Close the primary shutter
1	Open the primary shutter

Note:
Contrary to the control command, the tube window of the sealed tube (standard primary shutter) is automatically closed if
- the key switch is in position „SERVICE“,
- the generator high-voltage is not switched on or

- the left and/or right door of the enclosure is not closed and locked.

The **TW** command without an argument can be used to read back the current control of the primary shutter.

AC(<code>) AC Motor

Control command to switch the optional AC motor on and off.

<code>: Integer

code	Meaning
0	AC-motor OFF
1	AC-motor ON

The **AC** command without an argument can be used to read back the current AC-motor control line.

XR(<code>) X-RAY

Control command to switch the (standard) X-ray generator to stand-by or normal mode

<code>: Integer

Control word to switch the X-RAY Generator to STAND-BY or NORMAL mode

code	Meaning
0	Stand-by mode
1	nORMAL mode

The **XR** command without an argument can be used to read back the current X-RAY Generator mode.

DC(<code>) DC Power Output

Control command for the DC power output.

<code>: Integer

code	Meaning
0	DC power output OFF
1	DC power output ON

The **DC** command without an argument can be used to read back the current status of the DC power output.

AC(<code>) AC Power Output

Control command for the AC power output.

<code>: Integer

code	Meaning
0	AC power output OFF
1	AC power output ON

The **AC** command without an argument can be used to read back the current status of the AC power output.

OC(<bitmask>,<value>(,<chnl_id>)) Output Contact

Sets all digital outputs selected by <bitmask> to <value>.
The optional parameter <chnl_id> is used if a measuring channel must be synchronized with an detector enable or disable operation. A detector enable operation causes a counter start of the specified measuring channel while an detector disable command causes a counter stop.

<bitmask>: Integer
Total of bit significances of digital outputs 1 ... 16 according to following table:

Significance	No. of digital output
2^0	Digital output 1
2^1	Digital output 2
2^2	Digital output 3
2^3	Digital output 4
2^4	Digital output 5
2^5	Digital output 6
2^6	Digital output 7
2^7	Digital output 8
2^8	Digital output 9
2^9	Digital output 10
2^{10}	Digital output 11
2^{11}	Digital output 12
2^{12}	Digital output 13

2^{13}	Digital output 14
2^{14}	Digital output 16

<value>: Integer
Value of the digital outputs selected by <bitmask>

value	Meaning
0	Digital output high-impedance (disabled)
1	Digital output low-impedance (conducting)

<chnl_id>: Integer
This optional parameter specifies the measuring channel which must be synchronized with an detector enable or disable operation.

The **OC** command without an argument can be used to read back the current digital output contacts settings.

Commands for parameterizing and starting measuring functions and reading results

RM(<bitmask>)	Ready Mask
AM(<bitmask>)	Alarm Mask
ME(<chnl_id>,<time>(,<repeats>))	Measurement
SC(<drv_id>,<channels>,<steps>,<stepsize>,<time>)	(Continous) Scan
SS(<drv_id>,<channels>,<steps>,<stepsize>,<time>)	Step
SP<drive_id>,<pos1>,<pos2>,...<posn>	Set General Step Scan Positions
SG<drive_mask>,<channels>,<steps>,<time>	General Step Scan
HH(<drv_id >, <chnl_id>, <target>, <speed>,<time>, <number>, <thresh>)	Half Height Scan
PS(<drv_id >, <chnl_id>, <target>, <speed>, <time>, <number>, <thresh>)	Peak Search Scan
HP(<chnl_id>,<dhv_start>,<dhv_end>,<stepsize>,<time>)	High-voltage Plot
DP(<chnl_id>,<di_start>,<di_end>,<stepsize>,<time>)	Discriminator
IM(<sh_open_time>,<det_dis_time>)	Image
IS(<drv_id>,<range>,<sh_open_time>,<det_dis_time>, <sh_open_pos>)	Image Scan
AI(<attn_in_time>,<det_dis_time>)	Attenuator Image
AS(<drv_id>,<range>,<attn_in_time>,<det_dis_time>, <attn_in_pos>)	Attenuator Image Scan
HI(<det_enable_time>	HISTAR Image
HS(<drv_id>,<range>,<det_enable_time>, <det_enable_pos>)	HISTAR Image Scan
MF	Measuring Function Status
MV<chnl_id>,<number>(,<countmask>)	Measured value(s)
EV<drv_id>(,<number>)	Encoder Value(s)

RM(<bitmask>) Ready Mask

Bitmask for irrelevant ready flags of the instrument.

<bitmask>: Integer
Total of bit significances of instrument ready flags with the effect that all associated ready flags are ignored for measurement (see Section 8.9, „Ready Flags“ for significances)
Unmasked ready flags must match the ready condition for measurement.

The **RM** command without an argument can be used to read back the current ready mask.

AM<bitmask> Alarm Mask

Bitmask for irrelevant alarms of the instrument

<bitmask>: Integer
Total of bit significances of instrument alarms with the effect that all associated alarms are ignored (see Section 8.9, „Alarm Flags“ for significances).
If an alarm masked by the computer occurs, it is indicated as a warning!
The occurrence of at least one of the unmasked alarms disables a measurement or aborts a current measurement.
The **AM** command without an argument can be used to read back the current alarm mask.

ME(<channels>,<time>(,<repeats>)) Measurement

Start a measurement – with repeat if applicable – with the defined measuring time and using the specified measuring channels on the basis of the current parameters of the instrument

<channels>: Integer
Total of bit significances of selected measuring channels
The results are measured and stored separately. They can be read by MV command (see MV command).

<time>: Real
Measurement time in seconds
Range of values: $0.01 \leq \text{time} \leq 0.01*2^{32} - 1$
Resolution: 0.01 s

<repeats>: Integer
Number of repeats.
Range of values: $0 \leq \text{repeats} \leq 255$

Only one measurement is carried out if repeats = 0 or if the data are missing.

The **ME** command without an argument can be used to read the measuring function status.

SC(<drv_id>,<channels>,<steps>,<stepsize>,<time>) Scan

Parameterization and start of measuring function „Scan“

This command is used to determine the intensity distribution from the current position to target position of the specified drive. The drive moves at the specified constant speed <speed> over the range and the pulse counter(s) of the specified measuring channel(s) is/are read at equidistant intervals of <stepsize> and the counter value(s) recorded.

<drv_id>: Integer

Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and any coupled drives) must be present and initialized!

Coupled drives are tracked according to the coupling ratio if applicable (see CD command).

<channels>: Integer

Total of bit significances of selected measuring channels

The results are measured and stored separately. They can be read by MV command (see MV command).

<steps>: Integer

Number of steps with stepsize (total number of measurement results = number of steps)

<stepsize>: Real

Sampling interval in units of the drive

<time>: Real

Measuring time per sampling interval in seconds

Range of values: $0.01 \leq time \leq 0.01*2^{32} - 1$

Resolution: 0.01 s

The **SC** command without an argument can be used to read the measuring function status.

SS(<drv_id>,<chnl_id>,<steps>,<stepsize>,<time>) Step Scan

Parameter assignment and start of measuring function "Step scan"

This command is used to determine the intensity distribution from the current position to the target position of the specified drive. The range is divided into equidistant intervals of <stepsize>, the drive - starting from the current position - is positioned to the interval limits and, with the drive stationary, the intensity of the specified measuring channel(s) determined by a measurement over the period <time> and stored.

<drv_id>: Integer

Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and any coupled drives) must be present and initialized!

Coupled drives are tracked according to the coupling ratio if applicable (see CD command).

<channels>: Integer

Total of bit significances of selected measuring channels

The results are measured and stored separately. They can be read by MV command (see MV command).

<steps>: Integer

Number of steps with stepsize (total number of measurement results = number of steps + 1).

<stepsize>: Real

Sampling interval in units of the drive.

<time>: Real

Measuring time per sampling interval in seconds

Range of values: $0.01 \leq time \leq 0.01*2^{32} - 1$

Resolution: 0.01 s

The **SS** command without an argument can be used to read the measuring function status.

SP<drive_id>,<pos1>,<pos2>,...<posn>....Set General Step Scan Positions

This command is used to set positions for drive <drive_id>. The specified positions are used as target positions when executing a General Step Scan measuring function. The maximum number of positions is limited to 100 or limited by the maximum size of the instrument comport input buffer (1024 bytes).

The SP<drive_id> command without positions deletes the stored positions.

SG<drive_mask>,<channels>,<steps>,<time> General Step Scan

Parameter assignment and start of measuring function „General Step scan“.
This command is used to determine the intensity distribution from the current position to the target position of the specified drive(s) assuming the range is divided into non equidistant intervals. The drive(s) - starting from the current position – is (are) moved step by step to the target positions set by a SP command and, with the drive stationary, the intensity of the specified measuring channel(s) is (are) determined by a measurement over the period <time> and stored.

<drive_mask>: Unsigned Integer
Total of bit significances of positioning drives according to following table:

Significance	drive
2^0 ... 2^{15}	positioning drive #1 ... #16

Note: ☜
The selected drive(s) must be available and initialized!

<channels>: Integer
Total of bit significances of selected measuring channels.
The results are measured and stored separately. They can be read by MV command (see MV command).

<steps>: Integer
Number of steps (total number of measurement results = number of steps + 1).

<time>: Real
Measuring time per sampling interval in seconds
Range of values: $0.1 \leq time \leq 0.1*2^{32} - 1$
Resolution: 0.1 s

The **SG** command without an argument can be used to read the measuring function status (see Appendix „Measuring Function Status“).

HH(<drv_id >,<chnl_id>,<target>,<speed>,<time>,<number>,<thresh>) Half Height Scan
Parameterization and start of measuring function „Half Height Scan“.
This command is used to determine the intensity distribution from the current position to target position of the specified drive. The drive moves from the current position at the specified constant speed <speed> over the range and the pulse counter of the specified measuring channel is read at equidistant intervals of <time>. If the sum of <number> sampled counts is equal or less than the <thresh> value the drive and the measuring function will be stopped immediately and the current drive position stored. If the target position is reached before the sum is equal or less than the <thresh> value the „Peak Search Scan“ measuring function fails.
Then the routine described above will start again in the reversed moving direction.
If the measuring function has been executed succesfully the result = (current position + reverse point) / 2.
During measuring function execution or if the measuring function was aborted or failed the result = –1.

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and any coupled drives) must be present and initialized!
Coupled drives are tracked according to the coupling ratio if applicable (see CD command).

<chnl_id>: Integer
Selection of measuring channel

<target>: Real
End of measuring range in units of the drive

<speed>: Real
Moving speed in degrees/minute or millimeters/second or steps/second

<time>: Real
Measuring time per sampling interval in seconds
Range of values: $0.001 \leq time \leq 0.001*2^{32} - 1$
Resolution: 0.001 s

<number>: Integer
Number of sampled counts to be added for comparison with the threshold

<thresh>: Integer
Threshold for comparison with the sum of sampled counts.

The **HH** command without an argument can be used to read the measuring function status.

PS(<drv_id >,<chnl_id>,<target>,<speed>,<time>,<number>,<thresh>) Peak Search Scan

Parameterization and start of measuring function „Peak Search Scan“
This command is used to determine the intensity distribution from the current position to target position of the specified drive. The drive moves from the current position at the specified constant speed <speed> over the range and the pulse counter of the specified measuring channel is read at equidistant intervals of <time>. The sum of <number> sampled counts is computed. If the sum is equal or greater than the <thresh> value the peak search routine starts. This routine compares the sum of the previous sample interval (sum_{t-1}) with the current sum (sum_t). If the current sum will be less then the previous sum the drive and the measuring function will be stopped immediately.
If the target position is reached before the sum is equal or greater than the <thresh> value or the stop condition $sum_t < sum_{t-1}$ is not fulfilled the „Peak Search Scan“ measuring function fails.
If the measuring function has been executed succesfully the result = current drive position.
During measuring function execution or if the measuring function was aborted or failed the result = –1.

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and any coupled drives) must be present and initialized!
Coupled drives are tracked according to the coupling ratio if applicable (see CD command).

<chnl_id>: Integer
Selection of measuring channel

<target>: Real
End of measuring range in units of the drive

<speed>: Real
Moving speed in degrees/minute or millimeters/second or steps/second

<time>: Real
Measuring time per sampling interval in seconds
Range of values: $0.01 \leq \text{time} \leq 0.01*2^{32} - 1$
Resolution: 0.01 s

<number>: Integer
Number of sampled counts to be added for comparison with the threshold

<thresh>: Integer
Threshold for comparison with the sum of sampled counts.

The **PS** command without an argument can be used to read the measuring function status.

HP<chnl_id>,<dhv_start>,<dhv_end>,<stepsize>,<time> **High-voltage Plot**

Parameter assignment and start of measuring function „High-voltage plot“
This command is used to determine the intensity distribution of the specified measuring channel(s) depending on the detector high-voltage in the range <dhv_start> to <dhv_end>. The detector high-voltage is increased in steps of <stepsize> starting from the value <dhv_start>, and the intensity of the specified measuring channel(s) measured and stored for each high-voltage value by means of a measurement with the calculated time

t = <time>/n
n = number of measurements = INT((dhv_end - dhv_start)/stepsize + 1)

<chnl_id>: Integer
Selection of measuring channel

<dhv_start>: Integer
Initial value of high-voltage in volt
Range of values: $0.25 \leq \text{dhv_start} \leq 2400$
Resolution: 0.25 V

<dhv_end>: Integer
Final value of high-voltage in volt
Range of values: $\text{dhv_start} \leq \text{dhv_end} \leq 2400$
Resolution: 0.25 V

<stepsize>: Real
Sampling interval in volt

Range of values: 0.25 ≤ stepsize ≤ 10
Resolution: 0.25 V

<time>: Real
(Total) measurement time in seconds
Range of values: 0.01 ≤ time ≤ $0.01*2^{32} - 1$
Resolution: 0.01 s
n = number of measurements = INT((dhv_end - dhv_start)/5 + 1)

The **HP** command without an argument can be used to read the measuring function status.

DP<chnl_id>,<di_start>,<di_end>,<stepsize>,<time> Discriminator Plot

Parameter assignment and start of measuring function „Discriminator plot“
This command is used to determine the pulse height distribution of the specified measuring channel(s) in the range <di_end> to <di_start>. A discriminator window with a width of <stepsize> Volt is shifted starting from the value <di_start> to <di_end>, and the intensity of the specified measuring channel determined and stored for each discriminator value by means of a measurement with the calculated time

t = <time>/n
n = number of measurements = INT((di_end - di_start)/stepsize + 1)

<chnl_id>: Integer
Selection of measuring channel

<di_start>: Real
Initial value of lower discriminator threshold in volt
Range of values: 0 ≤ dimin ≤ 6.25
Resolution: 8 bits (approx. 6.25 V/ 256 = 24.5 mV)

<di_end>: Real
Final value of lower discriminator threshold in volt
Range of values: dimin ≤ dimax ≤ 6.25
Resolution: 8 bits (approx. 6.25 V/ 256 = 24.5 mV)

<stepsize>: Real
Discriminator window width in volt
Range of values: 0.0245 ≤ stepsize ≤ 0.1
Resolution: 8 bits (approx. 6.25 V/ 256 = 24.5 mV)

<time>: Real

(Total) measurement time in seconds
Range of values: $0.01 \leq time \leq 0.01*2^{32} - 1$
Resolution: 0.01 s
n = number of measurements = INT((di_end - di_start)/24.5mV + 1)
The **DP** command without an argument can be used to read the measuring function status.

IM(<sh_open_time>,<det_dis_time>) Image

Parameterization and start of measuring function „Image“.

<sh_open_time>: Real
Shutter open time in seconds.
Range of values: $0.001 \leq sh_open_time \leq (2^{32}-1)/1000$
Resolution: 0.001 sec

☞ **Note:**
If no secondary shutter(s) is(are) available the primary shutter is opened for the specified time.

If multiple secondary shutters are available all shutters will be opened for the specified time.

<det_dis_time>: Real
Delay time in seconds between the shutter(s) is(are) closed and the detector is disabled in seconds.
Range of values: $0.001 \leq det_dis_time \leq 65.535$
Resolution: 0.001 sec

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **IM** command without an argument can be used to read the (real) shutter open time.

IS(<drv_id>,<range>,<sh_open_time>,<det_dis_time>,<sh_open_pos>) Image Scan

Parameterization and start of measuring function „Image Scan“ (open shutter synchronized with the drive(s)).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and coupled drives) must be present and initialized!
Coupled drives are tracked according to the coupling ratio if applicable (see **CD**-command).

<range>: Real
Scan-range in units of the drive.

<sh_open_time>: Real
Shutter open time in seconds.
Range of values: $0.001 \leq$ sh_open_time $\leq (2^{32}-1)/1000$
Resolution: 0.001 sec

☞ **Note:**
If no secondary shutter(s) is(are) available the primary shutter is opened for the specified time.

If multiple secondary shutters are available all shutters will be opened for the specified time.

<det_dis_time>: Real
Delay time in seconds between the shutter(s) is(are) closed and the detector is disabled in seconds.
Range of values: $0.001 \leq$det_dis_time ≤ 65.535
Resolution: 0.001 sec

<sh_open_pos>: Real

Note:
If the scan speed is greater than the slow speed (see instrument configuration file „DEVICE.INI“ section „[DRIVEx]“ entry „SLOW“, x=drive_id) the trajectory profile (=trapezoidal point to point) must be considered when the drive is moved to its start position.
speed = <range>/<sh_open_time>
start position = sh_open_pos - (((speed + slow) / 2) * (((speed - slow) / (fast - slow))*accel_time).

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **AS** command without an argument can be used to read the measuring function results in following sequence separated by comma:

actual drive position when the shutter is opened,
actual speed when the shutter is opened,
(real) shutter open time.

AI(<attn_in_time>,<det_dis_time>) Attenuator Image

Parameterization and start of measuring function „Attenuator Image“.

☞ **Note:**
Only available with the (new) rotary shutter!

<attn_in_time>: Real
Attenuator IN time in seconds.
Range of values: $0.001 \leq attn_in_time \leq (2^{32}-1)/1000$
Resolution: 0.001 sec

<det_dis_time>: Real
Delay time in seconds between the shutter(s) is(are) closed and the detector is disabled in seconds.
Range of values: $0.001 \leq det_dis_time \leq 65.535$
Resolution: 0.001 sec

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **AI** command without an argument can be used to read the (real) attenuator IN time.

AS(<drv_id>,<range>,<attn_in_time>,<det_dis_time>,<attn_in_pos>) Attenuator Image Scan

Parameterization and start of measuring function „Attenuator Image Scan“ (attenuator IN is synchronized with the drive(s)).

☞ **Note:**
Only available with the (new) rotary shutter!

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and coupled drives) must be present and initialized!
Coupled drives are tracked according to the coupling ratio if applicable (see **CD**-command).

<range>: Real
Scan-range in units of the drive.

<attn_in_time>: Real
Attenuator IN time in seconds.
Range of values: $0.001 \leq$ attn_in_time $\leq (2^{32}-1)/1000$
Resolution: 0.001 sec

<det_dis_time>: Real
Delay time in seconds between the shutter(s) is(are) closed and the detector is disabled in seconds.
Range of values: $0.001 \leq$det_dis_time ≤ 65.535
Resolution: 0.001 sec

<attn_in_pos>: Real

☞ **Note:**
If the scan speed is greater than the slow speed (see instrument configuration file „DEVICE.INI“ section „[DRIVEx]“ entry „SLOW“, x=drive_id) the trajectory profile (=trapezoidal point to point) must be considered when the drive is moved to its start position.
speed = <range>/<sh_open_time>
start position = attn_in_pos - (((speed + slow) / 2) * (((speed - slow) / (fast - slow))*accel_time).

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **AS** command without an argument can be used to read the measuring function results in following sequence separated by comma:

actual drive position when the attenuator is IN,
actual speed when the attenuator is IN,
(real) attenuator IN time.

HI(<det_enable_time> HISTAR Image

Parameterization and start of measuring function „HISTAR Image“.

<det_enable_time>: Real
Detector enable time in seconds.
Range of values: 0.001 ≤ det_enable_time ≤ $(2^{32}-1)/1000$
Resolution: 0.001 sec

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **HI** command without an argument can be used to read the (real) detector enable time.

HS(<drv_id>,<range>,<det_enable_time>,<det_enable_pos>) HISTAR Image Scan

Parameterization and start of measuring function „HISTAR Image Scan“ (enable detector synchronized with the drive(s)).

<drv_id>: Integer
Selection of drive

drv_id	Meaning
1 ... 16	positioning drive #1 ... #16

The selected drive (and coupled drives) must be present and initialized!
Coupled drives are tracked according to the coupling ratio if applicable (see **CD**-command).

<range>: Real
Scan-range in units of the drive.

<det_enable_time>: Real
Detector enable time in seconds.
Range of values: 0.001 ≤ det_enable_time ≤ $(2^{32}-1)/1000$
Resolution: 0.001 sec

<det_enable_pos>: Real

☞ **Note:**
If the scan speed is greater than the slow speed (see instrument configuration file „DEVICE.INI“ section „[DRIVEx]“ entry „SLOW“, x=drive_id) the trajectory profile (=trapezoidal point to point) must be considered when the drive is moved to its start position.
speed = <range>/<det_enable_time>
start position = det_enable_pos - (((speed + slow) / 2) * (((speed - slow) / (fast - slow))*accel_time).

To check the status of the measuring function use the **MF**-command.

If the measuring function is successfully executed the **HS** command without an argument can be used to read the measuring function results in following sequence separated by comma:

actual drive position when the shutter is opened,
actual speed when the shutter is opened,
(real) detector enable time.

MF Measuring Function Status

The MF-command is used to read the measuring function status while a measuring function is running or after a measuring function is aborted.
The measuring function status information is transmitted to the externel computer in following sequence:

running/aborted measuring function ID[1)]
Measuring Sequence[2)]
Cause of Abort[2)]
Remaining number of repeats / steps
Missing ready flags on abort [3)]
Pending alarms on abort [3)]

separated by comma.

[1)] Measuring Function ID’s:
0 = Stand-by
1 = Measurement
2 = Detector-high-voltage Step-Scan

3 = Discriminator Step-Scan
4 = Drive Step-Scan
5 = Drive Scan
9 = Image
10 = Image Scan
11 = Detector image
12 = Detector image scan
13 = Attenuator image
14 = Attenuator image scan
15 = General drive scan

2) See Appendix „Measuring Function Status“
3) See Appendix „Status Flags“

MV<chnl_id>,<number>(,<countmask>) **Measured Value(s)**

Command for reading stored measured values
The number of stored measured values can be checked by an CS command (see CS command).

<chnl_id>: Integer
Selection of measuring channel whose measured values are to be read

<number>: Integer
Number of measured values which are to be transmitted to the external computer in one block

<countmask>: Integer
This optional bit coded argument is used to select the counter count, which has to be transmitted to the computer.

Significance	Meaning
$2^0 = 1$	Count of counter 1 of the detctor interface board
$2^1 = 1$	Count of counter 2 of the detctor interface board
$2^2 = 1$	Count of counter 3 of the detctor interface board

Measured values are transmitted to the computer as integers (range of values $0 \leq MV \leq 99\ 999\ 999$) with the code „MV“. A measured-value overflow is indicated by the number 100 000 000.
If fewer measured values are stored than requested, only the existing measured values are output.
If no measured values are stored, only a „MV“ string is output.

EV<drv_id>(,<number>) Encoder Value(s)

Command for reading sampled encoder values.

Note:
While executing a ME-command (Measuring function MEASUREMENT) or a SS-command (Measuring function STEP-SCAN) additionally to the measured values all encoder positions (encoders on the motor axis and/or optional Heidenhain-encoders) will be stored for later use.

The number of sampled encoder positions agrees with the number of stored measured values while executing a MEASUREMENT or STEP-SCAN measuring function and can be checked by an CS-command reading the number of stored measured values (see CS-command).

<drv_id>: Integer
Selection of the positioning drive whose sampled encoder positions are to be read.

<number>: Integer
Number of sampled encoder positions which are to be transmitted to the requesting computer in one block.

Examples:
If an encoder on the motor axis is present but no Heidenhain-encoder
EV<position #n of the encoder on the motor axis>,; ...
If an optional Heidenhain-encoder is present but no encoder on the motor axis
EV,< position #n of the Heidenhain-encoder >; ...
If both an encoder on the motor axis and a Heidenhain-encoder is present
EV<position #n of the encoder on the motor axis>,<position #n of the Heidenhain-encoder>; ...
(notice comma and semi-colon!)

If fewer encoder values are stored than requested, only the existing encoder values are transmitted to the requesting computer.
If no encoder values are stored, only a „EV“ string is transmitted to the requesting computer.

Commands for reading instrument status

ST(<id>)	(Instrument) Status
CS<chnl_id>(,<id>)	Channel Status
AV(<id>)	Read Errors
RE(<id>)	Read Errors
EP(<drv_id>)	Encoder Positions
RR{<adr>|<board_name>}	Read Register(s)
RI(<bitmask>)	Read Input(s)
RV(<id>)	Read Version

ST(<id>) (Instrument) Status

Request for transmission of instrument status to external computer

<id>: Integer

Selection of status information to be transmitted to the external computer.

id	Meaning
1	Control register of instrument
2	Ready messages
3	Warnings
4	Alarms
5	(Generator) shutdown circuit capture register
6 ... 21	positioning drive #1 ... #16
22	(standard) slit changer
23	(standard) tube window
24	(standard) X-RAY Generator
25	sample changer

The **ST** command without an argument can be used to read all status flags in an increasing sequence of code numbers separated by commas.

The contents of the status registers are output as decimal numbers. They are the total of the bit significances whose meanings are listed in the Section 8.9.

CS<chnl_id>(,<id>) Channel Status

Request to transmit measuring channel status information to the external computer

<chnl_id>: Integer
Selection of measuring channel

<id>: Integer
Selection of status information to be transmitted to the external computer

id	Meaning
1	Measuring channel status register
2	Counting rate of counter 1
3	Counting rate of counter 2
4	Counting rate of counter 3
5	Measuring time
6	Count of counter 1
7	Count of counter 2
8	Count of counter 3
9	Number of stored measured values

Measuring Channel Status Register

Total of bit significances with following meanings:

Significance	Meaning
$2^0 \cdots 2^1$	Status of detector high-voltage
$2^2 \cdots 2^4$	Reserved
2^5	Measuring channel busy
2^6	Measuring channel ready
2^7	Measuring channel faulty

Status of Detector High-voltage

2^1	2^0	Meaning
0	0	Detector high-voltage off
0	1	Detector high-voltage set
1	0	Detector high-voltage faulty

The **CS**<chnl_id> command can be used to read the complete status of the measuring channel in an increasing sequence of code numbers separated by commas.

AV(<id>) Actual Value(s)

Request to transmit the actual values of the instrument to the external computer

<id>: Integer

Selection of actual values to be transmitted to the external computer

id	Meaning
1 ... 16	positioning drive #1 ... #16
17	(Standard) Slit-changer
18	(Standard) Tube-window

The **AV** command without an argument can be used to read all actual values in an increasing sequence of code numbers separated by commas.

RE(<id>) Read Error(s)

Command to read error flags for diagnostic purposes

<id>: Integer

Selection of error flag with following assignment:

id	Meaning
1 ... 16	positioning drive #1 ... #16
17	(standard) slit changer
18	(standard) tube window
19	(standard) X-ray generator
20	sample changer

See Section 8.10 for the meaning of the error flags.

The **RE** command without an argument can be used to read all error flags in an increasing sequence of code numbers separated by commas.

EP(<drv_id>) Encoder Positions(s)

Command for reading the actual encoder positions.

<drv_id>: Integer

Selection of the positioning drive whose encoder positions are to be read.

Examples:
If an encoder on the motor axis is present but no Heidenhain-encoder
drv_id != 0**:** EP<position of the encoder on the motor axis>,
If an optional Heidenhain-encoder is present but no encoder on the motor axis
drv_id != 0**:** EP,< position of the Heidenhain-encoder >
If both an encoder on the motor axis and a Heidenhain-encoder is present
drv_id != 0**:** EP<position of the encoder on the motor axis>,<position of the Heidenhain-encoder>
(notice comma!)

The EP-command without an argument can be used to read the actual encoder positions of all drives separated by semi-colons.

RR{<adr>|<board_name>} **Read Register(s)**
Command to read instrument I/O ports for diagnostic purposes.
<adr>: Integer
I/O port address $|_{hex}$.
<board_name>: ASCII-string
Name of the board used in the DEVICE.INI file (e.g. [UIOB1])
The **RR<adr>** command is used to read a single I/O register.
The **RR<board_name>** command is used to read all (readable) I/O registers on the specified board separated by commas.
Notes:
Use this command with care.
The addressed port must be readable! Accessing not readable ports can cause an unpredictable behaviour.
The contents of the 8-bit digital inputs are output as hex-coded numbers (format 0xYY). The bit meanings are listed in Chapter 9.

RI(<bitmask>) Read Input(s)

Reads all TTL digital inputs selected by <bitmask> and transmits the number 0 for TTL Low input levels and the number 1 for TTL High input levels in an increasing sequence of significances to the external computer.

<bitmask>: Integer
Total of bit significances of digital inputs 1 ... 16

Significance	No. of digital input
2^0	Digital input 1
2^1	Digital input 2
2^2	Digital input 3
2^3	Digital input 4
2^4	Digital input 5
2^5	Digital input 6
2^6	Digital input 7
2^7	Digital input 8
2^8	Digital input 9
2^9	Digital input 10
2^{10}	Digital input 11
2^{11}	Digital input 12
2^{12}	Digital input 13
2^{13}	Digital input 14
2^{14}	Digital input 15
2^{15}	Digital input 16

The **RI** command without an argument is used to transmit all digital inputs.
Digital inputs which are not controlled are terminated by 1-kΩ resistors to +5 V and deliver TTL High level.

RV Read Version

Command to read the firmware version(s) for diagnostic purposes.

Miscellaneous Commands

BE<frequ>(,<time>, <number>)	Beep
WA(<time>)	Wait
DM<sio>(,<code>)	Data Monitoring

BE<frequ>(,<time>,<number>) Beep

Control command for the audible signal transmitter

<frequ>: Integer

Control word with the following effect:

frequ	Meaning
0	Signal off (default setting)
≥ 1	Tone frequency in hertz

<time>: Integer

This optional parameter defines the on-time in msec of the audible signal.
If time = –1 a permanent tone of the spezified frequency will be switched on.

<number>: Integer

If 1 ≤ number ≤ 32767 a periodic beep of the spezified frequency will be switched on. The time value specifies the on and off time. The number value determines the number of beeps.
If number = –1 a periodic beep of the spezified frequency will be switched ON. The time value specifies the on and off time

DM<sio>(,<code>) Data Monitoring

Command to switch output of data transfer on and off between instrument and analysis computer or X-ray generator at the service interface. The command is used to monitor the communication via the corresponding serial interface. In order to differentiate between received and transmitted data of the instrument, data bit D8 is set to 0 with received data and to 1 with transmitted data.
The **DM** command is only permissible at the service interface, does not require a preparatory command RC1 and is permissible at any time.

<sio>: Integer

Selection of communication channel to be monitored

<code>: Integer
Control code for switching output on and off

code	Meaning
0	Output off
1	Output on

The **DM0** command terminates the monitoring of all communication channels.

WA(<time>) Wait

This command is mainly used to set a delay time between command execution in command macro processing.

<time>: Real
Delay time in ms.

Range of values: $1 \leq \text{time} \leq 2^{16} - 1$

The **WA** command without an argument can be used to read the current delay time.

Measuring Function Status

A measuring function command without an argument can be used to read the measuring function status. The status information is transmitted in the following order:

- Running/aborted measuring function ID
- Measuring Sequence
- Cause of Abort
- Remaining number of repeats / steps
- Missing ready flags on abort
- Pending alarms on abort
- (result [6])

separated by comma.

Measuring Function ID's:

0 = Stand-by
1 = Measurement
2 = Detector-high-voltage Step-Scan
3 = Discriminator Step-Scan
4 = Drive Step-Scan
5 = Drive Scan
9 = Image
10 = Image Scan
11 = Detector Image
12 = Detector Image Scan
13 = Attenuator Image
14 = Attenuator Image Scan
15 = General Step Scan

Measuring Sequence

Value	Meaning
0	No measuring function in progress
1	Preparing measuring function
2	Preparing repetition of the last step

[6] Only with HH and PS command.

3	preparing next step
4	Waiting for instrument ready
5	Counting
6	Measuring function aborted
7	Measuring function failed

Cause of Abort

Value	Meaning
0	External abort (= abort command)
1	Abort because of instrument not ready
2	Abort because of pending alarm
3	Abort because of instrument setting timeout
4	Count storage overflow

Status Flags

Instrument Control Flags

Significance	Meaning
2^0	Instrument ready
2^1	Instrument warning pending
2^2	Instrument alarm pending
2^3	Macro execution
2^4	Measuring function running
2^5	Instrument remote control
2^6	Instrument service mode
2^7	Instrument setup mode (instrument controller inactive)
2^8	Ready flag(s) masked
2^9	Alarm flag(s) masked

Ready Flags

Significance	Meaning
2^0	Positioning drive(s)
2^1	Measuring channel(s) (to be measured)
2^2	(Standard) slit changer
2^3	(Standard) tube window
2^4	(Standard) X-ray generator
2^5	Sample in measuring position

Alarm Flags

Significance	Meaning
2^0	X-ray generator off
2^1	Tube window closed
2^2	Detector high-voltage off
2^3	Detector high-voltage faulty
2^4	Instrument faulty
2^5	Power supply faulty
2^6	Macro execution failed
2^7	–
2^8	–
2^9	–
2^{10}	–

2^{11}	–
2^{12}	–
2^{13}	–
2^{14}	–
2^{15}	–

The alarms can be masked by the AF command.
Alarms which are masked (= made ineffective) by the computer by means of the AF command are output as warnings.

Warnings

Significance	Meaning
2^{0}	Lead glass door open or not locked
2^{1}	Generator warning present
2^{2}	Key switch in position „SERVICE“
2^{3}	–
2^{4}	–
2^{5}	–
2^{6}	–
2^{7}	–
2^{8}	–
2^{9}	–
2^{10}	–
2^{11}	–
2^{12}	–
2^{13}	–
2^{14}	–
2^{15}	–
2^{16}	X-ray generator off
2^{17}	Tube window closed
2^{18}	Detector high-voltage off
2^{19}	Detector high-voltage faulty
2^{20}	Instrument faulty
2^{21}	Power supply faulty
2^{22}	Macro execution failed
2^{23}	–

If the „Generator warning“ (significance 2^1) occurs, the corresponding generator register should be read using the GR6 command and analyzed, and the existing generator warnings should be output on the screen of the analysis computer.

If the key switch is in the position „SERVICE“ (significance 2^2), the remote control commands GVxx and GCxx for selection of the voltage and current on the X-ray generator are rejected by the instrument with the error message „?13“. When calibrating on the instrument with the key switch in position „SERVICE“, it must nevertheless still be possible to carry out measurements with the function „Interactive measurement (adjust)“. The remote control commands GVxx and GCxx must not be sent in this case!

The warnings with the significances $\geq 2^{16}$ are alarms which have been masked (= made ineffective) by the external computer.

(Generator) Shutdown Circuit Capture Register

Significance	Meaning
$2^{0 \cdots} 2^7$	identical to Alarm flags (see „Alarm Flags“)
$2^8 = 1$	X-RAY Generator alarm pending
$2^9 = 1$	Goniometer not mounted (S651 & S652)
$2^{10} = 1$	Rear Panel not mounted (S653 & S654)
$2^{11} = 1$	X-RAY Generator OFF
$2^{12} = 1$	X-RAY Display o.k.
$2^{13} = 1$	„SERVICE“ (S624)
$2^{14} = 1$	Service mode Warning Display & Realis o.k.
$2^{15} = 1$	CFF Right Door switches o.k. (S659 & S660)
$2^{16} = 1$	CFF Left Door switches o.k. (S657 & S658)
$2^{17} = 1$	CFF Tube Window switches o.k. (S1 & S2)
$2^{18} = 1$	CFF Tube Window OPEN Display o.k.
$2^{19} = 1$	CFF X-RAY ON Display o.k.
$2^{20} = 1$	Right Door not closed (S660)
$2^{21} = 1$	Left Door not closed (S658)
$2^{22} = 1$	Tube Window OPEN (H1 & H2)
$2^{23} = 1$	Tube Window not closed (H1 & H2)
$2^{24} = 1$	Primary Optics not mounted (S5 & S6)
$2^{25} = 1$	Tube Mount not mounted (S3 & S4)
$2^{26} = 1$	Right Door locked (S655)
$2^{27} = 1$	Left Door locked (S656)

2^{28} = 1 Optional X-RAY ON Display not attached
2^{29} = 1 Tube Window Open Button operated
2^{30} = 1 Reserved
2^{31} = 1 X-ray Generator +24V/DC present
CFF = Capture-Flip-Flop

Status of the Positioning Drives

Significance	Meaning
2^0	Drive running
2^1	Drive position (coarse) known
2^2	Drive initialized
2^3	Drive coupled
2^4	Drive presetted
2^5	Reserved
2^6	Command executed
2^7	Drive fault
2^8	Lower limit over travel [1)]
2^9	Upper limit over travel [1)]
2^{10}	Lower collision limit over travel [2)]
2^{11}	Upper collision limit over travel [2)]

[1)] Set by control software if the drive over travels the limits specified in the DEVICE.INI file.
[2)] Set by control software if the drive over travels the collision limits set by an CL-command.

Status of the (Standard) Slit Changer

Significance	Meaning
2^0	Command execution
2^1	–
2^2	–
2^3	–
2^4	–
2^5	–
2^6	Command executed
2^7	Slit Changer fault

Status of the (Standard) Tube Window

Significance	Meaning
2^0	Command execution
2^1	–
2^2	–
2^3	–
2^4	–
2^5	–
2^6	Command executed
2^7	Tube Window fault

Status of the (Standard) X-ray Generator

Significance	Meaning
2^0	Heating on
2^1	X-ray generator high-voltage on
2^2	kV ready
2^3	mA ready
2^4	Remote control on
2^5	Break-down
2^6	X-ray generator warning
2^7	X-ray generator stand-by mode
2^8	X-ray generator fault

Status-flags of the Sample-changer

Significance	Meaning
2^0	Sample-changer busy
2^1	Sample-changer empty
2^2	Sample-changer adjusted
2^3	Magazine-position empty
2^4	_____
2^5	_____
2^6	Command executed
2^7	Sample-changer fault

Status-flags of the Sample-changer drives

Significance	Meaning
2^0	Drive running
2^1	reserved
2^2	Drive adjusted
2^3	reserved
2^4	reserved
2^5	reserved
2^6	Command executed
2^7	Drive faulty

Status of the Sample Changer

Significance	Meaning
2^0	Command execution
2^1	–
2^2	–
2^3	–
2^4	–
2^5	–
2^6	Command executed
2^7	Sample Changer fault

Error Flags

Error flags for the Positioning Drives

Significance	Meaning
2^0	Run-time error
2^1	Drive at lower limit switch
2^2	Drive at upper limit switch
2^3	Drive at collision limit switch
2^4	Positioning error
2^5	Chipset command error
2^6	Chipset wrap around error
2^7	Homing error

Error flags for the (Standard) Slit Changer

Significance	Meaning
2^0	Changer position 1 not reached
2^1	Changer position 2 not reached
2^2	–
2^3	–
2^4	–
2^5	–
2^6	–
2^7	–

Error flags for the (Standard) Tube Window

Significance	Meaning
2^0	Tube window mount failure
2^1	Tube window open command failed
2^2	Tube window open led failed
2^3	–
2^4	–
2^5	–
2^6	–
2^7	–

Error flags for the (Standard) X-ray Generator

Significance	Meaning
2^0	–
2^1	–
2^2	–
2^3	–
2^4	–
2^5	–
2^6	–
2^7	–

Error-flags of the Sample-changer

Significance	Meaning
2^0	Run-time overflow
2^1	Sample-magazine drive faulty
2^2	Sample-lock drivefaulty
2^3	Sample-rotation drive faulty
2^4	_____
2^5	_____
2^6	_____
2^7	_____

Error-flags of the Sample-changer drives

Significance	Meaning
2^0	Chip error
2^1	Command error
2^2	Referencing error
2^3	Positioning error
2^4	Drive at limit
2^5	reserved
2^6	reserved
2^7	reserved

Remote Control Command Set (Overview)

Commands for mode switchover

SU	Setup Mode
QU	Quit Setup Mode
RC(<code>)	Remote Control Mode
RS<code>(,<id>)	Reset
EX	Exit to DOS Level

Commands for instrument parameterization

SE(<section>(,<list of parameters>))	Section
ZI(<drv_id>(,ref))	Zeros Initial
DL(<drv_id>(,<lower>,<upper>))	Drive Limits
CL(<drv1_id>,<drv2_id>,<lower>,<upper>(,<reversed>))	Collision Limits
MO<drv_id>(,<modulus>)	Modulus
DR(<drv_id>(,<info_id>))	Drive(s)
CH(<chnl_id>(,<info_id>))	Channel(s)

Commands for channel parameterization

HV<chnl_id>(,<dhv>)	(Detector) High Voltage
DI<chnl_id>(,<lld1>,<width1>,<lld2>,<width2>)	Discriminators
LS<chnl_id>(,<code >)	Line Shift
AG<chnl_id>(,<ag >)	Amplifier Gain
TL<chnl_id>(,<code >)	Top Level Discriminator
DT<chnl_id>(,< dtime >)	Dead-time
PT<chnl_id>(,< ptime >)	Pile-up-time
CP<chnl_id>(,<dhv,<lld1>,<width1>,<lld2>,<width2>, <ls>, <ag>, <tldscr>, <dtime>, <ptime>)	Channel Parameters
TC<chnl_id>(,<tconst >)	Time Constant

Control commands

HT(<id>)	Halt
DS<drv_id>,<dir>(,<nsteps>)	Drive Step(s)
TU<drv_id>,<dir>,<speed>	Tuning
FR<drv_id>,<dir>	Find Reference
IN(<id>)	Initialization
CD<mdrv_id>(,<sdrv_id>,<ratio>)	Couple Drives
PD(<bitmask>)	Preset Drives
GO(<drv_id>,<target>(,<speed>))	Go
GL(<drv_id>,<target>(,<speed>))	Go Long Path
RG<drv_id>,<distance>(,<speed>)	Relative Go
OS<drv_id>,<ampl>,<speed>(,<number>)	Oscillation
RO(<speed>)	Rotation
FU<sdrv_id>(,<mdrv1_id>,<length>,<radius>,<distance> (,<mdrv2_id>))	Follow Up
SL(<code>)	Slit
SA(<pos>)	Sample
CC<cmd_id>(,<param>)	Sample-handler Control
DC(<code>)	DC Power Output
AC(<code>)	AC Power Output
SH(<code>)	Shutter
TW(<code>)	Tube-window
XR(<code>)	X-RAY
OC(<bitmask>,<value>)	Output Contact

Commands for parameterizing and starting measuring functions and reading results

RM(<bitmask>)	Ready Mask
AM(<bitmask>)	Alarm Mask
ME(<chnl_id>,<time>(,<repeats>))	Measurement
SC(<drv_id>,<channels>,<steps>,<stepsize>,<time>)	(Continous) Scan
SS(<drv_id>,<channels>,<steps>,<stepsize>,<time>)	Step Scan
SP<drive_id>,<pos1>,<pos2>,...<posn>	Set General Step Scan Positions
SG<drive_mask>,<channels>,<steps>,<time>	General Step Scan
HP(<chnl_id>,<dhv_start>,<dhv_end>,<stepsize>,<time>)	High Voltage Plot

DP(<chnl_id>,<di_start>,<di_end>,<stepsize>,<time>)	Discriminator Plot
IM(<sh_open_time>,<det_dis_time>)	Image
IS(<drv_id>,<range>,<sh_open_time>,<det_dis_time>, <sh_open_pos>)	Image Scan
AI(<attn_in_time>,<det_dis_time>)	Attenuator Image
AS(<drv_id>,<range>,<attn_in_time>,<det_dis_time>, <attn_in_pos>)	Attenuator Image Scan
HI(<det_enable_time>	HISTAR Image
HS(<drv_id>,<range>,<det_enable_time>,<det_enable_pos>)	HISTAR Image Scan
MF	Measuring Function Status
MV<chnl_id>,<number>(,<countmask>)	Measured value(s)
EV<drv_id>(,<number>)	Encoder Value(s)

Commands for reading instrument status and instrument registers

ST(<id>)	(Instrument) Status
CS<chnl_id>(,<id>)	Channel Status
AV(<id>)	Actual Value(s)
RE(<id>)	Read Error(s)
EP(<drv_id>)	Encoder Position(s)
RR{<adr>|<board_name>}	Read Register(s)
RI	Read Input(s)
RV	Read Version

Miscellaneous Commands

BE<frequ>(,<time>,<number>)	Beep
WA(<time>)	Wait
DM<sio>(,<code>)	Data Monitoring

Remote Control Command Set (alphabetical order)

Command	Description
AC(<code>)	AC-Motor
AC(<code>)	AC Power Output
AG<chnl_id>(,<ag >)	Amplifier Gain
AM(<bitmask>)	Alarm Mask
AV(<id>)	Actual Value(s)
BE<frequ>(,<time>,<number>)	Beep
CC<cmd_id>(,<param>)	Sample-changer Control
CD<mdrv_id>(,<sdrv_id>,<ratio>)	Couple Drives
CH(<chnl_id>(,<info_id>))	Channel(s)
CL(<drv1_id>,<drv2_id>,<lower>,<upper>(,<reversed>))	Collision Limits
CP<chnl_id>(,<dhv,<lld1>,<width1>,<lld2>,<width2>, <ls>, <ag>, <tldscr>, <dtime>, <ptime>)	Channel Parameters
CS<chnl_id>(,<id>)	Channel Status
DC(<code>)	DC Power Output
DI<chnl_id>(,<lld1>,<width1>,<lld2>,<width2>)	Discriminators
DL(<drv_id>(,<lower>,<upper>))	Drive Limits
DM<sio>(,<code>)	Data Monitoring
DP(<chnl_id>,<di_start>,<di_end>,<stepsize>,<time>)	Discriminator Plot
DR(<drive_id>(,<info_id>))	Drive(s)
DS<drv_id>,<dir>(,<nsteps>)	Drive Step(s)
DT<chnl_id>(,< dtime >)	Dead-time
EP(<drv_id>)	Encoder Position(s)
EV<drv_id>(,<number>)	Encoder Value(s)
EX	Exit to DOS Level
FR<drv_id>,<dir>	Find Reference
FU<sdrv_id>(,<mdrv1_id>,<length>,<radius>,<distance>(,<mdrv2_id>))	Follow Up
GL(<drv_id>,<target>(,<speed>))	Go Long Path
GO(<drv_id>,<target>(,<speed>))	Go

Command	Description
HH(<drv_id >,<chnl_id>,<target>,<speed>,<time>,<number>,<thresh>)	Half Height Scan
HP(<chnl_id>,<dhv_start>,<dhv_end>,<stepsize>,<time>)	High Voltage Plot
HT(<id>)	Halt
HV<chnl_id>(,<dhv>)	(Detector) High Voltage
IN(<id>)	Initialization
LS<chnl_id>(,<code >)	Line Shift
ME(<chnl_id>,<time>(,<repeats>))	Measurement
MF	Measuring Function Status
MO<drv_id>(,<modulus>)	Modulus
MV<chnl_id>,<number>(,<countmask>)	Measured value(s)
OC(<bitmask>,<value>)	Output Contact
OS<drv_id>,<ampl>,<speed>(,<number>)	Oscillation
PD(<bitmask>)	Preset Drives
PS(<drv_id >,<chnl_id>,<target>,<speed>,<time>,<number>,<thresh>)	Peak Search Scan
PT<chnl_id>(,< ptime >)	Pile-up-time
RG<drv_id>,<distance>(,<speed>)	Relative Go
SA(<pos>)	Sample
SH(<code>)	Shutter
TW(<code>)	Tube-window

Command Macros

The controller offers the possibility to name and execute command sequences as a command macro.
The usage of command macros speeds up the execution of fixed command sequences.

Macro Definition

A macro consist of a macro name and a macro body. The macro name (max 8 ASCII-characters) is delimited by '%'-characters. The macro body is a command sequence of remote control commands separated by a ';'-character.

%macro_name%cmd#1;cmd#2;cmd#3; ... ;cmd#n

The stringlength of a macro defintion command is limited to 255 characters including the macro name. The number of commands in the command string is limited to 32 commands. The macro is stored in a macro structure in the system memory.

The macro stored in the system memory can be saved on disk with the command **%macro_name% /s**. The macro is stored as a textfile „**MACRO_NAME.MAC**" with one command per line.

cmd#1
cmd#2
.
.
.
cmd#n

An existing file with the same name will be overwritten.

A special macro named **%AUTO%** can be defined and stored on disk with filename **AUTO.MAC**. This command macro - if it exists on disk - will be executed after system initialization.

The command **%macro_name% /l** can be used to load a macro from disk into the system memory.

The command **%macro_name% /d** can be used to delete a macro in the system memory and on the disk.

The command **%macro_name%** can be used to read out the macro stored in the system memory or on the disk. If stored in the system memory the replied string includes the macro name limited by '%' characters, the commands separated by ';' characters, the index of the current processed command when executing a macro, the (remaining) number of repeats, the control word and the status word all seperated by ',' characters.

If the macro only exists on the disk the replied string includes the macro name limited by '%' characters and the commands separated by ';' characters. If the macro neither exists in the system memory nor on the disk only **%macro_name%** is replied.

Macro Execution

To execute a macro in normal instrument operating mode call it by the command **%macro_name%/e**. An optional number #n can be used to repeat a macro (**%macro_name%/e#n)**. If the specified macro already exists in the system memory it will be executed at once otherwise the macro will be loadet from the disk and then executed.
Macro execution can be stopped by the command **%macro_name% /h** or by a HT command (see HT command description).

Assignment of the I/O Ports

Universal I/O Boards

(Universal-IO-Board C79298-A3220-B103)
Port = Board-Base-Adr. + Offset
Offset = 00_{hex}: PIO#1 Port A (used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**1**		X-RAY Generator alarm pending
x	x	x	x	x	x	**0**	x		Goniometer mounted (S651 & S652)
x	x	x	x	x	**0**	x	x		Rear Panel mounted (S653 & S654)
x	x	x	x	**0**	x	x	x		X-RAY Generator ON
x	x	x	**1**	x	x	x	x		X-RAY Display o.k.
x	x	**1**	x	x	x	x	x		Service Switch in position „SERVICE“ (S624)
x	**1**	x	x	x	x	x	x		Service Mode Warning Display & Relais o.k.
1	x	x	x	x	x	x	x		CFF Right Door switches o.k. (S659 & S660)

Offset = 01_{hex}: PIO#1 Port B (used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**1**		CFF Left Door switches o.k. (S657 & S658)
x	x	x	x	x	x	**1**	x		CFF Tube Window switches o.k. (S1 & S2)
x	x	x	x	x	**1**	x	x		CFF Tube Window OPEN Display o.k.
x	x	x	x	**1**	x	x	x		CFF X-RAY ON Display o.k.
x	x	x	**0**	x	x	x	x		Right Door closed (S660)
x	x	**0**	x	x	x	x	x		Left Door closed (S658)
x	**1**	x	x	x	x	x	x		Tube Window OPEN (H1 & H2)
1	x	x	x	x	x	x	x		Tube Window not closed (H1 or H2)

Offset = 02_{hex}: PIO#1 Port C (used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0**		Primary Optics mounted (S5 & S6)
x	x	x	x	x	x	**0**	x		Tube Mount mounted (S3 & S4)
x	x	x	x	x	**1**	x	x		Right Door locked (S655)
x	x	x	x	**1**	x	x	x		Left Door locked (S656)
x	x	x	**1**	x	x	x	x		Ext. X-RAY ON Display not attached
x	x	**1**	x	x	x	x	x		Tube Window OPEN Button operated
x	**1**	x	x	x	x	x	x		reserved
1	x	x	x	x	x	x	x		X-RAY Generator +24V/DC present

Offset = 04_{hex}: PIO#2 Port A (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Close Tube Window Open Tube Window
x	x	x	x	x	x	↑**1**	x		Clear alarm flags (L-H-L pulse)
x	x	x	x	x	**0** **1**	x	x		Enable External Beeper Disable External Beeper
x	x	x	x	**0** **1**	x	x	x		Run-LED OFF Run-LED ON
x	x	x	**0** **1**	x	x	x	x		Alarm-LED OFF Alarm-LED ON
x	x	**0** **1**	x	x	x	x	x		Busy-LED OFF Busy-LED ON
x	**0** **1**	x	x	x	x	x	x		Slit Changer set position #1 Slit Changer set position #2
0 **1**	x	x	x	x	x	x	x		AC-motor ON AC-motor OFF

Offset = 05_{hex}: PIO#2 Port B (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		12V/DC-Power Output OFF 12V/DC-Power Output ON
x	x	x	x	x	x	**0** **1**	x		NMI of timer #2 enabled NMI of timer #2 disabled
x	x	x	x	x	↓**0**	x	x		Beep Frequency (H-L-H pulses)
x	x	x	x	**0** **1**	x	x	x		Board-Interrupt-Request disabled Board-Interrupt-Request enabled
x	x	x	**0** **1**	x	x	x	x		+5V/DC pre-warning active low +5V/DC pre-warning active high
x	x	↑**1**	x	x	x	x	x		Watchdog trigger (L-H-L pulse)
x	↑**1**	x	x	x	x	x	x		Clear Page Select (L-H-L pulse)
↑**1**	x	x	x	x	x	x	x		Clear Page Offset (L-H-L pulse)

Offset = 06_{hex}: PIO#2 Port C (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	↓**0**		Rearm Board-Interrupt-Request (H-L-H pulse)
x	x	x	x	x	x	↓**0**	x		Load Prescaler & Timer #1 (H-L-H pulse)
x	x	x	x	x	**0** **1**	x	x		Timer #2 disabled Timer #2 enabled
x	x	x	x	**0** **1**	x	x	x		Timer #1 disabled Timer #1 enabled
x	x	x	**0** **1**	x	x	x	x		8-bit-Digital I/O #2 used as outputs 8-bit-Digital I/O #2 used as inputs
x	x	**0** **1**	x	x	x	x	x		8-bit-Digital I/O #3 used as outputs 8-bit-Digital I/O #3 used as inputs
x	**0** **1**	x	x	x	x	x	x		8-bit-Digital I/O #0 used as outputs 8-bit-Digital I/O #0 used as inputs
0 **1**	x	x	x	x	x	x	x		8-bit-Digital I/O #1 used as outputs 8-bit-Digital I/O #1 used as inputs

Offset = 08_{hex}: PIO#3 Port A (used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Slit Changer at position #1 Slit Changer at position #2
x	x	x	x	x	x	**1**	x		+12V/DC power supply present
x	x	x	x	x	**1**	x	x		-12V/DC power supply present
x	x	x	x	**1**	x	x	x		-5V/DC power supply present
x	x	x	**1**	x	x	x	x		+24V/DC power supply present
x	x	**1**	x	x	x	x	x		+80V/DC power supply (unregulated) present
x	**1**	x	x	x	x	x	x		24V/AC power supply present
1	x	x	x	x	x	x	x		100Hz interrupt request

Offset = 09_{hex}: PIO#3 Port B (used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**1**		Timer #1 running
x	x	x	x	x	x	**1**	x		Timer #2 running
x	x	x	x	x	**1**	x	x		+5V/DC pre-warning interrupt request
x	x	x	x	**1**	x	x	x		Light Barrier #1
x	x	x	**1**	x	x	x	x		Light Barrier #2
x	x	**1**	x	x	x	x	x		UART #1 interrupt request
x	**1**	x	x	x	x	x	x		UART #2 interrupt request
1	x	x	x	x	x	x	x		CAN-Bus interrupt request

Offset = $0A_{hex}$: PIO#3 Port C (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		+5V/DC pre-warning NMI enabled +5V/DC pre-warning NMI disabled
x	x	x	x	x	x	**0**	x		CAN Controller Mode
x	x	x	x	x	**0**	x	x		reserved
x	x	x	x	**0**	x	x	x		reserved
x	x	x	**0** **1**	x	x	x	x		Auto-Increment mode ON Auto-Increment mode OFF
x	x	**0** **1**	x	x	x	x	x		Watchdog enabled Watchdog disabled
x	**1**	x	x	x	x	x	x		reserved
1	x	x	x	x	x	x	x		reserved

Offset = $0C_{hex}$: PIO#4 Port A (used as userdefined Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Offset = $0D_{hex}$: PIO#4 Port B (used as userdefined Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Offset = $0E_{hex}$: PIO#4 Port C (used as userdefined Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Offset = 10_{hex}: PIO#5 Port A (used as userdefined Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Offset = 11_{hex}: PIO#5 Port B (used as userdefined Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Offset = 12_{hex}: PIO#5 Port C (used as userdefined Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x			
x	x	x	x	x	x		x		
x	x	x	x	x		x	x		
x	x	x	x		x	x	x		
x	x	x		x	x	x	x		
x	x		x	x	x	x	x		
x		x	x	x	x	x	x		
	x	x	x	x	x	x	x		

Detector Interface Boards

(Detector Interface C79298-A3220-B102)
Port = Board-Base-Adr. + Offset
Offset = $0C_{hex}$: PIO#1 Port A (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	**pt3**	**pt2**	**pt1**	**pt0**		Pile-up Time
x	x	x	**0** **1**	x	x	x	x		Counter #1 integral mode enabled Counter #1 integral mode disabled
x	x	**0** **1**	x	x	x	x	x		Counter #2 integral mode enabled Counter #2 integral mode disabled
x	**0** **1**	x	x	x	x	x	x		Top Level Discriminator disabled Top Level Discriminator enabled
0 **1**	x	x	x	x	x	x	x		Death Time = 1300 nsec Death Time = 600 nsec

Offset = $0D_{hex}$: PIO#1 Port B (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Counter #1 (low) enabled Counter #1 (low) disabled
x	x	x	x	x	x	**0** **1**	x		Counter #2 (low) enabled Counter #2 (low) disabled
x	x	x	x	x	**0** **1**	x	x		Counter #3 (low) enabled Counter #3 (low) disabled
x	x	x	x	↓**0**	x	x	x		Load Counter #1 (high) (H-L-H pulse)
x	x	x	↓**0**	x	x	x	x		Load Counter #2 (high) (H-L-H pulse)
x	x	↓**0**	x	x	x	x	x		Load Counter #3 (high) (H-L-H pulse)
x	↓**0**	x	x	x	x	x	x		Load Timer (high) (H-L-H pulse)
0 **1**	x	x	x	x	x	x	x		Timer disabled Timer enabled

Offset = $0E_{hex}$: PIO#1 Port C (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	**sel1**	**sel0**		Counter #1 source select
x	x	x	x	**sel1**	**sel0**	x	x		Counter #2 source select
x	x	x	**0** **1**	x	x	x	x		Repetition mode enabled Repetition mode disabled
x	x	↓**0**	x	x	x	x	x		Reset Counters (H-L-H pulse)
x	↓**0**	x	x	x	x	x	x		Reset FIFO (H-L-H pulse)
0 **1**	x	x	x	x	x	x	x		16Mhz Clock enabled 1Mhz Clock enabled

Offset = 10_{hex}: PIO#2 Port A (used as Output)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	**sh1**	**sh0**		Shaping time constant select
x	x	x	x	x	**0** **1**	x	x		Detector-High-Voltage range < 1300 V Detector-High-Voltage range ≥ 1300 V
x	x	x	x	**0** **1**	x	x	x		Source = Detector Pulses Source = Test Pulses
x	x	x	**0** **1**	x	x	x	x		Detector-High-Voltage ON Detector-High-Voltage OFF
x	x	↑**1**	x	x	x	x	x		Test pulses (L-H-L pulses)
x	**0** **1**	x	x	x	x	x	x		Pile-up rejection enabled Pile-up rejection disabled
0	x	x	x	x	x	x	x		reserved

Offset = 11_{hex}: PIO#2 Port B (used as Intput)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0**		FIFO empty
x	x	x	x	x	x	**0**	x		FIFO half full
x	x	x	x	x	**0**	x	x		FIFO full
x	x	x	x	**1**	x	x	x		Counter running
x	x	x	**0**	x	x	x	x		Counter #1 overflow
x	x	**0**	x	x	x	x	x		Counter #2 overflow
x	**0**	x	x	x	x	x	x		Counter #3 overflow
0	x	x	x	x	x	x	x		reserved

Offset = 12_{hex}: PIO#2 Port C (D0 ... D3 used as Output, D4 ... D7 used as Input)

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Board-Interrupt disabled Board-Interrupt enabled
x	x	x	x	x	x	**0**	x		Rearm Interrupt (H-L-H pulse)
x	x	x	x	**ls1**	**ls0**	x	x		Line shift efficiency select
x	x	x	**0**	x	x	x	x		Detector-High-Voltage o.k.
x	x	**1**	x	x	x	x	x		Detector-High-Voltage fault
x	**0**	x	x	x	x	x	x		reserved
0	x	x	x	x	x	x	x		reserved

2-Axis Indexer Boards

(2-Axis Indexer 419-306500)
Port = Board-Base-Adr. + Offset
Offset = 02_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0**		reserved
x	x	x	x	x	x	**0**	x		reserved
x	x	x	x	x	**0**	x	x		reserved
x	x	x	x	**1**	x	x	x		reserved
x	x	x	**0**	x	x	x	x		reserved
x	x	**0**	x	x	x	x	x		reserved
x	**0**	x	x	x	x	x	x		Chipset status flag „Interrupt request“
1	x	x	x	x	x	x	x		Chipset status flag „Host ready“

Offset = 03_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		X-Axis step output active low X-Axis step output active high
x	x	x	x	x	x	**0** **1**	x		X-Axis direction output active low X-Axis direction output active high
x	x	x	x	x	**0** **1**	x	x		Y-Axis step output active low Y-Axis step output active high
x	x	x	x	**0** **1**	x	x	x		Y-Axis direction output active low Y-Axis direction output active high
x	x	x	**0**	x	x	x	x		reserved
x	x	**0**	x	x	x	x	x		reserved
x	**0**	x	x	x	x	x	x		reserved
0	x	x	x	x	x	x	x		reserved

Offset = 04_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		X-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		X-Axis motor type
x	**0** **1**	x	x	x	x	x	x		X-Axis degree mark selected X- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		X-Driver disabled X-Driver enabled

Offset = 05_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		X-Axis encoder direction = normal X-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		X-Axis motor direction = normal X-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		X-Axis limit switch direction = normal X-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		X-Driver fullstep mode disabled X-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		X-Driver standby mode disabled X-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		X-Driver forceon time constant = 0.5 usec X-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		X-Axis home switch selected X- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		X-Axis home switch active low X-Axis home switch active high

Offset = 06_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		Y-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		Y-Axis motor type
x	**0** **1**	x	x	x	x	x	x		Y-Axis degree mark selected Y- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		Y-Driver disabled Y-Driver enabled

Offset = 07_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Y-Axis encoder direction = normal Y-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		Y-Axis motor direction = normal Y-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		Y-Axis limit switch direction = normal Y-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		Y-Driver fullstep mode disabled Y-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		Y-Driver standby mode disabled Y-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		Y-Driver forceon time constant = 0.5 usec Y-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		Y-Axis home switch selected Y- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		Y-Axis home switch active low Y-Axis home switch active high

4-Axis Indexer Boards

(4-Axis Indexer 419-306600)
Port = Board-Base-Adr. + Offset
Offset = 02_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0**		reserved
x	x	x	x	x	x	**0**	x		reserved
x	x	x	x	x	**0**	x	x		reserved
x	x	x	x	**1**	x	x	x		reserved
x	x	x	**0**	x	x	x	x		reserved
x	x	**0**	x	x	x	x	x		reserved
x	**0**	x	x	x	x	x	x		Chipset status flag „Interrupt request“
1	x	x	x	x	x	x	x		Chipset status flag „Host ready“

Offset = 03_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0**		reserved
x	x	x	x	x	x	**0**	x		reserved
x	x	x	x	x	**0**	x	x		reserved
x	x	x	x	**0**	x	x	x		reserved
x	x	x	**0** **1**	x	x	x	x		X-Driver low-current mode disabled X-Driver low-current mode enabled
x	x	**0** **1**	x	x	x	x	x		Y-Driver low-current mode disabled Y-Driver low-current mode enabled
x	**0** **1**	x	x	x	x	x	x		Z-Driver low-current mode disabled Z-Driver low-current mode enabled
0 **1**	x	x	x	x	x	x	x		T-Driver low-current mode disabled T-Driver low-current mode enabled

Offset = 04_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		X-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		X-Axis motor type
x	**0** **1**	x	x	x	x	x	x		X-Axis degree mark selected X- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		X-Driver disabled X-Driver enabled

Offset = 05_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		X-Axis encoder direction = normal X-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		X-Axis motor direction = normal X-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		X-Axis limit switch direction = normal X-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		X-Driver fullstep mode disabled X-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		X-Driver standby mode disabled X-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		X-Driver forceon time constant = 0.5 usec X-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		X-Axis home switch selected X- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		X-Axis home switch active low X-Axis home switch active high

Offset = 06_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		Y-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		Y-Axis motor type
x	**0** **1**	x	x	x	x	x	x		Y-Axis degree mark selected Y- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		Y-Driver disabled Y-Driver enabled

Offset = 07_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Y-Axis encoder direction = normal Y-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		Y-Axis motor direction = normal Y-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		Y-Axis limit switch direction = normal Y-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		Y-Driver fullstep mode disabled Y-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		Y-Driver standby mode disabled Y-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		Y-Driver forceon time constant = 0.5 usec Y-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		Y-Axis home switch selected Y- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		Y-Axis home switch active low Y-Axis home switch active high

Offset = 08_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		Z-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		Z-Axis motor type
x	**0** **1**	x	x	x	x	x	x		Z-Axis degree mark selected Z- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		Z-Driver disabled Z-Driver enabled

Offset = 09_{hex}

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		Z-Axis encoder direction = normal Z-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		Z-Axis motor direction = normal Z-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		Z-Axis limit switch direction = normal Z-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		Z-Driver fullstep mode disabled Z-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		Z-Driver standby mode disabled Z-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		Z-Driver forceon time constant = 0.5 usec Z-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		Z-Axis home switch selected Z- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		Z-Axis home switch active low Z-Axis home switch active high

Offset = $0A_{hex}$

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	**ms2**	**ms1**	**ms0**		T-Driver microsteps per step
x	x	**mt2**	**mt1**	**mt0**	x	x	x		T-Axis motor type
x	**0** **1**	x	x	x	x	x	x		T-Axis degree mark selected T- Axis incremental encoder selected
0 **1**	x	x	x	x	x	x	x		T-Driver disabled T-Driver enabled

Offset = $0B_{hex}$

D7	D6	D5	D4	D3	D2	D1	D0		Meaning
x	x	x	x	x	x	x	**0** **1**		T-Axis encoder direction = normal T-Axis encoder direction = reversed
x	x	x	x	x	x	**0** **1**	x		T-Axis motor direction = normal T-Axis motor direction = reversed
x	x	x	x	x	**0** **1**	x	x		T-Axis limit switch direction = normal T-Axis limit switch direction = reversed
x	x	x	x	**0** **1**	x	x	x		T-Driver fullstep mode disabled T-Driver fullstep mode enabled
x	x	x	**0** **1**	x	x	x	x		T-Driver standby mode disabled T-Driver standby mode enabled
x	x	**0** **1**	x	x	x	x	x		T-Driver forceon time constant = 0.5 usec T-Driver forceon time constant = 2 usec
x	**0** **1**	x	x	x	x	x	x		T-Axis home switch selected T- Axis enc index mark/degree mark selected
0 **1**	x	x	x	x	x	x	x		T-Axis home switch active low T-Axis home switch active high

Alignment of the diffractometer

The alignment is necessary to ensure best performance of the diffractometer system. In the first step the zero positions of the θ- and 2θ-angular scale are aligned in respect to the center of the goniometer. In the second step the translation positions of all slits are aligned in respect to the center of the goniometer. In further steps other optical components which might be mounted to your system are aligned. The alignment of these optical components are described in separate sections.

All alignment steps are done step by step with X-ray radiation on. This method ensures that the alignment can be done under full X-ray protection conditions.

Before shipped, each diffractometer system was carefully put into operation and was completely aligned. Therefore, it is not necessary to change the settings of the alignment screws on any optical component if the control values obtained during the alignment steps are within the tolerances. The settings of the alignment screws are altered only if this is required for corrections.

During the putting into operation the settings of the different electronic boards in the controller are verified for your system. The appropriate values are written into the DEVICE.INI file which is stored on the floppy disk. The floppy also carries the operating system and the controller software for the system. It is not necessary to change the DEVICE.INI file using an editor. The configuration program as a part of the users software DIFFRAC^{plus} is used to do safe changes on the settings.

The maximum count rate should be between 10^5 and $5 \cdot 10^5$ cps (counts per second) in order to ensure the statistic accuracy of the measured values. Use another generator setting or absorbers in the beam to get an appropriate count rate.

During alignment steps which do not have the glass slit in place it must be guaranteed that the sample stage does not shadow the beam. E.g. the rotation sample stage should be turned to 90° although if it is not marked specifically.

For doing all the alignment work you are supported by the ADJUST program module of DIFFRAC^{plus}. It is recommended to be familiar with the usage of ADJUST or to refer to section ADJUST of the DIFFRAC^{plus} software manual.

Before you start with the alignment of the diffractometer system the measurement electronics should be set up.

A bell-shaped curve results if beam aperture and detector aperture are approximately equal. The beam direction is identical to the maximum intensity and can be determined using the usual peak value detecting methods. In a different arrangement, the correlation between control angle and intensity shows more squared or plateau characteristics without specific maximum. The beam direction in this case is then the edge mean value at 80 % of the maximum value.

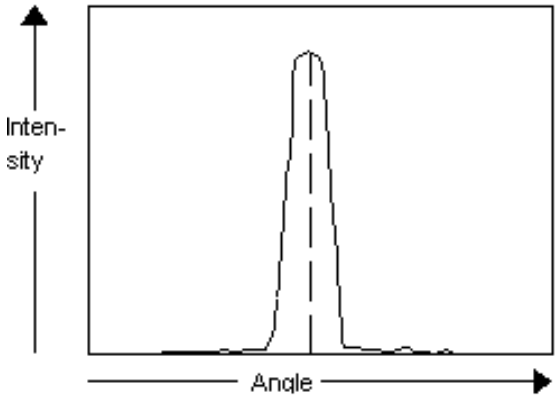


Fig. 3-36: Beam direction according to the maximum



Fig. 3-37: Beam direction according to mean value of the 80 % edges

If in doubt, the mean value method should be used. Measurements are executed under computer control.

All measurements should start at the small angular values in order to eliminate the back slash influence when changing the direction of movement.

The alignment is done without sample rotation and with the sample changer initialized.

Alignment of the fixed slit assembly

Zero point definition of the θ scale

Constellation

Fixed aperture slit	6 mm
Sample	Glass slit
Fixed anti-scatter slit	Open
Kβ filter	if required
Receiving slit	6 mm + absorber (according to the used wavelength)
θ without correction	$-1° < \theta < +1°$
2θ without correction	0°

Measurement

Execute a rocking curve measurement or tube alone scan $-1° < \theta < +1°$, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position θ_Z of the intensity maximum.

Consequence

The alignment of the θ scale is o.k. if the zero angle θ_Z lies within the range $-1° < \theta_Z < +1°$; if not, check sample stage and its installation.

Result

The exact zero angle of the beam passing through the center of the goniometer on the uncorrected θ scale is θ_Z. The difference between the actual Z_I angular position (reference angle) and θ_Z is used to calculate the new Z_I position of the θ angular scale. Repeat the measurement to verify the result. This alignment step is done if $|\theta_Z| < 0.004°$.

Typical Z_I values for fixed or variable slit assemblies on incident and diffracted beam side are given below. These values may differ for specific set-ups and other X-ray optical components mounted.

Theta/Theta instruments:	Tube: 35.8°±0.8°,	2Theta: 30.5°±0.8°
Theta/2Theta vertical:	Theta: 30.8°±0.8°,	2Theta: 60.8°±0.8°
Theta/2Theta horizontal:	Theta: 0.8°±0.8°,	2Theta: 30.8°±0.8°

The determination of θ_Z and the correction of the reference angle of the θ scale is done using the menu item “Determine ZI Value” in ADJUST program of DIFFRAC^{plus}. If required, the correction is exported to the D8 instrument controller (accept by press the OK button). Also the configuration file on the hard disk of the control computer is updated.

Zero point definition of the 2θ scale

Constellation

Fixed aperture slit	6 mm
Sample	Glass slit
Fixed anti-scatter slit	6 mm + absorber (if required, according to the used wave-length)
Kβ filter	when required
Receiving slit	0.1 mm
θ	0°, according to the above alignment step
2θ without correction	–1° < 2θ < +1°

Measurement

Execute a detector scan measurement –1°< 2θ < +1°, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC*plus* ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum.

Consequences

The alignment is o.k. if the zero angle $2\theta_Z$ lies within the range $-1.0° < 2\theta_Z < +1.0°$, if not, check sample stage and its installation.

Both above mentioned alignment steps must be repeated if the sample stage mounting is changed.

Result

The exact zero angle of the beam passing the center of the goniometer on the uncorrected 2θ scale is $2\theta_Z$. The difference between the actual Z_I angular position (reference angle) and $2\theta_Z$ is used to calculate the new Z_I position for 2θ. Repeat the measurement to verify the result. This alignment step is done if $|2\theta_Z| < 0.004°$.

The determination of $2\theta_Z$ and the correction of the reference angle of the 2θ scale is done using the menu item “Determine ZI Value” in ADJUST program of DIFFRAC*plus*. If required, the correction is exported to the D8 instrument controller.

Centering the anti-scatter slit to the zero beam

Constellation

Fixed aperture slit	6 mm
Sample	Glass slit
Fixed anti-scatter slit	0.1 mm
Kβ filter	If required
Receiving slit	6 mm + absorber (according to the used wavelength)
θ	0°
2θ	–1° < 2θ < +1°

Measurement
Execute a detector scan measurement –1°< 2θ < +1°, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum.

Consequences
The alignment is o.k. if $|2\theta_{max}| < 0.01°$.

If this condition is not fulfilled, loose the two fixing screws of the diffracted beam assembly (#2 shown on fig. 3-38). To access to the screws remove the cover of the slit assembly. The second fixing screw is covered by the assembly cover.

If $2\theta_{max} \leq -0.01°$, turn the alignment screw #1 (fig. 3-38) counter clockwise and secure using the screw opposite to #1.

If $2\theta_{max} \geq +0.01°$, turn the alignment screw opposite to #1 (Fig. 3-38) counter clockwise and secure using screw #1.

Repeat the measurement to verify the result. Keep in mind in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max}| < 0.01°$ is fulfilled. Fasten the fixing screw before going on with the alignment procedure.

Result
The anti-scatter slit is aligned to the zero beam and therefore in respect to the center of the goniometer.

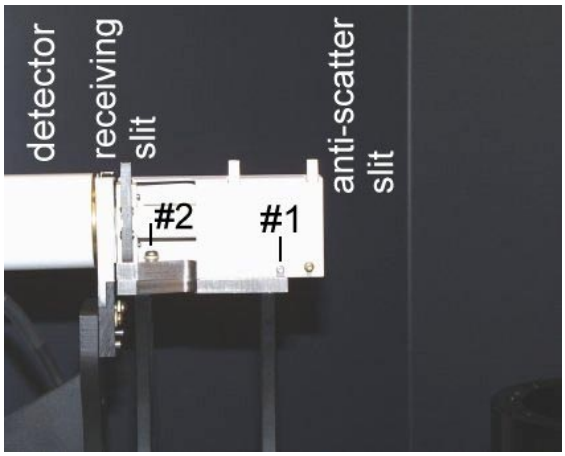


Fig. 3-38: Diffracted beam fixed slit assembly

Centering the aperture slit to the zero beam

Constellation

Fixed aperture slit	0.1 mm
Sample	None
Fixed anti-scatter slit	Open
Kβ filter	if required
Receiving slit	0.1 mm + absorber (according to the used wavelength)
θ	0°
2θ	–2° < 2θ < +2°

Measurement
Execute a detector scan measurement –2°< 2θ < +2° (or smaller), step size 0.01° (or smaller), 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum or determine the mean value of the 80 % edge angles.

Consequences
The calibration is o.k. if $|2\theta_{max}| < 0.005°$.

If this condition is not fulfilled then loose the screw which fixes the incident beam fixed aperture slit assembly (#3, fig. 3-39). The screw is accessible from the bottom of the assembly.

If $2\theta_{max} \geq +0.005°$, turn the alignment screw to #1 (fig. 3-39) counter clockwise and secure using screw opposite to #1.

If $2\theta_{max} \leq -0.005°$, turn the alignment screw opposite to #1 counter clockwise and secure using #1.

Repeat the measurement to verify the result. Keep in mind the in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max}| < 0.005°$ is fulfilled. Fasten the fixing screw before going on with the alignment procedure.

Result
The aperture slit is aligned to the zero beam and therefore in respect to the center of the goniometer.

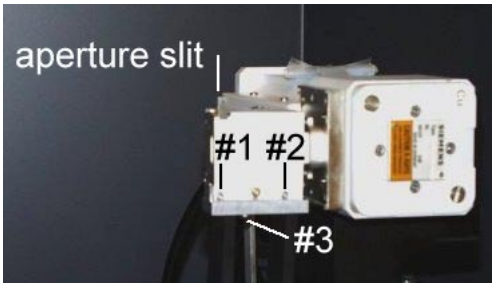


Fig. 3-39: Fixed aperture slit assembly

Centering the radiation outlet flange

Constellation

Fixed aperture slit	Open
Sample	None
Fixed anti-scatter slit	3°
Kβ filter	if required
Receiving slit	0.1 mm + absorber
θ	0°
2θ	–4° < 2θ < +4°

Measurement
Execute a detector scan measurement –4°< 2θ < +4°, step size 0.02°, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular positions $2\theta_1$ and $2\theta_2$ of the left and right edges of the obtained intensity plateau.

Consequences
The alignment is o.k. if both $|2\theta_{1,2}| \geq 3.5°$.

If this condition is not fulfilled then loose the screw which fixes the incident beam fixed aperture slit assembly (#3, fig. 3-39). The screw is accessible from the bottom of the assembly.

If the high angle edge is less than 3.5° and positive, turn the alignment screw opposite to #2 (fig. 3-39) counter clockwise and secure using #2.

If the high angle edge is bigger than 3.5°, turn the alignment screw #2 (fig. 3-39) counter clockwise and secure using the counter screw opposite to #2.

Repeat the measurement to verify the result. Keep in mind the in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{1,2}| \geq 3.5°$ is fulfilled. Fasten the fixing screw before going on with the alignment procedure.

In dependence of the used measurement circle diameter the intensity plateau might by wider. The main goal of this alignment step is to have a primary beam plateau which is symmetric around the 0° incident beam e.g. $|2\theta_1| \sim |2\theta_2|$.

Result
The radiation outlet flange defines a beam having an aperture angle of 3°.

Remark
After the alignment is finished it is recommended to enter the DIFFRAC^{plus} configuration program and save the actual configuration with the new Z_l to hard disk (save as menu item). Use a file name which makes later on reference easy.

Alignment of the variable slit assembly

Zero definition of the θ scale

Constellation

Variable Aperture slit Fixed	3° 6 mm
Sample	Glass slit
Fixed Anti-scatter slit Variable	Open 3°
Kβ filter	If required
Receiving slit	6 mm + absorber (according to the used wavelength)
θ without correction	–1° < θ < +1°
2θ without correction	0°

Measurement

Execute a rocking curve measurement or tube alone scan –1°< θ < +1°, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position θ_Z of the intensity maximum.

Consequence

The calibration is o.k. if the zero angle θ_z is within the range –1° < θ_Z < +1°; if not check sample stage and its installation.

Result

The exact zero angle of the beam passing through the center of the goniometer on the uncorrected θ scale is θ_Z. The difference between the actual Z_I angular position (reference angle) and θ_Z is used to calculate the new Z_I position of the θ angular scale. Repeat the measurement to verify the result. . This alignment step is done if $|\theta_Z| < 0.004°$.

The determination of θ_Z and the correction of the reference angle of the θ scale is done using the menu item “Determine ZI Value” in ADJUST program of DIFFRAC^{plus}. If required, the correction is exported to the D8 instrument controller.

Zero definition of the 2θ scale

Constellation

Variable Aperture slit Fixed	3° 6 mm + absorber
Sample	Glass slit
Fixed Anti-scatter slit Variable	open 3°
Kβ filter	If required
Detector diaphragm	0.1 mm
θ	0°
2θ without correction	–1° < 2θ < +1°

Measurement

Execute a detector scan measurement –1°< 2θ < +1°, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC*plus* ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum.

Consequence

The alignment is o.k. if the zero angle $2\theta_Z$ lies within the range $-1.0° < 2\theta_Z < +1.0°$, if not, check sample stage and its installation.

Both above mentioned alignment steps must be repeated if the sample stage mounting was changed.

Result

The exact zero angle of the beam passing the center of the goniometer on the uncorrected 2θ scale is $2\theta_Z$. The difference between the actual Z_I angular position (reference angle) and $2\theta_Z$ is used to calculate the new Z_I position for 2θ. Repeat the measurement to verify the result. This alignment step is done if $|2\theta_Z| < 0.004°$.

The determination of $2\theta_Z$ and the correction of the reference angle of the 2θ scale is done using the menu item “Determine ZI Value” in ADJUST program of DIFFRAC*plus*. If required, the correction is exported to the D8 instrument controller.

Centering the variable anti-scatter slit to the zero beam

Constellation

Variable aperture slit Fixed	3° 6 mm
Sample	Glass slit
Fixed Anti-scatter slit Variable	open 0.1°
Kβ filter	If required
Receiving slit	6 mm + absorber (according to the used wavelength)
θ	0°
2θ	–1° < 2θ < +1°

Measurement

Execute a detector scan measurement –1°< 2θ < +1°, step size 0.01° or smaller, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum.

Consequences

The alignment is o.k. if $|2\theta_{max}| < 0.01°$.

If $2\theta_{max} \leq -0.01°$, turn the alignment screw opposite to #1 (fig. 3-40) counter clockwise and secure using screw #1 (fig. 3-40).

If $2\theta_{max} \geq +0.01°$, turn the alignment screw #1 (fig. 3-40) counter clockwise and secure using the screw opposite to #1 (fig. 3-40).

Repeat the measurement to verify the result. Keep in mind the in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max}| < 0.01°$ is fulfilled.

Result

The variable anti-scatter slit is aligned to the zero beam and therefore in respect to the center of the goniometer.

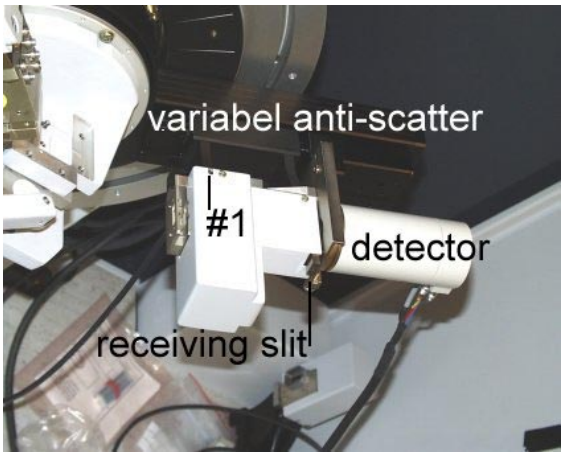


Fig. 3-40: Diffracted beam variable slit assembly

Centering the variable aperture slit to the zero beam

Constellation

Variable aperture slit Fixed	0.1° 6 mm
Sample	None
Fixed Anti-scatter slit Variable	Open 3°
Kβ filter	If required
Receiving slit	0.1 mm
θ	0°
2θ	–2° < 2θ < +2°

Measurement

Execute a detector scan measurement –2°< 2θ < +2°, step size 0.01°, 0.1sec/step, using DIFFRAC*plus* ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum or determine the mean value of the 80 % edge angles.

Consequences

The alignment is o.k. if $|2\theta_{max}| < 0.01°$.

If $2\theta_{max} \geq +0.01°$, turn the alignment screw #1 (fig. 3-41) counter clockwise and secure using screw opposite to #1 (fig. 3-41).

If $2\theta_{max} \leq -0.01°$, turn the alignment screw opposite to #1 (fig. 3-41) counter clockwise and secure using screw #1.

Repeat the measurement to verify the result. Keep in mind the in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max}| < 0.01°$ is fulfilled.

Result

The variable aperture slit is aligned to the zero beam and therefore in respect to the center of the goniometer.

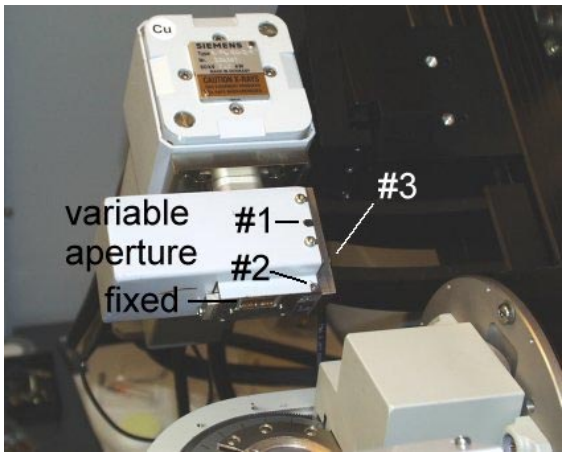


Fig. 3-41: Variable aperture slit assembly

Centering the fixed aperture slit to the zero beam

Constellation

Variable Aperture slit Fixed	3° 0.1 mm
Sample	None
Fixed Anti-scatter slit Variable	open 3°
Kβ filter	if required
Receiving slit	0.1mm + absorber (according to the used wavelength)
θ	0°
2θ	–2° < 2θ < +2°

Measurement
Execute a detector scan measurement –2°< 2θ < +2°, step size 0.01°, 0.1sec/step, using DIFFRAC^{plus} ADJUST. Determine the angular position $2\theta_{max}$ of the intensity maximum or determine the mean value of the 80 % edge angles.

Consequences
The alignment is o.k. if $|2\theta_{max}| < 0.01°$.

If this condition is not fulfilled then loose the screw which fixes the incident beam slit assembly. The screw is accessible from the bottom of the assembly (#3, fig. 3-41).

If $2\theta_{max} \geq +0.01°$, turn the alignment screw #2 (fig. 3-41) counter clockwise and secure using the screw opposite to #2 (fig. 3-41).

If $2\theta_{max} \leq -0.01°$, turn the alignment screw opposite to #2 (fig. 3-41) counter clockwise and secure using screw #2.

Repeat the measurement to verify the result. Keep in mind the in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max}| < 0.01°$ is fulfilled. Fasten the fixing screw before going on with the alignment procedure.

Result
The fixed aperture slit is aligned to the zero beam and therefore in respect to the center of the goniometer.

Aligning the receiving slit changer

For the basic alignment, it is assumed that the receiving slit changer is open or has not been inserted.

The receiving slit changer is aligned after the basic alignment. The slit changer is aligned to the zero beam in such a way that the zero angles of the fixed receiving slit mounted and the receiving slit changer in position are the same.

Constellation
The constellation is like the *Zero definition of the 2θ scale* (see above)**.**

Measurement
Execute two detector scans $-1° < 2\theta < +1°$ (or smaller), step size 0.01° (or smaller), 0.1sec/step, the first one with 0.1mm fixed slit mounted, the second one with removed fixed slit and slit changer in position. For each scan determine the angular position $2\theta_{max,f}$ (fixed slit) and $2\theta_{max,c}$ (slit changer) of the obtained intensity maximum.

Consequence
The alignment is o.k. if $|2\theta_{max,f} - 2\theta_{max,c}| < 0.005°$.

If the condition is not fulfilled, then remove the cover of the receiving slit changer and loose the three fixing screws (#2 shown on fig. 3-42).

If $2\theta_{max,f} - 2\theta_{max,c} \geq +0.005°$, turn the alignment screw to #1 (fig. 3-42) counter clockwise and secure using the screw opposite to #1.

If $2\theta_{max,f} - 2\theta_{max,c} \leq -0.005°$, turn the alignment screw opposite to #1 (fig. 3-42) counter clockwise and secure using screw #1.

Repeat the measurement to verify the result. Keep in mind in which direction you have turned the screw. Remember, the screws may show a back slash effect. This step of alignment is done if $|2\theta_{max,f} - 2\theta_{max,c}| < 0.005°$ is fulfilled. Don't forget to fasten the fixing screw.

Result
The angular values of plug-in slit and receiving slit changer are identical and both can be used alternatively.

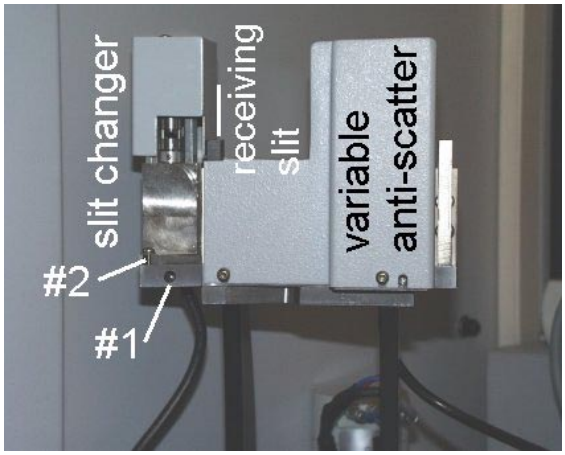


Fig. 3-42: Variable slit assembly with receiving slit changer

Aligning the Parameters of the Measurement Electronics

Before you can start to work or even to align your diffractometer system the parameters of the measuring electronics must be set respectively aligned. These parameters are:

1. the pulse shape
2. the amplification gain of the main amplifier
3. the detector high-voltage
4. the lower level of the discriminator
5. the width of the discriminator window.

The parameters 2 - 5 have to be aligned under X-ray radiation. They depend on the radiation you use and they depend on the detector type you use. The pulse shape parameter is defined in the configuration file (for details see section [CHANNELx] on page 3-84.

The alignment is done using the interactive measurement module of DIFFRAC^{plus} ADJUST. After the alignment is finished the parameters are stored in the configuration file on the hard disk of the computer on which DIFFRAC^{plus} runs. Furthermore the parameters are stored in the initialization file of the control electronics.

1. For aligning a scintillation counter or a proportional counter the counter has to be mounted directly behind the detector slit. Remove any monochromator if mounted. Remove all slits, absorbers or Kß-filters out of the beam path. Mount the standard Quartz sample which is shipped with every powder diffractometer system.
2. Start ADJUST and enter the menu *Diffractometer -> Detector settings*. Enter an amplification gain (e.g. 120 at shaping=2) to start the alignment. Enter 1.5 for the lower level of the discriminator and a window width of 0.1 (values in V, Fig. 3-43). The entered values will ensure that the intensity maximum in the energy distribution of the detector system will occur around 1,5 V. This is well above the electronical background. Press OK to close the menu.

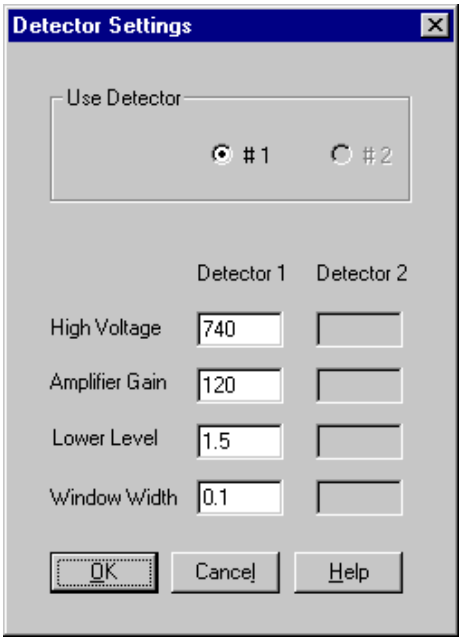


Fig. 3-43: Detector Settings Menu of DIFFRAC^{plus} ADJUST

3. Select the scan type HV-scan from the list, enter 600 V and 1000 V (scintillation counters, 1000 V to 1800 V for proportional counters) for start and stop values of the scan and 40 kV and 40 mA for the generator (Cu long fine focus tube, 2.2 kW).

   The values for the generator depend on the tube you use. Please enter values which you will typically use later on during the measurements. Next, the nominal Θ and 2Θ values for the 100% reflection of Quartz for the used wavelength must be entered in the requested column (tab. 3-8). In case you use a Θ/Θ instrument you have to enter the Θ value in the requested value field for 2Θ and for the tube.

   Tab. 3-8: Nominal Θ– and 2Θ -values for the 100% reflection of Quartz

Radiation	θ	**2θ**
Cr Kα	20.023°	40.046°
Fe Kα	16.879°	33.657°
Co Kα	15.517°	31.033°
Cu Kα	13.319°	26.638°
Mo Kα	6.089°	12.177°

4. Execute the measurement. The obtained plot should look similar to Fig. 3-44. Move the cursor to the position where the intensity is halve of that of the plateau. Double-click to mark this position and enter *File -> Update Configuration*. The selected high-voltage is stored into the configuration file.

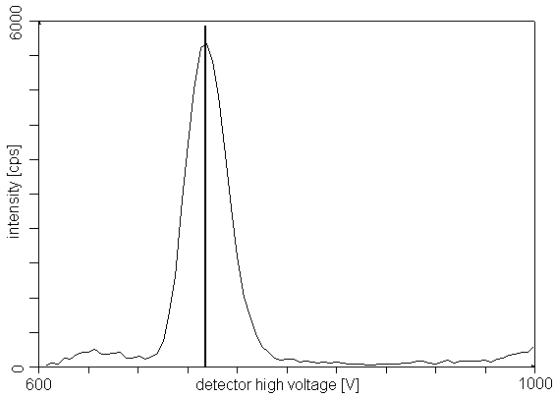


Fig. 3-44: High-voltage measurement using Cu radiation at 40 kV and 35 mA

Fig. 3-44 depicts a high-voltage measurement executed at 40 kV and 35 mA, amplification 120, Shape=2, lower discriminator level 1.5 V and discriminator width 0.1 V. 1 mm detector slits and aperture slits have been mounted in the beam path, as well as a primary soller slit and a secondary 2° soller slit. A high-voltage of 732 V has been configured.

The determined high-voltage depends much on the characteristic of the individual detector but it should be between 700 V and 1000 V for a scintillation counter and between 1400 V and 1700 V for a proportional counter.

The vertical line in Fig. 3-44 indicates where the appropriate high-voltage is to be defined.

If the high-voltage is smaller than 700°V (scintillation counter) the amplification is to strong.

Reduce the amplification (step 2) and repeat the procedure.

If the high-voltage is bigger than 1000°V the amplification is to low. Increase the amplification (step 2) and repeat the procedure.

If the pulse shape parameter has been set to 3, the defined high-voltage will be different in comparison to one with shape=2. Fig. 3-45 shows an example.

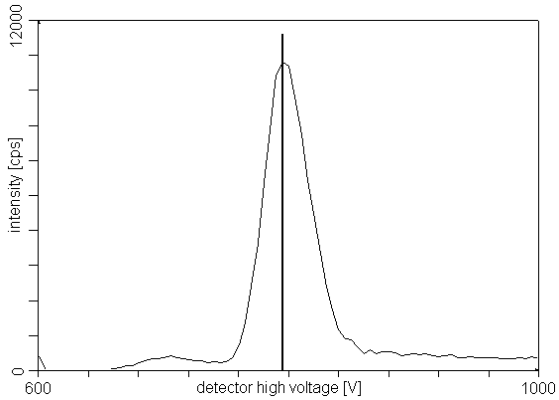


Fig. 3-45: High-voltage measurement using Cu radiation at 35 kV and 40 mA

Fig. 3-45 depicts a high-voltage measurement using Cu radiation at 35 kV and 40 mA, amplification 80, Shape=3, lower discriminator limit 1.5 V and discriminator width 0.1 V. A 2 mm aperture slit and a 1 mm detector slit have been mounted in the beam path as well as the primary and the secondary 2° soller slit.

If you change the type of radiation, the high-voltage will also be different. Fig. 3-46 shows an examples using a Cr radiation. The secondary soller slit has been removed for these measurement, because Cr radiation is much more absorbed in air than Cu radiation.

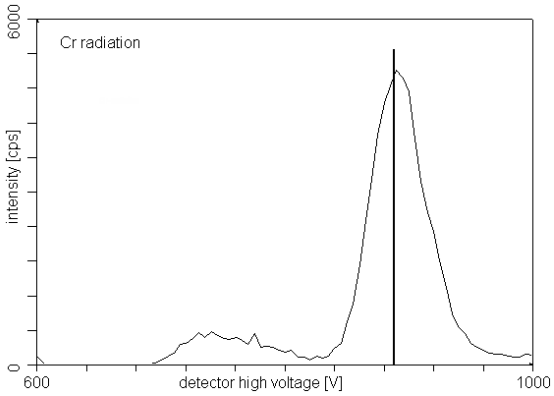


Fig. 3-46: High-voltage measurement using Cr radiation at 35 kV and 45 mA

Fig. 3-46 shows a high-voltage measurement using Cr radiation at 35 kV and 45 mA, amplification 80, Shape=2, lower discriminator level 1.5 V and discriminator width 0.1 V. A 2 mm detector slit and a 0.6 mm aperture slit have been mounted in the beam path, as well as a primary 2° soller slit.

This section is finished if you have defined a high-voltage and if you have updated the configuration.

5. Change to the scan type PHA scan, enter 0.2 V and 4 V for start and stop values and execute the measurement. The obtained plot should look similar to that shown in Fig. 3-47. A clear intensity maximum around 1,5 V indicates, that the alignment of the discriminator window can be executed successfully. Move the cursor to the left of the peak, close to the peak but in the background, and press the left mouse button. That defines the lower level of the discriminator. Hold the button pressed and move to the right of the maximum. Release the mouse button and a red line will indicate the discriminator window you have chosen. Enter *File -> Update Configuration* to store the values in the configuration file.

   In the example shown in Fig. 3-47 a lower level of 0.75 V and a width of 1.6 V have been configured.

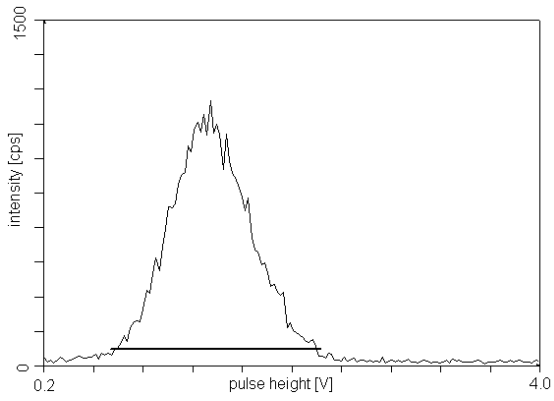


Fig. 3-47: Pulse height analysis scan using Cu radiation at 40 kV and 35 mA

Fig. 3-47 shows a pulse height analysis scan using Cu radiation at 40 kV und 35 mA generator power, amplification 120 and Shape=2. 1 mm detector slits and aperture slits have been mounted in the beam path as well as the primary and the secondary 2° soller slit. The detector high-voltage was 732 V.

The pulse height distribution using Cr radiation is very similar to the one above. Fig. 3-48 shows such an example. The measured intensity is smaller because of the higher absorption of Cr radiation in comparison to that of Cu radiation. At a level that is a little bit above 0.2 V in the pulse height distribution the decreasing part of the electronic background is visible. In the example shown in Fig. 3-48 a lower level of 0.87 V and a width of 1.4 V have been configured.

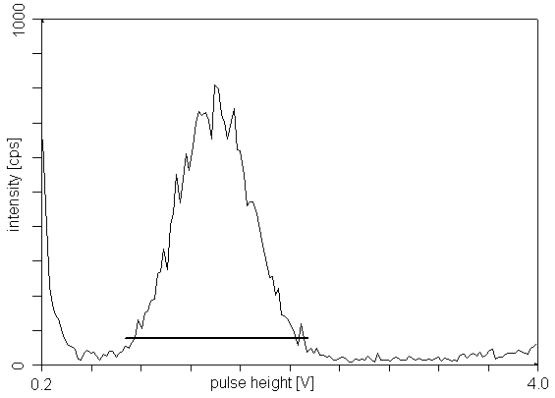


Fig. 3-48: Pulse height analysis scan using Cr radiation at 35 kV and 40 mA

Fig. 3-48 shows a pulse height analysis scan using Cr radiation at 35 kV and 40 mA generator power, amplification 80 and Shape=2. 2 mm detector slits and 0.6 mm aperture slits have been mounted in the beam path as well as the primary 2° soller slit. The detector high-voltage amounts to 890 V.

4 KRISTALLOFLEX 760 X-ray Generator K760-A21

For Diffraction Tubes and Side-Window Spectrometer Tubes (Order No. C79249-A3054-A21)

Table of Contents

4 KRISTALLOFLEX 760 X-ray Generator K760-A21 4-1
Description 4-1
Application 4-1
Control 4-1
Design 4-2
Method of Operation 4-4
High-Voltage Generation and Regulation 4-4
Regulation of Tube Current 4-4
Protection Circuits 4-4
Radiation Protection 4-5
Technical Data 4-6
Installation 4-7
Set-up 4-7
Mains Connection 4-7
Terminal Block X3 4-7
Connection of High-Voltage Cable 4-7
External Warning Lamps (in Connection with a Window Control) 4-10
Commissioning and Start-up 4-10
Operation 4-11
Local Operation and Display 4-11
Setpoints for High-Voltage and Tube Current 4-13

Maximum Values for High-Voltage, Tube Current and Power 4-13
Baud Rate 4-13
Explanation of Status and Diagnostic Information 4-14
Start-up Routine for New X-ray Tubes 4-14
Generator Stand-by 4-15
Interface between X-ray Generator and External Computer 4-15
Hardware 4-15
Data Transmission 4-15
Data transmission from external computer to X-ray generator 4-16
Data transmission from X-ray generator to external computer 4-16
Description of interface commands RC to X-ray generator 4-17
Maintenance and Repair 4-20
Routine Maintenance 4-20
Troubleshooting 4-20
Spare Parts List 4-25

4 KRISTALLOFLEX 760 X-ray Generator K760-A21

Description

Application

The KRISTALLOFLEX 760 X-ray generator is a highly-stable device for supplying diffraction tubes and side-window spectrometer tubes (high voltage applied to cathode).

Control

The X-ray generator has a processor control. The green “Ready” LED on the front panel signals that the X-ray generator is ready for operation. This readiness is established if the key switch is in the “I” or “II” position. The key switch should be positioned to “0” during extended pauses in operation.

Reference values can be set using a local control panel, and status and diagnostic information can be read.

The generator can be connected to a computer via a serial V.24 interface.

The X-ray generator has an operating-hours counter.



Fig. 4-1: X-ray generator KRISTALLOFLEX® K760-A21

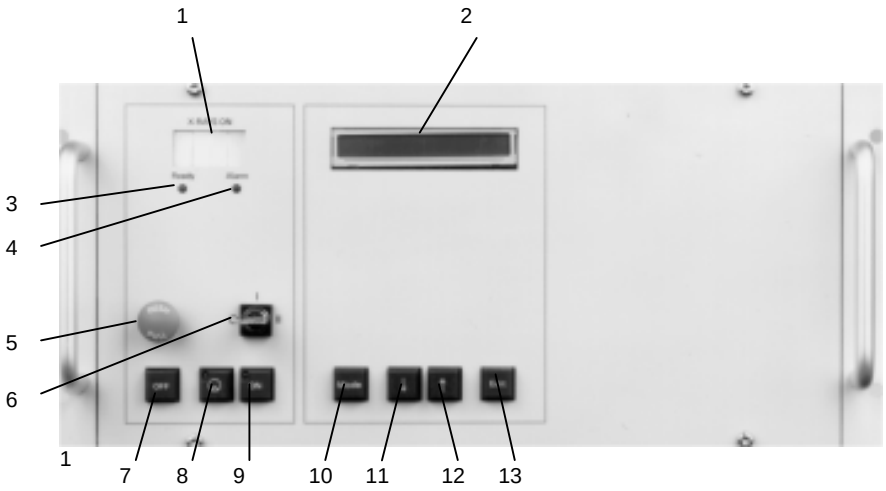
Design

The design of the X-ray generator makes it easy to service. All parts are accessible from above and are fitted into a 19-inch wide, U-shaped chassis. The front control panel is hinge-mounted. The rear panel includes connections for the cooling water supply, the V.24 interface and connectors for the X-ray instrument and its internal cooling water unit.

The following components are fitted:

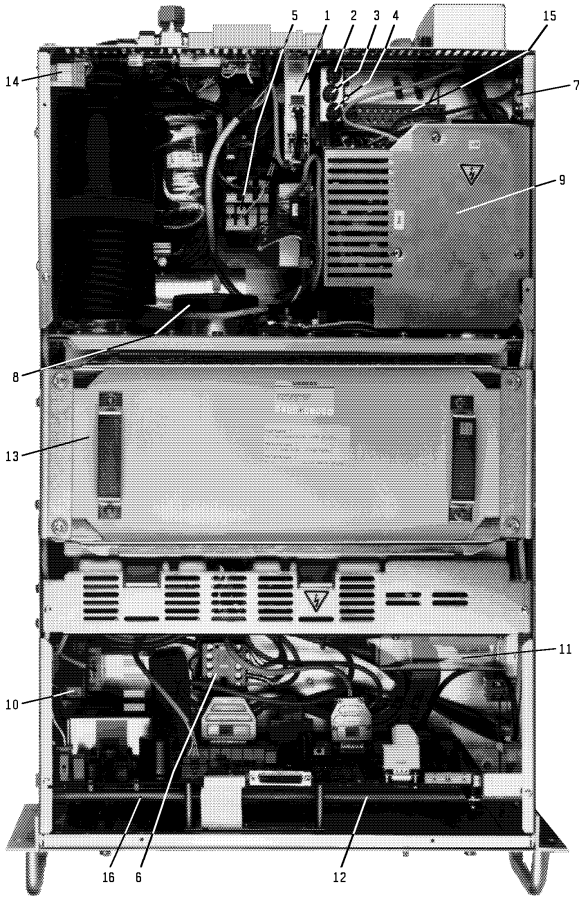
- Interference suppression unit
- Rectifier
- Inverter
- High-voltage module
- PCBs with the electronic regulators, control and protection circuits
- Cooling water supply

The X-ray generator can be built into 19-inch racks.



1 Signal lamp "X-RAYS ON
2 Display panel
3 LED "Ready"
4 LED "Alarm""
5 Red button (emergency-off)
6 Key switch
7 Key "OFF"
8 Key "Heater""
9 Key "ON"
10 Key "Mode"
11 Key "¯"
12 Key "-"
13 Key "-"

Fig. 4-2: Control panel



1 Circuit breaker, 32 A A
2 Fuse F2, T 1.6 A
3 Fuse F7, T 4 A
4 Fuse F6, T 4 A
5 Contactor K52
6 Contactor K51
7 Mains connection terminals X13
8 High-voltage socket
9 Inverter
10 Transformer T51
11 Thyodul with voltage regulator
12 Integral board (-B20)
13 High-voltage tank
14 Terminal X10 for mains frequency daptation
15 Terminal block X3
16 Fuse F1 on integral board (-B20), F 1 A

Fig. 4-3: Top view

Method of Operation

High-Voltage Generation and Regulation

The medium-frequency AC voltage from the inverter is transformed to high-voltage, then rectified and smoothened by a special circuit. The DC voltage is applied to the high-voltage socket (Fig. 4-3.8) via a series resistor, which is necessary to protect the X-ray tube. The electrical connection to the X-ray tube is made by a double-screened high-voltage cable (Fig. 4-5.1).

The high-voltage is measured via a precision voltage divider. The voltage with respect to ground is used for the high-voltage display and as the actual value for the high-voltage regulator.

The high-voltage regulator on PCB -B20 amplifies the difference between the setpoint and the actual value and applies this to the voltage control element -B4. This adjusts the primary voltage of the high-voltage transformer by means of the thyristor control element and the inverter such that the high-voltage is maintained constant to ± 0.01 %.

Regulation of Tube Current

Tube current is regulated by the cathode heater. The actual value of the tube current is measured by a resistor on the ground side of the high-voltage circuit. The tube current regulator is on PCB -B20. The difference between the setpoint and the actual value of the tube current is amplified there and applied to the control element -B215. This alters the heater current so that the tube current is maintained constant to ± 0.01 %. The control element -B215 has a current transformer which allows the heater current to be displayed (Fig. 4-2.2).

Protection Circuits

The X-ray generator has the following protection circuits for the X-ray generator and tube:

- An overcurrent and an undercurrent relay in the heater circuit of the X-ray tube.
- An overcurrent and an overvoltage monitoring circuit in the high-voltage circuit.
- A fast-acting short-circuit protection in the high-voltage circuit. This switches off the high-voltage in less than 10 ms if there is a tube flashover (impacts), preventing damage to the tube and X-ray generator. The high-voltage automatically returns to the setpoint after the short-circuit has been tripped. The correct value is reached via a slow ramp to spare the tube. The X-ray generator switches off if the short-circuit is constant, e.g. with a defective tube.

- A temperature monitor in the high-voltage module which trips at approx. 60 °C.
- A temperature monitor in the power section of the inverter which trips at approx. 100 °C.
- A level monitor in the high-voltage generator which trips if the oil level falls by approx. 10 mm.
- A switch-off circuit which allows the X-ray generator to be switched to zero power via connected devices (external warning lamp, cooling-water unit).

Radiation Protection

The radiation protection circuit is provided for the safety of operating personnel and to meet the prerequisites for a fully-protected device. The protection circuit switches the X-ray generator off if a safety switch on the connected equipment is open, or if the high-voltage cable is not connected (ripcord not inserted)

Technical Data

Tab. 4-1: X-ray generator technical data

Description	Value
Continuous output power	Max. 3000 W
High-voltage	10 to 60 kV
Tube current	5 to 80 mA
Frequency	20 kHz
Stability of high-voltage and tube current with mains fluctuations up to ±10 %	< 0,01 %
High-voltage ripple	< 5 %
Regulation time constant	< 100 ms
Tube heating current	2 to 4.5 A
Tube heating voltage	5 to 12 V
Power supply	230 V ± 10%, 50/60 Hz
Power consumption	5.5 kVA
Mains fuse	25 A, slow-blow
Cooling-water connection	½ “
Cooling-water flow rate	Min. 3.5 l/min
Water pressure	5 to 8 bar
Water temperature	10 to 35 °C
Degree of protection to DIN 40050	IP 20
Dimensions (w x h x d)	
Desk-top version	483 mm x 266 mm x 761 mm
Rack-mounted version	483 mm x 222 mm x 761 mm
Gewicht	
Desk-top version	76 kg
Rack-mounted version	65 kg

Installation

Set-up

The rack-mounted version is fitted on telescopic rails in the electronics cabinet of the X-rax instrument.

Mains Connection

☞ **Note:**
An additional ground connection (10 mm^2) must be made in addition to the protective earth conductor of the mains cable. The connection point is the M6 ground terminal on the rear panel (Fig. 4-6.10).

The X-ray generator is factory-set to the required mains frequency. The set value is shown on the rating plate.

If changes are made on-site, the rating plate must be altered accordingly.

The mains frequency is selected at terminal X10 (Fig. 4-3.14)

Terminal Block X3

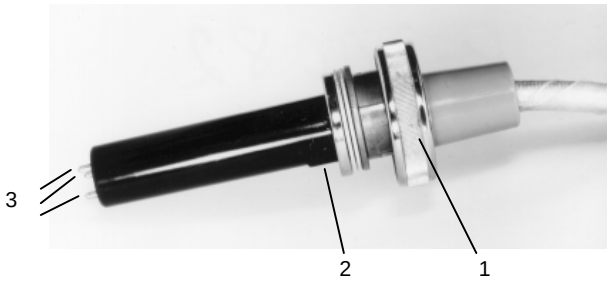
The terminal block X3 (Fig. 4-3.15) must be connected in accordance with the reqirements of the analysis instrument.

Tab. 4-1: Connection of the terminal block X3

Terminals	Connection	Remarks
1-2	Radiation warning lamp	A jumper must be inserted if the X-ray generator is mounted in a D 500 or D 5000 diffractometer or in a film camera measuring station
5-6	Jumper for shut-off circuit	This jumper must be removed if an internal cooling-water unit is connected.

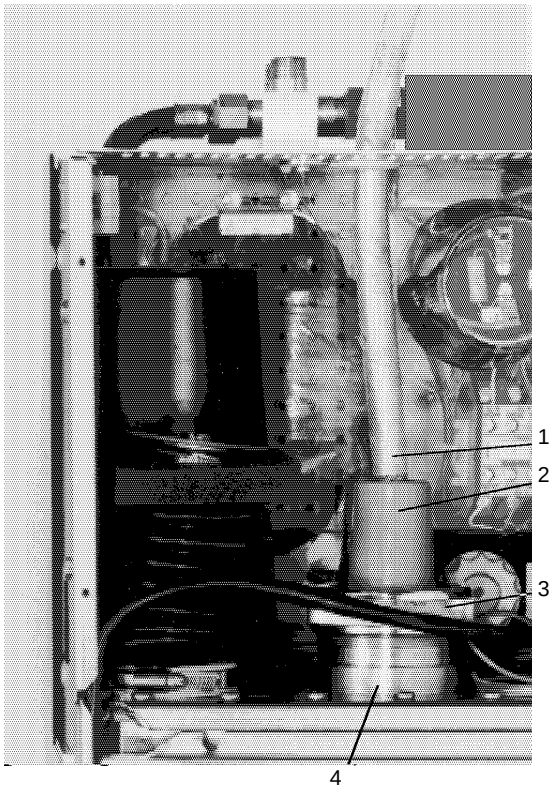
Connection of High-Voltage Cable

The high-voltage sockets and plugs must be clean. If necessary, clean and dry using a lint-free cloth and alcohol.



1 Union nut
2 Guide lug
3 Contact pins

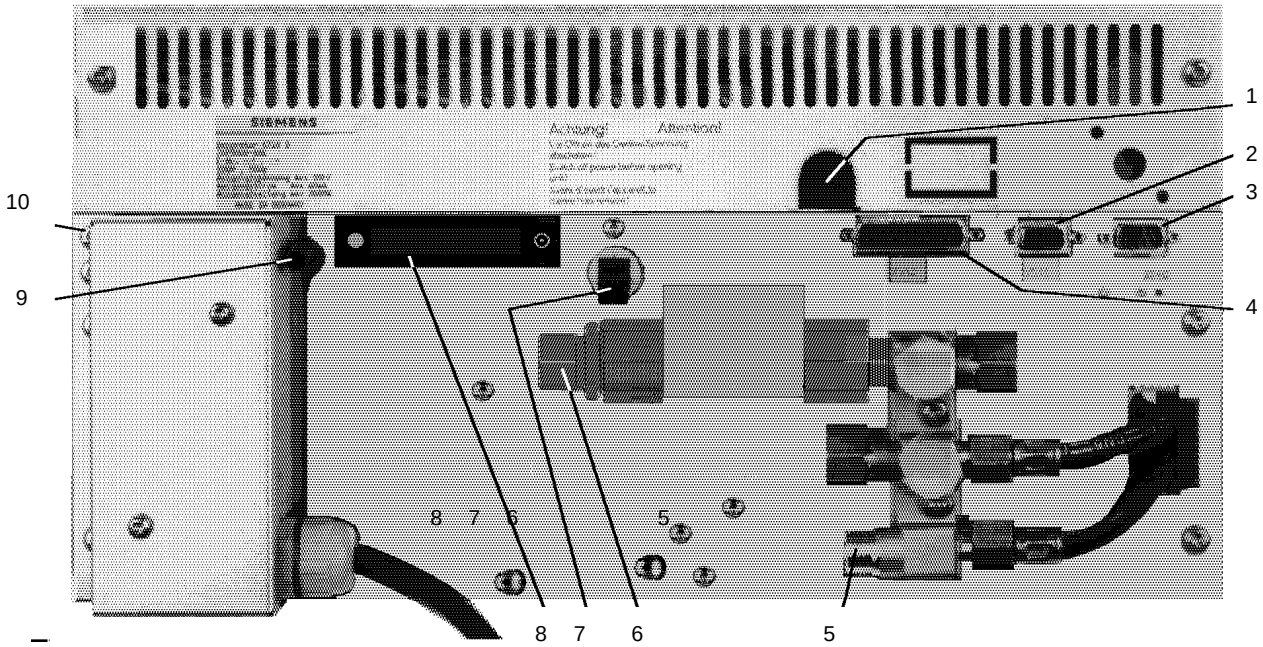
Fig. 4-4: High-voltage plug



1 High-voltage cable
2 High-voltage plug
3 Union nut
4 High-voltage socket

Fig. 4-5: Connection of the high-voltage cable

- Push the gasket onto the high-voltage plug (Fig. 4-4.2, Fig. 4-5) ensuring that the slot in the gasket slides over the guide lug (Abb. 4-4.2) on the plug.
- Smear enough vaseline (approx. 2 cm^3) onto the end of the plug to completely cover the pins.
- Push the plug into the high-voltage socket (Fig. 4-5.4) until the vaseline makes contact.
- Carefully press the plug home until the contact pins (Abb.4-4.3) engage.
- Tighten the union nut (Fig. 4-5.3) securely and tighten again after 30 minutes of operation.



1 Inlet for high-voltage cable
2 Connector X541 for X-ray instrument
3 Connector X540 for computer interface
4 Connector X542 for internal cooling-water unit C79298-A3179-A1 or solenoid valve V0
5 Cooling-water inlet from external cooling-water unit or municipal water supply respectively, M18 x 1.5 thread
6 Cooling-water outlet to external cooling-water unit or water sink respectively, 3/8“ thread
7 Circuit breaker (shown in “Off” position)
8 Connector X543 for tube stand
9 Cable inlet for connection of an additional radiation warning lamp (to special order)
10 Ground (earth conductor) connection, M6

Fig. 4-6: Rear view

External Warning Lamps (in Connection with a Window Control)

Two fail-safe warning lamps (24 V, 2...8 W) with the functions “All window shutters closed” and “At least one window shutter open” can be connected to terminal block X3 (Fig. **4-3**.15) in the X-ray generator:

- Terminals 9-10: “All window shutters closed”
- Terminals 11-12: “At least one window shutter open”

Commissioning and Start-up

Open external cooling-water tap or switch on external cooling-water unit respectively.

Switch on external power switch (master switch).

Pull the red emergency-off button (Fig. 4-2.5).

Set key switch (Fig. 4-2.6) to the “I” position.

The most recent cause for shut-off is shown on the display (Fig. 4-2.2): “Error-Code: xy” or “kV=0mA= 0”. The green “Ready” LED (Fig. 4-2.3) lights. The limit values of the X-ray tube are set to maximum (60 kV, 80 mA, 3000 W).

Press the “Heater” key (Fig. 4-2.8) for approx. 2 s. The setpoint values are shown on the display: “kV20, mA: 5”. Data are sent to the internal cooling-water unit (X-ray instruments with internal cooling-water unit C79298-A3179-A1).

If the LED in the “Heater” key flashes, the conductivity of the cooling water is too high (actual value of conductivity >2,5µS. After some time the LED is lit continuously, and the X-ray generator can be switched on.

Press the “ON” key (Fig. 4-2.9). The “X-RAYS ON” signal lamp (Fig. 4-2.1) and the radiation warning lamp at the X-ray instrument light up. The X-ray generator is switched on. The LED in the “Heater” key goes off; the LED in the “ON” key lights up. On the display the actual values are shown: “kV= 20mA= 5”.

Adjust the voltage and current setpoints. First adjust the voltage setpoint, and then the current setpoint.

When using new X-ray tubes or tubes which have been out of operation for longer than 12 hours, observe the following start-up instructions unless other values have been specified by the manufacturer:

An automatic start-up routine can be selected for new tubes.

The maximum high-voltage is 60 kV.

The X-ray generator is switched off by pressing the “OFF” key (Fig. 4-2.7). To protect the tube (very small thermal load of filament and anode), reduce the tube current to 5 mA before switching off. The high-voltage may remain at the operating value.

During initial commissioning, check the function of the water flow monitor and the radiation protection circuit.

Tab. 4-2: Start-up instructions for X-ray tubes

Pause in operation (days)	**High-voltage/duration**								**Total time for 55 kV**
	20 kV	25 kV	30 kV	35 kV	40 kV	45 kV	50 kV	55 kV	
0.5 to 3	30 s	30 s	30 s	30 s	30 s	30 s	1 min	2 min	6 min
3 to 30	30 s	30 s	2 min	2 min	5 min	5 min	10 min	10 min	35 min
> 30 or new X-ray tube	30 s	30 s	2 min	2 min	5 min	10 min	15 min	15 min	50 min

Operation

The X-ray generator is equipped with a local control panel for entering parameter values and a 16-digit LCD for displaying entered values and status and diagnostic information.

Local Operation and Display

A keypad with 4 keys is used for local operation. The keys have an auto-repeat function. These keys are used to select input values or desired status and diagnostic information or to enter parameter values.

Select parameters to be entered or status and diagnostic information to be output by simultaneously pressing the “Mode” (Fig. 4-2.10) and “-” (Fig. 4-2.12) or “¯” (Fig. 4-2.11) keys. The display then changes accordingly to one of the following possible messages:

Tab. 4-3: Entering the parameters using the local control panel

Parameter	Description
kV= mA=	Actual values of high-voltage in kV and tube current in mA
kV: kV=	Setpoint and actual value of high-voltage
mA: mA=	Setpoint and actual value of tube current
Hcu=	Actual value of heater current in A
Flow=	Actual value of cooling-water flow in l/min (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
Temp=	Actual value of cooling-water temperature in °C (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
Conduct=	Actual value of conductivity in mS (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
U-AK=	Actual value of voltage at the thyodul in V
I-input=	Mains current consumption in A
Warn	Warning
STATUS	Generator status register
Relay=	Relay status
DIAG	Operating-voltages status register
MODE	Generator operating-mode register
Error-Code	Shut-off cause
RTi=	Operating hours
kV min	Minimum high-voltage in kV
mA min	Minimum tube current in mA
kV max	Maximum high-voltage in kV
mA max	Maximum tube current in mA?
P abs	Absolute limiting power in W
BdR	Baud rate for V.24 interface
Release version of firmware and software	
Automatic?	Start-up routine

All actual values are identified by the index “=”, setpoints and status informations by the index “:”.

The display cycles in increasingly shorter intervals if the “-” or “¯” key is pressed for longer than approx. 1 second (auto-repeat function). Actual-value and status displays are updated at intervals of 200 ms.

In order to modify parameters, press the “Edit” key (Fig. 4-2.13) together with the “-” or “¯” key. The parameter value is then increased or decreased by a fixed amount. The value is changed at shorter intervals in the corresponding direction if the “-” or “¯” key is pressed for longer than approx. 1 second (auto-repeat function).

Parameter input on the local control panel is disabled if the X-ray generator is remote-controlled.

Setpoints for High-Voltage and Tube Current

The setpoints can be adjusted using the functions “kV: kV=” and “mA: mA=”. The step size is 1 kV or 1 mA respectively. Setpoint values must not be smaller than the minimum values (10 kV, 5 mA) and not be larger than the definable maximum values.

Limiting is also carried out if the defined maximum power is exceeded.

Setpoints are at the minimum values when the X-ray generator is switched on.

When modifying the setpoints in the “Operation” position, the actual values are adjusted to the setpoints when the “Edit” key is released.

Maximum Values for High-Voltage, Tube Current and Power

The maximum values can be set using the functions “kV max:”, “mA max:” and “P abs:”. Step sizes for the power are from 100 W up to a maximum of 3000 W.

Preset values are 60 kV, 80 mA and 3000 W. The maximum values can only be changed if the key switch is in the “II” position.

Baud Rate

The baud rate can be adjusted using the “BdR” function. The adjustable baud rates are: 1200, 2400, 4800 and 9600 bd (preset value: 9600 bd).

The baud rate can only be changed if the key switch is in the “II” position.

The new baud rate is first activated after a generator reset.

Explanation of Status and Diagnostic Information

Status information is constantly regenerated and can be displayed using the “MODE”, “STATUS”, “Error-Code”, “DIAG” and “Relay” functions. Status and diagnostic informations “Error-Code”, “DIAG” and “Relay” are explained in Chapter 3, "D8 Operating Instructions", Section "Description of Remote Control Commands".

“MODE” (generator operating-mode register) is a decimal number resulting from the following bit significances:

Tab. 4-4: Status and Diagnostic Information (1)

Significance	Meaning
1	Heating mode
2	High-voltage on
4	kV actual value = kV setpoint
8	mA actual value = mA setpoint
16	Remote control on
32	High-voltage flashover
64	Generator warning
128	Generator stand-by

Start-up Routine for New X-ray Tubes

A start-up routine (total duration 50 min) can be selected using the “Automatic?” function.

Switch on high-voltage.

Set key switch to the “II” position.

Select the “Automatic?” function.

Start automatic routine by operating the “Edit” key together with the “Up” key.

The display alternates between “Automatic run” and “kV = min =” (kV = current value of high-voltage, min = expired time in minutes). “Automatic end” appears on the display after 50 min if the program is completely executed without errors.

If an error occurs during the routine, “Error at kV = ” appears on the display (kV = actual value of high-voltage at which the error occurred).

The routine can be aborted at any time by selecting another function.

Generator Stand-by

In stand-by mode the X-ray generator remains switched on, but does not generate high-voltage.

The setpoint values of kV and mA are set to zero.

Generator stand-by can be activated via the serial interface.

Generator stand-by is activated by opening the switch-off circuit.

Generator stand-by can only be disabled via the serial interface. For this purpose the switch-off circuit must be closed and permitted setpoint values of kV and mA be set.

Stand-by mode is ended by switching off the generator.

Interface between X-ray Generator and External Computer

Hardware

Data transfer between the X-ray generator and an external computer is via an asynchronous serial interface in full-duplex mode (RS 232 C) at 9600 Bd, and with 8 data bits, no parity, 1 stop bit.

Pin assignments of computer interface of X-ray generator

9-pin connector (Cannon):

2	TxD	Transmitted data
3	RxD	Received data
7	Signal Ground	

Data Transmission

Transmission protocol:

Start	------	Start character (programmable)
DAT1 DAT2 ... ... DATn	------	Data string
CR	------	ASCII control character “Carriage Return”

Data string: string with representable ASCII characters, contains information for receiver.

The string may be up to 8 characters long including the control characters at the beginning and end of a data transmission.

Data transmission can be interrupted at any time by the receiver using the ASCII control character DC3 (X-OFF) and restarted using the control character DC1 (X-ON).

A faulty string is acknowledged by the ASCII control character NAK (negative acknowledge). The transmitter then repeats the data transmission.

Data transmission from external computer to X-ray generator

Each command from an external computer to the X-ray generator consists of a command identifier (2 letters) and an argument.

The external computer transmits a command to the X-ray generator and immediately checks that it has been received by evaluating the command acknowledgement from the X-ray generator. The command acknowledgement is made on the initiative of the computer by transmitting the polling character ENQ. If the command has been accepted, the acknowledgement consists of only the start character SOH and the string terminator CR. If the command has been rejected, an error message (string identifier “?”) with error number is transmitted to the computer.

Data transmission from X-ray generator to external computer

Messages from the X-ray generator to the external computer include:

- Error messages
- Parameters of X-ray generator
- Status messages
- Diagnostic information

An error message is the response of the X-ray generator to an illegal command and has the identifier “?”. The reason for rejection of the command is passed in the error message to the computer in a 2-digit error code.

Tab. 4-5: High voltage generator error codes

Error code	Meaning
1	Illegal command
2	Arguments required
3	Incorrect argument(s)
4	Command only permissible in computer mode
20	Generator switched off
21	Generator power limited
22	Switch-off circuit open

Parameters, status messages and diagnostic information of the X-ray generator are transmitted to the computer on command and following the authorization to transmit by output of

the polling character ENQ with the command code (2 letters).

The X-ray generator outputs the following message without being requested every time there is a change in the operating mode control word:

<BEL>

<G>

<S>

<Operating-mode control word>

<CR>

<ENQ>

This message is sent every second, until the computer sends the following acknowledgement:

<ACK>

☞ **Note:**
SCII control character BEL = 0716 instead of SOH = 4116 as start character.

Description of interface commands RC to X-ray generator

The X-ray generator can be controlled by an external computer via a number of commands. The X-ray generator must be set to the “computer control” operating mode by the preparatory command RC1. Parameter, status and diagnostic scans are permissible in every mode.

Commands are processed in parallel.

The maximum delay between a command for generator control and the commencement of its execution is 200 ms. Corrrect execution can then be monitored by the computer by reading the corresponding status information (ready message or operating-mode control word).

Command for mode switch-over of X-ray generator:

RC<code> Remote Control

Switches the X-ray generator to the “remote control” mode and back to the “local” mode depending on the <code> value.

<code>: Integer

code	Meaning
0	“Local” mode
1	“Remote control” mode

Commands for selection of voltage and current (Commands for selection of voltage and current are ignored with error message “?13” if the service switch is in “SERVICE” position):

GV<value> Generator voltage

GC<value> Generator current

GV<value> Generator voltage

Setpoint for generator high-voltage

<value>: integer

Generator high-voltage in kV

Value range: kVmin ≤ value ≤ kVmax; 0: select generator stand-by

GC<value> **Generator current**

Setpoint for generator current

<value>: integer

Generator current in mA

Value range: mAmin ≤ value ≤ mAmax; 0: select generator stand-by

Commands for reading parameters, status and diagnostic information of the X-ray generator

GP<code> **Generator parameter**

GS<code> **Generator status**

GR<code> **Generator register**

GP<code> **Generator parameter**

Request to transmit parameters of the X-ray generator to the external computer

<code>: integer

Selection of parameters to be transmitted to the external computer

code	Meaning
1	Minimum voltage in kV (kVmin)
2	Maximum voltage in kV (kVmax)
3	Minimum current in mA (mAmin)
4	Maximum current in mA (mAmax)
5	Limiting power

These parameters are device-specific limits which can only be entered on the local control panel of the X-ray generator

GS<code> **Generator status**

Request to transmit status information of the X-ray generator to the external computer

<code>: integer

Selection of status information to be transmitted to the external computer

code	Meaning
1	Operating mode control word
2	Actual voltage
3	Actual current
4	Heater current
5	Cooling-water flow (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
6	Voltage at thyodul
7	Cooling-water temperature (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
8	Cooling-water conductivity (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
9	Power consumption
10	Operating hours

GR<code> **Generator register**

Command to read diagnostic information of the X-ray generator

<code>: integer

Selection of diagnostic information with the following assignment:

code	Meaning	Display
1	Program version	
2	Instrument st?atus	STATUS
3	Switch-off cause	Error-Code
4	Relay status	Relay
5	Voltage diagnosis	DIAG
6	Generator warning	Warn

<code> = 1:

String with program No. and release version of installed control software of the X-ray generator

<code> = 2 ... 6:

Total of bit significances whose meaning is explained in Section 8. These are output as a decimal number ≤ 255.

Maintenance and Repair

Routine Maintenance

Check water filter (if fitted) for contamination according to manufacturer's instructions.

Check the X-ray protection circuit following each shut-down or maintenance operation: Switch the X-ray generator to "Operate". Disconnect the ripcord from the high-voltage plug. The X-ray generator must switch off.

Troubleshooting

The power supply of the digital section is not in order, if the green "Ready" LED (Fig. 4-2.3) is not lit and the display panel (Fig. 4-2.2) remains dark. The following reasons are possible:

- External power switch open or fuse defective.
- Key switch (Fig. 4-2.6) in the "0" position or red button (Fig. 4-2.5) has been operated.
- Fuse F6 (Fig. 4-2.4) or F7 (Fig. 4-2.3) defective.
- Plug X506 on pushbutton board -B1 not connected.
- Plug X511 on integral board (Fig. 4-2.12) not connected.
- Transformer T51 (Fig. 4-2.10) defective.

If the X-ray generator cannot be switched to the "Heating" position, the following reasons can be indentified by the status and diagnosis bytes:
Fuse F2 defective or tube heating cable not connected (Error-Code: 1).

Heating current controller defective (Error-Code: 2).

High-voltage cable not connected correctly (Error-Code: 5).

Circuit breaker F1 switched off (Error-Code: 22).

If "STATUS: " remains at a value < 8, the integral board (-B20) is defective.

If the LED in the "Heater" key (Fig. 4-2.8) flashes, the switch-off circuit is open, "STATUS= 8".
Switch-off circuit of X-ray instrument open (see Instructions of X-ray instrument for troubleshooting).

If the "Alarm" LED (Fig. 4-2.4) flashes in addition, "Warn" is displayed and warnings can be read. The following reasons are possible (X-ray instruments with internal cooling-water unit C79298-A3179-A1):
Conductivity > 2,5 µS ("Conduct= ").

Water level too low (dry sensor) or sensor broken, conductivity < 0,1 µS ("Level= ").

Cooling water temperature > 50 °C ("Temp= ").

Cooling water flow < 3.6 l/min ("Flow= ").

If the "ON" key (Fig. 4-2.9) has been operated, "Error code: " is indicated after switching-off.
This information is displayed approx. 3 s after the "X-RAYS ON" signal lamp (Fig. 4-2.1) is extinguished. The X-ray generator is in swiched-off status.

Status and diagnosis informations are described in the following:

Tab. 4-6: Status and diagnosis information (2)

Error-Code	
Heating current too small	1
Heating current too large	2
kV actual value > 110 % of setpoint	3
mA actual value > 110 % of setpoin	4
Temperature monitoring of inverter	5
High-voltage > 68 kV	6
Voltage at thyodul > 480 V	7
Oil volume in high-voltage tank too small	8
Temperature monitoring of high-voltage generator	9
Shut-off circuit in spectrometer open	10
Water temperature > 50 °C (X-ray instruments with internal cooling-water unit C79298-A3179-A1)	12
Sensor broken, conductivity < 0,1 µ (X-ray instruments with internal cooling-water unit C79298-A3179-A1)	13
Water flow < 4 l/min	14
Generator stand-by longer than 15 min	16
Temperature of deionized water > 56 °C (X-ray instruments with internal cooling-water unit C79298-A3179-A1)	17
Level of deionized water too low (X-ray instruments with internal cooling-water unit C79298-A3179-A1)	18
Aquastop	19
Generator switched off via "OFF" button	20
Power cut	21
Circuit breaker F1 switched off	22
Mains current too large	23
Supply voltage out of range	24
Additional radiation warning lamp defective	25

Error-Code	
Short circuit to ground in shut-off circuit	29
Safety circuit open	30
Short circuit to ground in safety circuit or radiation warning lamp defective	31
Relay K11 open	33
Relay K3 open	34
Relay K5 open	35
Relay K6 open	36
Relay K12 open	37
Relay K13 open	38
Tube surges	40
High-voltage in stand-by mode	41
Voltage at thyodul in stand-by mode	42
Generator not in in stand-by mode	43
Stand-by function not parametrized	50
Generator type not indentified	51
EEPROM type not indentified	52
Parameter memory reset	53
Warning lamp “At least one window shutter open ” defective (Generators with window control)	60
Control command not executed (Generators with window control)	61

☞ **Note:**
Make a note of the Error-Code before the X-ray generator is switched on.

STATUS

Relay contact or actual-value registration defective	0
All inactive relays OK	1
Check relay K3	3
Check relay K12	4
Generator in the “Heating” position	5
Check power supply	6
Check relay K13	7
Check shut-off circuit	8
Shut-off circuit closed	9
Check safety circuit	10
Safety circuit closed	11
Check relay K5 andK6	12
Check short-circuit monitoring to ground	13
Check supply voltage for relay K52	14
Generator ready	15

Warn

Significance	Meaning	Display
1	Flow of deionized water < 4 l/min	Flow (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
2	Level of deionized water too low	Level (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
4	Temperature of deionized water > 40 °C	Temp (X-ray instruments with internal cooling-water unit C79298-A3179-A1)
16	Tube current controller out of controlling range or generator in stand-by mode	Limit_mA Stand-by
32	External green warning lamp defective	ext. lamp (Generators with window control)

Several warnings occurring at the same time are displayed cyclically.

DIAG

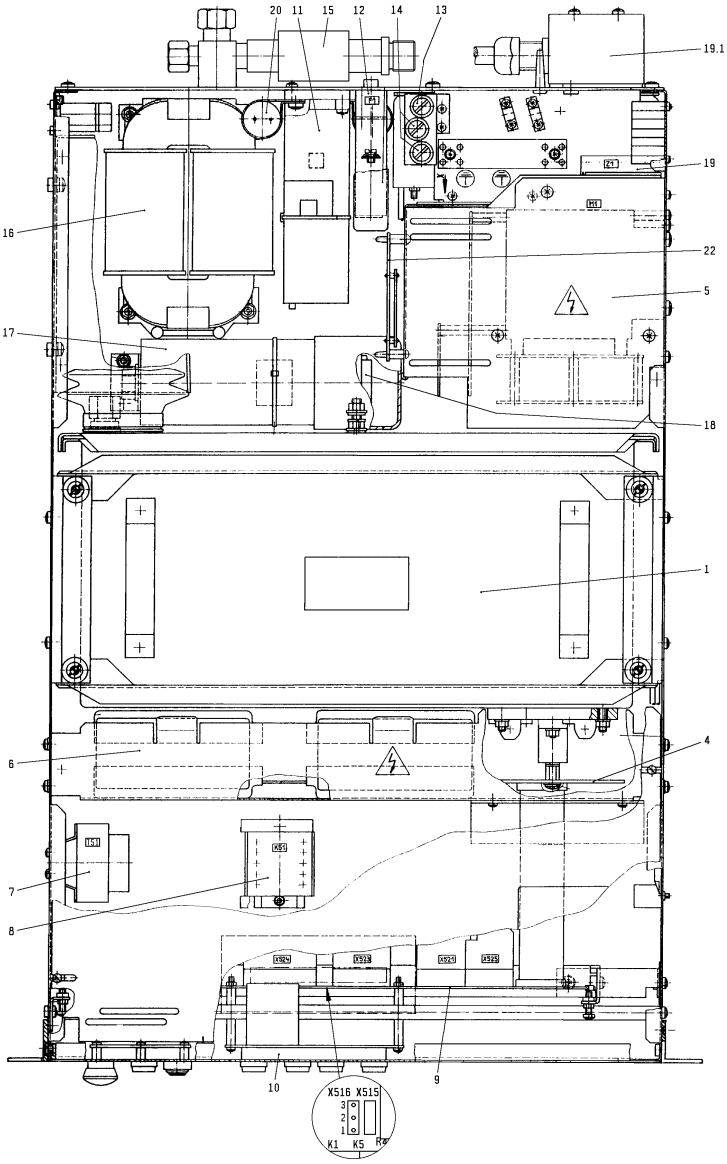
Significance	Meaning
1	+15 V present
2	–15 V present
4	–5 V present
8	+14 V present
16	Contactor K2 on

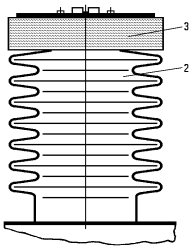
Relay

Significance	Meaning
1	Relay K3 closed
2	Relay K12 closed
4	Relay K13 closed
8	Relay K11 closed
16	Relay K10 closed
32	Relay K5 closed
64	Relay K14 closed
128	Relay K6 closed

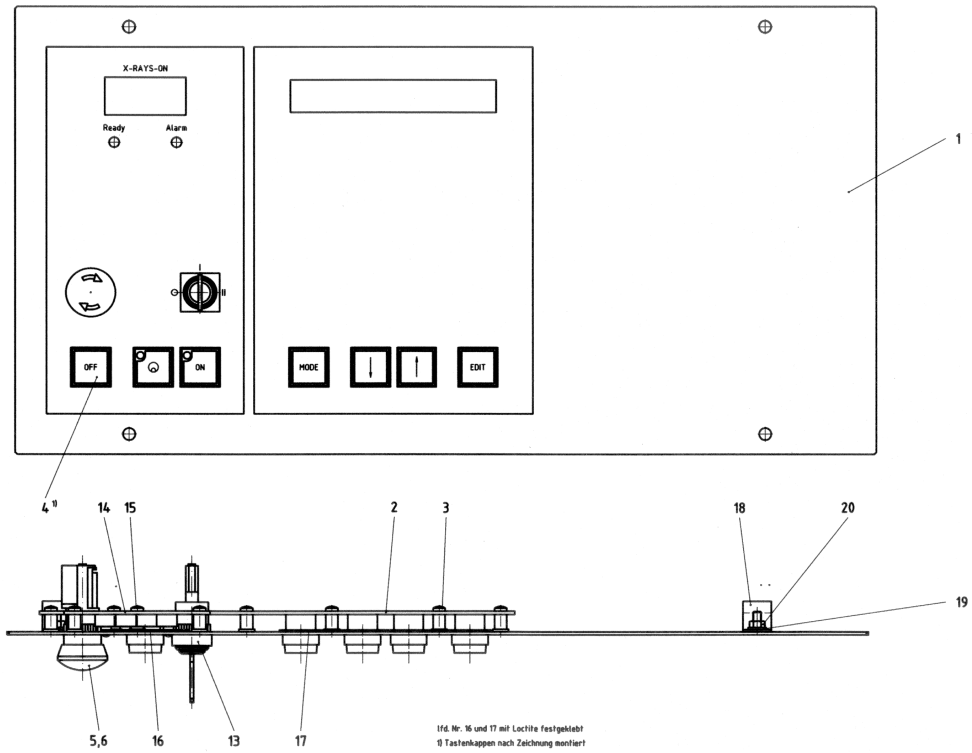
Spare Parts List

Ordering Instructions
All orders should specify the following:
1. Quantity
2. Order No.
3. Designation
4. Designation and Serial No. of the instruments to which the spare part belongs


20
11
15
12
14
13
19.1
19
16
22
5
17
18
1
4
6
7
8
10
9
X516
X515
3
2
1
K1
K5


3
2

Part no.	Designation	Remarks	Remarks
1	High-voltage tank	C79249-A3054-B95	
2	Bellows	C79249-A3028-D10	Exchange kit
3	Spacer	C79249-A3028-C109	
4	Voltage regulator	C79249-A3053-B4	
4.1	Thyristor THY-MTT 40 A 12 N	W79024-A6122-T483	V1
4.2	Wire-wound resistor, 51 W , 5 %, 50 W	W79005-F4510-J8	R2, R3
5	Inverter	C79249-A3054-B210	
5.1	Spacer	C79249-A3028-C86	glued
6	Capacitor battery	C79249-A3028-B74	
6.1	Electrolytic capacitor, 1000 mF, 350 V	W79010-M3108-T350	
6.2	Metal-film resistor, 39 kW, 5 %, 4 W	C71004-Z39-A77	
7	Mains transformer	W75040-B14-A55	T51
8	Coupling element, 24 V DC	W75053-B1001-N402	K51
9	Integral board	C79249-A3054-B20	
9.1	ROM package	S79610-G94-A900	
9.2	G-type fuse, F 1 A, 250 V	W79054-L1021-F100	F1
10	Display, complete	C79249-A3053-B54	
11	Contactor, 24 V DC	W75053-B1002-N113	K52
12	Protective switch, 32 A	W75051-B3112-A320	F1
13	G-type fuse, T 1.6 A	W79054-L1010-T160	F2
14	G-type fuse, T 4 A	W79054-L1011-T400	F6, F7
15	Flow meter cell		
15.1	Impeller, complete	C79249-A3000-D8	
15.2	Bearing	C79249-A3000-C9	
16	Mains choke	W79041-A1505-C1	L1



Part no.	Designation	Remarks	Remarks
22	Step switch	C79249-A3052-B140	
24	Front panel, complete		
24.1	Display board	C79249-A3053-B3	
24.2	Pushbutton board	C79249-A3053-B1	
24.3	Key-operated switch	W79050-E7552-A922	
24.4	Switch	W75050-T1101-U102	
24.5	Filter pane	C79249-A3028-C209	
24.6	Filter pane	C79249-A3028-C208	
Y	Relay	C79298-A3200-C34	K53, 24 VDC
X	Relay	C79298-A3200-C35	K54, 230 VAC
27	Radio interference filter	C79298-A3230-C33	Z1

5 Diffracted Beam Monochromator

Table of Contents

5 Diffracted Beam Monochromator 5-1
Description 5-1
Application 5-1
Design and Mode of Operation 5-1
Technical Data 5-3
Installation 5-3
Adjustment 5-4
Preliminary Work 5-4
Pre-adjustment 5-5
Final Adjustment 5-8
Radiation Protection 5-9

5 Diffracted Beam Monochromator

Description

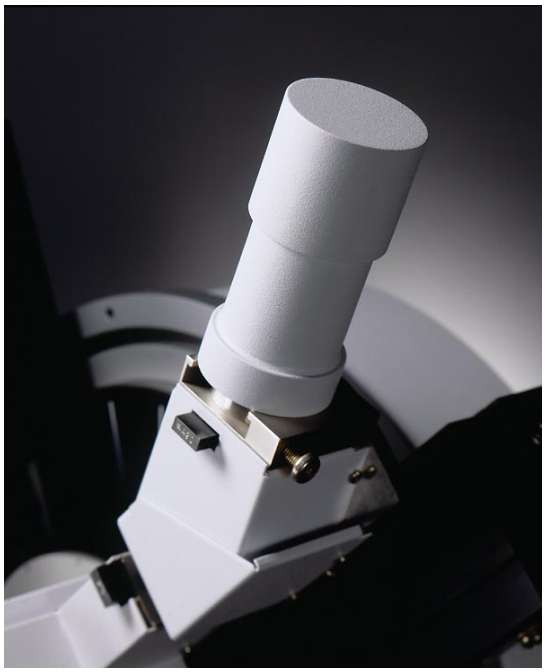


Fig. 5-1: Diffracted-Beam Monochromator

Application

Diffracted-beam monochromators inserted between the detector slit and the detector suppress fluorescence radiation which may still be excited in the sample in addition to the white spectrum and Kβ radiation.

The $K\alpha_1$ and $K\alpha_2$ peaks cannot be separated because of the mosaic structure of the graphite monochromator crystal.

Design and Mode of Operation

The practical advantage of the diffracted-beam monochromator is, that in contrast to the primary monochromator it can be simply mounted onto already adjusted diffractometers.

The diffracted-beam monochromator is prealigned in the factory.

Further adjustment is not necessary if the diffracted-beam monochromator is delivered together with the diffractometer.

The diffracted-beam monochromator is fastened to the dove clamps for detectors.

Fig. 5-2 shows the beam path with sample and diffracted-beam monochromator during reflectivity measurements.

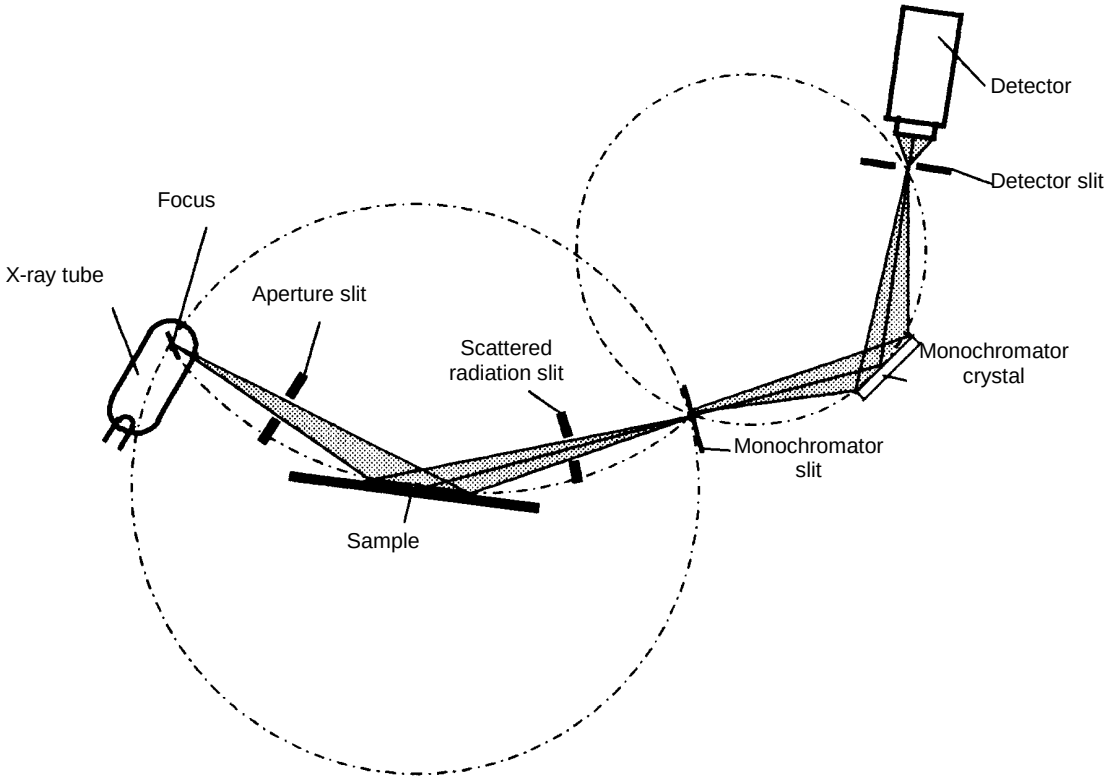


Fig. 5-2: Beam path of the diffractometer with diffracted-beam monochromator

Elimination of the Kβ reflections results in greater clarity of the recorded diffraction pattern. The ratio between the peak and the background is also improved, in case of a strong fluorescence radiation by a factor of up to 1000. The intensity of the signal due to Cu radiation is reduced to approx. one quarter in the process; compared to the wanted signal with a Kβ filter, the loss in intensity is only approx. 50 %, however.

Tab. 5-1: Intensity yield with a diffracted-beam monochromator compared to a measurement with unfiltered radiation

Anode	E (kV)	Intensity compared to Standard Bragg Brentano without Kβ-Filter
Cr	5.415	1/8
Co	6.930	1/5
Cu	8.048	1/4
Mo	17.479	1/3

Technical Data

Radiation: Cr, Fe, Co, Cu, Mo

Graphite crystal (2d = 0.2708 nm)

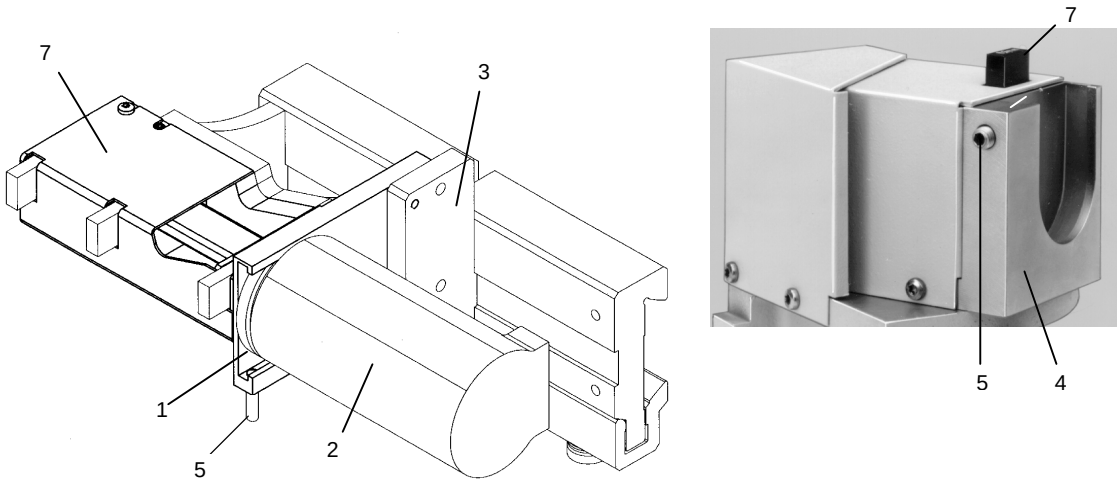
Fixed diffracted-beam monochromator

For scintillation or proportional counters

Measuring range (2θ) for θ/2θ standard diffractometers	–35° to +168° (vertical configuration)
(Cu radiation)	–100° to +168° (horizontal configuration)

Installation

- Loosen locking screw on the detector holder (1).
- Remove detector (2).
- Disassemble detector holder (1)
- Fit diffracted-beam monochromator with its flange to the mounting surface (3) of the dove clamp.
- Push detector with ist mounting flange into the holder (4) of the diffracted-beam monochromator.
- Tighten locking screw (5).
- The Cr and Co diffracted-beam monochromators are fitted using an adapter.



1 Detector holder
2 Detector
3 Mounting surface for the detector holder or for the monochromator's flange
4 Detector holder at monochromator
5 Locking screw
6 Detector slit
7 Secondary fixed slit assembly

Fig. 5-3: Secondary fixed slit assembly

Adjustment

The following adjustments are not necessary if the diffracted-beam monochromator is delivered together with the diffractometer.

Preliminary Work

The diffractometer must be fitted and adjusted.

The first measurements are done without a diffracted-beam monochromator. Use a scintillation counter as a detector.

- Insert the following slits:

Slit position	Aperture slit	Scattered radiation slit	Detector slit
Slit	1 mm	1 mm	0.1 mm

- In the case of continuously-adjustable slits, open the slits completely and insert the 1-mm fixed slit.
- In the case of a replaceable slit, set to a freely-selectable plug-in slit.
- Set the 2θ angle (in θ/2θ mode), high-voltage and tube current as follows:

Radiation	2θ	High-voltage	Tube current
Cr	40.06°	40 kV	≈ 30 mA
Co	31.04°	40 kV	≈ 30 mA
Cu	26.63°	40 kV	≈ 30 mA
Mo	12.17°	40 kV	≈ 30 mA

- Insert the quartz sample into the sample carrier.
- Open the window shutter of the tube stand.
- Set the 2θ angle to maximum intensity.
- Record the values of the angle and intensity.
- Close the window shutter of the tube stand.
- Fit the diffracted-beam monochromator as described in Section "Installation" on page 5-3.
- Remove the sheet-metal shields of the diffracted-beam monochromator.

⚠ **Caution!**
The crystal must not be touched.

Pre-adjustment

- Place the adjustment template onto the scattered radiation and monochromator slits; also place on the detector slit in the longitudinal direction (Fig. 5-4). Hold the template verfically with respect to the slits. The slits must not be pushed out of position.
- Slide a piece of white paper under the crystal holder to brighten in up.

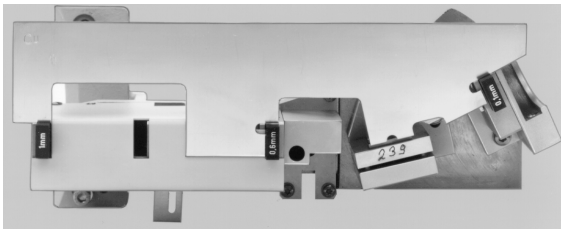
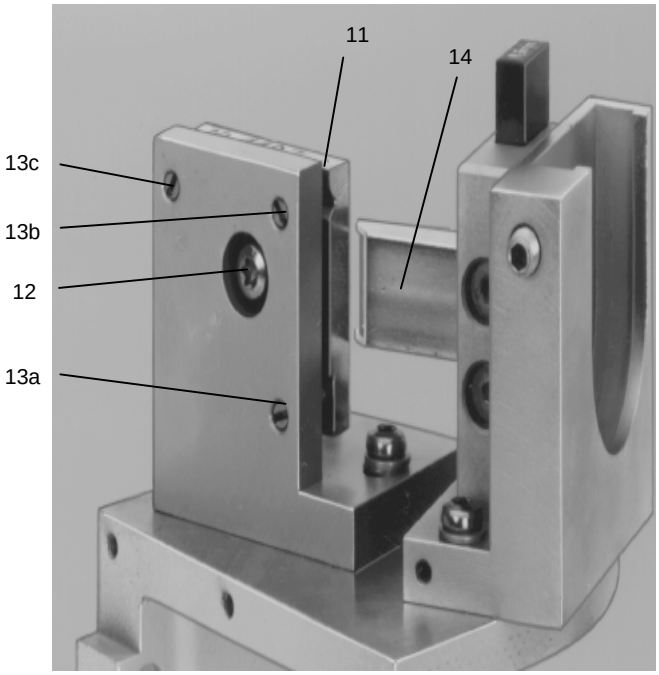


Fig. 5-4: Fixed slit assembly and diffracted-beam monochromator with adjustment template

Angle θ

- Adjust crystal using the left-hand screw 5-5.13c) so that its edges (dots A and B in fig. 5-6) are in line with those of the template.
- Tighten the mounting screw (12) completely and then loosen it by half a turn.



11 Crystal holder
12 Mounting screw
13 Adjustable screws
14 Shielding tube

Fig. 5-5: Diffracted beam monochrometer without protective cover

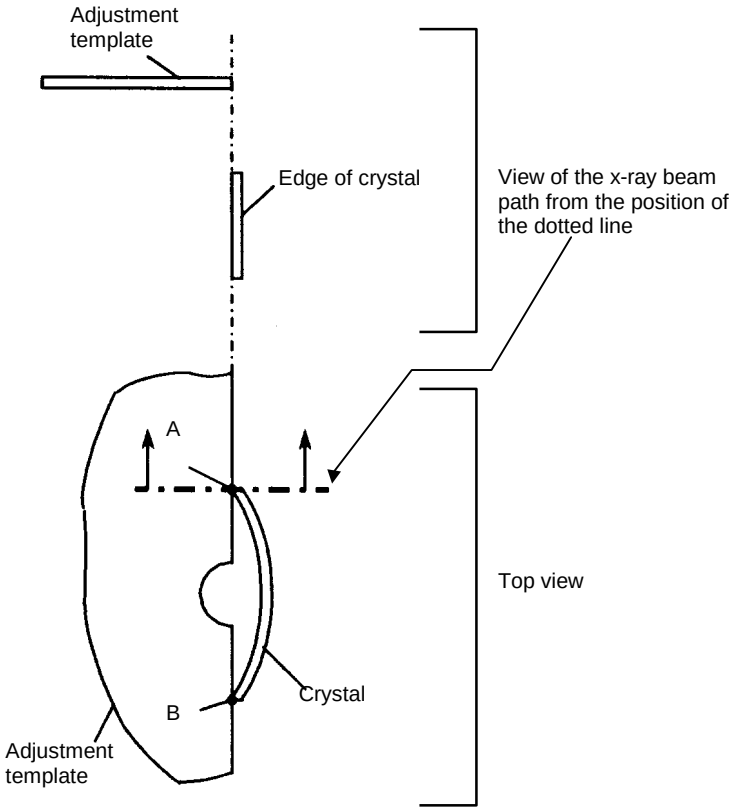


Fig. 5-6: Pre-adjustment of angle

Adjustment to Center of Radiation

- Mark the positions of the three screws (fig. 5-5.13a, b, c) between the screw heads and the crystal holder using a pencil or felt-tip pen.
- Adjust the crystal using the three screws (13a, b, c) so that the edges of the hole (dots C and D in fig. 5-7) are in line with the surface of the crystal. The three screws must be adjusted **evenly** to ensure that the angle θ is retained as adjusted.
- Tighten the mounting screw (12) completely and then loosen by half a turn.

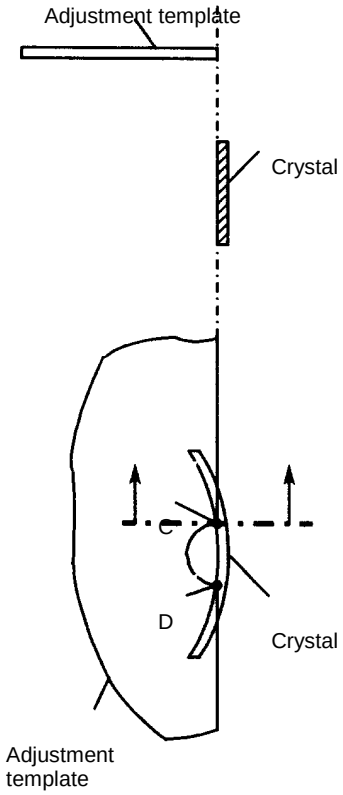


Fig. 5-7: Adjustment to center of radiation

Angle 2θ

- Insert a 0.6-mm slit into the diffracted-beam monochromator for Cu or Mo radiation, and a 1-mm slit for Cr, Fe or Co radiation.
- Loosen the mounting screws of the detector holder ((Fig. 5-3.4) so that it can be moved with a little effort.
- Adjust the detector holder 5-3.4 so that the slit just touches the adjustment template and the shielding tube (fig. 5-5.14) lies parallel to the edge of the template.
- Carefully tighten the mounting screws of the detector holder.

Final Adjustment

- Set the recorded angle (refer to section "Preliminary Work“).
- Insert the following slits:

Position	Aperture slit	Scattered radiation slit	Mono-chromator slit	Detector slit
Slit width	1 mm	1 mm	0.1 mm	0,6 mm (Cu, Mo) 1 mm (Cr, Fe, Co)

- Adjust high-voltage and tube current as described in Section "Preliminary Work".
- Open the window shutter of the tube stand.
- Display the intensity using the ratemeter (radiation protection box must be closed). After each adjusting of the screws 13a, b, c in fig. 5-5 the intensity should be checked with the ratemeter.
- Set to maximum intensity using the left-hand screw (13c).
- Offset the two right-hand screws (13a, b) by one turn each in the same direction.
- Set to maximum intensity again using the left-hand screw 13c).
- Set the maximum intensity by alternately adjusting the two right-hand screws (13a, b) by **the same amount** and using the left-hand screw (13c) until no further improvement in intensity can be achieved. If necessary, the mounting screw (12) must be loosened or tightened a little.
- Then tighten the mounting screw (12) completely and loosen it again by half a turn.
- Close the window shutter of the tube stand.
- Check the vertical position of the crystal (visual check on crystal and on markings of the two right-hand screws (13a, b). The final adjustment must be repeated if a correction is necessary.
- Remove the detector slit.
- Open the window shutter of the tube stand.
- The intensity now measured must not be more than 110 % of the intensity measured with the monochromator slit inserted. Otherwise repeat the complete adjustment.

- Close the window shutter of the tube stand.
- Mount the cover of the monochromator.
- Insert the detector slit again.
- The adjusted diffracted-beam monochromator can be dismounted and subsequently refitted without readjustments being necessary.

Radiation Protection



Caution!
The type approval only applies if the protective cover of the monochromator is completely mounted and if the entire safety circuit functions correctly. This is the case when the diffractometer is handed over to customer and is applicable to any routine operation. If the protective cover is dismounted or if the safety circuit is partially or completely bypassed, the type approval is no longer valid. For this reason, the key must only be used by AXS maintenance personnel or by personnel possessing a special licence according to the X-ray regulation.

Adjustments with the radiation switched on (key inserted) may only be carried out by persons professionally exposed to radiation and subject to personal dose rate measurements and medical supervision. Work must only be carried out with the lowest high-voltage and tube current values.

Use long adjustment tools!

Never reach into the primary beam!

6 Grazing Incidence Attachment

Table of Contents

6 Grazing Incidence Attachment 6-1
Application 6-1
Design and Operation 6-1
Design 6-1
Operation 6-1
Operation without Monochromator 6-2
Operation with Monochromator in Non-dispersive Arrangement 6-2
Operation with Monochromator in Dispersive Arrangement 6-3
Installation 6-3
Adjustments 6-4
Adjustment of Attachment with Monochromator 6-4
Preadjustment 6-4
Adjustment without Monochromator 6-8
Crystal Change 6-8
Radiation Protection 6-9
Technical Data 6-9
Figures 6-11

6 Grazing Incidence Attachment

Application

The grazing incidence attachment is designed for the measurement of thin films, surfaces and multilayers. X-ray diffraction using Bragg-Brentano geometry is only partially suitable for this type of application due to the unfavourable peak-to-background ratio. Applying small incidence angles (0.1° to 3°) of the X-ray beam leads to strongly reduced penetration depths and an increased size of the irradiated area. The diffracted beam is paralleled in the Soller slit of the attachment and can be monochromatized using a plane monochromator.

Design and Operation

Design

The grazing incidence attachment consists of four parts:

- Collimator block (containing the Soller slit)
- Foot of collimator block
- Monochromator block
- Detector holder

The attachment can be operated with or without monochromator.

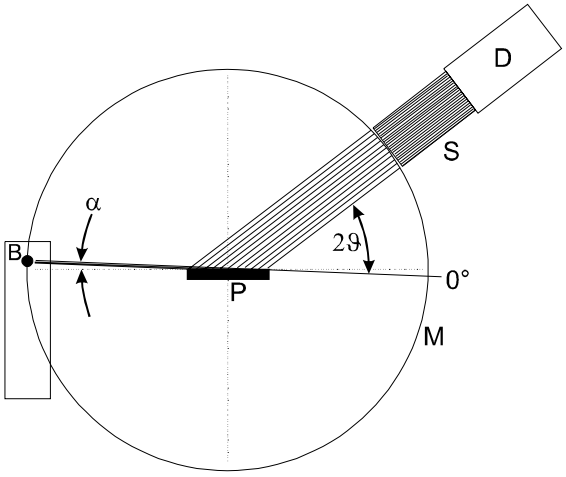
Operation

The grazing incidence attachment can be used for specimen analysis in the following three operating modes:

- Operation without monochromator
- Operation with monochromator in non-dispersive arrangement
- Operation with monochromator in dispersive arrangement

The pictures below show the basic principle of operation. It should be noted that the incidence angle a of the X-ray beam on the specimen is very small ($0{,}1° < \alpha < 3°$).

Operation without Monochromator

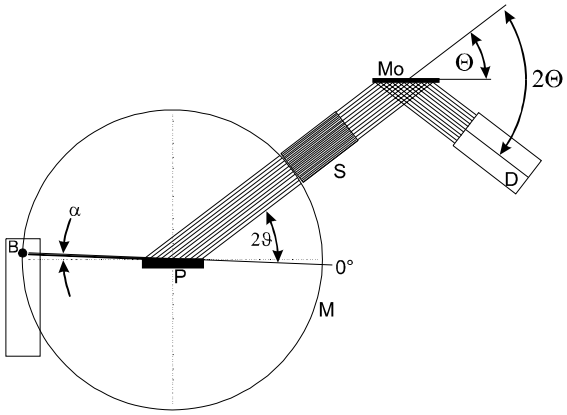


B Focal spot of X-ray tube
S Soller slit
D Detector
M Measuring circle
2ϑ Diffraction angle
P Specimen

Fig. 6-1: Operation without monochromator

Operation without monochromator gives relative high intensity but poor resolution.

Operation with Monochromator in Non-dispersive Arrangement



Mo Monochromator
θ Grazing angle of monochromator
2θ Diffraction agle of monochromator

Fig. 6-2: Monochromator in non-dispersive arrangement

Operation with Monochromator in Dispersive Arrangement

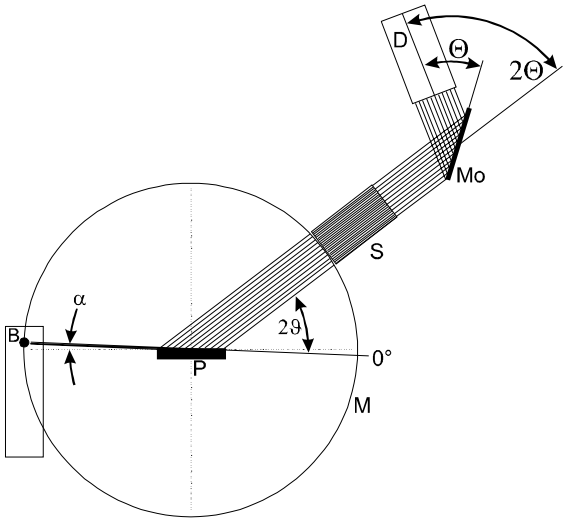


Fig. 6-3: Monochromator in dispersive arrangement

Operation in dispersive arrangement leads to better separation of the Kα doublets whereas the non-dispersive arrangement deteriorates the FWHM (Full Width at Half Maximum) and increases the intensity (overlap of the $K\alpha_1$ and $K\alpha_2$ lines).

Installation

Set the safety switches located on the tabletop of the radiation protective housing in accordance with the planned diffractometer configuration as described in the Installation Guidelines C79298-A3128-A10-*-28.

Caution:
Do not touch the surface of the monochromator crystal (Fig. 6-7.1) and the foils of the Soller slit.

Tools required for installation:

- Socket wrenches (sizes: 4, 3, 1.5, 0.9)
- Torx screwdriver for M 2 and M 4 screws

For operation without monochromator, the detector holder (fig. 6-7.2) is inserted into the pin guide direct at the foot (fig. 6-7.3) and fixed with two M 4 x 20 hexagon socket screws.

For operation with monochromator, the monochromator block is fitted into the pin guide at the foot (fig. 6-7.3) and fixed with four M 4 x 20 hexagon socket screws. The detector holder (fig. 6-7.2) is adapted to the monochromator block with two hexagon socket screws.

The whole attachment is mounted on the detector ring of the goniometer at the foot of the collimator block with two hexagon socket screws (instead of detector support).

Adjustments

⚠ **Caution:**
For alignment under radiation the safety circuit has to be by-passed using a key-switch. Please observe radiation safety regulations (see chapter "Radiation Protection).

The diffractometer itself has to be aligned in advance (please refer to the diffractometer operating instructions).

The grazing incidence attachment is adjusted using the Kα reflection of the anode material.

The following tools are required for adjustment:

- Long screwdriver
- Torx screwdriver
- Hexagon socket wrenches (sizes: 0.9, 1.5)
- Open-end spanner, width across flats 10 mm
- Knife-edged try square

Adjustment of Attachment with Monochromator

The measuring attachment is supplied with the following preadjustments:

- Coarse adjustment of cystal
- Coarse adjustment of Soller slit

The crystal holder (fig. 6-7.10) and detector holder (fig. 6-7.2) are set to the 0° mark of the scale graduations.

Preadjustment

Preparations for Adjustment

For adjusting the Θ angle (fig. 6-6.4), the cover (fig. 6-6.4) and the side panels (fig. 6-6.5) of the monochromator housing must be unscrewed. To remove the cylinder (fig. 6-6.6), the threaded pins (fig. 6-7.7) must be unlocked.

Caution: ⚠
Avoid touching the crystal surface in order not to destroy it!

Coarse Adjustment of Crystal

The crystal (fig. 6-7.1) is fixed to the holder (fig. 6-7.10) with tension screws and springs (fig. 6-8.8). The crystal is not directly attached to the crystal holder base plate. It must be parallel to this plate. For this purpose, equal distances between the four corner points of the crystal and the crystal holder base plate must be established. Using the tension screws (fig. 6-8.8) and a knife-edged try square, the crystal is adjusted vertically to the crystal holder disk (fig. 6-9.11).

⚠ **Caution:**
Do not touch the crystal with the try square.

The crystal (fig. 6-7.1) must be moved to the centre of the disk with an accuracy of 0.3 mm. This can be easily done by using the centre of the screw bolt (Figure 6-8.13) for adjustment.

Adjustment of Monochromator Diaphragm

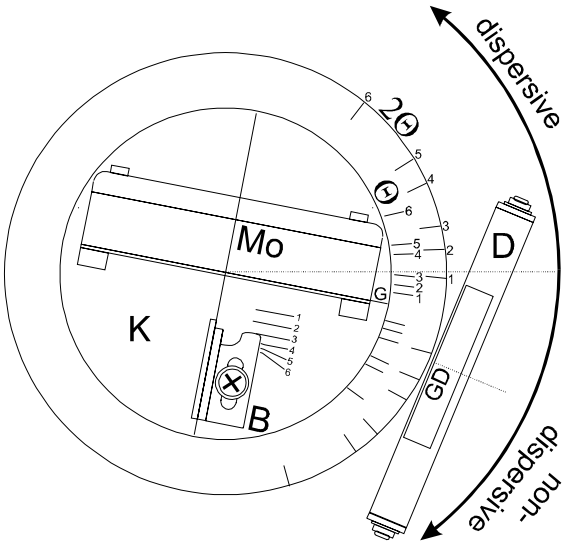
The monochromator diaphragm (fig. 6-9.12) must be screwed to the crystal at the proper distance depending on the type of radiation and crystal used (see fig. 6-5).

Adjustment of θ Angle

Slacken the nut (fig. 6-8.13) below the crystal holder (fig. 6-7.10) using an open-end spanner (width across flats 10 mm) and adjust the crystal holder (fig. 6-7.10) to θ (see fig. 6-5) with the aid of the inner graduations on the mounting bracket (fig. 6-7.15). Retighten the nut (fig. 6-8.13).

Adjustment of 2θ Angle

Slacken the nut (fig. 6-8.14) below the mounting bracket (fig. 6-7.15) with the open-end spanner (width across flats 10 mm). Adjust the detector holder (fig. 6-7.2) to 2θ with the aid of the external graduations (see fig. 6-5).



K *Crystal holder disk*
D *Detector holder*
GD *Graduation on detector holder (set to 2θ)*
θ *Inner scale graduations*
2θ *Outer scale graduations*
B *Diaphragm*
Mo *Monochromator crystal*
G *Graduation on crystal holder disk (set to θ)*

Fig. 6-5: Adjustment of 2θ angle

Radiation / Crystal	Cr	Cu	Mo
LiF	6	5	2
Graphite (Graphite crystal delivered on request)	4	3	1

If the dispersive configuration is to be used for measurements, the crystal holder disk must be rotated by 180°.

Coarse Adjustment of Soller Slit

⚠ **Caution:**
Do not touch the foils of the Soller slit.

Centre the Soller slit with respect to the opening of the shaft with the aid of the screws (fig. 6-7.9).

Change the direction of the Soller slit with the screw (9a) until it is in the middle of the shaft. Then turn the Soller slit by means of the screws (9b) and (9c) until the foils are parallel to the shaft sides and centrally to the shaft (this can be checked by reference to the Soller slit which must also be in a central position with respect to the lead diaphragm (fig. 6-9.17).

Mounting the Attachment on the Diffractometer

First the Soller slit must be taken out of the shaft. The leaf springs (fig. 6-10.18) into which a whole is drilled can be seen on the slit (fig. 6-10.27). Apply slight pressure to the leaf springs (fig. 6-10.18) and pull them out with the aid of a rod (e.g. hexagon socket wrench). Remove the Soller slit. Mount the attachment on the detector ring of the goniometer (instead of the detector support) and fix it. Insert the detector into the detector holder (fig. 6-7.2) and fix it with threaded pin (fig. 6-7.20).

Adjustment with the Radiation Source On

Fine adjustments of the crystal and the Soller slit with the radiation source on are made in such a manner that the foils of the Soller slit are parallel to the direct beam from the X-ray tube (0° beam).

Preparations for Crystal Adjustment

- To improve the resolution, insert the primary Soller slit or the divergence diaphragm close to the specimen with round diaphragm.
- Set the goniometer angles θ and 2θ to 0°.
- Insert the adjustment glass slit into the specimen changer.
- Insert the divergence diaphragm with small aperture angle (< 0,1°).
- Set the lowest high-voltage and tube-current values on the X-ray generator.
- Insert an absorber in the divergence diaphragm (pulse rate on detector to be limited to 10^5 per second) for X-ray generator values which are greater than (or equal to) 20 kV and 5 mA.
- Short out the X-ray safety circuit.
- Open the window slide of the tube stand.

Coarse Adjustment not Correct

If the X-ray beam does not enter the detector, a coarse adjustment has to be made first. To do this, slacken the nut (fig. 6-8.13) and insert a screwdriver or a rod (diameter less than 5 mm) into the pin guide (fig. 6-9.21) and rotate the crystal until the Kα reflection is detected.

⚠ **Caution:**
Adjustments must not be made with respect to the Kβ reflection. This is about 5 times smaller than the Kα reflection.

Retighten the nut (fig. 6-8.13).

Fine Adjustment of Crystal

If the Kα peak falls on the detector, the maximum peak intensity must still be reached. Rotate the crystal about the horizontal axis by turning the screw (8a) until the maximum intensity is reached. If the crystal is then outside the centre tolerance (0.3 mm), recentre the crystal by turning the three screws (8a, 8b, 8c) in the same direction and by the same amount. Then determine the maximum intensity with the screw (8a). If necessary, repeat these steps until the maximum intensity is reached with the crystal in the centre position. Then tighten the clamping screws (fig. 6-8.26).

Inserting the Soller Slit

Close the window slide of the tube stand. Unscrew the shaft of the Soller slit from the diffractometer; otherwise it will not be possible to replace the Soller slit. A small plate is glued to one side of the Soller slit. Move the Soller slit into the shaft in such a manner that the adjusting screw (9a) engages into the hole in this plate. The Soller slit must be flush with the shaft opening. Insert the two leaf springs. The leaf springs must engage into the two holes (fig. 6-10.22). Fix the slit shaft to the attachment again.

Adjusting the Soller Slit

Assuming correct coarse adjustment, the foils of the Soller slit are parallel to the shaft walls and vertical to the shaft bottom. To check this, first turn the screw (9a) until maximum intensity is reached (rotation about the horizontal axis). Then carefully turn one of the screws (9b or 9c) until maximum intensity is reached (rotation about the vertical axis). Readjust with screw (9a). In order to prevent the X-ray beam impinging direct on a foil, turn the screws (9a, 9b, 9c) in the same direction and by the same amount until maximum intensity is attained.

Enclosing the Monochromator Crystal

- Close the window slide of the tube stand.
- Switch off the X-ray generator.
- Cancel the short-circuit of the X-ray safety circuit.

Place the cylinder according to the set-up selected, making sure the 0 mark of the cylinder is in line with the 0 mark of the mounting bracket (fig. 6-7.15). Fix the cylinder with the threaded pins (fig. 6-7.7). Assemble the side panels (fig. 6-6.5) and the cover (fig. 6-7.4) with the detector holder (fig. 6-7.2). The side panels must be flush with the cylinder (fig. 6-6.6).The cylinder and side panels must immerse in the cover groove.

Adjusting the Safety Switch

Unlock the screws (fig. 6-8.24) and then shift the angle (fig. 6-8.25) of the safety switch (fig. 6-8.23) so that the switch is activated shortly before collision of the tube stand and the attachment. Adjust the cam for pressing the limit switch on the goniometer so that the attachment will not collide with the table top of the goniometer housing (for angles see Section "Technical Data" on page 6- 9).

Adjustment without Monochromator

Proceed as follows when adjusting the attachment without monochromator (the unit is supplied with the Soller slit already adjusted).

- Fix the detector holder (fig. 6-7.2) to the collimator block
- Follow section "Coarse Adjustment of the Soller Spalt" (see page 6-6).
- Screw the foot of the collimator block to the detector ring of the gonimeter (instead of detector support)
- Insert the detector in the detector holder (fig. 6-7.2) and screw down with threaded pin (20).
- Follow section "Preparation of the crystal alignment" of the Alignment with Monochromator (page 6-4).
- Follow section "Alignment of the Soller slit" of the Alignment with Monochromator
- Follow section "Alignment of the safety switch" of the Alignment with Monochromator (page 6-8)

Crystal Change

The crystal (fig. 6-7.1) is fixed in the crystal holder (fig. 6-7.10) by means of the tension screws (fig. 6-8.8). Other crystals can also be used; but this requires readjustments.

Radiation Protection

⚠ **Caution:**

The construction license is only valid if the radiation protective housing is completely mounted and if the entire safety circuit functions properly. This is the case when the diffractometer is handed over to the customer in operational condition and holds for any routine operation. If parts of the protective housing are dismounted or if the safety circuit is bridged partially or completely, the construction license is no longer valid. For this reason, the shorting plug must only be used by BRUKER AXS service staff or by authorized persons having an operating license according to the X-ray regulations. The shorting plug is not included in the standard supply of the diffractometer. It may only be handed over to clients having a special operating license.

The client must be informed about the danger arising from the use of the shorting plug.

Adjustments with the radiation source on (shorting plug inserted) may only be carried out by authorized persons who are subjected to regular dose rate measurements and medical supervision. Work may only be carried out with the lowest high voltage and tube current.

Only use long adjusting tools.

Never reach into the beam path.

Technical Data

Soller slit	0,15° (delivered on request); 0,40°
Crystal	LiF 100; graphite (graphite delivered on request)

Setting angles

2θ angle marked with graduations

Radiation / Crystal	Mo	Cu	Cr
LiF	20.32°	44.99	69.29°
graphite (delivered on request)	12.16°	26.57°	39.93°

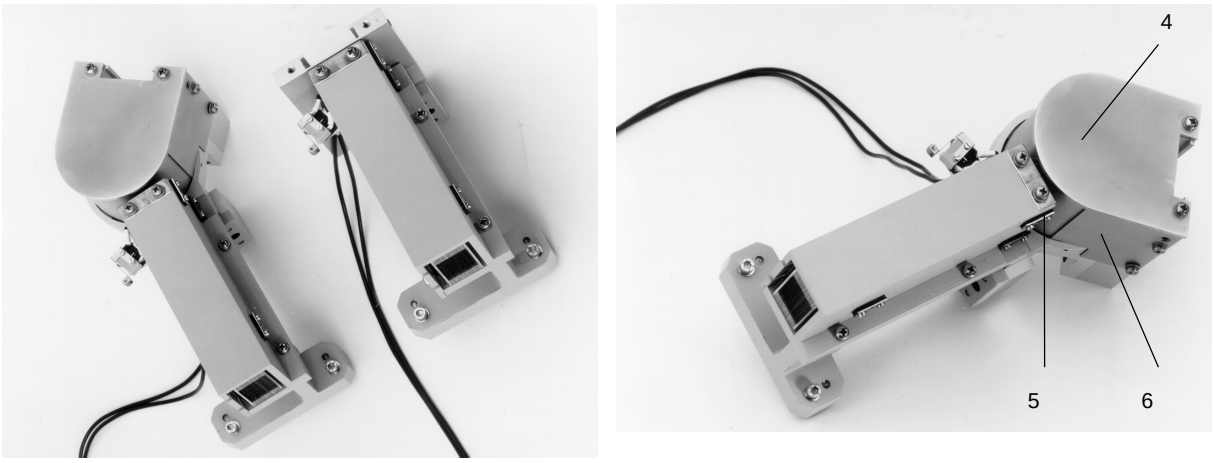
2θ angle not marked by graduations

Radiation / Crystal	Ag	Co	Fe
LiF 100	16.00°	52.75°	57.47°
graphite (delivered on request)	9.59°	30.95°	33.56°

Configuration	• monochromator in dispersive arrangement • monochromator in non-dispersive arrangement • without monochromator
Detector	Each detector whose mass does not exceed 3.5 kg
Obtainable 2θ-angles	• non-dispersive arrangement: -2.5° to 160° • dispersive arrangement: -15.0° to 16° • without crystal: -30.0° to 160

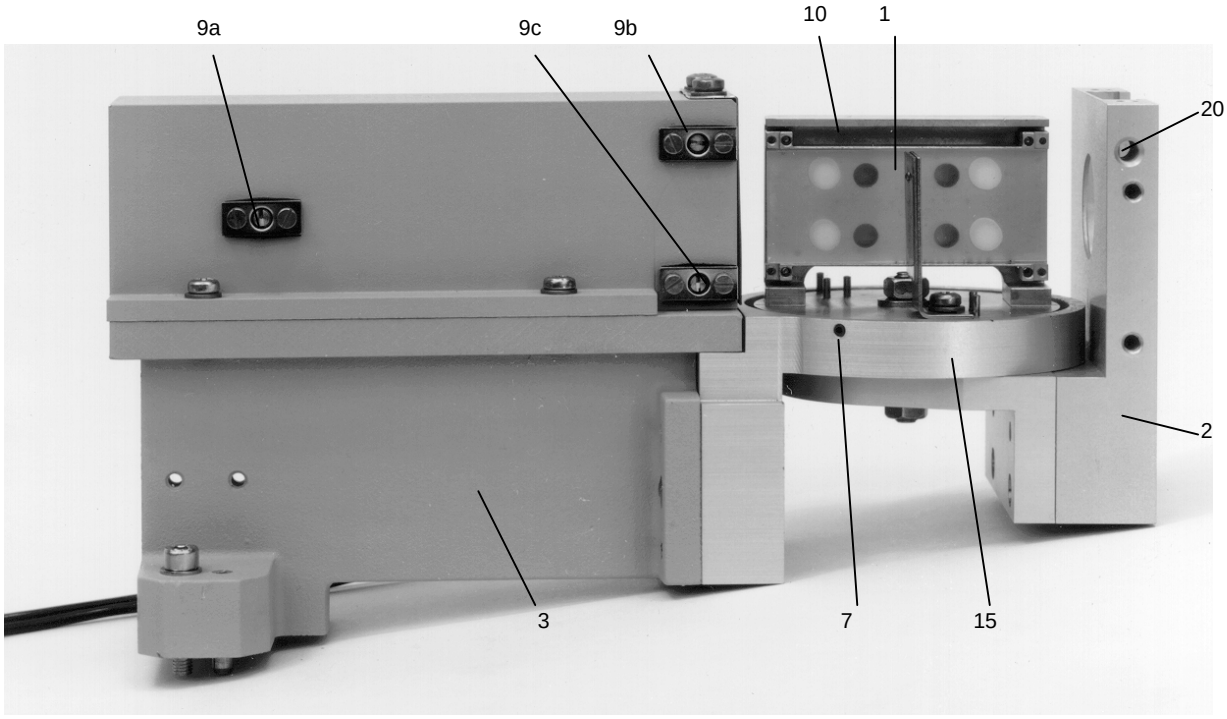
These angles apply to operation in vertical arrangement and for a scintillation counter as the detector. If the diffractometer is operated in the horizontal position, the measuring range is increased (in the minus range) because the measuring attachment must only be braked shortly before it comes into collision with the tube stand.

Figures



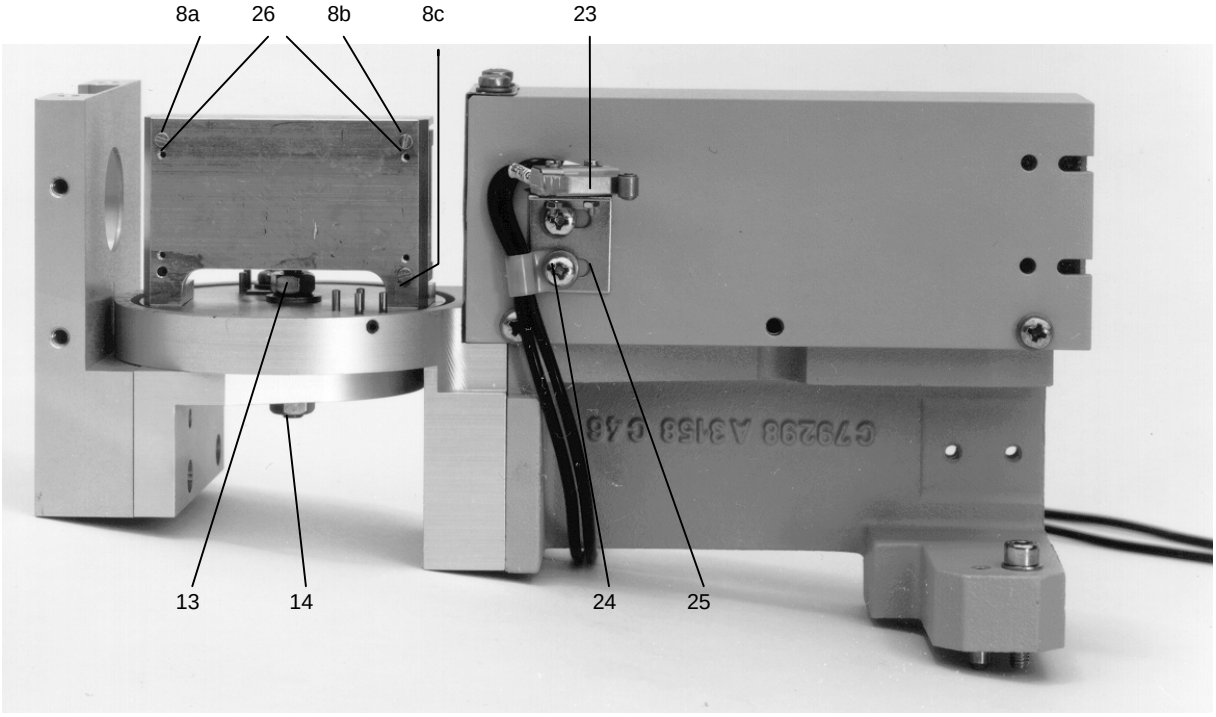
4 Cover
5 Side panel
6 Cylinder

Fig. 6-6: Grazing incidence attachment with and without monochromator



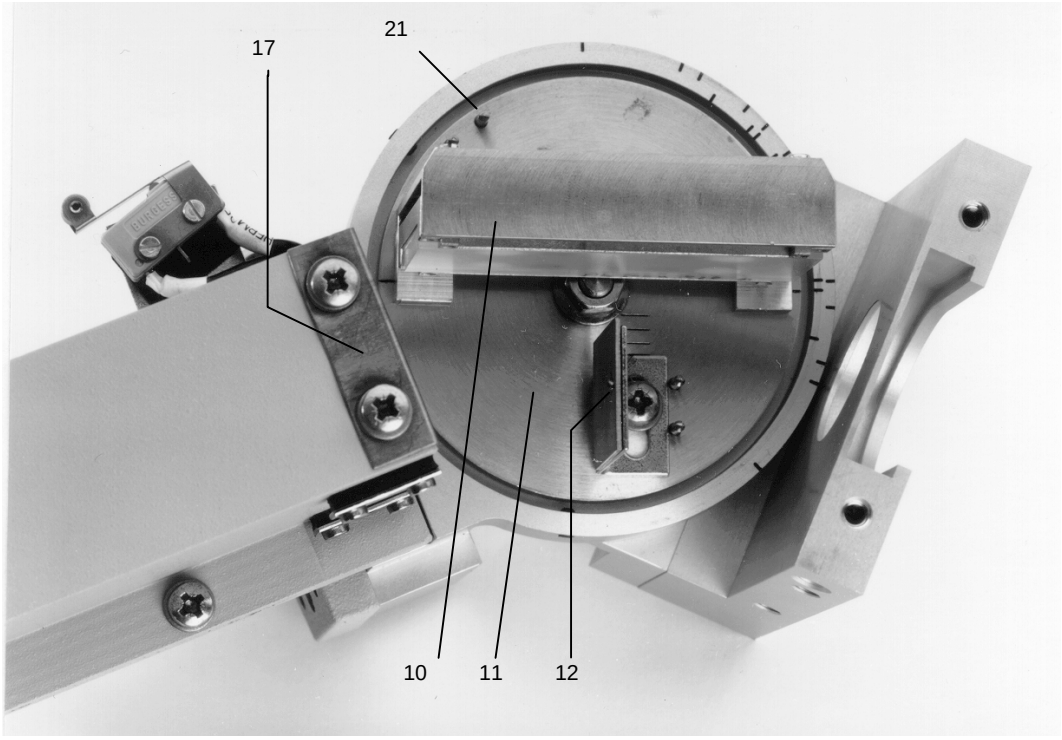
1 Crystal
2 Detector holder
3 Foot of collimator block
7 Threaded pins
9 a ... c Screws for Soller adjustment
10 Crystal holder
15 Mounting bracket
20 Threaded pins

Fig. 6-7: Attachment with the monochromator uncovered (front of crystal holder)



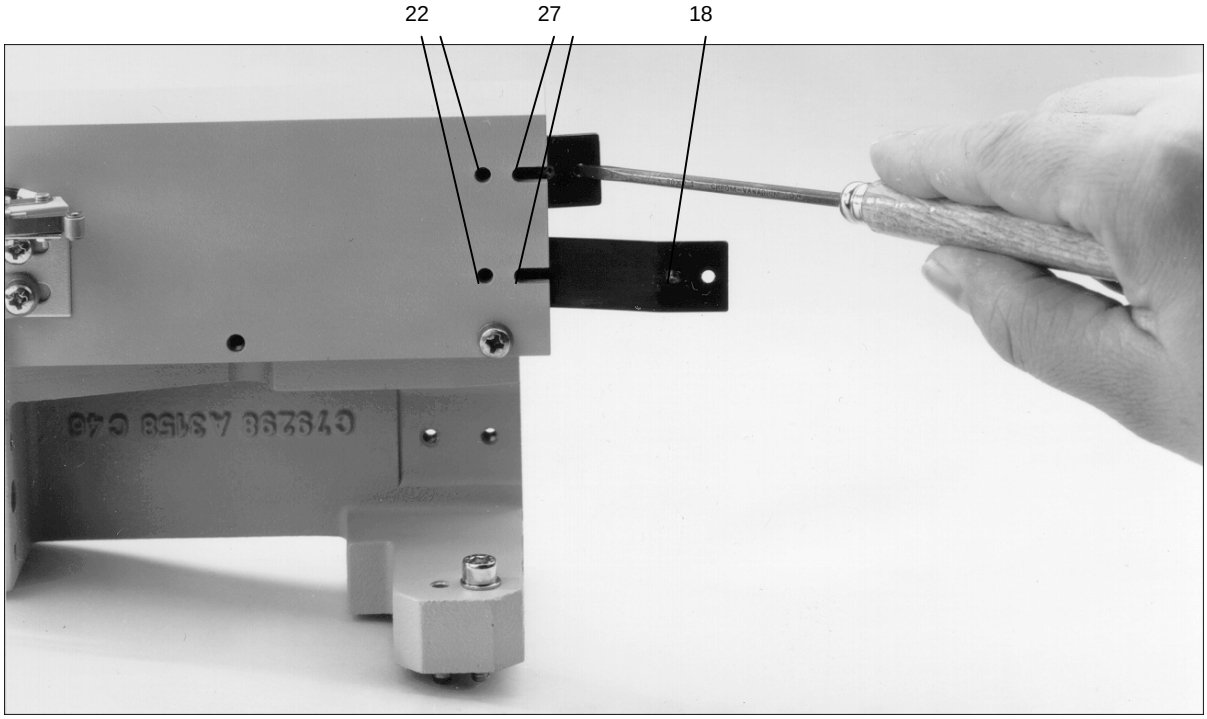
8a, b, c Screws for crystal adjustment
13 Nut for mounting bracket
14 Nut for detector holder
23 Safety switch
24 Screws for angle
25 Angle
26 Locating screws for crystal adjustment

Fig. 6-8: Measuring attachment (rear of crystal holder)



10 Crystal holder
11 Crystal holder disk
12 Diaphragm
17 Lead diaphragm
21 Pin guide

Fig. 6-9: Monochromator (top view)



18 Leaf springs
22 Holes for leaf spring engagement
27 Slot in Soller shaft

Fig. 6-10: Removing the Soller slit

7 Reflectometer Sample Stage

Table of Contents

7 Reflectometer Sample Stage 7-1
Alignment of the Reflectometer Sample Stage 7-1
Introduction 7-1
Calibrating the Edge Diaphragm 7-2
Mounting Instructions 7-2
Alignment of the Edge Diaphragm 7-2
The Alignment of the Reflectometer Sample Stage 7-4
Introduction 7-4
Alignment of the Angular Scales 7-4
The Alignment of the Sample 7-8
The Mounting of the Sample 7-8
The Alignment of the Distance between Edge and Sample Surface 7-8
The ϑ-Alignment with a Mounted Sample 7-9
Example for a Sensible Reflectivity Measurement 7-10
Introduction 7-10
The Standard Experimental Set-Up 7-11
Alignment 7-11
Creating Measurement Instructions for a Reflectivity Measurement 7-12
Creating Measurement Instructions for a Reflectivity Measurement using DIFFRAC^{plus} 7-13
Instruction for the alignment of the edge diaphragm 7-18
Alignment of Reflectometry for Theta-Theta 7-19
Differences compared to theta-2theta 7-19
First alignment after installation of reflectometry stage (especially Temperature chamber "TC-Reflectometry") 7-19

Alignment of sample (use appropriate Cu absorber) 7-20

7 Reflectometer Sample Stage

Alignment of the Reflectometer Sample Stage

Introduction

For executing reflectivity measurements with the D8 the special Reflectometer Sample Stage (RSS, Fig. 7-1) was designed. The main components of this RSS are the vacuum sucker and the edge diaphragm in front of the vacuum sucker. Both are mounted on translation stages. Both translations are controllable by using micrometric screws (see also Fig. 7-2 and 7-3). The absolute position of the edge diaphragm is displayed by a dial indicator. The zero point of this position must be calibrated before the dial indicator can be used for controlling the absolute position of the edge diaphragm. The calibration is described in the next section.

After this procedure the RSS can be mounted on the D8. The alignment of the RSS, the alignment of a sample and an example how to execute a reflectivity measurement are shown in the following sections.

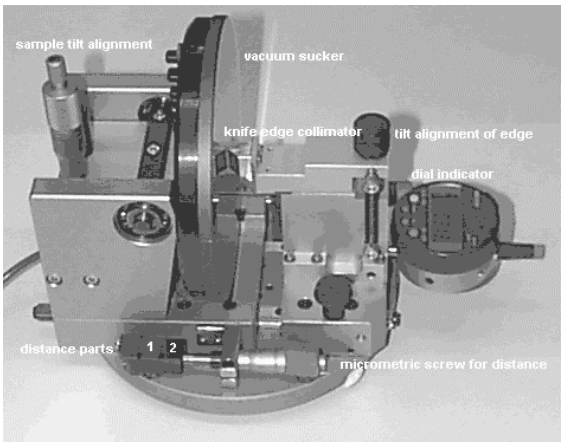


Fig 7-1: A side view (from the reflected beam side) of the reflectometer sample stage.

Calibrating the Edge Diaphragm

Mounting Instructions

The tilt angle of the edge and the zero position of the dial indicator must be calibrated to ensure reproducible results for the reflectivity measurements. This is done during the factory alignment before the RSS is shipped.

To repeat the alignment procedure for any reason (e.g. if the edge must be changed), every RSS is shipped with a precise bolt of hardened steel. The exact diameter of the uppermost cylinder of the bolt is 10 mm. The bolt must be mounted in the middle of the RSS (fig. 7-2). Its position is factory aligned and is reproducibly defined by two pins. To mount the bolt on the RSS, the vacuum sucker must be moved to its most distant position. For this purpose the two distance parts (fig. 7-1) must be removed and the micrometric screw must be turned until the position base for the bolt is visible. To avoid unintentional contacts, the edge diaphragm has also to be moved to its most distant position (use the fast moving option, loose the lock and move the sliding carriage manually).

If the complete mounting base is visible on the bottom of the RSS, the bolt can be inserted. The pins must match with the referring holes. The position of the bolt must be fixed by tightening the four screws. The screws shall first be tightened a little bit. Finally the screws shall be tightened crosswise.

Compared to fig. 7-1 the two distance parts at the micrometric screw seen on the bottom of figure 7-2 are removed. The bolt is mounted in centre of the RSS.

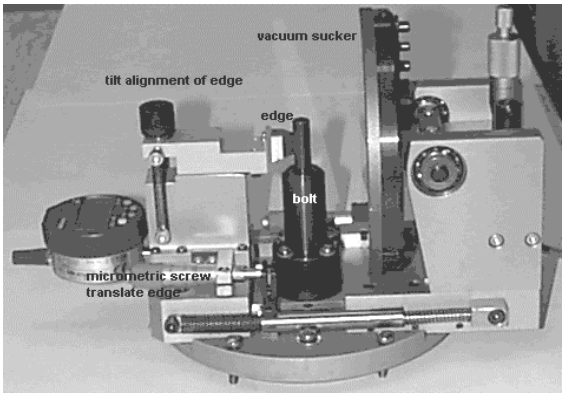


Fig. 7-2: A side view of the RSS.

Alignment of the Edge Diaphragm

The uppermost cylinder of the bolt is the reference for the zero point of the dial indicator. As well it is the reference for the tilt angle of the edge diaphragm. Both parameters must be aligned simultaneously.

First, the edge must be brought close to the bolt. Therefor the lock of the sliding carriage of the edge must be loosen. It must be taken care to avoid a collision of the edge with the bolt. The micrometric screw (fig. 7-3) is then used to bring the edge closer to the bolt.

By observing the distance, the bolt is moved closer and closer to the bolt. The observing can be done directly or by using a magnifying

glass. More comfortable is the use of a telescope.

Simultaneously, the tilt between the bolt and the edge must be controlled. If any tilt is observable, the tilt of the edge must be changed. Therefor the top of the tilt alignment screw must be removed and an 1/4" Allen screw becomes accessible. If the alignment is finished the top must be remounted to avoid unintentional changes of the tilt angle of the edge.

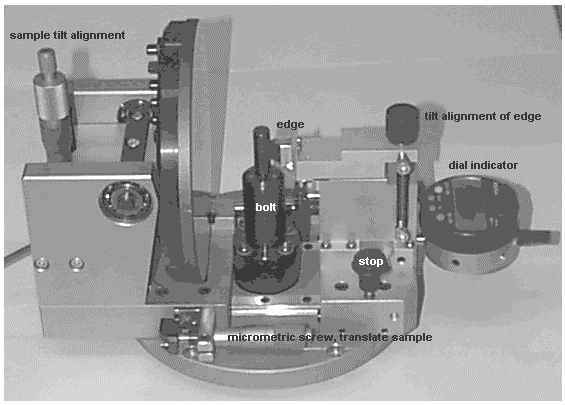


Fig. 7-3: Side view of the RSS (from the incident beam side).

If the edge and the bolt are absolutely parallel, the edge can be moved towards the bolt. The correct position is reached if no light passes the slit between the bolt and the edge.

After reaching the correct position the display of the dial indicator can be set to zero (Zero/Abs button).

Pay attention that the display of the dial indicator is set to **invers**. That means the the displayed values have to decrease if the edge diaphragm is moved towards the bolt.

Then the edge has to be moved away from this position to allow the removal of the bolt.

When the bolt is removed the edge must be moved to his front position. It is reached if the lock of the sliding clicks into place again.

After this the micrometric screw is used to move the edge to –**5.000 mm** (half the diameter of the uppermost cylinder of the bolt). This position is now the correct centre of the RSS. The display of the dial indicator must be set to zero again. This zero point is the reference for all following alignment procedures, e.g. alignment of the sample.

From now on the dial indicator shall not be switched off because otherwise the exact zero position is lost. If the RSS shall not be used for a long time move the edge to **0 mm** and then switch off the dial indicator. After the dial indicator will be switched on again the display will show **0 mm** again and this value will be correct.

Note:
If the edge touches the bolt a spring avoids a damage of the edge. But nevertheless, the user himself shall avoid this collision. Especially, the collision can damage the edge, if the fast sliding of the edge is used.

The Alignment of the Reflectometer Sample Stage

Introduction

Before starting with the alignment of the RSS, the D8 and all optical components shall be aligned by the standard procedure.

In detail that means that the radiation outlet flange, the aperture diaphragm, the scattered-radiation diaphragm, the zero point of ϑ and 2ϑ are aligned. All these work is done by using the standard sample changer or similar stages.

After this the sample changer must be removed and the Reflectometer sample stage has to be mounted. For executing reflectivity measurements at least the following optical components have to be installed:

1. Incident beam optics:
   the aperture diaphragm holder for fixed diaphragm including primary soller slit or alternatively the aperture diaphragm holder for variable diaphragm.
2. Reflected beam optics:
   the detector diaphragm holder for fixed diaphragms including the secondary soller slit or alternatively the detector diaphragm holder for variable diaphragms including the secondary soller slit.

Depending on the necessary resolution of the measurements a diffracted beam monochromator can be used. In this circumstances resolution means which layer thickness must be resolved by the reflectivity measurements. To resolve interferences coming from thin layers (<100 nm) only standard resolution is necessary. For all investigations the use of a diffracted beam monochromator is recommended. Nevertheless, if a secondary monochromator is mounted, it is not necessary to remove it.

If no secondary monochromator is available a Kβ-filter and a detector slit can be used to execute reasonable reflectivity measurements.

The application of any measuring circle diameter is possible. Increasing circle diameter effects an improving resolution but a decrease of intensity. That means as well for the incident beam as well for the diffracted beam side. For the reflectivity measurements it is not necessary to fulfil the Bragg-Brentano parafocusing condition. But if also standard powder or thin film investigations (gracing incidence diffraction) shall be done with the RSS, it is recommended to select a circle diameter fulfilling the Bragg-Brentano condition.

A recommendation is to use the 600 mm measuring circle diameter for the position of the X-ray source and the detector diaphragm holder. If a smaller measuring circle diameter is used a smaller angular range for standard powder diffraction measurements is accessible.

Alignment of the Angular Scales

To align the zero points of the measuring drives ϑ and 2ϑ the user must be familiar with the D8 controlling software DIFFRAC^{plus}.

To execute the following steps D8 *Immediate Measurement* must be started.

The alignment is done by using the glass slit at the sample position. For this purpose the exact thickness of the glass slit must be known. Fig. 7-4 shows a sketch of a glass slit shipped with the D8.

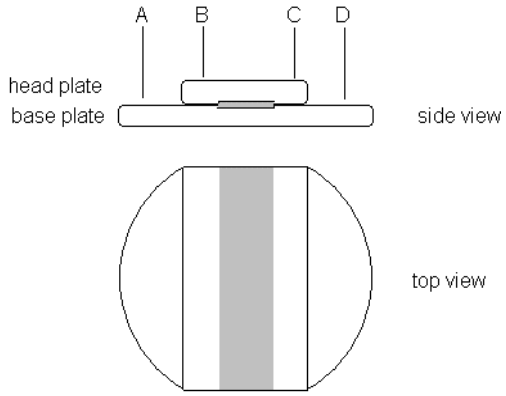


Fig. 7-4: A sketch of the glass slit.

In figure 7-4 a side view and a top view is shown. The characters A, B, C and D mark the points where the thickness of the glass slit shall be determined.

After the thicknesses at the marked points are measured an interpolation shall be done to determine the average thickness of the base plate D_{base} and the overall thickness of the glass slit D_{slit}. The necessary thickness of the head plate is the given by $D_{head} = D_{slit} - D_{base}$.

The glass slit is be mounted on the RSS. The position of the glass slit must be aligned in two steps. First of all the edge is moved to the **0 mm** position. Then the glass slit is moved towards the edge until the slit between the edge and the glass slit is close. The width of the remaining slit shall be light proofed. Now the glass slit is **not** in the centre of the RSS. To bring the 100 µm channel of the glass slit in the centre of the goniometer it must be translated by D_{head} mm. But first the edge must be moved to its most distant position. After this the scale of the micrometric screw of the vacuum sucker is used to find the correct position of the glass slit. The micrometric screw must be turned clockwise by an amount of D_{head} mm.

a) Zero Point Definition of the Θ-Scale

Constellation
Generator: 40 kV, 40 mA; the RSS is mounted on the D8; the glass slit is mounted and the channel in the glass slit is in the centre of the goniomete

variable aperture diaphragm fixed	342 (open) 6 mm
sample	glass slit
fixed scattered–radiation diaphragm variable	open or 342 (open)
Kβ filter	as required
detector diaphragm	open
ϑ	-0.5° ≤ ϑ ≤ +0.5°
2ϑ	0.0°
Cu absorber 0.1 mm	

Measurement
A rocking curve with -0.5° ≤ ϑ ≤ +0.5° and a step size of 0.02° is executed. The angular position ϑ_{max} of the maximum of intensity is determined by using *determine ZI-values* (ZI key).

Consequence
If $|\vartheta_{max}| < 0.001°$ is fulfilled then the zero point of the ϑ-scale is correct (leave *determine ZI-values* by <ESC>).

Otherwise ϑ_{max} must be set to 0.0° (leave *determine ZI-values* by <RETURN>) and the measurement must be repeated.

Result
The zero point of the ϑ-scale is defined.

Remarks
If no maximum of intensity is found, the range of the rocking curve must be increased.

The reflection width is small (FWHM < 0.05°), please decrease the step size and the range of the rocking curve.

Fig. 7-5 shows rocking curve measurements which were obtained during the alignment of the zero point of the ϑ-scale. The sequence of the alignment was from the bottom curve to the top curve.

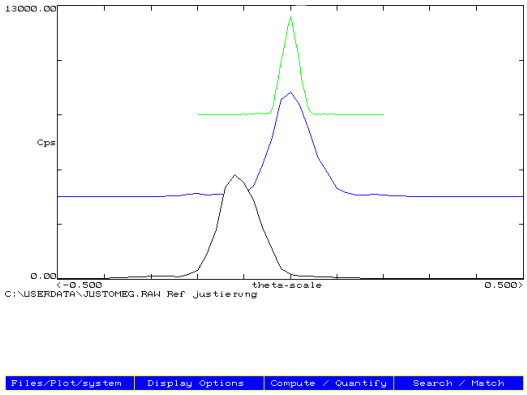


Fig. 7-5: Rocking curve measurements

b) Zero Point Definition of the 2ϑ–Scale

Constellation
The same as given in section a).

variable aperture diaphragm fixed	342 (open) 6 mm
sample	glass slit
fixed scattered–radiation diaphragm variable	open or 342 (open)
Kβ filter	as required
detector diaphragm	0.1 mm
ϑ	0.0°
2ϑ	–0.5° ≤ 2ϑ ≤ +0.5°
Cu absorber 0.1 mm	

Measurement
A detector–scan (2ϑ-scan) with -0.5° ≤ 2ϑ ≤ +0.5° and a step size of 0.02° is executed. The angular position $2\vartheta_{max}$ of the maximum of intensity is determined by using *determine ZI-values* (<ZI> key).

Consequence
If $|2\vartheta_{max}|$<0.001° is fulfilled then the zero point of the 2ϑ-scale is correct (leave the *determine ZI-values* by <ESC>).

Otherwise $2\vartheta_{max}$ must be set to 0.0° (leave *determine ZI-values* by <RETURN>) and the measurement must be repeated.

Result
The zero point of the 2ϑ-scale is defined.

Remarks
If the zero point of the 2ϑ-scale is correct please repeat section a) to verify the results. At least section a) and b) shall be executed two times.

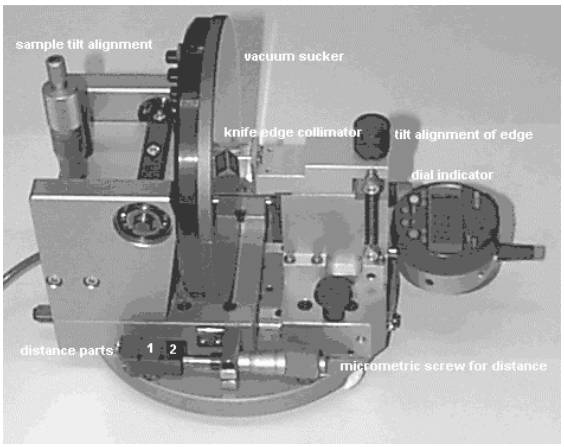


Fig. 7-6: Measurement results obtained during the alignment of the zero point of the 2ϑ-scale.

In the figure above the sequence of the alignment was from the bottom curve to the top.

The Alignment of the Sample

The Mounting of the Sample

Originally, the RSS is designed to carry semiconductor wafers or other flat samples. This kind of samples can be fixed by using the vacuum sucker. The sucker posses a number of holes with small diameter. They are the jets for the vacuum pump. Holes which are arranged at the same distance from the centre of the suck can be closed simultaneously by using the valve at the back side of the suck. So a big number of different sized sample can be fixed with the suck.

Samples with a bented or a very rough backside must be fixed at the suck using for example a scotch tape. The same is true if the contour of the sample does not match to the arrangement of the holes.

The Alignment of the Distance between Edge and Sample Surface

To align the sample and to ensure sensible reflectivity measurements the distance between the edge and the surface of the sample must be well aligned. For this purpose the edge is moved to the 0 mm position by turning the micrometric screw counter clockwise (fig. 7-3). This is done under control of the dial indicator.

Caution:
When moving the sliding carriage towards the edge diaphragm avoid to touch the edge!



Under optical control the sliding carriage of the vacuum sucker is moved towards the edge diaphragm. The referring micrometric screw must be turned clockwise to decrease the distance between edge and sample surface. If any deviation is visible between the surface orientation of the sample and of the edge the tilt of the sample must be changed by using the sucker tilt alignment screw (fig. 7-1). A clockwise turn of the screw effects a tilting of the surface of the sample towards the base of the stage.

The alignment must be continued until

1. the edge and the surface of the sample are parallel and
2. the slit between edge and sample is as close as no visible light can pass it.

The ϑ-Alignment with a Mounted Sample

Because the front and the backside of any sample never are absolutely parallel the zero point of the ϑ-scale must be defined for every individual sample.

Configuration

Generator: 40 kV, 40 mA; the zero settings must be unlocked

variable aperture diaphragm fixed	342 (open) 6 mm
sample	mounted
fixed scattered–radiation diaphragm variable	open or 342 (open)
Kβ filter	if required
detector diaphragm	0.1 mm
ϑ	0.15° ≤ ϑ ≤ +0.25°
2ϑ	0.4°
Cu absorber 0.1 mm	

Measurement

A rocking curve measurement is done with 0.15° ≤ ϑ ≤ 0.25° and a step–width of 0.004°. The angular position ϑ_{max} of the maximum of intensity is determined by using *determine ZI-values*.

Consequences

If no maximum of intensity appears, the width of the rocking curve must be increased.

The alignment is correct if the maximum of intensity appears and ϑ_{max}=0.2°±0.001° is fulfilled. The *determine ZI-values* must be closed by <ESC>.

Otherwise ϑ_{max} must be set to 0.2°, the *determine ZI-values* must be closed by <RETURN> and the rocking curve measurement must be repeated.

Result

The zero point of the ϑ-circle is aligned in respect to 2ϑ and by considering the parallelism of the surfaces of the sample.

2ϑ = 0.4° is typically well below two times the critical angle of most materials (ϑ_0 = critical angle). If the surface of a sample is very rough, it may be possible that 2ϑ must be set to a smaller angle $2\vartheta_0$. In this case the rocking curve must be done with $2\vartheta_0/2 - 0.05° \leq \vartheta \leq 2\vartheta_0/2 + 0.05°$. The determined ϑ_{max} must be set to $2\vartheta_0/2$ and the rocking curve must be repeated.

If the full width at half maximum (FWHM) of the reflection is much broader than 0.02°, the step-width and the range of the rocking curve must be increased.

The intensity of the maximum should be about 20000 c/s to have a statistically sensible value.

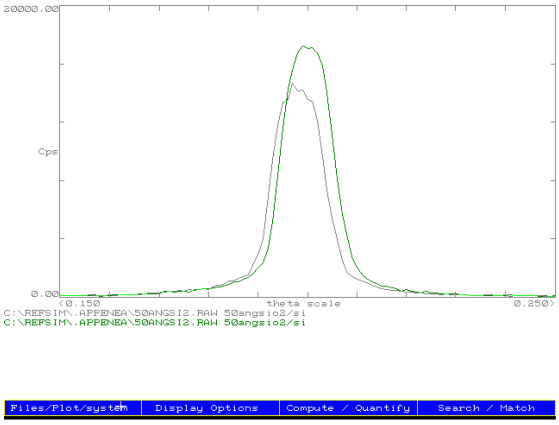


Fig. 7-7: Two rocking curves obtained during the alignment of the ϑ-circle.

Fig. 7-7 shows two rocking curves obtained during the alignment of the ϑ-circle. 2ϑ is 0.4° and a sample is mounted on the RSS.

Example for a Sensible Reflectivity Measurement

Introduction

Reflectivity measurements are typically executed from 0.0° up to several degrees. The possible endpoint of the ϑ/2ϑ coupled scan depends on the reflectivity power of the sample. This power depends on the surface and interface roughnesses of the sample, on the scattering power of the individual atoms in the sample and the density of the material.

On the other side, the endpoint of reflectivity measurement is defined by the accessible overall measuring time for each sample and on the information which shall be obtained by the measurement.

The example given below is a typical application for a reflectivity measurement. The sample is a part of a silicon wafer with a about 50 Å thick oxide layer on top. A 50 Å thick layer causes interference fringes with angular distances of about 0.8°. Therefore the reflectivity measurement has to go up to 6° in 2ϑ to make a number of interference fringes visible. Furthermore, the difference between the electronic densities of crystalline silicon and amorphous or polycrystalline silicon oxide is very small. Therefor the height of the interference fringes above the continuos decrease of the reflectivity curve is very small. So enough measuring time is necessary to obtain the fringes besides the statistical deviations of the measurement.

The Standard Experimental Set-Up

The distances between the X-ray source and the sample respectively between the sample and the detector influence the resolution of the reflectivity measurements. Therefore the user has to decide which distances he/she wants to use.

But the parameters of the following optical components are standard. As well the primary as the secondary soller slit is recommended. A sensible width of the aperture diaphragm is 1 mm. Its only sense is to reduce the background. In principle compared to standard powder diffraction measurements the edge diaphragm works as the aperture diaphragm. Therefor the use of small slit (e.g. 0.2 mm or less) makes no sense and can cause problems.

If the height of the sample is smaller the 15 mm or it is bented so that only a part of the surface of the sample should be illuminated a beam height limiter is recommended. Two small pieces of lead glued in the 1 mm aperture slit are a serious beam height limite For samples which are flat and cover the whole edge diaphragm a 6 mm high beam limiter in the 1mm aperture slit is recommended. This avoids that parts of the vertical divergent beam passes above or below the edge diaphragm.

A sensible distance between the surface of the sample and the edge diaphragm depends on

1. the resolution which should be reached
2. the size of the sample and
3. the range which the reflectivity measurement should cover

If the length of the sample is about 1 cm only and very high resolution is necessary a light proofen slit is recommended. More usual for standrad measurements is a 10-µm or 20-µm slit. The last should be used if the measurements should go up to big incident angles (e.g.>4°).

An anti-scattering slit of 2 mm is helpful to reduce the background. A detector slit of about 0.3° (use the distance between sample and detector slit to evaluate the width in mm) is recommended. The best way to select a sensible detector slit width is to decrease the width as long as no intensity decrease is noticeable.

Alignment

First of all the sample must be mounted on the RSS face to face to the edge. After this section the steps in section "Creating Measurement Instructions for a Reflectivity Measurement" must be executed.

The next goal is to optimise the scan ranges, the step size, the power of the generator (if a remote controllable generator is in use) and measuring time per step. That means that within *Immediate Measurement* some reflectivity measurements are done. Starting with $2\vartheta = 0°$ and a generator power of 20 kV and 5 mA the endpoint $2\vartheta_{end,1}$ for the first range of a complete reflectivity measurement must be found. The intensity of the endpoint shall at

least be above thousand counts per seconds. The endpoint $2\vartheta_{end,1}$ of the first range is the start point $2\vartheta_{start,2}$ of the next range. For this range the generator power can be increased to get more reflected intensity. The maximum count rate should not exceed roughly 100,000 c/s. As long as its is possible $2\vartheta_{end,2}$ shall fulfil the same condition as $2\vartheta_{end,1}$. The same is valid for all following ranges. If no further increase of the generator power is possible and the further ranges are necessary, the measuring time per step must be increased.

So, with the help of *Immediate measurement* an overview of the measurement parameters can be obtained. But the "real" reflectivity measurement is done by using *JOB measurements.*

If the generator is not remote controllable the increasing power can be entered manually.

Creating Measurement Instructions for a Reflectivity Measurement

The informations which are got by *Immediate Measurement* are the input for the "real" reflectivity measurement. To enter the measurement instructions for a qualitative measurement *EDIT DQL* must be selected. After creating a file name for the instructions (extension DQL) the measuring ranges can be edit.

Fig. 7-9 shows the set–up of the measuring parameters of the next range. The power of the generator is increased to the maximum compatible to the X–ray tube. The selected step size is optimised for interference fringes with a big angular distance. For the region very close to the critical angle of total external reflection (first range) the step size should be smalle But for further investigations all ranges of a complete reflectivity measurement must have the **same step size** and the step mode: **step scan** must be selected! Also, a smaller step size must be selected if interference fringes caused by thick layers are investigated.

Two successive ranges must have an overlap. That means that the stop position of one range must be the start position of the following range. Otherwise the evaluation software used later on can not work correctly.

(If the simulation program REFSIM^{TM} for reflectivity measurements is available it can be used to optimize the step size. The coarse sample parameters are necessary to set–up a simulation. Using the calculated angular differences between the interference fringes the step size can be optimised. If possible, at least 10 steps per interference fringe have to be selected.)

Because for the second range a generator power of 40 kV and 40 mA is used no further increasing power is selectable. Therefor all following ranges only differ by increasing measuring time per step.

The result of the complete reflectivity measurement can be displayed by the simulation program REFSIM.

If the generator is not remote controllable the power increase must be done manually. For

this purpose a delay time can be entered. The delay time interrupts the measurement at the beginning of a range and the power can be increased.

An alternative way to work is to use absorbers to reduce the primary intensity meanwhile the generator runs with full powe Also a delay time must be entered to get enough time to change or remove the absorber between successive ranges.

Fig. 7-8 shows the measurement results of the above defined measurement instructions. Because of the dynamical range of the intensity a logarithmic y-scale is used.

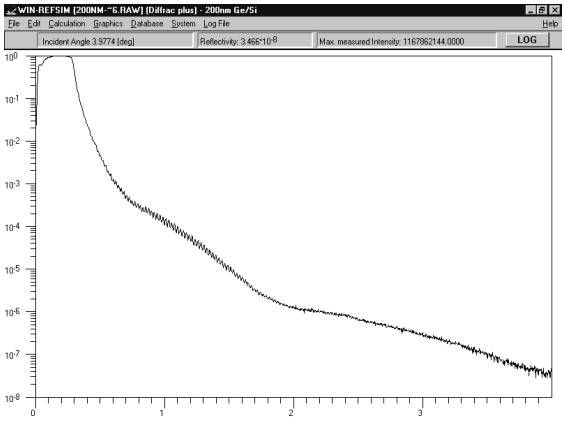


Fig. 7-8: Complete reflectometry measurement with 5 ranges

Fig. 7-8 shows the complete reflectometry measurement composed of 5 ranges. The data are displayed in an REFSIM window and can now be used for the sample parameter determination.

Creating Measurement Instructions for a Reflectivity Measurement using DIFFRAC*plus*

The information's about the intensity decrease which are got by *ADJUST* are the input for the "real" reflectivity measurement running in background. To enter the measurement instructions for a qualitative measurement *EditDQL ->Measurement Setup -> Qualitative Extended* must be selected. First, the instruction input form is displayed on the screen (fig. 7-9). In respect to the configuration of the diffractometer several entry fields may be greyed respectively disabled. Enter all the parameters which are necessary for the first measurement range. Typically the scan type is locked coupled and the scan mode is step scan. The step size entered in this input form has to be used for all successive ranges.

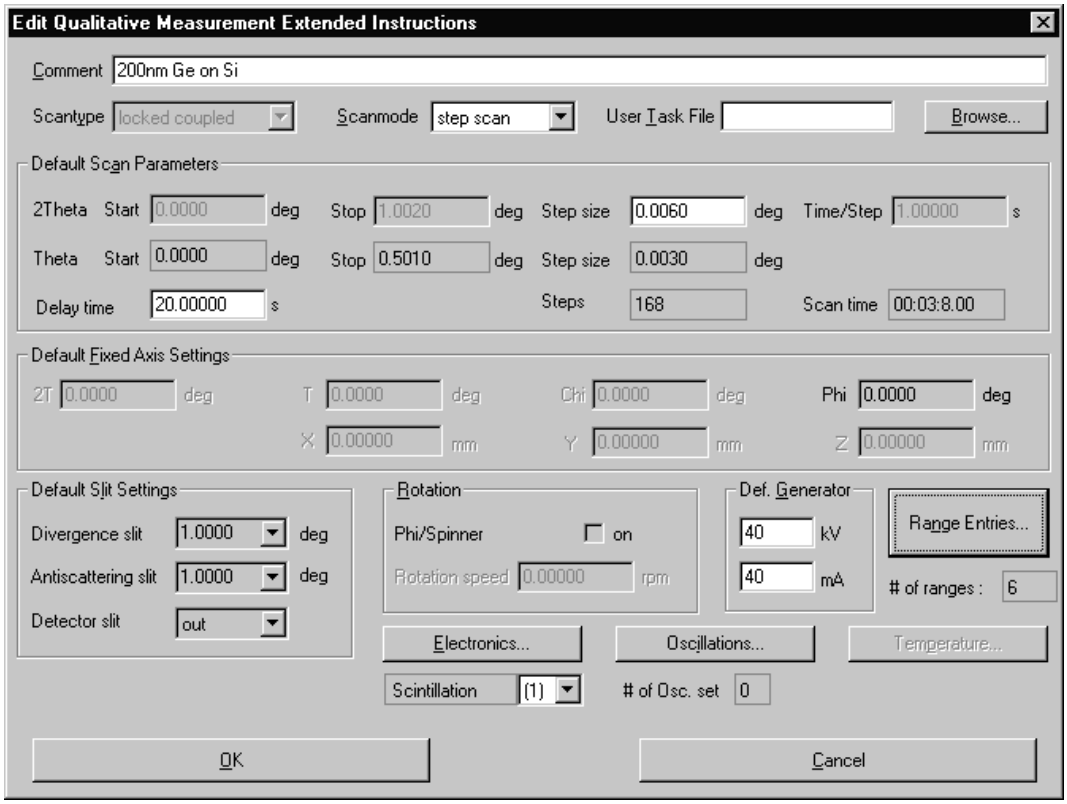


Fig. 7-9: The extended input form of EditDQL

Fig. 7-9 shows the extended input form of EditDQL with typical parameters for a first range of a reflectivity measurement

The example shown in figure 7-9 uses a delay time of 20 seconds. That means that between two successive ranges a waiting time of 20 seconds is included. This time can be used to remove a probably mounted absorber out of the diffracted beam optics. In case the diffractometer is equipped with an automatic absorber changer, a delay time is not necessary. The changer can be aligned into the beam by entering *Detector slit* in.

For all 6 ranges (# *of ranges field*) of this example the generator is set to 40 kV and 40 mA. Therefore it is necessary to have an absorber in front of the detector if the measurement range is executed in the regime of total external reflection (first ranges starts at 0° 2-theta).

In case the generator is not remote controllable the entry fields are disabled. The generator has to be set manually. In case you like to change the setting of the generator from range to range it might be better to increase the delay time by some extend.

For entering the parameters for the other ranges of the reflectivity measurement press the *Range* button (figure 7-10).

How to use the range editor is explained in the DIFFRAC^{plus} software manual.

As mentioned on page 7-11 the end position of a range must be the start position of the following range. This condition is fulfilled for the set of ranges shown on figure 7-10. After the first range will be finished the measurement program will stop for 20 seconds. Within this time the absorber must be removed. The measurement program will start immediately after 20 seconds and will break the measurement if for example the front door of the enclosure is still open for any reason.

The second range is measured again with 1 second per step, but because of the removed absorber the count rate will be high enough for statistical relevance. For the next ranges the measurement time per step is increased to obtain a better statistics although the count rate decreases.

The step size for all ranges is the same and therefor this parameter is not displayed in this form.

The overall measurement time is displayed in the *total meas. time* field.

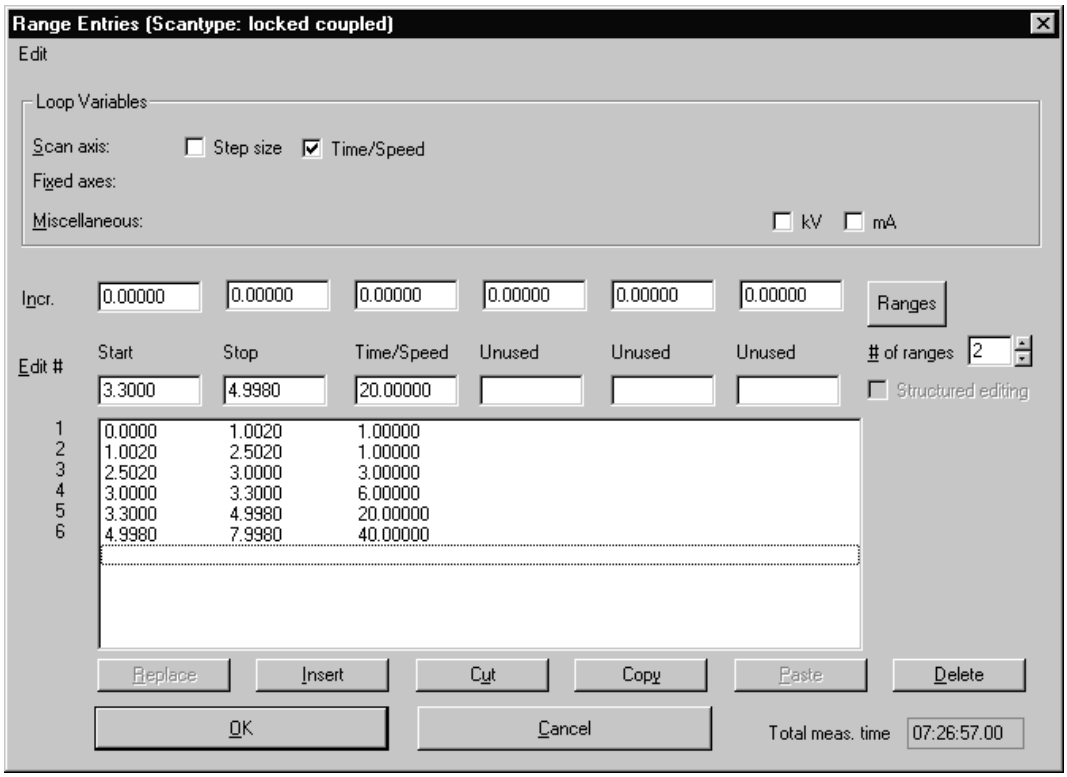


Fig. 7-10: The range entries form showing a typical set of ranges for a reflectivity measurement

The ranges entries input form has to be left by pushing the OK button. The same has to be done when the instruction form (fig. 7-9) is left. Safe the instructions into a DQL file.

The measurements are defined using EditJOB (refer to DIFFRAC^{plus} manual) and started with *JOB Measurement*.

After the measurement is successfully finished the data containing *.RAW file consist of 6 individual ranges (fig. 7-11). Using the logarithmic counts intensity scale within DIFFRAC^{plus} data evaluation program *EVA* the individual ranges become visible.

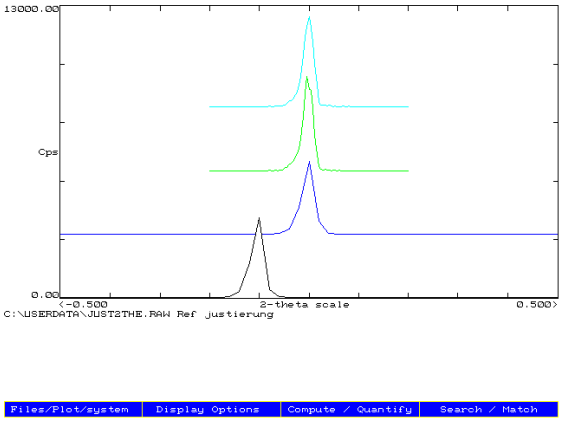


Fig. 7-11: The measurement results (displayed by DIFFRAC^{plus} *EVA)*

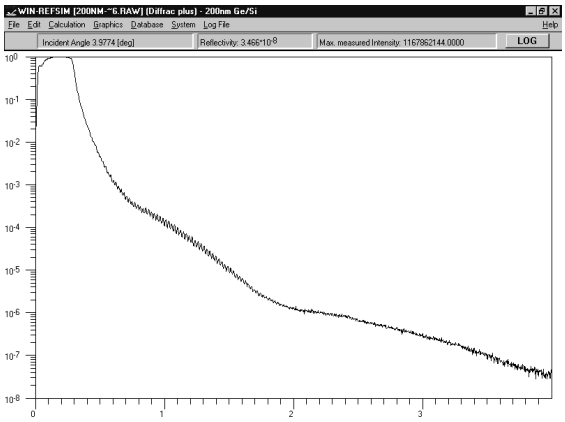


Fig. 7-12: The result of the reflectivity measurement defined above.

Fig. 7-11 shows the measurement results of the above defined measurement instructions displayed by DIFFRAC^{plus} *EVA.*

The evaluation of the reflectometry measurements is done via REFSIM. REFSIM automatically scales successive ranges in respect to each other (figure 7-12) if a data file is opened. On the display using a logarithmic intensity scale the overall covered intensity regime becomes perceptible. Within REFSIM it can not be recognised how many ranges the *.RAW data file contains.

In comparison to fig. 7-11 the x-scale is incident angle instead of 2-theta angle. The individual ranges are scale in respect to each other.

Instruction for the alignment of the edge diaphragm

With the help of the alignment bolt the edge diaphragm is aligned in respect to the centre of the goniometer. This work is necessary if a new edge diaphragm is mounted or if the display of the dial indicator must be set to zero again.

The following steps must be executed:

1. The sliding carriage of the sample must be moved to its most distant position (35 mm, remove the two distant pieces).
2. The sliding carriage of the edge diaphragm must be moved away from the centre, at least by 5 mm.
3. The alignment bolt can be mounted in the centre of the stage. The four fixing screws must be tighten step by step at least crosswise.
4. Step 4 is only necessary if a new edge diaphragm is mounted
5. Alignment in the X-direction (parallel to the vacuum sucker): loos the two screws fixing the edge diaphragm. Then mount the two alignment wedge-grips as shown on the sketch below on the right bottom. While tightening the two fixing screws the edge diaphragm will be automatically move towards the correct position in respect to the bolt. The screws fixing the edge diaphragm can be tighten again and the wedge-grips can be removed.
6. The tilt of the edge diaphragm must be aligned in that way that it is parallel to the bolt (use a 1/4" allen screw driver to change the tilt angle by rotating the tilt alignment screw). Furthermore, the correct translation position of the edge diaphragm must be found. The position is correct if no visible light can pass the slit between the edge and the bolt (light-proofen).
7. The display of the dial indicator must be set to zero.
8. Move away the sliding carriage of the edge diaphragm from the centre position to remove the alignment bolt.

Move the sliding carriage of the edge diaphragm to the -5-mm position. Again set the display of the dial indicator to zero. The edge is now in the centre of the stage because the diameter of the alignment bolt is 10 mm. The dial indicator now displays the exact distance from the centre of the stage if the edge is moved. If the sample is correctly aligned then the dial indicator gives the width of the slit between sample and edge.

Note:
The alignment of the bolt must be done by the service respectively is done before the reflectometry stage is shipped.

Alignment of Reflectometry for Theta-Theta

Differences compared to theta-2theta

- Actual position of 2theta: Angle between detector and horizontal position
- Requested position of 2theta: Angle between detector and tube
- Start and stop position of detector scan: Angle between detector and tube
- Start and stop position of unlocked coupled scan: Angle between detector and tube

First alignment after installation of reflectometry stage (especially Temperature chamber "TC-Reflectometry")

In case of the TC-Reflectometry stage it is absolutely necessary that the instrument alignment is checked with a standard sample stage. It is required to perform the alignments with the glass slit to ensure that

- The primary beam goes through the centre of the goniometer
- The zero position of the primary beam is at 0° +/- 0.002°.

Immediately after installation the absolute angle of the sample stage might be poorly defined, i.e. tube and detector angles with respect to the sample surface might be off by more than 0.5°. In this case the convergence of the procedure given below might not be given. Following procedure helps to get better defined starting positions:

1. Put a silicon wafer as sample (in case of TC-Reflectometry a piece of approx. 15 x 10 mm^2)
2. Translate the sample well below the primary beam, take care that the knife edge is not hitting the beam. Check the zero position of the primary beam with a detector scan –0.2° ... 0.2° step 0.002°, 0.1 mm detector slit, tube=0°). If the maximum position is not 0° +/- 0.002°, put the standard stage and repeat the glass slit tests. Memorise the intensity of the primary beam, avoid saturation of the detector.
3. Translate the sample into the beam. The position of the sample is checked with a rocking curve at 2theta requested at 0°. Compare the maximum intensity with that of the primary beam. The result should be a triangular shaped peak with maximum intensity 0.5*primary intensity +/- 5%. If the intensity is higher the sample must be moved up. If the intensity is lower the sample must be moved down.
4. Check the maximum position of the rocking curve. If it is 0° +/- 0.1° go on with the standard alignment (next chapter).

5. Otherwise use the ZI-button to reset the zero of the tube to the maximum of the rocking curve.

6. Now the ZI of the detector is offset by the value tube has been reset. Therefore, the sample must be moved well below the primary beam (memorise the position of the micrometer screw for moving the sample height). Perform a detector scan at tube = 0°, -0.2° ... 0.2°, step 0.002° . Reset the maximum to detector = 0°. Go back to step 2.

Alignment of sample (use appropriate Cu absorber)

1. Alignment with **glass slit** should be done first, i.e. tube=2theta=0° should mean that the beam is parallel to reflectometry stage.

2. For checking the alignment of the stage take the accessory **silicon** 001 wafer as sample.

3. Set 2Theta requested to 0.4°.
   Perform a **rocking curve** 0° to 0.4° with 0.002° step.
   The peak maximum corresponds to the position incident angle equal exit angle. Double click on maximum of peak. By this, the tube will be set to a physical incident angle of 0.2° for the next scan.

4. Perform a **detector scan** from 0.2° to 0.6°.

   Set Peak maximum position to new ZI value of 2theta. The value must be 0.4°.

5. Set 2theta requested to 0.2°.
   Perform a **tube scan** 0° to 0.4° and set maximum to new ZI of the tube. The value must be 0.2°.

6. Set 2theta requested to 0.4° and repeat the **rocking curve** from 0° to 0.4°. If everything was done correctly the maximum must now be at 0.200° (+/- 0.002° for silicon wafer)!

7. Perform a **locked coupled scan** from 0° to 1°. For checking the absolute position of the angles compare the measured reflectivity curve of the silicon wafer with one simulated by REFSIM. The critical angle should be correct within 0.01°.

8 Special Instructions

Table of Contents

8 Special Instructions 8-1

D8TOOLS Software 8-1

D8TOOLS Overview 8-2

Instrument status 8-2

Instrument status overview 8-2

ONLINE / OFFLINE instrument status 8-3

Instrument Status Data File 8-4

Instrument Status Errorlog Data File 8-4

Instrument Status View 8-5

Instrument View 8-5

Status Flags View 8-6

Ready Flags View 8-7

Warnings View 8-8

Alarms View 8-8

Measuring Function View 8-9

Power Supply View 8-10

Instrument Components Status Views 8-10

Drives View 8-10

Drive Status View 8-11

Drive Settings View 8-13

Chipset Status View 8-14

Chipset Mode View 8-14

Measuring Channels View 8-15

Measuring Channel Status View 8-15

Measuring Channel Settings View 8-17

Slit Changer Status 8-17
Slit Changer Status View 8-17
Tube Window Status View 8-18
X-RAY Generator Status View 8-19
X-RAY Generator More Values View 8-21
X-RAY Generator Settings View 8-22
X-RAY Capture Register View 8-22
Control Boards 8-23
Control Boards Overview 8-23
Universal I/O Board View 8-24
Detector Interface Board View 8-25
2-Axis-Indexer Board View 8-26
4-Axis-Indexer Board View 8-27
Instrument Setup 8-28
Instrument Setup Overview 8-28
Instrument Online Setup Data 8-28
Instrument Setup Data File 8-29
Manual Instrument Control 8-29
Manual Instrument Control Overview 8-29
Manual Instrument Control Dialog 8-29
Communication interface configuration 8-31
Overview of the communication interface configuration 8-31
Comm Port Configuration Dialog 8-31
Instrument and user information 8-32
Overview of the instrument and user information 8-32
Instrument and Customer Info Dialog 8-32
Terms and Definitions 8-33
Conversion manual for ϑ - 2ϑ systems into ϑ - ϑ systems 8-34
Conversion manual for ϑ - ϑ systems into ϑ - 2ϑ systems 8-38
Maintenance of the Quarter Circle Eulerian Cradle 8-41
Installation / Transportation 8-41
Lubrication 8-41
Collision Switch for the Eulerian Quarter Cradles 8-44
Collision switch for open Eulerian Cradles 8-46

8 Special Instructions

D8TOOLS Software

D8TOOLS is a software package for PC's using Win95 / Windows NT operating system to help users and service staff with maintenance, error diagnosis and correction of D8 diffractometers.

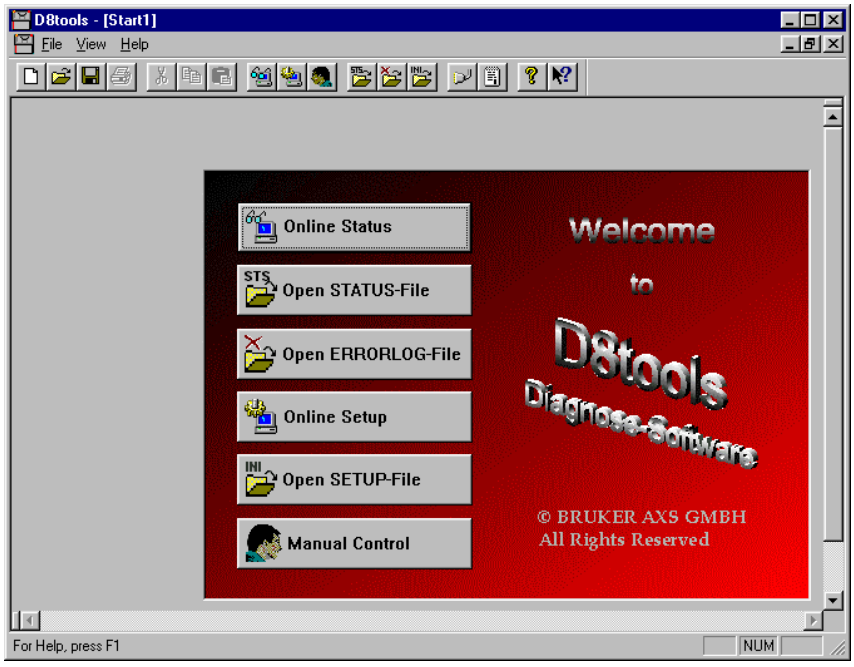


Fig. 8-1: D8TOOLS: The Starting Window

D8TOOLS Overview

D8TOOLS consists of the following functions:

- Configuring the communication interface between the analysing instrument and the service PC
- (Online-/Offline-)Instrument status and instrument status protocol
- (Online-/Offline-)Analysis of the signal level on the control and feedback lines
- (Digital-Input/Output of the control electronics
- (Online-/Offline-)Analysis of the instrument configuration and of the initializing parameters
- (Online-/Offline-)Analysis of the X-ray generator status
- Manual instrument control
- Automatic error correction
- Online-Help assistant

These functions are activated by using buttons in the main menu, in various menus or toolbars respectively.

Instrument status

Instrument status overview

The instrument control software uses internal data registers in which the initialization values, the set points, the actual value, and the control, status and error flags are stored. These registers can be read via the communication interfaces (serial V24 interface) using the appropriate commands from the command set.

A manual analysis of the instrument status requires a knowledge of the commands and the command syntax and is very time-consuming because of the large number of registers and their partially compressed structure.

With the help of D8TOOLS instrument status ONLINE[1] or OFFLINE[2] can be easily analysed and visualised.

The windows show only that information which actually corresponds to the analysed instrument status. Thus misinterpretation and misoperation are excluded to a great extent.

1 The software reads cyclically the status of the analysing instrument via the communication interface and displays it on the monitor.

2 The software shows a snapshot of a instrument's status. The communication interface is inactive.

ONLINE / OFFLINE instrument status[3]

You can start the function "Online-Status" by activating the toolbar button  "Online ON/OFF". The button will change to the active status . The active function is also shown in the application frame headline by the text "[Online]". First the instrument configuration is read and then the windows are adjusted to the data read. Afterwards only the data from the selected window are read cyclically out of the analysing instrument and the display is updated. You can select the windows containing the desired information with the help of the tree diagram. Press the toolbar button  "OnlineON/OFF" again to switch to the "Offline" status. The communication with the analysing instrument and the windows‘ actualization will be stopped. The toolbar button changes into the deactivated status  . Additionally, the deactivated function is displayed in the application frame headline by the text "[Offline]".

In case communication between the PC and the analysing instrument becomes impossible or disrupted, the cause of the error will be displayed in a message window on the PC's monitor.

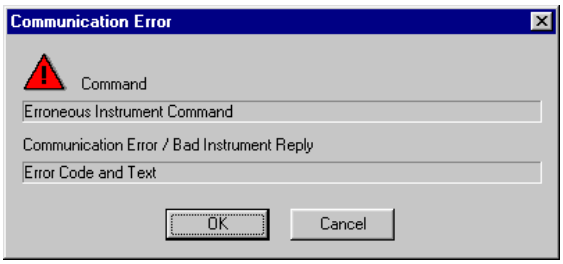


Fig. 8-2: D8TOOLS: Communication error message

The last instrument status read can be stored in an ASCII file, using the menu command "File" - "Save as ... ", under any file name with the recommended extension "sts" for a later analysis. To facilitate data identification, files are marked with a protocol header[4] (instrument serial number, user, date, time ...).

3 Information on the status of the analysing instrument

4 Refer to the dialog "Instrument and Customer Info".

Instrument Status Data File

The instrument status stored in an ASCII file can be loaded and analysed with the menu command "File" - "Open" or with the toolbar button  "StatusFile“. The application frame headline shows the file name after loading the file. The display can be switched by means of the toolbar buttons between graphic view (toolbar button  "InstrumentView"), text view (toolbar button  "TextView") or file view (toolbar button  "FileView"). The text view can be printed out.

Instrument Status Errorlog Data File

After the cancellation of a measuring task, the actual system status is read by the evaluation software and saved in the ASCII file “ERRORLOG.ERR“ with additional information like the program name of the measuring task, date and time in the item’s heading. This cancellation can be caused by the control of the analysis system or by exceeding the time limit during the adjustment of the measuring parameters via the evaluation software. This data usually contains numerous status entries with various supplementary information.

The file can be loaded via the menu command "File" - "Open" or via the toolbar button  "ErrorlogFile" respectively. After loading the file, the application frame headline shows the file name. You can search the entry to be analysed in the file document view via the menu command "Edit“ - "Find" by entering an appropriate search string. The selected entry will be analysed up to the final line feed and the result will be shown on the display. The display can be switched by means of the toolbar buttons between graphic view (toolbar button  "InstrumentView"), text view (toolbar button  "TextView") or file view (toolbar button  "FileView"). The text view can be printed out.

Instrument Status View

Instrument View

The instrument view depicts in a compressed form all instrument status registers, the instrument components status, the measuring channels, and the instrument box.

The instrument view can be activated

- by clicking on the main menu button "Online Status" or "open Status File"
- by clicking on the main menu button  "Instrument Status File"
- by opening a "Instrument status" object via the menu "File" - "New"
- by clicking on the frame window button  "New Document"
- by clicking on the frame window button  "Open Status File"
- by clicking on the branch "Instrument" or "Instrument Status" in the tree diagram
- by clicking on the toolbar button  "InstrumentView"
- via the menu "View“ - "Instrument"

Thus the view created does not show a valid instrument status. This is shown in the tree diagram branches by the text "No data available".

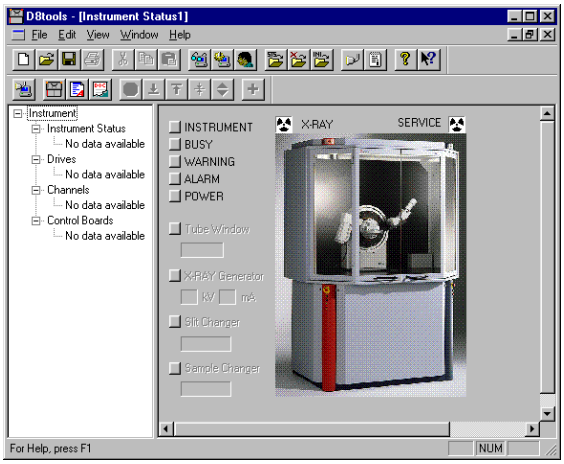


Fig. 8-3: D8TOOLS: The Instrument Status View

The instrument view has to be connected first with an instrument status object (e. g. via the function "Online status").

The instrument view is automatically activated and updated

- after opening a instrument status file
- after opening and analyzing a status entry in a error log file.

The instrument view includes buttons to switch quickly to a detailed view, field for the output of actual values and graphic elements for the status display.

The graphic element " X-RAY" shows the X-ray generator's operating status:



X-RAY high voltage off



X-RAY high voltage on



Stand-by operation

The graphic element "SERVICE" shows the key switch position "SERVICE":



Key switch "SERVICE" in position "OFF"



Key switch "SERVICE" in position "ON"

The button color gives information on the instrument's status, the instrument components' status, and the measuring channels.

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
orange		Warning
red		Error or alarm

Status Flags View

The Status Flags View shows the flags of the respective instrument status register[5]. This view is activated

- by clicking on the button "INSTRUMENT" of the instrument view
- by clicking on the tree diagram branch "Status Flags"

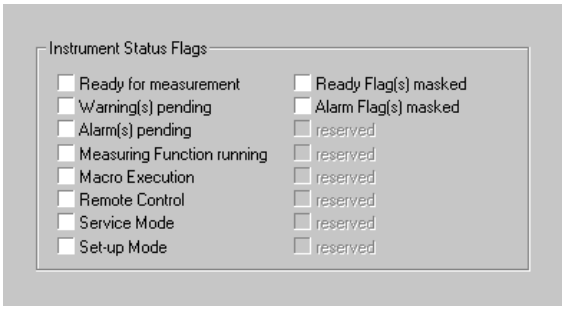


Fig. 8-4: D8TOOLS: The Instrument Status Flags View

5 Flags for the control of the analysing instrument.

The indicator before the name gives information on the status of the flag:

grey		Actual value<> set point
green		Actual value = set point
yellow		occupied
orange		Warning
red		Error or alarm
blank		not applying
marked	☑	applying

Ready Flags View

The Ready Flags View shows the flags of the respective instrument status register[6]. This view is activated

- by clicking on the button "INSTRUMENT" of the instrument view
- by clicking on the tree diagram branch "Ready Flags"

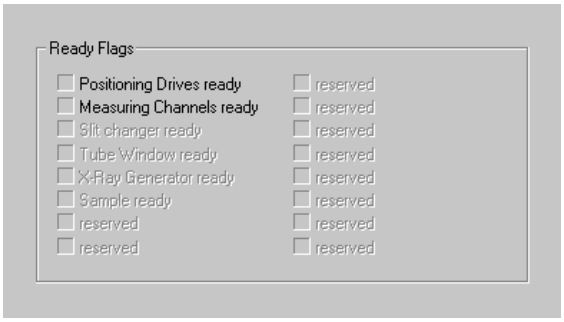


Fig. 8-5: D8TOOLS: The Ready Flags View

The indicator before the name gives information on the status of the flag:

grey		Actual value<> set point
green		Actual value = set point

[6] Status flags of the instrument's components. A flag value of "1" (= set) means that the actual status of the respective component matches with the set point status.

Warnings View

The Warnings View shows the instrument warnings[7]. This view is activated

- by clicking on the button "WARNING" of the instrument view
- by clicking on the tree diagram branch "Warning"

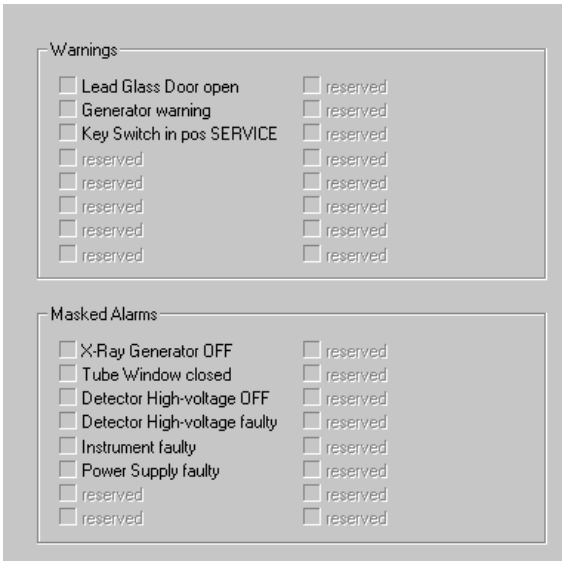


Fig. 8-6: D8TOOLS: The Warnings View

The indicator before the name gives information on a waiting warning:

grey		Actual value<> set point
orange		Actual value = set point

Alarms View

The Alarms View shows the instrument alarms[8]. This view is activated

- by clicking on the button "ALARM" of the instrument view
- by clicking on the tree diagram branch "Alarms"

[7] Warnings are status flags which show a status that deviates from the normal status, and whose causes should be removed as soon as possible.

[8] Alarms are status flags showing that the system is not in operating condition. The causes of an alarm must be eliminated before starting a measuring job.

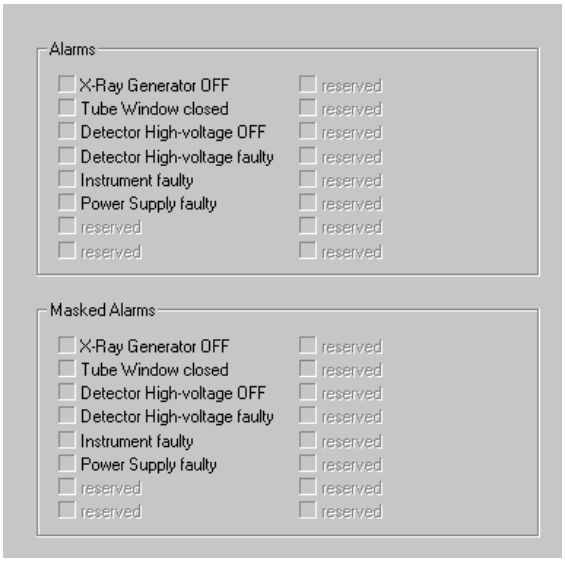


Fig. 8-7: D8TOOLS: The Alarms View

The indicator before the name gives information on a waiting alarm:

grey		No waiting alarm
red		Waiting alarm
orange		a masked alarm is waiting

Measuring Function View

The Measuring Function View shows the status of the measuring job[9]. This view is activated

- by clicking on the button "BUSY" of the instrument view
- by clicking on the tree diagram branch "Measuring Function"

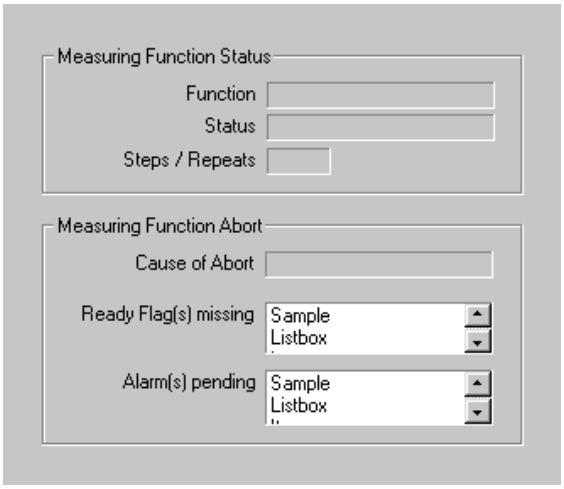


Fig. 8-8: D8TOOLS: The Measuring Function View

9 Control unit for the registration of measuring values.

This view contains - in the frame "Measuring Function Status" - fields for the output of the identification key, the status, the number of the remaining steps / repetitions of the measuring job. The frame "Measuring Function About" provides fields for the output of the cause(s) when a measuring job is canceled.

Power Supply View

The Power Supply View shows the status of all the distribution voltages of the analysing instrument. This view is activated

- by clicking on the button "POWER" of the instrument view
- by clicking on the tree diagram branch "Power Supply "

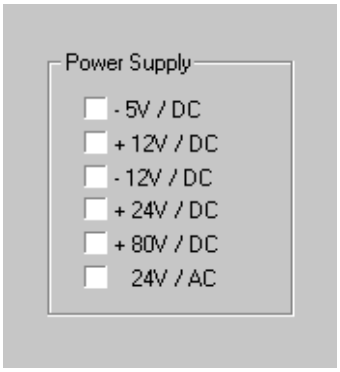


Fig. 8-9: D8TOOLS: The Power Supply View

The indicator before the name gives information on the status of the respective voltage:

green		Voltage o.k.
red		Voltage not o.k.

Instrument Components Status Views

Drives View

The Drives View shows the status of the motor drives. The view is activated by clicking on the branch "Drives" of the tree diagram.

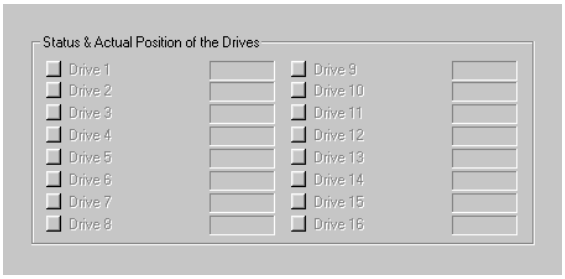


Fig. 8-10: D8TOOLS: The Drives View

The button color before the name gives information on the status of the drive:

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
red		Error

By clicking on the button left of the drives' name the Drive Status view is activated.

Drive Status View

The Drive Status View shows details of the selected drive. This view is activated

- by clicking on the button "drive name" of the Drives view
- by clicking on the branch "drive name" of the tree diagram.

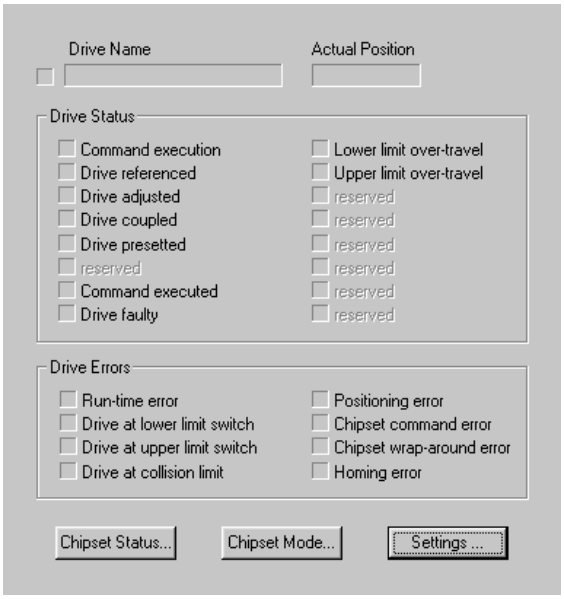


Fig. 8-11: D8TOOLS: The Drive Status View

This view contains fields for the output of the drive name, the drive position, indicators for the drive status and indicators for drive errors as well as buttons for the quick switch to detal views.

The indicator color before the name gives information on the drive status.

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
red		Error

The indicators inside the frame "Drive Status" give information on the status of the status flags:

	not applying
☑	applying

The indicators inside the frame "Drive Errors" give information on the status of the error flags:

grey		no error
red		error

By clicking on the button "Settings" the dialogue "Drive Settings" is activated.

By clicking on the button "Chipset Status" the dialogue " Chipset Status " is activated.

By clicking on the button "Chipset Mode" the dialogue " Chipset Mode " is activated.

If necessary, the following drive basic functions can be started via toolbar buttons:

stops the drive	
Searches drive reference downwards	
Searches drive reference upwards	
initializes the drive	
activates the upwards-/downwards driving command	
Restores the drive's operating status if possible	

After activating the upwards-/downwards drive command using the button  "MOVE", you can adjust the drive speed between 0 and the value Slow-speed (see Drive Settings) with the slide control unit and the rotation direction with the spin button "UP / DOWN". This is also allowed when the drive is running.

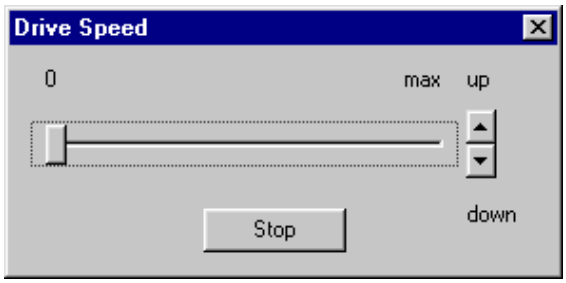


Fig. 8-12: D8TOOLS: Slide control unit for the drive speed

⚠ **Caution:**
These functions are not allowed if a analyzer PC controls the analyzing instrument.

Drive Settings View

The view "Drive Settings" shows a snapshot of the actual parameters of the selected drive. This view is activated by clicking on the button "Settings..." in the view "Drive Status".



Fig. 8-13: D8TOOLS: The Drive Settings View

Click on the button "Close" in the Drive Settings View to return to the view "Drive Status".

Chipset Status View

The dialogue "Chipset Status" shows the actual axis status register of the signal processor chip which controls the selected drive. The dialogue is activated by clicking on the button "Chipset Status ..." in the Drive Status view.

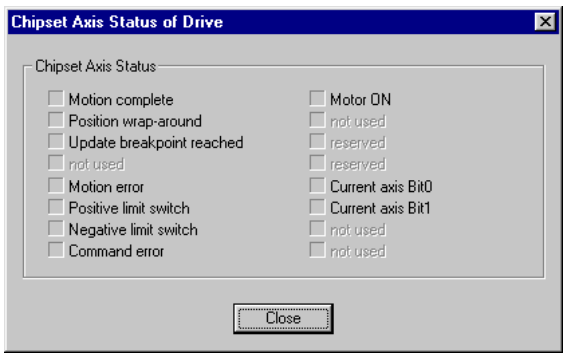


Fig. 8-14: D8TOOLS: The Chipset Status View

The indicator color before the flag name gives information on the flag status.

- not applying
- applying
- Flag not set or 0-level
- Flag set or 1-level

By clicking on the button "Close" in the chipset status view you return to the drive status view.

Chipset Mode View

The dialogue "Chipset Mode" shows the actual axis operation register of the signal processor chip which controls the selected drive. The dialogue is activated by clicking on the button "Chipset Mode ..." in the Drive Status view.

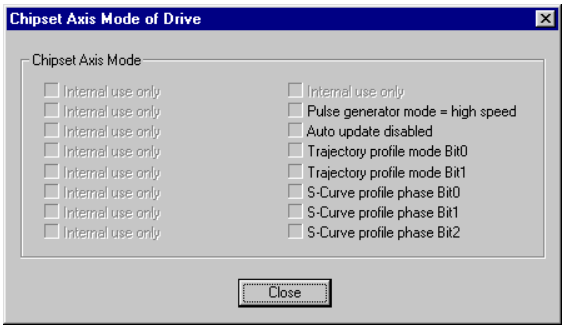


Fig. 8-15: D8TOOLS: The Chipset Axis Mode of Drive View

The indicator color before the flag name gives information on the flag status.

☐	not applying
☑	applying
0	Flag not set or 0-level
1	Flag set or 1-level

By clicking on the button "Close" in the chipset mode view you return to the drive status view.

Measuring Channels View

The view "Channels" shows the status of the measuring channels. This view is activated with the branch "Channels" of the tree diagram.

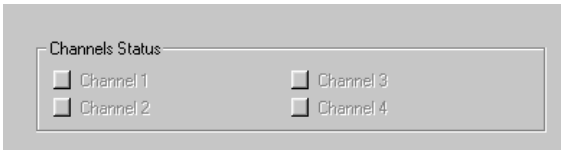


Fig. 8-16: D8TOOLS: The Channels Status View

This view contains buttons for the quick switch to the detail view.

The button color before the name gives information on the status of the measuring channel:

grey	■	Actual value <> set point
green	■	Actual value = set point
yellow	■	occupied
red	■	error

By clicking on the button left of the measuring channel name the channel status view is activated.

Measuring Channel Status View

The Channel Status View shows details of the selected measuring channel. This view is activated:

- by clicking on the Button "Channel-Name" of the Channels View
- by clicking on the branch "Channel-Name" of the tree diagram.

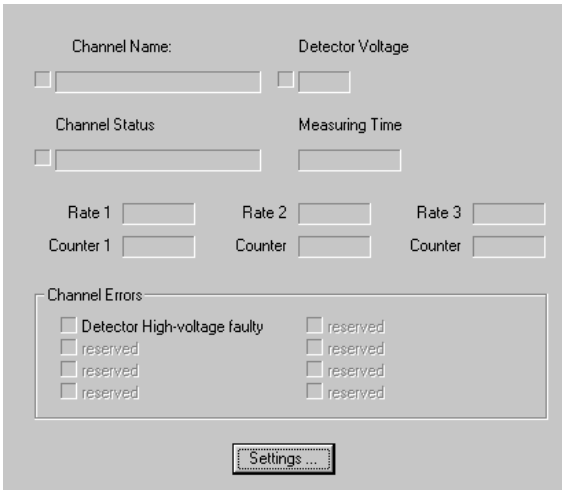


Fig. 8-17: D8TOOLS: The Measuring Channel Status View

This view provides fields for the output of the measuring channel name, the count rates, the counters, the measuring time, indicators for the measuring channel status and indicators for measuring channel errors as well as buttons for the quick switch to detail views.

The indicator color before the name gives information on the measuring channel status:

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
red		Error or alarm

The indicators inside the frame "Channel Status" give information on the status flags:

☐	not applying
☑	applying

The indicators inside the frame "Channel Errors“ give information on the error flags:

grey		no error
red		error

By clicking on the button "Settings" the dialogue "Channel Settings" is activated.

Measuring Channel Settings View

The dialogue "Channel Settings" shows a snapshot of the actual parameters of the selected measuring channel in detail. The dialogue is activated by clicking on the button "Settings..." in the Channel Status View.

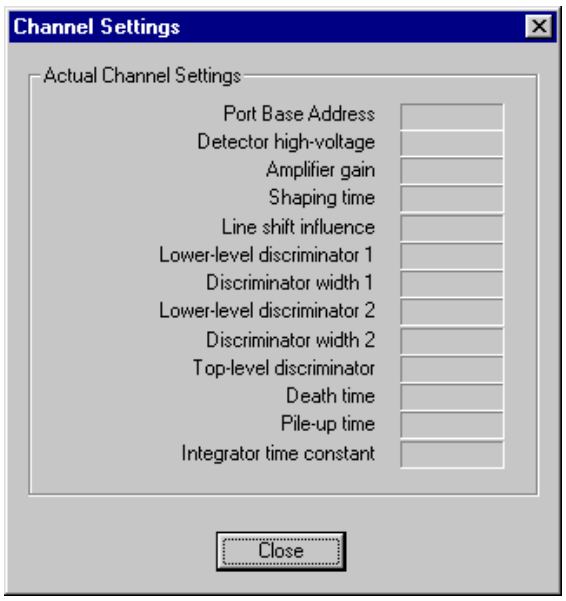


Fig. 8-18: D8TOOLS: The Channel Settings View

By clicking on the button "Close" in the channel settings view you return to the Channel status view.

Slit Changer Status

Slit Changer Status View

The Slit Changer View shows details of the slit changer.

This view is activated

- by clicking on the button "Slit Changer" of the instrument view
- by clicking on the branch "Slit Changer" of the tree diagram.

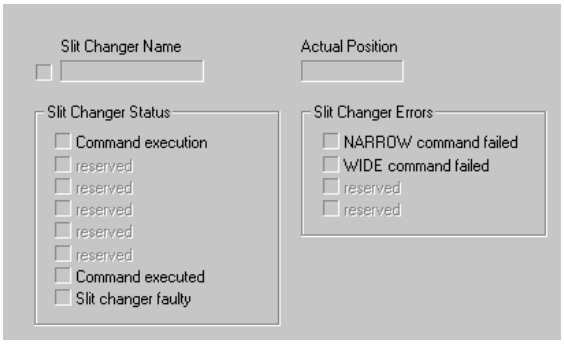


Fig. 8-19: D8TOOLS: The Slit Changer Status View

This view provides fields for the output of the name, the position, indicators for the status and indicators for errors.

The indicator color before the name gives information on the slit changer status:

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
red		error

The indicators inside the frame "Slit Changer Status" give information on the status flags:

☐	not applying
☑	applying

The indicators inside the frame " Slit Changer Errors" give information on the error flags:

grey		no error
red		error

Tube Window Status View

The Tube Window Status View shows details of the tube window. This view is activated

- by clicking on the button "Tube Window" of the instrument view
- by clicking on the branch "Tube Window" of the tree diagram

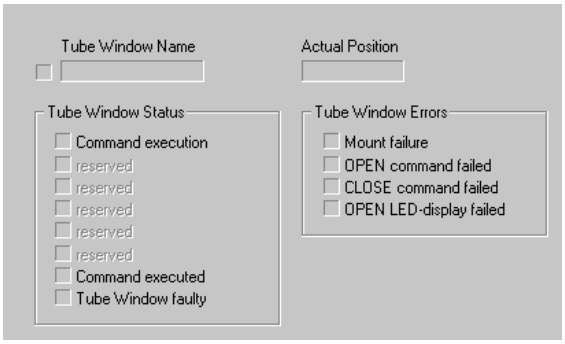


Fig. 8-20: D8TOOLS: The Tube Window Status View

This view contains fields for the output of the name, the position, indicators for the status and indicators for errors.

The indicator color before the name gives information on the slit changer status.

grey		Actual value <> set point
green		Actual value = set point
yellow		occupied
red		error

The indicators inside the frame "Tube Window Status" give information on the status flags:

☐	not applying
☑	applying

The indicators inside the frame "Tube Window Errors" give information on the error flags:

grau		no error
rot		error

X-RAY Generator Status View

The X-ray Generator Status View shows the X-ray generator's status. This view is activated

- by clicking on the button X-ray generator of the instrument view
- by clicking on the branch "X-ray generator" of the tree diagram

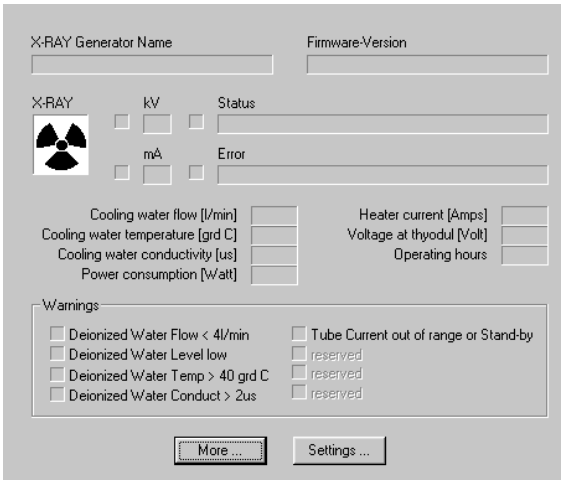


Fig. 8-21: D8TOOLS: The X-ray Generator Status View

This view contains fields for the output of the name, the firmware version, actual values, actual conditions, indicators for the status and warnings as well as buttons for the display of additional values and conditions.

The indicator color before the field "Status" gives information on the operation conditions:

grey		not in operating condition
green		in operating condition

The graphic element "X-ray" shows the operating condition of the X-ray generator.



High voltage OFF



High voltage ON



Stand-by operation

The indicator color before the fields "kV" and "mA" give information on the status of the X-ray high voltage and the tube current.:

grey		Actual value <> set point
green		Actual value = set point

The indicators inside the frame "Warnings" give information on the status of the warning flags:

grey		no warning
orange		warning

The indicator color before the field "Errors" gives information on errors that have appeared:

grey		no error
red		error

By clicking on the button "More..." the dialogue "X-RAY Generator More" is activated.

By clicking on the button "Settings..." the dialogue "X-RAY Generator Settings" is activated.

X-RAY Generator More Values View

The dialogue "X-RAY Generator More ..." shows additional information about the X-ray generator.

This dialogue is activated by clicking on the button "More" in the X-ray Generator Status View.

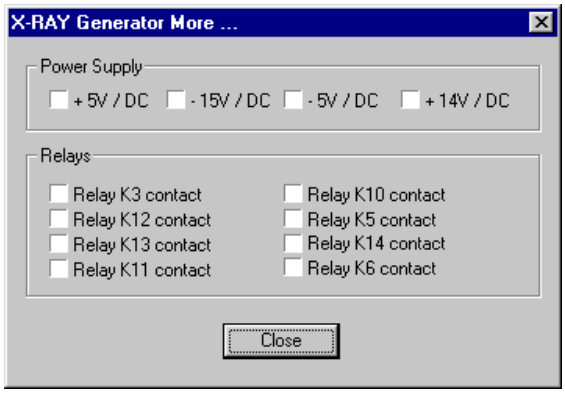


Fig. 8-22: D8TOOLS: The X-ray Generator More View

The indicators inside the frame "Power Supply" give information on the status of the power supply:

green		Voltage o.k.
red		Voltage not o.k.

The indicators inside the frame "Relays" give information on the status of the relay contacts.:

☐	no contact
☑	contact

By clicking on the button "Close" in the X-ray Generator More View you return to the X-ray generator status view.

X-RAY Generator Settings View

The dialogue "X-ray Generator Settings" shows the implemented threshold values of the X-ray generator. The dialogue is activated by clicking on the button "Settings ..." in the X-ray generator status view.

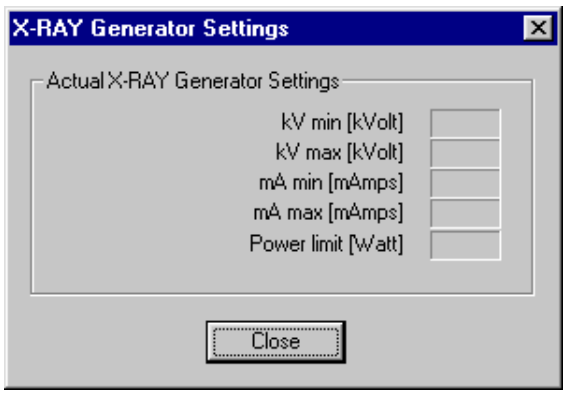


Fig. 8-23: D8TOOLS: The X-RAY Generator Settings View

By clicking on the button "Close" in the X-ray generator settings view you return to the X-ray generator status view.

X-RAY Capture Register View

In the X-ray Capture Register the status of the hardware comparer of the X-ray protection installation and waiting alarms are stored in order to allow evaluation in case of automatic shutdown, breakdown or starting problems of the X-ray generator.

The Bits 0 ... 7 are actualized by the control program as soon as the X-ray generator's power is cut off by the control program because of instrument failures and contain the waiting alarms at the shutdown moment. The Bits 8 ... 31 of the X-ray Capture Register are actualized by the hardware as soon als the level comparison of two signals of the X-ray protection installation shows unequal levels.

The X-ray Capture Register View shows the status of the register of the same name.

This view is activated by clicking on the branch "X-ray Capture Register ... " of the tree diagram.

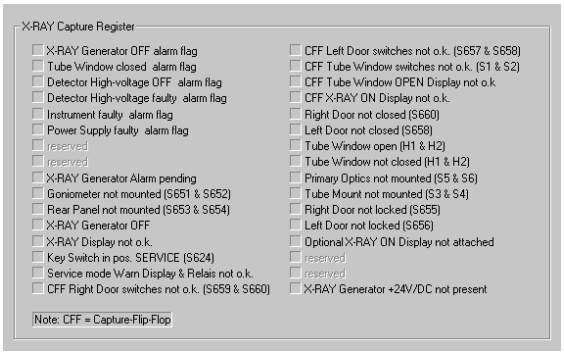


Fig. 8-24: D8TOOLS: The X-ray Channel Register View

The indicators left of the bits give information on their status:

grey		no error
red		error

Control Boards

Control Boards Overview

The electronic boards form the interface between the components and the CPU. The electronic boards are AT-Bus-compatible PC plug-in cards with front plugs for the interconnection of the components. They provide the necessary outputs with level adjustment (digital / analog) for the control and power supply of the components and inputs with level transmitter for feedback signals. The I/O addresses and interrupts of the electronic boards can be adjusted by means of jumpers.

The diffractometer uses 4 different electronic boards:

- Universal I/O Board
- Detector Interface Board
- 2-Axis Indexer Board
- 4-Axis Indexer Board

Depending on the number of similar components of the analyzing instrument, the electronic boards may exist several times. The components' assignment to the electronic boards is defined in the instrument configuration file "DEVICE.INI".

Universal I/O Board View

The electronic board contains the following units:

- Interface to the radiation protection box
- Radiation protection control logics (safety circuit)
- Interface to the slit changer
- Interface to the tube window
- Serial and parallel interface to the X-ray generator
- Serial interface for the connection of a manual control box
- Voltage control logics
- Watch-Dog function

The view "Universal-I/O Board" shows the levels of the inputs/outputs of the selected registers on the electronic board.

This view is activated by clicking on the respective branch of the tree diagram.

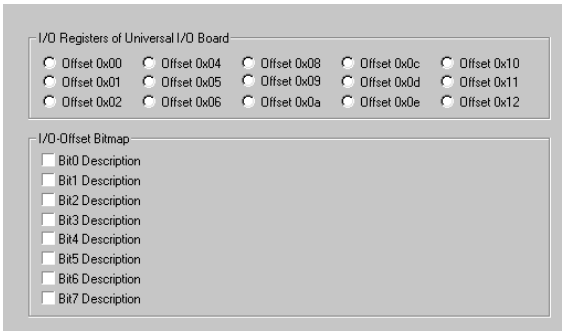


Fig. 8-25: D8TOOLS: The I/O Registers of Universal I/O Board View

The register to be shown is selected by clicking on the radio button left of the register name. The input/output levels are displayed in the frame "I/O Offset bitmap" in the indicator before the I/O description:

0 Input/Output = low level

1 Input/Output = high level

Detector Interface Board View

The electronic board contains the following units:

- Interface to scintillation and flow detectors (Detector high voltage, pulse input)
- Pulse shape (adjustable amplification and differentiation time constant)
- Pulse discrimination (2 windows with lower threshold and window width which can be adjusted independently)
- Detection and registration of over-amplified pulses
- Dead time correction (can be cut off, time constant is adjustable)
- Line Shift correction (can be cut off, sensitivity adjustable)
- independent pulse counts for the three discriminators
- Automatic check functions

The view "Detector Interface Board" shows the input/output levels of the selected registers on the electronic boards.

This view is activated by clicking on the respective branch of the tree diagram.

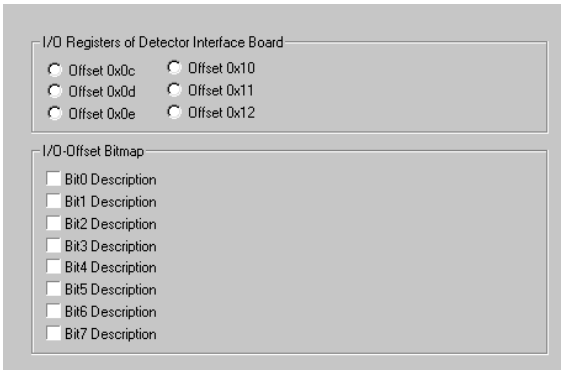


Fig. 8-26: D8TOOLS: The I/O Registers of Detector Interface Board View

The register to be shown is selected by clicking on the radio button left of the register name. The input/output levels are displayed in the frame "I/O Offset bitmap" in the indicator before the I/O description:

0 Input/Output = low level

1 Input/Output = high level

2-Axis-Indexer Board View

The electronic board provides the following functions:

- Power and logics for two 2-phase step motors which can be configured independently
- phase currents adjustable
- rotation direction adjustable
- reference inputs (active level adjustable)
- Inputs for lower and upper threshold switches (active level adjustable)
- pulse and rotation direction outputs for the connection of a position sensitive detector (active level adjustable)
- interface and logics for incremental encoder (phase A-B signals and rotation direction adjustable)

The view "2-Axis Indexer Board" shows the input/output levels of the selected registers on the electronic board.

This view is activated by clicking on the respective branch of the tree diagram.

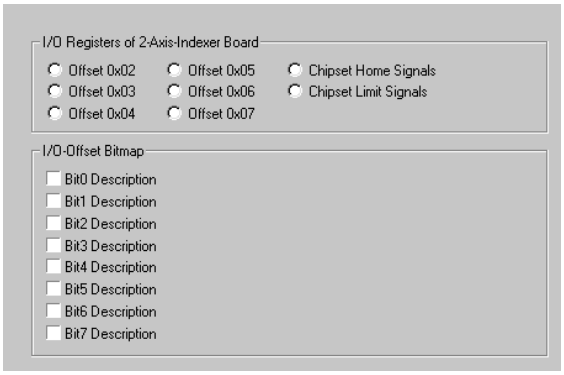


Fig. 8-27: D8TOOLS: The I/O Registers of 2-Axis Indexer Board View

The register to be shown is selected by clicking on the radio button left of the register name. The input/output levels are displayed in the frame "I/O Offset bitmap" in the indicators before the I/O description:

0 Input/Output = low level

1 Input/Output = high level

4-Axis-Indexer Board View

The electronic board provides the following functions:

- Power and logics for two 2-phase step motors which can be configured independently
- micro-step operation
- rotation direction adjustable
- reference inputs (active level adjustable)
- Inputs for lower and upper threshold switches (active level adjustable)
- pulse and rotation direction outputs for the connection of a position sensitive detector (active level adjustable)
- interface and logics for incremental encoder (phase A-B signals and rotation direction adjustable)

The view "4Axis Indexer Board" shows the input/output levels of the selected registers on the electronic board.

This view is activated by clicking on the respective branch of the tree diagram.

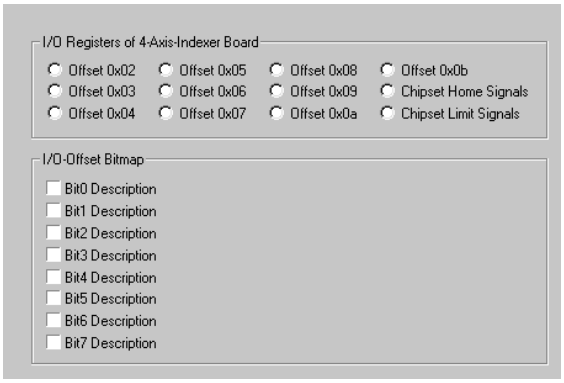


Fig. 8-28: D8TOOLS: The I/O Registers of 4-Axis Indexer Board View

The register to be shown is selected by clicking on the radio button left of the register name. The input/output levels are displayed in the frame "I/O Offset bitmap" in the indicators before the I/O description:

0 Input/Output = low level

1 Input/Output = high level

Instrument Setup

Instrument Setup Overview

The control program needs information on

- the existing hardware
- the I/O addresses
- the interrup addresses
- the components to be controlled and their initialization values.

The instrument configuration file "DEVICE.INI" contains this information.

The control program reads this file after the start and parameterizes the hardware according to the entries.

Since the analyzing instrument does not provide a local possibility to show the actual instrument configuration, this configuration must be outputted via the communication interfaces using appropriate commands.

A manual analysis of the instrument configuration requires knowledge of those commands and of their syntax and is very time-consuming because of the complex configurations and the large number of parameters.

Using D8TOOLS the instrument configuration and the configuration parameters can be easily analysed and visualized online or offline respectively.

The windows display only that information which does correspond to the analysed instrument configuration; therefore, misinterpretation and misoperation can be excluded to a great extent.

Instrument Online Setup Data

You can start the function "Online" with the toolbar button  "Online ON/OFF" in the window "Instrument Setup". The button changes to the activated state . The actual instrument configuration is read. The tree diagram is updated according the configuration read showing those branches that correspond with the section names in the instrument configuration file "DEVICE.INI". After this the toolbar button changes automatically into the deactivated state .

The application frame headline displays the shown configuration by the text "[Online]".

The configuration parameters (= section entries) can be selected by clicking on the tree diagram branches.

The instrument configuration that has been read can be stored using the menu command "File" - "Save as" in an ASCII file under any name with the recommended extension "ini" for a later analysis. The data is provided with a protocol header for identification purpose (serial number of the analysing instrument, user, date, time, ...).

Instrument Setup Data File

The instrument configuration saved in an ASCII file or the instrument configuration file "DEVICE.INI" can be opened and analysed via the menu command "File" - "Open" or via the toolbar button  "SetupFile". After loading the file, the application frame headline shows the file name. You can activate the file view using the toolbar button  "FileView". The file view can be printed out on a connected printer.

Manual Instrument Control

Manual Instrument Control Overview

Occasionally during maintainence the analyzing instrument may have to be controlled manually; therefore, the dialog "Manual Instrument Control" is used.

In order to facilitate the manual control of the system, help for selecting the commands and for the command syntax have been included.

Manual Instrument Control Dialog

The dialog "Manual Instrument Control" is used for the manual control of the analyzing instrument.

The dialog is activated by clicking on the toolbar button  "ManualCtrl" in the application frame.

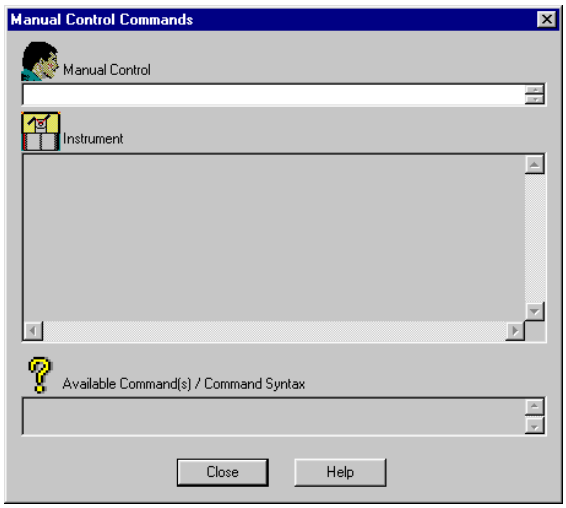


Fig. 8-29: D8TOOLS: The Manual Control Commands View

The dialog contains the command entry window "Manual Control Command", the output window "Instrument Reply" for the instrument response and the window "Available Commands / Command Syntax“ for the output of the allowed commands if an initial letter has been entered or the command syntax of the entered command.

The last command can be repeated with the key "ENTER".

You can leaf through the command window with the cursor keys "UP" and "DOWN", and the command shown at the actual cursor position can be repeatet with the "ENTER" key.

You can also leaf through the reply window to display former instrument replies with the cursor keys "UP" and "DOWN".

You can activate the Online-Help by clicking on the "Help" button.

You finish the dialog by clicking on the "Close" button.

Caution:
A manual control of the analyzing instrument should be carried out only by trained personnel and only in the case of an emergency since inadmissible or incorrect commands may impair the operation status of the analyzing instrument.

In case communication between the PC and the analysing instrument becomes impossible or disrupted, the cause of the error will be displayed in a message window on the PC's monitor.

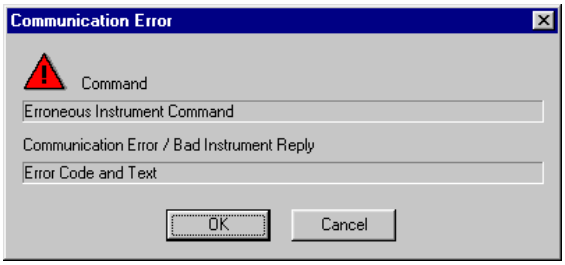


Fig. 8-30: D8TOOLS: The Communication error message

Communication interface configuration

Overview of the communication interface configuration

Before the PC can communicate with the analyzing instrument the communication interface to the analyzing system must be configured; therefore, the dialog "Communication Port Configuration" is used. With this dialog the interface parameters are defined and stored in the ASCII file "COMPORT.CFN".

Comm Port Configuration Dialog

With this dialog the interface parameters are defined and stored in the ASCII file "COMPORT.CFN".

The dialog is activated by clicking on the toolbar button  "COMConfig" in the application frame.

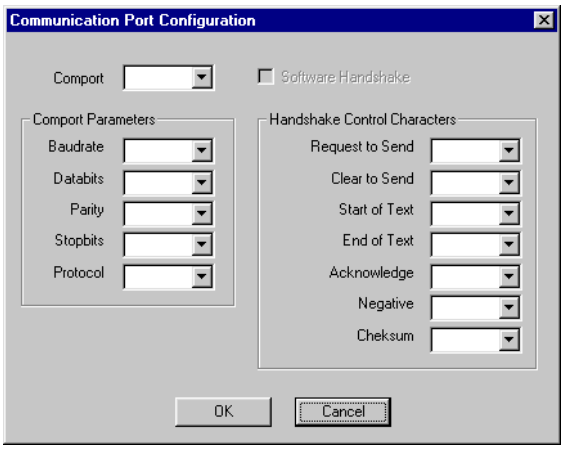


Fig. 8-31: D8TOOLS: The Communication Port Configuration View

The parameters are selected out of the lists by clicking on them and they must match the values which are set on the instrument and which are defined in the instrument configuration file "DEVICE.INI".

By clicking on the button "OK" the selected parameters are stored in the ASCII file "COMPORT.CFN" and the dialog is closed. A mouse click on the "Cancel" button closes the dialog without saving the parameters in the ASCII file "COMPORT.CFN".

Instrument and user information

Overview of the instrument and user information

The instrument data is marked while the file is being saved or during printing with a protocol header for a unequivocal identification. The protocol header contains information about the instrument type, the serial number, name, telephone, and fax number as well as e-mail address of the user. This information is entered in the dialog "Instrument and Customer Infos" and stored in the ASCII file "INFOS.TXT" after having closed the dialog.

Instrument and Customer Info Dialog

The instrument data is marked while the file is being saved or during printing with a protocol header for a unequivocal identification. The protocol header contains information about the instrument type, the serial number, name, telephone, and fax number as well as e-mail address of the user. This information is entered in the dialog "Instrument and Customer Infos".

The dialog is activated by clicking on the toolbar button  „Infos“ in the application frame.

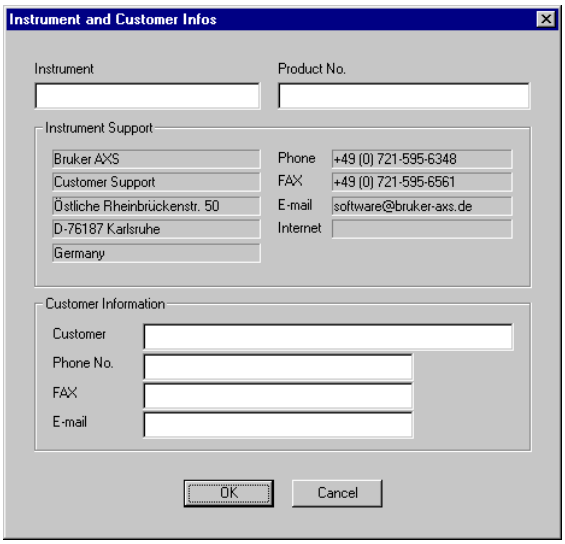


Fig. 8-32: D8TOOLS: The Instrument and Customer Infos View

Apart from the input fields for instrument and user information, the dialog contains the service hotline address (Customer Support Hotline) for the user's information.

The "OK" button closes the dialog and the entered data is stored in the ASCII file "INFOS.TXT".

The "Cancel" button closes the dialog without storing the entered data in the ASCII file "INFOS.TXT".

Terms and Definitions

D8tools
Software package for PCs with Win95 / Windows NT operating system to support the users and the service staff in case of maintainance, error diagnosis and error handling of D8 diffractometers.

Online
The software reads cyclically the instrument status via the communication interface and displays it on the monitor.

Offline
The software shows the snapshot of the instrument status. The communication interface is inactive.

Instrument Status
Information about the status of the system (ONLINE, OFFLINE).

Instrument Setup
Information about the configuration and the initialization values of the system (ONLINE, OFFLINE).

Status Flags
Flags for the control of the system.

Ready Flags
Status flags of the instrument's components. A flag value of "1" (= set) means that the actual status of the respective component matches with the set point status.

Warnings
Warnings are status flags which show a status that deviates from the normal status, and whose causes should be removed as soon as possible.

Alarms
Alarms are status flags showing that the system is not in operating condition. The cause of an alarm must be eliminated before starting a measuring job.

Measuring Function
Control unit for the registration of measuring values.

Power Supply
Power supply of the system. The distribution voltages are monitored.

Drive
Positioning drive driven by a step motor.

Measuring Channel
Measuring channel of the system. This channel may include:

detector, pulse shaper, pulse discriminators, diskriminator for over-amplified pulses, line-shift correction, deadtime correction, pulse counter.

Control Board
Electronic board for the control of instrument components or for the communication with external devices and PC's.

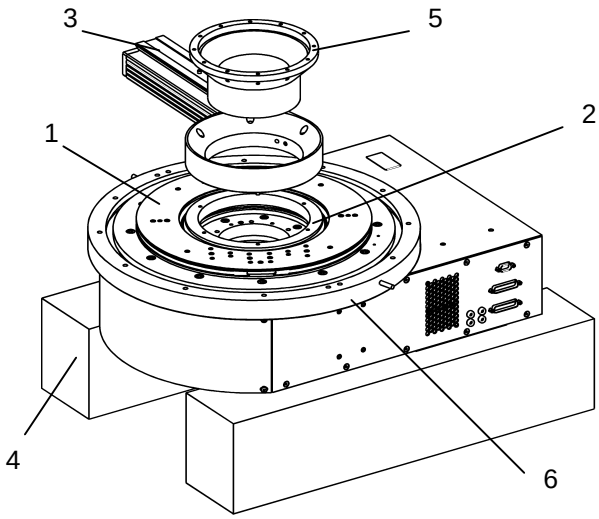
Conversion manual for ϑ - 2ϑ systems into ϑ - ϑ systems

1. First of all remove all parts from the goniometer, i.e. optics, tube housing, detector, interlock, weights, counterbalance, tracks, sample stage including the black adapter ring in the centre of the goniometer.

2. Now firstly mount the track for the inner circle onto the goniometer and after that the conical shaped adapter ring (any orientation). Just tighten the screws of the adapter ring softly because the ring needs to be centred in a further step. Flip the goniometer over onto two supporting beams of approximately 150 mm height, so that the screws of the adapter ring are accessible. Look at the picture below.

3. Take of the base plate before you start centring the adapter ring.

⚠ **Caution:**
Only handle the goniometer at its housing or the fixed T-slotted outer ring. Never handle it using the tracks. Take care of your hands and fingers while flipping the goniometer.



1 outer circle
2 inner circle
3 track for detector and diffracted beam optics (inner circle)
4 supporting beams
5 adapter ring
6 fixed T-slotted outer ring

Fig. 8-33: Conversion into ϑ-ϑ configuration

The adjustment works as shown in the picture below using a stand and a dial indicator.

4. Screw the measurement stand into the delivered black spacer.

5. Slide the black spacer onto the track and clamp it.

6. Plug the dial indicator into the stand, clamp it and adjust it such that it touches the fit at the inside of the adapter ring. There is an adjusting screw at the stand with which the dial indicator can be adjusted to the middle of its measurement range. For a better reading you can turn the scale until the indicator shows zero. Now drive the inner circle to the angles 0°, 180° and 90°, 270° respectively and align the ring carefully using a protection hammer to the centre line of the goniometer. That means to minimise the deflection of the indicator. Because of unavoidable inaccuracy due to manufacturing there will always remain a certain deflection. The adapter is centred when the total amount of indicator deflection error is below 0.02 mm. Double check the adjustment and the accuracy of the adapter while putting the dial indicator on the top surface of the ring. This reading should not increase 0.02 mm either. Repeat this procedure, for any further adapter ring needed for different measurement heights that goes on top of the first one. The first ring on the goniometer is always conical shaped, the second ring is 64 mm and the third one is 44 mm in height.

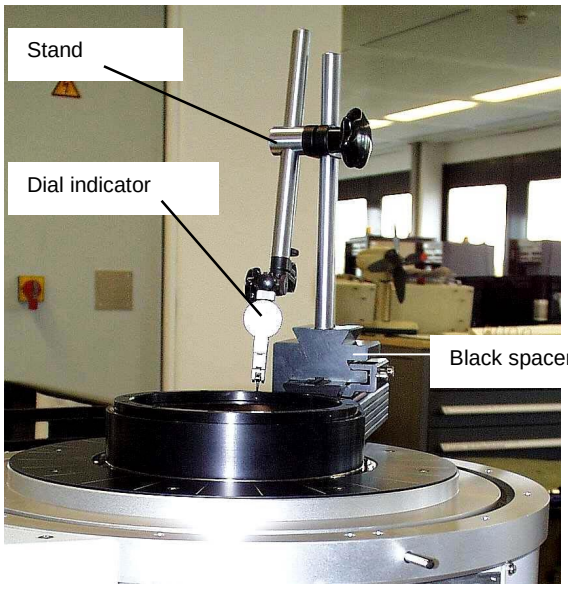


Fig. 8-34: Measuring attachment to adjust the spacer ring

Caution:
After finishing the adjustment of the adapter ring tighten the screws properly while the goniometer is still horizontal. Double check the adjustment finally just to make sure that nothing changed during tightening.

7. After the adjustment, mount the second track to the outer circle and initialise the two circles at around 30°. Now the collision switch can be fixed to the T-sloted ring at the goniometer and the base plate can be reassembled. Connect the plug to the port at the side panel of the goniometer. While connecting the plug of the limit switches to the side panel one has to take care of the polarity. GND on the plug means ground and has to go into a black socket whereas the other part of the plug needs to go into a red socket. After that put the goniometer back on its original place and **! fix it to the table top !** of the enclosure and bring the safety switches back in position.

⚠ **Caution:**
Never ever lift the goniometer at its tracks!

Make sure, that the goniometer is securely fastened to the table top of the enclosure.

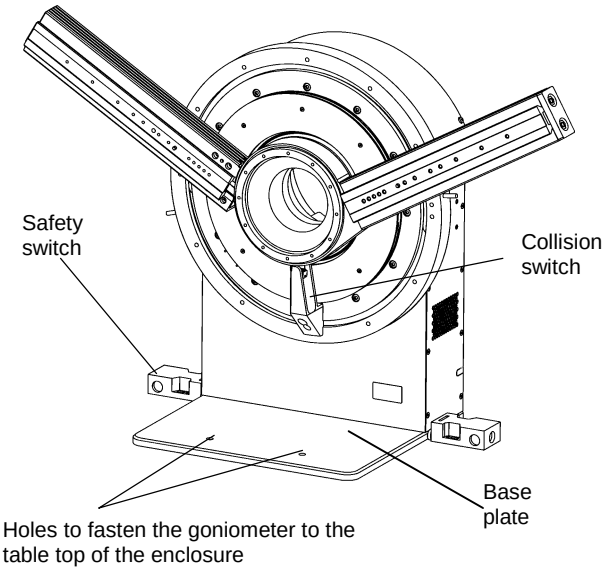


Fig. 8-35: Vertical goniometer in ϑ - ϑ configuration

Now that the goniometer is securely fastened and back in its spot in the enclosure you can now assemble the counterbalance to the back of the goniometer. The flat part of the flange shows to the ground. Before installing the weights, you first have to investigate the right position with respect to the optics an stuff mounted to the track on the front side of the goniometer. This can be done in the table in the chapter “counterbalance”. Eventually you can mount the weight(s) to the appropriate position to ensure flawless operation.

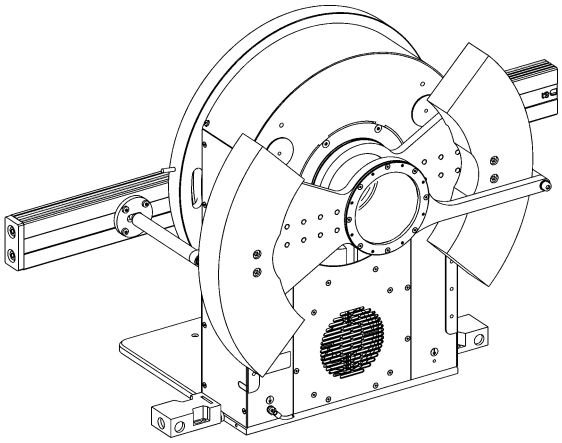


Fig. 8-36: Counterbalance for inner and outer circle

9. Eventually you can start to reassemble and align things like optics, mount / tube housing / interlock / sample stage / detector again.

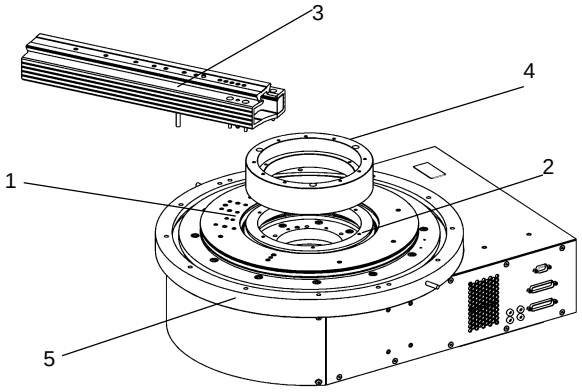
Conversion manual for ϑ - ϑ systems into ϑ - 2ϑ systems

1. First of all remove all parts from the goniometer, i.e. optics, tube housing, detector, interlock, weight, counterbalance, tracks, sample stage including the black adapter ring in the centre of the goniometer.

2. Now firstly mount the track for the inner circle onto the goniometer and after that the adapter ring (44 mm height, any orientation). Just tighten the screws of the adapter ring softly because the ring needs to be centred in a further step. Flip the goniometer over in horizontal position. Look at the picture underneath.

3. Take of the base plate before you start centring the adapter ring.

⚠ **Caution:**
Only handle the goniometer at its housing or the fixed T-slotted outer ring. Never handle it using the tracks. Take care of your hands and fingers while flipping the goniometer.



1 outer circle
2 inner circle
3 track for detector and diffracted beam optics (outer circle)
4 adapter ring
5 fixed T-slotted ring

Fig. 8-37: Conversion into ϑ-2ϑ configuration

The adjustment works as shown in the picture on page 8-39 using a stand and a dial indicator.

4. Screw the measurement stand into the delivered black spacer.

5. Slide the black spacer onto the track and clamp it.

6. Plug the dial indicator into the stand, clamp it and adjust it such that it touches the fit at

the inside of the adapter ring. There is a adjusting screw at the stand with which the dial indicator can be adjusted to the middle of its measurement range. For a better reading you can turn the scale until the indicator shows zero. Now drive the inner circle to the angles 0° , 180° and 90° , 270° respectively and align the ring carefully using a protection hammer to the centre line of the goniometer. That means to minimise the deflection of the indicator. Because of unavoidable inaccuracy due to manufacturing there will always remain a certain deflection. The adapter is centred when the total amount of indicator deflection error is below 0.02 mm. Double check the adjustment and the accuracy of the adapter while putting the dial indicator on the top surface of the ring. This reading should not increase 0.02 mm either. Repeat this procedure, for any further adapter ring needed for different measurement heights that goes on top of the first one. The first ring on the goniometer is always 44 mm in height, the second ring is 64 mm and the third one is again 44 mm in height.

⚠ **Caution:**
After finishing the adjustment of the adapter ring tighten the screws properly while the goniometer is still horizontal. Double check the adjustment finally just to make sure that nothing changed during tightening.

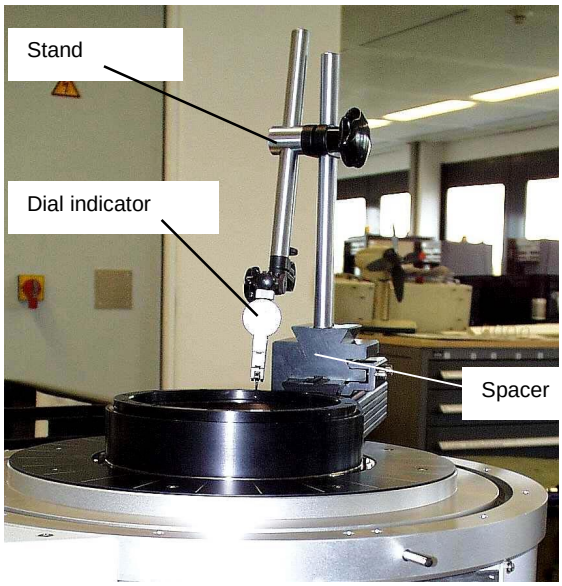


Fig. 8-38: Measuring attachment to adjust the spacer ring

7. After the adjustment mount the second fixed track on 30° to the fixed T-slotted ring and initialise the outer circle at around 30°. Now the base plate can be reassembled. Connect the plug to the port at the side panel of the goniometer. After that put the goniometer back on its original place, **! fix it to the table top !** of the enclosure and bring the safety switches back in position.

⚠ **Caution:**
Never ever lift the goniometer at its tracks!

Make sure, that the goniometer is securely fastened to the table top of the enclosure.

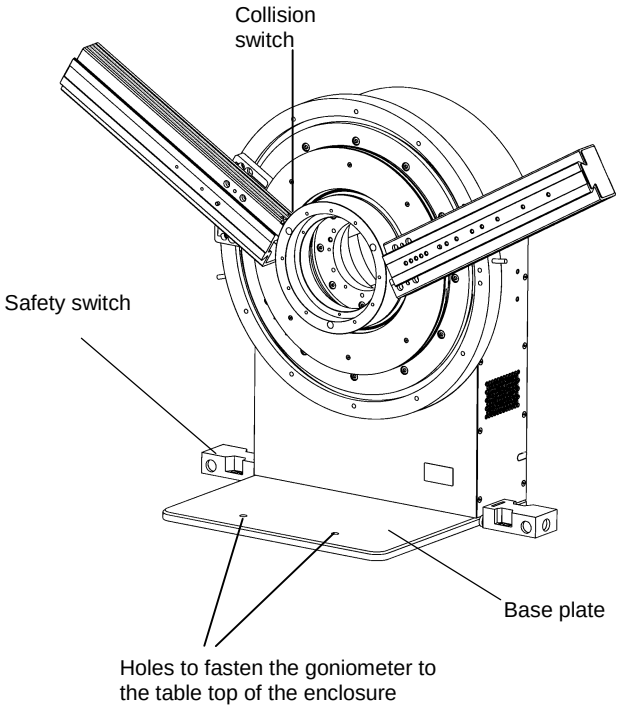


Fig. 8-39: Vertical goniometer in ϑ-2ϑ configuration

8. After the goniometer is securely fastened back in its spot in the enclosure you can now assemble the counterbalance to the back of the goniometer. The flat part of the flange shows to the ground. Before installing the weight you first have to investigate the right position with respect to the optics an stuff mounted on the front side of the goniometer. This can be done in the table in the chapter “counterbalance”. Eventually you can mount the weight to the appropriate position to ensure flawless operation.

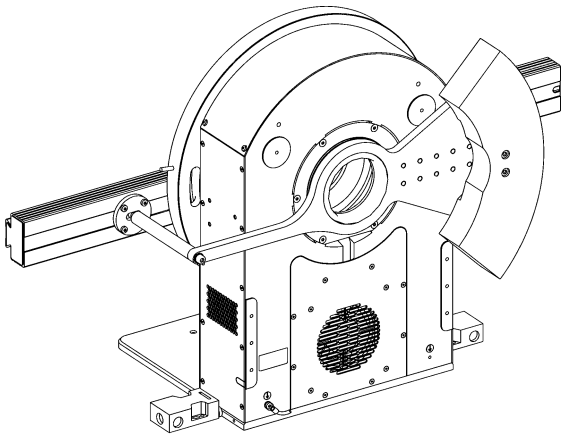


Fig. 8-40: Counterbalance for diffracted beam side

8. Eventually you can start to reassemble and align things like optics, mount / tube housing / interlock / sample stage / detector again.

Maintenance of the Quarter Circle Eulerian Cradle

Installation / Transportation

⚠ The quarter circle Eulerian cradle must only be handled at the mounting base and directly at the Chi segment (cf. Fig. 8-41). Any other positions especially the x,y,z translation stages and the Phi circle are absolutely forbidden! Violation of this rule leads to damages. The sphere of confusion might increase dramatically!

⚠ Large accelerations must be avoided. Handle the cradle as softly as possible!

⚠ For transportation the specially designed box must be used.

⚠ Remove fuzz stemming from the transportation box before operating the cradle.

⚠ Never loosen screws which are secured with colour!

Lubrication

The lubrication is only for the 4 guiding tracks of the Chi-Circle-rollers (see the 4 arrows in fig. 8-42). Shake the container until powder and lubrication are mixed. After the old lubrication is removed from the Chi-Circle apply new lubrication on the guiding tracks of the Chi-Circle-rollers with your fingers or a thin cloth.

Molykote is only for the teeth of the Chi-Circle. After the old grease and dust is removed from the teeth apply new grease on the teeth using a brush.

Apply lubrication and grease as required! (i.e. if oil is dried, Chi drive is noisy, loosing steps, or having problems with referencing.)

Almost no maintenance is required for the other drives of the quarter circle Eulerian Cradle. This is also valid for the Phi circle which has a marked lubrication spot.

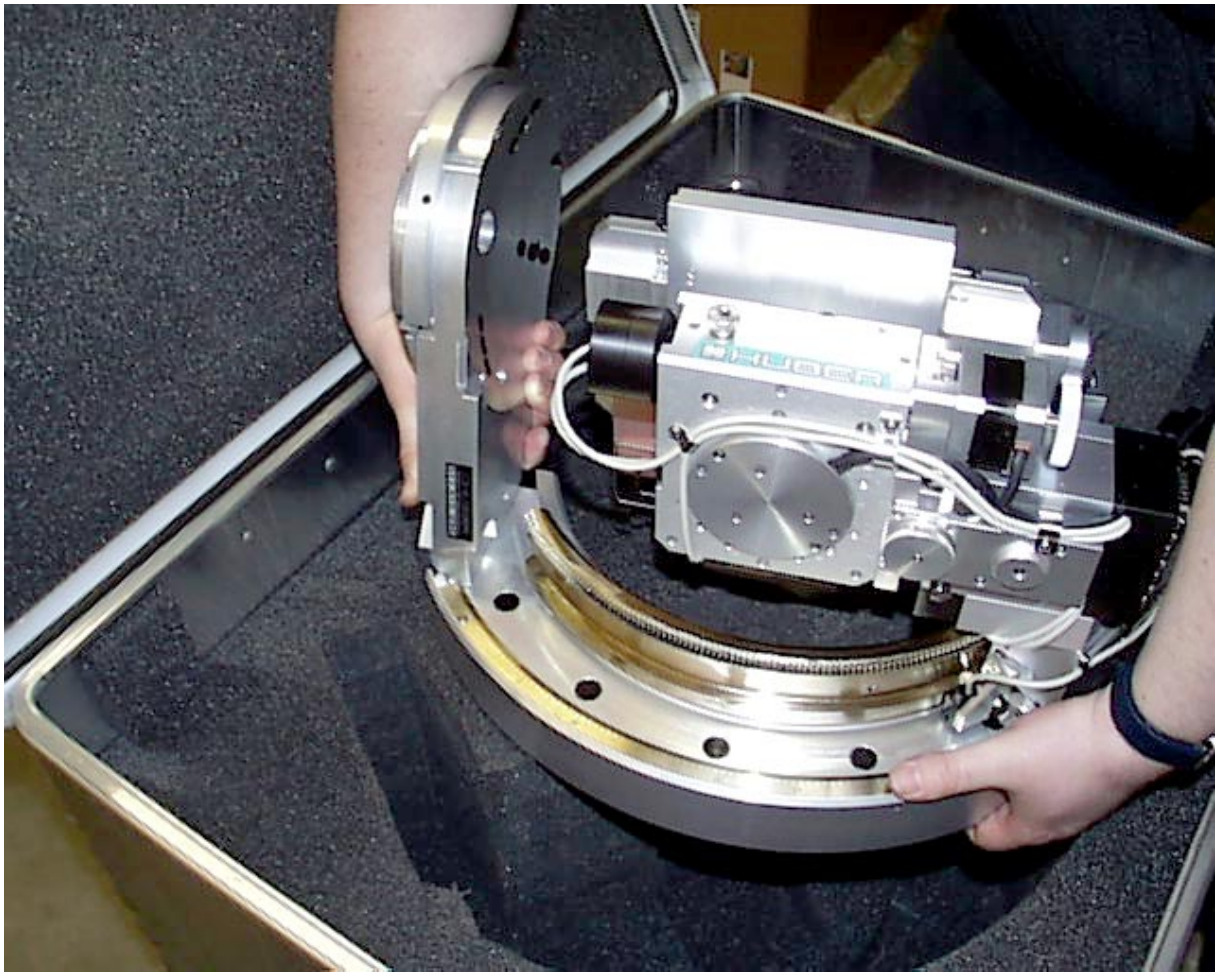


Fig. 8-41: Handle the cradle with care

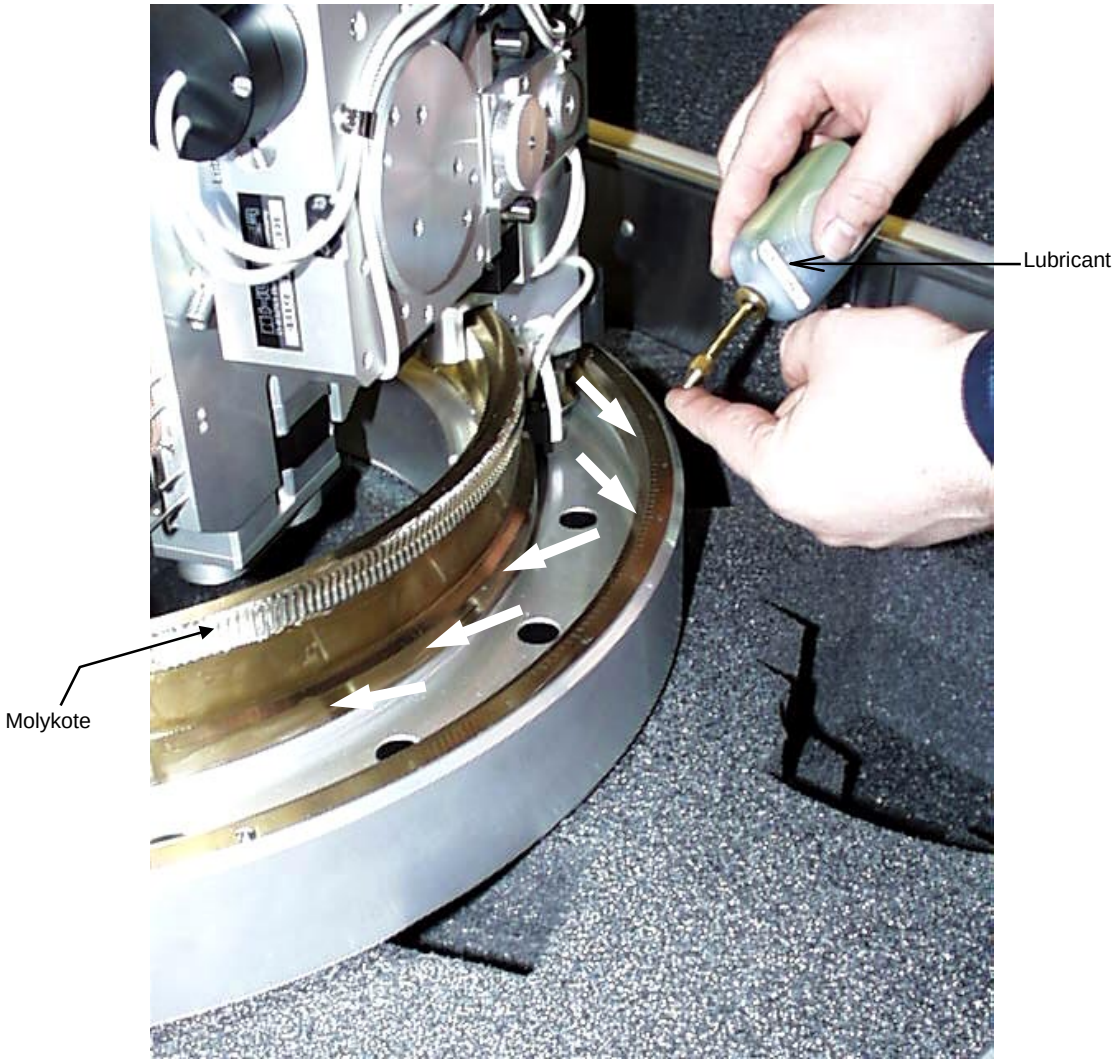


Fig. 8-42: Lubricating the guiding tracks

Collision Switch for the Eulerian Quarter Cradles

1. Solder the two black cables to the two switch contacts before mounting the collision switch (microswitch) onto the plate. Please be sure to use only those contacts with which the microswitch functions as a closer, i.e. so that a continuity checker would react or sound when the switch is being actuated.
2. Remove the two screws as depicted in fig. 8-43, Pos. 1 and Pos. 2.
3. Screw the switch to the plate supplied (see fig. 8-43).
4. Screw this plate directly to the Eulerian cradle (see fig. 8-43, Pos. 1).
5. Push the two cables into the strain relief clamp and attach it to the Eulerian cradle (Abb. 8-43, Pos. 2).
6. Before adjusting the switch, plug the two cables into the goniometer as a precaution (Fig. 8-44) and make sure that the switch works properly.

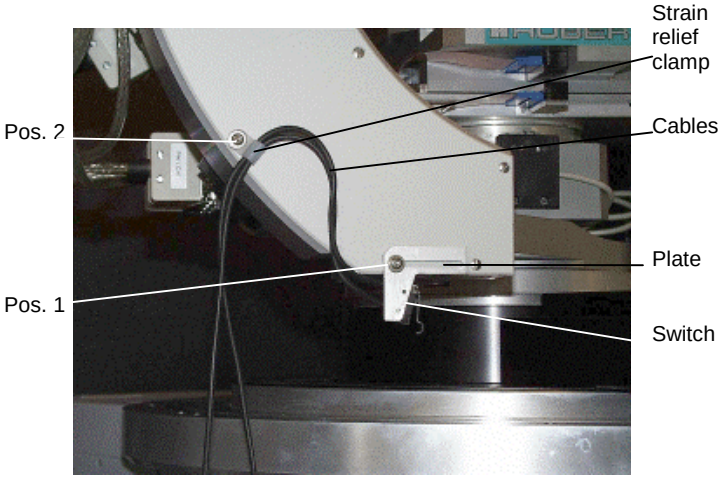


Fig. 8-43: Switch mounting to the Eulerian cradle

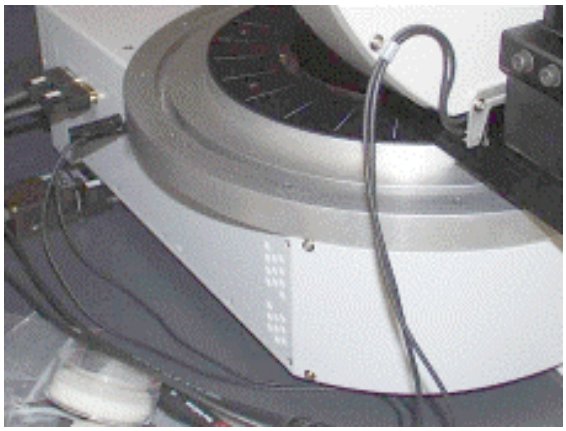


Fig. 8-44: Switch connection to the goniometer sockets

7. Adjust the switch - **very carefully and step by step -** by moving the ϑ - circle and 2ϑ - circle in opposite directions until both circles nearly touch.

8. Move the plate with the mounted switch until the switch is actuated by the black track (see fig. 8-45).

☞ **Please note:**
Tests have shown, that for the movement Δ 5° between ϑ and 2ϑ are sufficient. This means when adjusting ϑ to 0° und 2ϑ to –5° the collision switch will have contact in this position.



Fig. 8-45: Adjusting the collision switch

9. Finally, adjust the actuators of the goniometer limit switches and collision switches between ϑ and 2ϑ respectively.

Hint: ☜
It's been shown that the actuator for the ϑ - circle is best adjusted by proceeding between the angle area from –5° to +185°. The actuators of the 2ϑ - circle are best adjusted between -95° and +165°.

Collision switch for open Eulerian Cradles

1. Before mounting the collision switch (micro switch) onto the plate, first solder the two black cables to two switch contacts. Please be sure to use only those contacts with which the micro switch works as a closer, i.e. so that a continuity checker would react or sound.
2. Screw the switch onto the plate supplied (see fig. 8-46) using the two screws M2x10 with washers.
3. Now assemble this plate with the micro switch to the dove clamp of the special raiser for open Eularian cradles, using the screw M3 x 14 with washer (see fig. 8-46). Attach the strain relief clamp around the two cables and put it underneath the screw M3 mentioned above (see fig. 8-46)
4. Before adjusting the switch, plug the two cables into the goniometer as a precaution and check the switch to see if it works properly.
5. Adjust the switch - **very carefully and step by step -** by moving the ϑ - circle and 2ϑ - circle in opposite directions until something nearly collides.
6. Move the plate with the mounted switch until the switch is actuated by the housing of the cradle. Double check - **again very carefully and step by step** – that the cradle can drive around without any different collision at some other place.
7. Finally, adjust the actuators of the limit switch or the collision switch between ϑ and 2ϑ respectively.

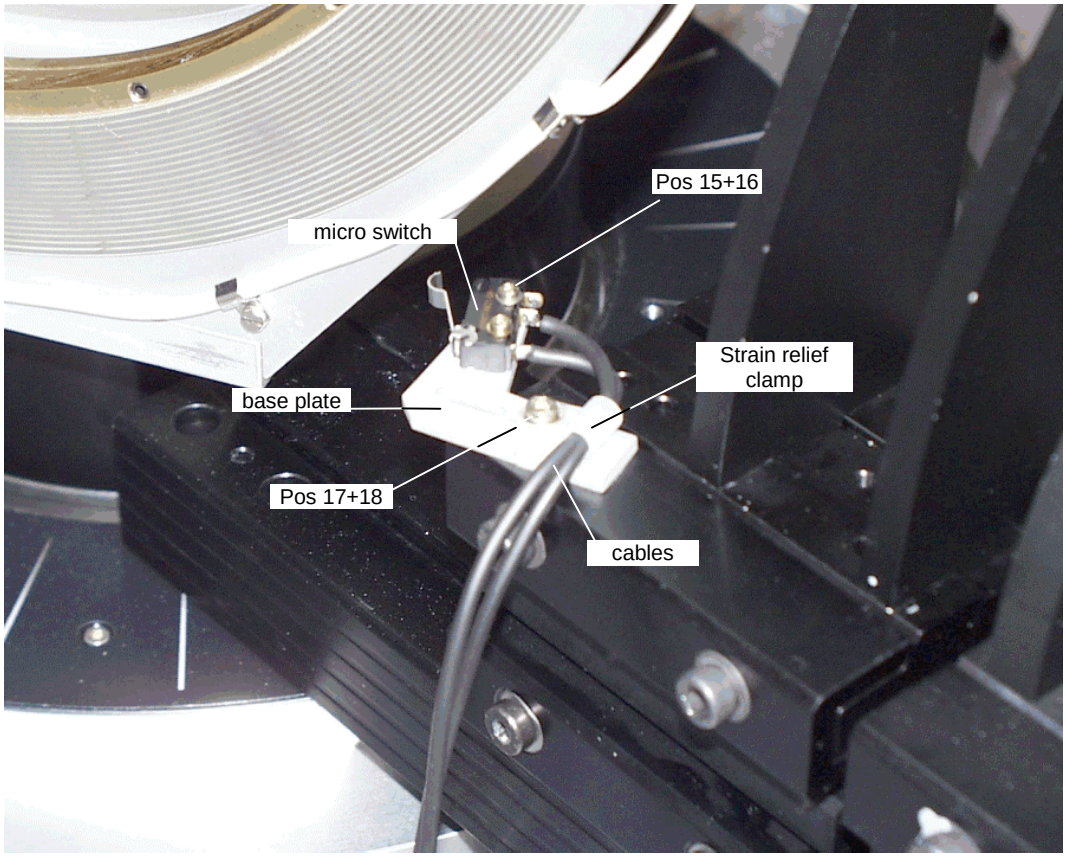


Fig. 8-46: Mounting the collision switch

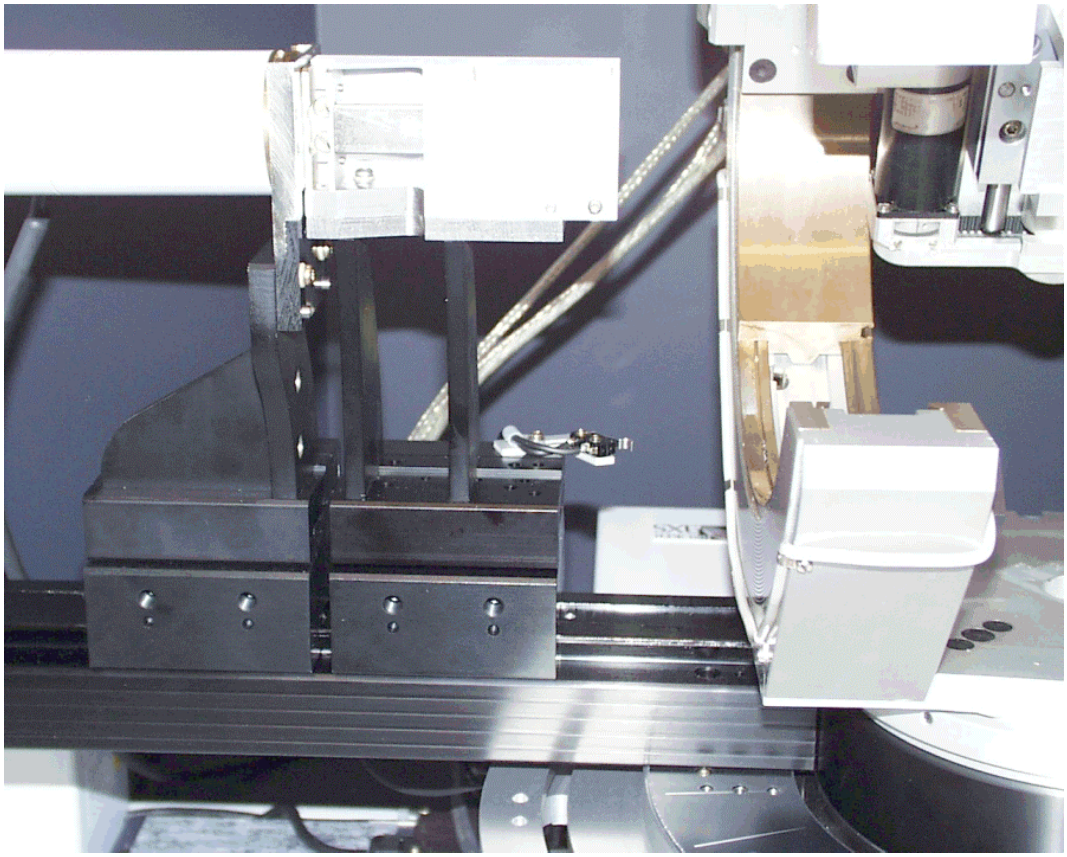


Fig. 8-47: Adjusting the collision switch

9 Appendix

Table of Contents

9 Appendix 9-2
Spare parts list 9-2
Spare Part Package 9-6
Basic Package C79298-A3242-D10 9-6
Advanced Package C79298-A3242-D11 9-8
Spare Parts Package D85 (Extended Package) C79298A3244D120 9-9

9 Appendix

Spare parts list

Tab. 9-1: Spare parts list

Part - No.	Name	Position in parts list	Comment
enclosure	**C79298-A3242-A1**		
C79298-A3230-C2	neon lamp	29	220V
W79087-A2001-B160	axial fan	32	220V
C71315-Z153-C4	micro switch	36	
C71315-Z153-M9	roller actuator	37	
W75050-U1104-A102	safety switch	39	
625-2Z DIN 625	ball bearing	41	
C79298-A3220-B210	warning display	65	
2x10xDIN 94	cotter pin		
cabinet	**C79298-A3242-A101**		
W74247-L8750-A2	fan	37	220V
W79029-X4605	LED holder	21	
W79025-L2707-K120	LED green	22	
W79025-L1802-K120	LED red	23	
W79025-L3706-K120	LED yellow	24	
C79298-A3200-C25	switch unit with 1 switch element	66	
C79298-A3200-C26	switch unit with 2 switch elements	67,77	
C79298-A3200-C30	key switch	76	
C79298-A3200-C33	tumbler switch	80	

Part - No.	Name	Position in parts list	Comment
C79298-A3200-C28	switch unit for emergency stop	69	
C79298-A3200-C24	push button	65	
C79298-A3200-C27	emergency stop	68	
C79298-A3200-C31	red push button	78	
C79298-A3200-C32	green push button	79	
C79298-A3200-C20	green cover for push button	61	
C79298-A3200-C21	red cover for push button	62	
C79298-A3200-C22	light bulb for push button	63	
C79298-A3200-C23	switch	64	
C79298-A3200-C24	push button	65	
C79298-A3242-C55	symbols for buttons	74	
supply board	**C79298-A3242-B102**		
W79054-L1011-T630	slow blow fuse T 6.3A	22	
C79298-A3220-B200	box distribution board for enclosure	2	
3TB4011-0AN1	contactor AC 220V	17	
W75053-B1001-N402	coupling unit 24V	18	
E116-C1	anti suppress capacitor 220N	54	
C72298-A210-B43	mains adaption transformator		
K180-C14	automatic circuit breaker 16 A		
control unit	**C79298-A3240-A1**		
C79298-A3220-B106	slot CPU	50	
C79298-A3220-B103	universal control board	51	
C79298-A3220-B102	detector interface board	59	
C79298-A3230-C30	floppy drive	65	
SXI-419-306500	indexer driver board 2Axis / 4A	52	
SXI-419-306600	indexer driver board 4Axis / 2A		
C79298-A3230-C32	switching mode power supply	6	
C79298-A3230-A33	fan	2	
W79054-L1011-T630	slow blow fuse T6.3A	26	
W79010-M3109-T100	capacitor 10000U	8	

Part - No.	Name	Position in parts list	Comment
W79010-M3109-T63	capacitor 10000U	12	
W74004-M304-J49	resistance 100R 4W	15	
W75040-B21-B90	mains transformator	16	
W79021-C1013-A203	bridge rectifier	21	
W79054-N1011-M160	medium fuse M1,6A	27	
C79298-A3220-B205	power bus board	31	
C79298-A3220-B206	ISA-AT passive backplane	33	
W79041-E4103-B2	filter for radio interference suppression	36	
W79028-A3033-M232	NTC-resistance	54	
C79298-A3230-C31	hard drive	66	
C71187-Z46-K3	insulation bead	79	
goniometer	**C79298-A3244-A20**		
K150-C3	stepper motor with encoder	11	
C79298-A3220-B228	goniometer wiring board	24	
C79298-A3230-A34	fan		12V
K110-C2	T - nut M6 x 10		
K110-C3	T - nut M8 x 10		
C79298-A3244-C86	spring		
C79298-A3244-D102	Wiring Set		
C79298-A3244-B199	actuator for limit switch		
tube housing	**C79298-A3244-A1**		
C79298-A3244-C7	shutter	7	
C79298-A3244-C8	sliding piece	9	
C79298-A3190-C13	compression spring	10	
EN 28752 2x8	spring pin	11	
C79298-A3244-C9	centering pin	14	
C79298-A3244-B11	lifting magnet	16	

Part - No.	Name	Position in parts list	Comment
C71121-Z100-A22	O-ring	28	
C79298-A3200-C3	micro switch	30	
C79298-A3200-C4	light barrier	34	
C79298-A3244-C21	insulating foil	49	
C79298-A3202-C19	cobra clamp	59	
C79298-A3230-C5	HV cable		
C79298-A3244-B10	control cable for shutter unit	42	
C79298-A3202-C1	clutch	60	
C79298-A3202-C18	water hose	61	
C79298-A3220-B202	shutter status display	17	
tracks, optics, etc.			
C79298-A3130-A73	cable for scintillation counter	5	
SXI-015-005100	pin stop		
SXI-472-028400	collision switch with cable and plug (2 pin)		
C79298-A3244-C86	spring for variable slit optics		
SXI-472-028300	collision switch with cable and plug (sub-D)		
C79195-Z122-A3	cable strip		
miscellaneous			
C79298-A3160-D32	tool set		

Spare Part Package

Basic Package C79298-A3242-D10

Tab. 9-2: Spare Parts Package: Basic Package

Part No.	Name	Comment	Amount
enclosure			
C71315-Z153-C4	micro switch		3
C71315-Z153-M9	roller actuator		3
W79087-A2001-B160	axial fan	220V	1
DIN 625 625-2Z	ball bearing	21012792	2
base cabinet			
W74247-L8750-A2	fan	220V	1
W79054-L1011-T630	slow blow fuse T 6.3A		10
control panel at front pillar			
W79029-X4605	LED holder		2
W79025-L2707-K120	LED green		2
W79025-L1802-K120	LED red		2
W79025-L3706-K120	LED yellow		2
C79298-A3200-C25	switch unit with 1 switch element		2
C79298-A3200-C26	switch unit with 2 switch elements		2
C79298-A3200-C30	key switch		1
C79298-A3200-C33	tumbler switch		1
C79298-A3200-C28	switch unit for emergency stop		2
tube housing			
C79298-A3244-C8	sliding piece		1
C79298-A3190-C13	compression spring		1
EN 28752 2x8	spring pin	Bau Nr.10559911	1
C79298-A3244-C9	centering pin		1
C79298-A3244-B11	lifting magnet		1
C71121-Z100-A22	O-ring		10

Part No.	Name	Comment	Amount
C79298-A3200-C3	micro switch		2
C79298-A3200-C4	light barrier		2
C79298-A3244-C21	insulating foil		2
C79298-A3202-C19	cobra clamp		4
C79298-A3220-B202	shutter status display		1
goniometer			
W79050-X6001	micro switch		3
C71315-Z153-M4	roller actuator		3
C79298-A3156-D12	filter		3
C79298-A3230-A34	fan	12V	1
C79298-A3190-C53	T-nut	M8x10 DIN 508	2
SXI-015-005100	pin stop		4
C79298-A3244-C86	spring		2
W79025-G1913-X	light barrier	OPB 960	2
control unit			
C79298-A3230-A33	fan		1
W79054-L1011-T630	slow blow fuse T6.3A		10
generator			
C79249-A3000-D9	propeller, bearing (water flow)		1

Advanced Package C79298-A3242-D11

Tab. 9-3: Spare Parts Package: Advanced Package

Part No.	Name	Comment	Amount
enclosure			
W75050-U1104-A102	safety switch		1
C79298-A3220-B210	warning display		2
cabinet			
C79298-A3200-C23	switch		2
C79298-A3200-C24	push button		2
C79298-A3200-C27	emergency stop		2
C79298-A3200-C31	pushbutton red		2
C79298-A3200-C32	pushbutton green		2
tube housing			
C79298-A3230-C5	HV cable		1
C79298-A3244-B10	control cable for shutter unit		1
control unit			
C79298-A3220-B106	slot CPU		1
C79298-A3220-B103	universal control board		1
C79298-A3220-B102	detector interface board		1
C79298-A3230-C30	floppy drive		1
C79298-A3220-B205	power bus board		1
SXI-419-306500	indexer driver board 2Axis / 4A		1
C79298-A3230-C32	switching mode power supply		1
goniometer			
SXI-402-018900	stepper motor with encoder		1
C79298-A3220-B214	goniometer wiring board		1

Spare Parts Package D85 (Extended Package) C79298A3244D120

Tab. 9-4: Spare Parts Package: Extended Package D85

Part No.	Name	Position in parts list	Amount
W75050U1104A102	Safety switch	0001	1
C79298A3220B210	Warning display 1	0002	2
C79298A3200C23	Switch	0003	2
C79298A3200C24	Actuator	0004	2
C79298A3200C27	Emergency Stop	0005	2
C79298A3200C31	Actuator	0006	2
C79298A3200C32	Actuator	0007	2
C79298A3230C14	High-voltage cable	0008	1
C79298A3244B10	Control cable	0009	1
C79298A3220B106	Slot CPU board	0010	1
C79298A3220B103	Universal control	0011	1
C79298A3220B102	Measuring electronics	0012	1
C79298A3230C30	Floppy disc drive	0013	1
C79298A3220B205	Power bus	0014	1
SXI-419306601	Indexer board 4x2A 24V	0015	1
C79298A3230C32	Power supply	0016	1
C79298-A3244-B209	Stepper motor D85	0017	1
C79298A3220B228	Gonioboard	0018	1
C79298A3244D102	Wiring set	0019	1

10 Index

2

2θ scale
zero definition 3-195
zero point definition 3-190, 7-6
2-Axis indexer boards 3-179

4

4-Axis indexer boards 3-182

A

Absorber 3-15
Accessories
for sample carriers 3-24
Accessories components 2-6
ADJUST 3-187
Aligning the discriminator window 3-203
Aligning the parameters of the measurement electronics 3-200
Aligning the receiving slit changer 3-199
Alignment
of the fixed slit assembly 3-189
of the reflectometer sample stage 7-4
Alignment of the angular scales
of the reflectometer sample stage 7-4
Alignment of the diffractometer 3-187
Alignment of the variable slit assembly 3-194
Anti-scatter slit
centering to the zero beam 3-191
Aperture slit
centering to the zero beam 3-192
Aperture slit system 3-10
with fixed slit 3-10
with variable slit 3-11
Application
of the diffractometer 3-1
Area of installation 1-1

B

Box distribution board 3-51
Bragg-Brentano law 3-3

C

Cable protection cover
for the X-ray tube 3-9
Centering the anti-scatter slit to the zero beam3-191
Centering the aperture slit to the zero beam....3-192
Centering the fixed aperture slit to the zero beam 3-198
Centering the radiation outlet flange 3-193
Centering the variable anti-scatter slit to the zero beam 3-196
Centering the variable aperture slit to the zro beam 3-197
Circuit diagrams 3-30

list 3-30
Cleaning the diffraction system 2-5
Collision switch
for the ¼ - circle Eulerian cradle 8-44
Command macros 3-167
Commands
miscellaneous 3-150
Connection
of the cooling water hoses 3-68
Connection to the X-ray generator 3-68
Control electronics
circuit diagrams 3-30
modules 3-33
Control panel 3-52
Control rack 3-32
Cooling water hoses
connecting 3-68
Cooling water supply 1-12
Counter tube gas cylinder 1-15

D

D8TOOLS
diagnosis software 8-1
Design
of the diffractometer 3-4
Detector 3-4, 3-26
position sensitive detector 3-28
Si(Li) semiconductor detector 3-27
Detector cable
tensile stress relief 3-26
Detector interface board 3-38
Detector interface boards 3-176
detector slit system
with a variable and a fixed slit 3-12
Detector slit system 3-12
with fixed slits 3-12
DEVICE.INI 3-71, 3-187
[2AIBx] section 3-75
[4AIBx] section 3-75
[CHANNELx] section 3-84
[COM] section 3-76
[DEVICE] section 3-72
[DIBx] section 3-74
[DRIVE] section 3-78
[UIOBx] section 3-72
Dial indicator
reflectometer sample stage 7-3
DIFFRAC*plus*
ADJUST 3-187
reflectivity measurements 7-13
DIFFRAC*plus* ADJUST
module for aligning measurement parameters 3-200
Diffracted-beam monochromator
angle 2θ 5-8
pre-adjustment 5-5
radiation protection 5-9
Diffracted-beam monochromator
adjustment 5-4
adjustment to center of radiation 5-7
angle θ 5-5
application 5-1
design and mode of operation 5-1
final adjustment 5-8
installation 5-3
preliminary work 5-4
technical data 5-3
Diffractometer
alignment 3-187
dimensions 1-2
method of operation 3-2
supplements 3-1
weight 1-3
Discriminator window
aligning 3-203
Displays
illuminated status displays 2-7
Divergence slit next to the sample 3-15

E

Earth terminal 1-5
Edge diaphragm
alignment 7-2
mounting 7-2
EditDQL 7-13
Error flags 3-160
Eulerian Cradle
Lubrication of the Quarter Circle Eulerian Cradle 8-41
Maintenance of Quarter Circle Eulerian Cradle 8-41
Example for a reflectivity measurement
using the reflectometer sample stage 7-10
External warning display 3-53

F

Filter
Kβ filter 3-15
Fitting the tube 3-69
Fixed aperture slit
centering to the zero beam 3-198
Fixed slit assembly
alignment 3-189
Fixed slits 3-13
width and opening angle for the fixed slits 3-14
Focussing 3-3
Fuses 1-4

G

Gas flow 1-15
General safety precautions 2-2
Glass slit
of the reflectometer sample stage 7-5
Goniometer 3-4
description 3-5
ϑ/2ϑ goniometer 3-5
ϑ/ϑ goniometer 3-5
Grazing incidence attachment 6-1
adjustment of attachment with monochromator 6-4
adjustment without monochromator 6-8
adjustments 6-4
application 6-1
crystal change 6-8
design 6-1
figures 6-11
installation 6-3
operation 6-1
operation with monochromator in dispersive arrangement 6-3
operation with monochromator in non-dispersive arrangement 6-2
operation without monochromator 6-2
radiation protection 6-9
technical data 6-9

H

Heat dissipation 1-3
High-voltage cable
connecting 3-68
High-voltage measurement
using Cr radiation 3-202
using Cu radiation 3-201

I

I/O ports
assignment 3-169
Illuminated status displays 2-7
Indexer/driver 2 axis / 4 amps 3-43
Indexer/driver 4 axis / 2 amps 3-47
Initialisation

of the diffractometer 3-71
Interfaces
to external computers 3-93
Interlock
safety system 2-14

K

Kβ filter 3-15

M

Macros 3-167
Main processor 3-33
Mains connection and earthing 1-4, 1-6
Mains distribution board 3-31
Mains supply
automatic circuit breakers 1-4
fuses 1-4
power cable 1-4
preset of different voltages 1-4
Maintaining the measuring equipment 2-5
Manual control box 3-54
Additional information about functions 3-62
Configuration 3-55
Firmware 3-55
Hardware setup 3-54
Keyboard setup 3-58
Short description of functions 3-58
Steps for Installation 3-54
Measuring function status 3-152
Method of operation
of the diffractometer 3-2
Micro diaphragms 3-14
Modem
for teleservice 1-12
Monochromators
Diffracted-beam monochromator 5-1
Mounting 3-68

O

Operating instructions 3-1

P

Parameters of the measurement electronics
aligning 3-200
Power cable 1-4
Power supply of accessories components 2-6
Pre-installation 1-1
earth terminal 1-5
gas flow 1-15
mains supply 1-4
Proportional counter
aligning 3-200
Protection against radiation 2-8
safety circuits 2-9

Q

Quartz sample
for aligning measurement parameters 3-200

R

Radiation
protection 2-8
Radiation outlet flange
centering 3-193
Receiving slit changer
aligning 3-199
Reflectometer sample stage 7-1
aligning the reflectometer sample stage 7-4
alignment of the angular scales 7-4
alignment of the edge diaphragm 7-2
alignment of the sample 7-8

calibrating the edge diaphragm 7-2
dial indicator 7-3
example for a reflectivity measurement 7-10
glass slit 7-5
zero point definition of the 2θ-scale 7-6
zero point definition of the θ-scale 7-5
REFSIM
simulation program 7-12
Remote control
by an external computer 3-95
Remote control commands
desciption 3-96
Removing the tube 3-69
Room humidity 1-3
Room planning 1-1
Room temperature 1-3
RS 232 C serial connectors
cable wiring 3-95

S

Safety circuits 2-9
Safety guidelines 2-1
Safety precautions 2-2
Safety system
interlock 2-14
Sample
aligning (on reflectometer sample stage) 7-8
Sample carrier 3-4, 3-16
0° rotating sample carrier 3-23
accessories 3-21, 3-24
rotating sample carrier 3-22
rotating/transmission sample carrier 3-22
standard sample carrier 3-16
Sample stage
reflectometer sample stage 7-1
Scattered-radiation slit next to the sample 3-15
Scintillation counter 3-26
aligning 3-200
Scintillation counter cable
tensile stress relief 3-26
Servicing precautions 2-5
Slit changer 3-14
Slit system 3-4
Slits
divergence slit next to the sample 3-15
fixed slit 3-13
scattered radiation slit next to the sample 3-15
variable slit 3-14
Software handshake 3-94
Spare parts list 9-2
Special instructions
diagnosis software, conversion manuals 8-1
Standard sample carrier 3-16
Status flags 3-154
Supplements
of the diffractometer 3-1
Switch
collision switch for the ¼ - circle Eulerian cradle 8-44
System control
buttons 2-6

T

Technical specifications
diffractions components 2-18
electrical specifications 2-17
general diffraction system 2-15
Teleservice
modem 1-12
Transmission protocol 3-94
Tube 3-4
Tube stand 3-4, 3-8

U

Universal I/O board 3-34, 3-169

V

Variable anti-scatter slit
centering to the zero beam ... 3-196
Variable aperture slit
centering to the zero beam ... 3-197
Variable divergence slit ... 3-14
Variable slit assembly
alignment ... 3-194

W

Warnings and Symbols
illuminated warning displays ... 2-4
symbols ... 2-4

X

X-ray generator
baud rate ... 4-13
components ... 4-2
control ... 4-1
cooling water supply ... 1-12
description ... 4-1
design ... 4-2
external warning lamps ... 4-10
high-voltage generation and regulation ... 4-4
mains connection ... 4-7
method of operation ... 4-4
operation ... 4-11
protection circuits ... 4-4
radiation protection ... 4-5
regulation of tube current ... 4-4
setup ... 4-7
start-up instructions for X-ray tubes ... 4-11
technical data ... 4-6
terminal block X3 ... 4-7
X-ray shutter
control ... 2-12
control cable ... 3-69
status display ... 3-52
warning displays ... 2-13
X-ray tube ... 3-8
Cable protection cover ... 3-9

Z

Zero definition of the 2θ scale ... 3-195
Zero point definition of the 2θ scale ... 3-190

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP