



OPERATING INSTRUCTIONS

EN

Translation of the original instructions

HIQUAD™

QMG 700 Quadrupole Mass Spectrometry System

PFEIFFER  **VACUUM**

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1 Safety

1.1 Symbols Used

DANGER

Information on preventing any kind of physical injury.

WARNING

Information on preventing extensive equipment and environmental damage.

CAUTION

Information on correct handling or use. Disregard can lead to malfunctions or minor equipment damage.

NOTE

All work described in this document may only be carried out by persons who have suitable technical training and the necessary experience or who have been instructed by the end-user of the product.

1.2 Intended Use

The QMG 700 is a mass spectrometer designed for gas analysis in the high vacuum range. It may be used only for this purpose. The instructions in this operating manual and those of the accessories must be followed.

DANGER

The QMG 700 is not intended to produce measurement results on which the safety of persons or material depend. For such applications the safety must be ensured by additional measures.

1.3 Basic Safety Instructions

- ♦ Please follow the relevant instructions and take the necessary precautions when handling the process media used.
- ♦ Please obtain information before working with contamination. Please follow any relevant instructions and take the necessary precautions when handling devices used with contaminated parts.
- ♦ Pass these safety instructions on to other users.

1.4 Liability and Warranty

Pfeiffer Vacuum assumes no liability and the warranty becomes null and void if the custodian or third parties:

- ♦ disregard the information in this document
- ♦ use the product in a non-conforming manner
- ♦ make any kind of changes (modifications, alterations, etc.) to the product
- ♦ use the product with accessories not listed in the corresponding product documentation

The custodian assumes the responsibility in conjunction with the process media used.

1.5 Training

NOTE

For the optimal use of this product, Pfeiffer Vacuum offers application, operation, and maintenance courses. Your Pfeiffer Vacuum partner would be glad to provide the information.

2 System Overview

System components

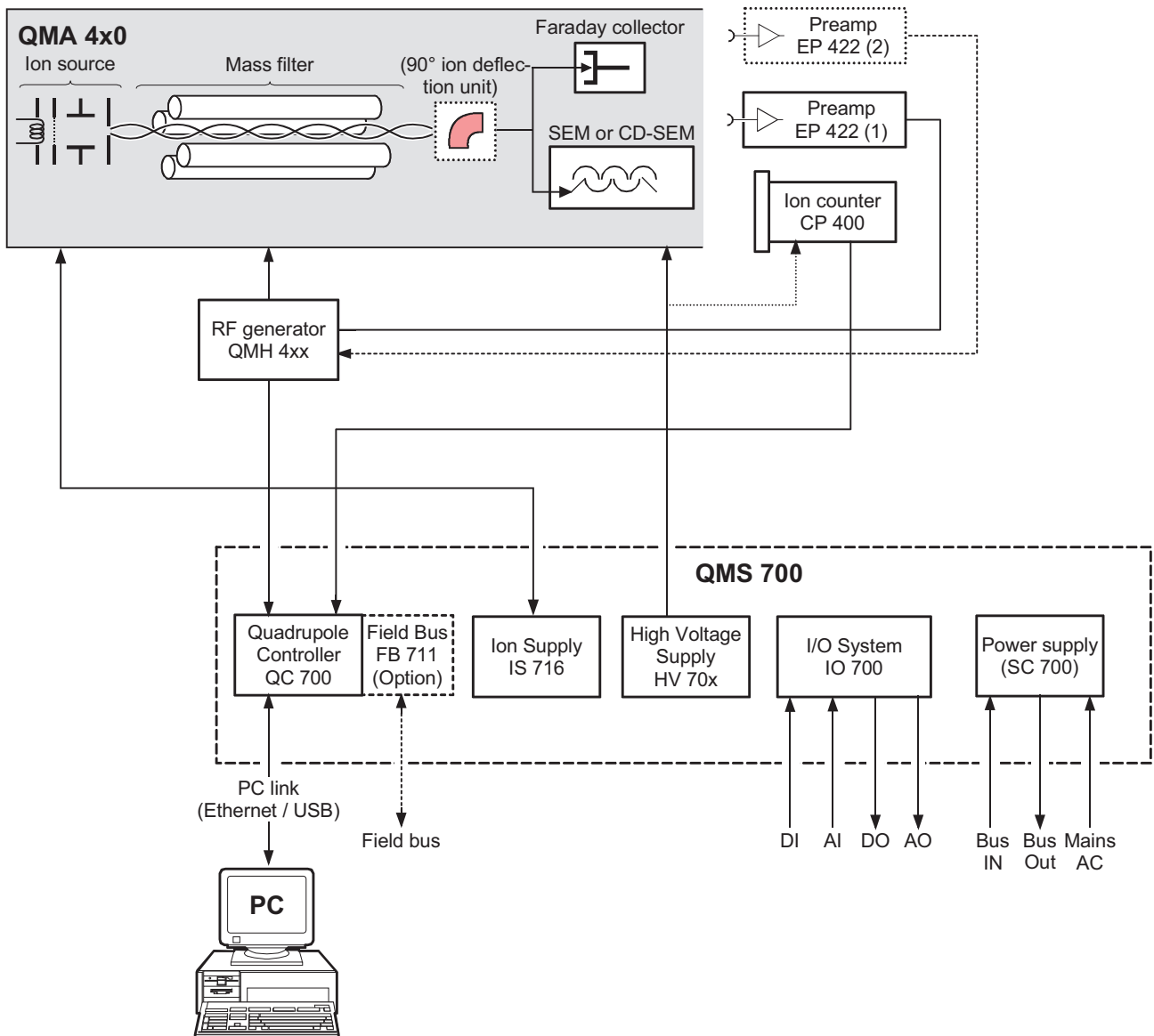
The QMG 700 comprises of the controller QMS 700 (system chassis SC 700 including the modules: QC 700, FB 711, IS 716, HV 701, HV 702, and IO 700). From the 42x system the modules RF generators (QMH 4xx-x), analyzers (QMA 4x0), the electrometer preamplifier (EP 422), and the ion counter preamplifier CP 400 are utilized as well.

System structure QMG 700

The following block diagram shows the general QMG 700 system structure. Depending on the application, various configurations are possible.

For ion counting the electrometer preamplifier EP 422 is replaced by the ion counter preamplifier CP 400.

Individual modules are described in detail on the following pages. The block diagram below shows a configuration example.



2.1 QMG 700 Quadrupole Mass Spectrometer, Components and Modules

Controller QMS 700



Controller

Comprises the system chassis SC 700 and the modules described below.

SC 700



System Chassis

Comprises the power supply, the internal bus plane and the system ventilation. It houses the modules described below.

QC 700



Quadrupole Controller

Comprises:

- ♦ QMG 700 system controller and LAN/USB PC interface
- ♦ Control circuits for the RF generator
- ♦ Measuring signal processing
- ♦ Interface for the CP 400

FB 711 (QC 700 option)



Field Bus

Enables the integration of the QMG 700 in a CANopen network.

IS 716



Ion Source Supply

Supplies all necessary operating voltages for the ion source.

- ♦ Programmable potentials, short-circuit-proof
- ♦ Polarity reversible for positive and negative ions
- ♦ Normal mode / degas mode
- ♦ Suitable for all ion source types of the QMA 4x0

HV 701



High Voltage Supply

Supplies high voltage to the SEM 217 for positive ion detection.

HV 702



High Voltage Supply

Supplies high voltage to the SEM 218 for positive ion detection or the required voltages to the SEM 217 for positive and negative ion detection (biased potentials).

IO 700



I/O System

Provides programmable digital and analog inputs and outputs.

42x Components

42x components have initially been designed for the QMG 420/421 and QMG 422 system, however they are fully compatible to the QMG 700 system.

EP 422



Electrometer Preamplifier

The EP 422 amplifies the very small ion current signals of the analyzer to voltage levels that are suitable for further processing. It is installed directly on the analyzer in order to minimize parasitic noise.

- ◆ Compact, simple installation on QMA 4x0
- ◆ Low-noise, low-drift, little vibration sensitivity
- ◆ Fast response and quick recovery from overdriving

NOTE

On analyzers with 90° off-axis SEM, two EP 422 can be connected. This allows simple changeover from Faraday to SEM mode.

CP 400**Ion Counter Preamplifier**

Comprises the pulse coupling, amplifier, and pulse height discriminator with adjustable threshold.

It is installed directly on the QMA 4x0 with 90° off-axis SEM.

QMH 4xx**HF-Generator**

Produces the high frequency voltage required for mass separation (separate operating instructions).

QMH-Typ	Range	QMA type	Rod ø
QMH 400-1	128 amu	QMA 410	16 mm
QMH 400-5	300 amu	QMA 430	8 mm
QMH 400-5	512 amu	QMA 400	8 mm
QMH 410-1	1024 amu	QMA 400	8 mm
QMH 410-2	2048 amu	QMA 400	8 mm
QMH 410-3	340 amu	QMA 410	16 mm
QMH 402-2	16 amu	QMA 410	16 mm

NOTE

In the following QMH 4xx or QMA 4x0 always refers to all types if not specified otherwise.

QMA 4x0**Analyzer**

Comprises the ion source, mass filter, ion collector and housing. Ion collector types:

- ♦ Faraday collector
- ♦ SEM 217 (90° off-axis with integrated Faraday collector)

3 Technical Data

3.1 General

This information applies to all QMS 700 modules unless specified otherwise.

Ambient conditions

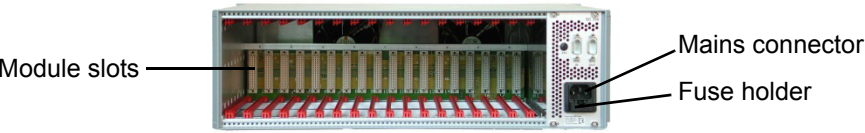
Temperature	
Storage	–40 °C ... +65 °C
Operation	+5 °C ... +40 °C
Relative humidity	≤80% up to +31 °C, decreasing linearly to 50% at +40 °C
Use	indoors, altitude up to 2000 m NN
Type of protection	IP 30
Overvoltage category	II
Pollution degree	2

3.2 System Chassis SC 700

Front panel



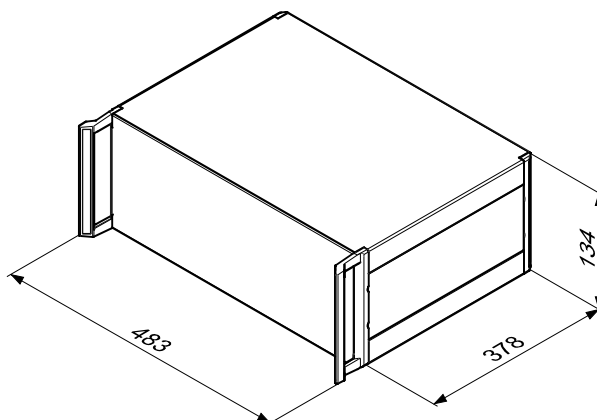
Rear panel



Power supply

Mains connection	
Mains voltage	100 ... 240 VAC, 50 ... 60 Hz
Power requirement	≤500 W
Connector	mains connector with integrated fuse holder
Fuse	6.3 AT HBC, 5×20 mm
Mains cable	country specific

Dimensions [mm]



Weight

7.5 kg (without modules)

Module slots

18 (4U each)

System expansion

In order to expand system functionality, up to four SC 700 chassis can be cascaded.

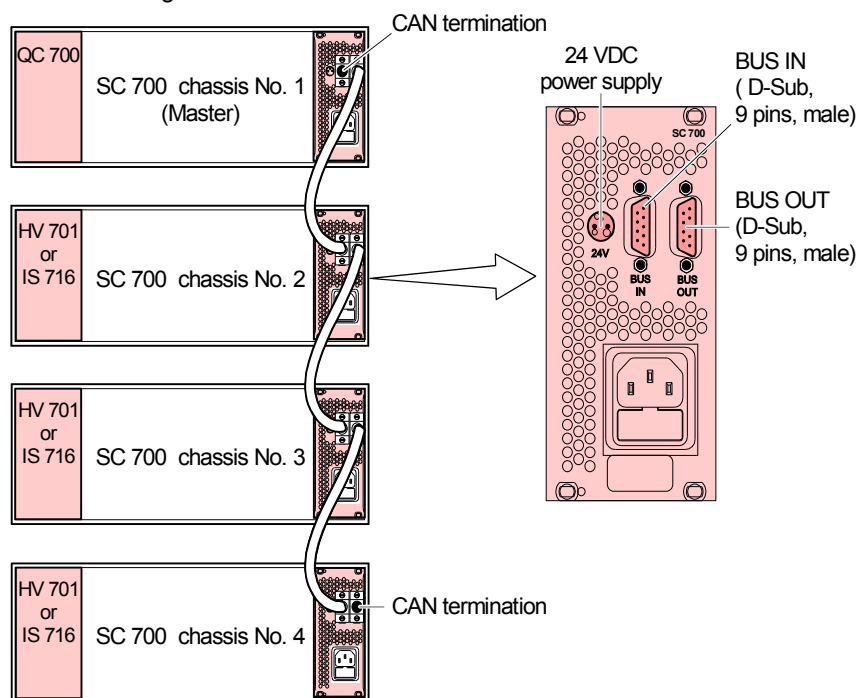
Two versions of the SC 700 chassis are available:

- ♦ Standard system chassis (operated as a single chassis).

NOTE

BUS IN, BUS OUT, and 24 VDC power supply connectors are not equipped on this version.

- ♦ System chassis with the expansion option (up to four chassis can be operated on a bus, interconnection between chassis is made via bus cable ¹⁾).
- ♦ Module arrangement in chassis No. 2 ... 4 differs from chassis No. 1.



¹⁾ Chassis version with the expansion option is configured in the factory and will be delivered with an additional set of documents.

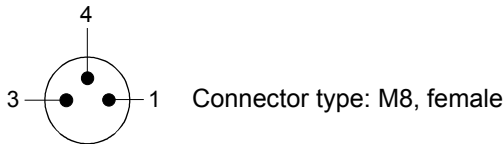
BUS IN Connector for optional chassis expansion, must be terminated with a resistor if not used.

BUS OUT Connector for optional chassis expansion, must be terminated with a resistor if not used.

24 VDC power supply

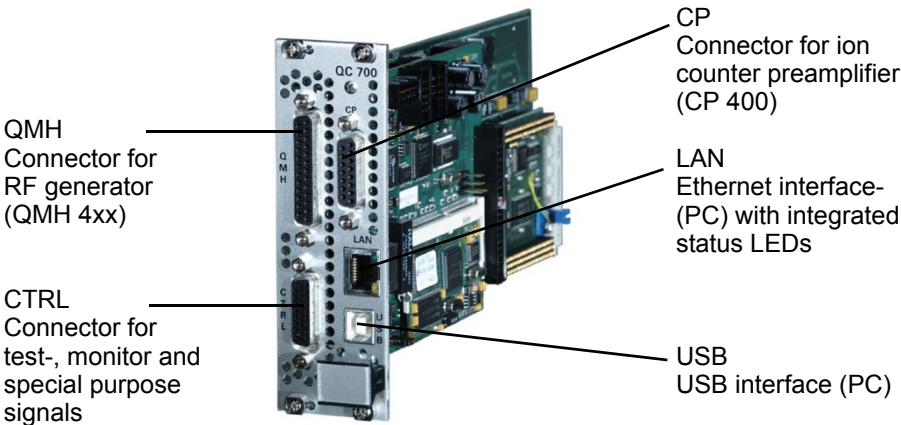
CAUTION

This 24 VDC supply may only be used for an external bus node. Do not use it for any other purpose.



Pin	Signal	Comment
1	+24 V	$I_{max.} \ 2 \ A$
3	0 V	
4	Not connected	

3.3 **Quadrupole Controller QC 700**



General	
Compatibility	system chassis SC 700
Number of slots occupied	2
Modules per system	1
Slot No.	1 and 2 (lefthand side of system chassis)
Weight	0.4 kg

Operation Modes and Parameters

Number of measuring channels	128
Operation modes	<i>MONO- / MULTI channel</i>
Measuring cycles	1 ... 10,000 or <i>REPEAT</i>
Time required for a channel change	100 ... 200 μ s (at min. <i>PAUSE</i> in Cycle)

Mass scan modes

<i>mass-MODE</i>	Measuring method
<i>SCAN-N</i>	Analog scan normal
<i>SCAN-F</i>	Analog scan with FIR filter for measuring value
<i>STAIR</i>	Scan bargraph in steps of 1 amu
<i>SAMPLE</i>	Single mass and MID (Multiple Ion Detection)
<i>PEAK-L</i>	Scan bargraph using level criterion
<i>PEAK-F</i>	Scan bargraph using FIR FILTER
<i>ADJUST-C</i>	Coarse search
<i>ADJUST-F</i>	Fine search

Mass scale resolution

<i>Scan-SPEED</i>	<i>STEPS per mass</i>	
	<i>FIX-Range</i>	<i>AUTO-Range</i>
125 μ s/amu	8/amu	---
250 μ s/amu	16/amu	---
0.5 ... 1 ms/amu	32/amu ¹⁾	---
2 ... 20 ms/amu	64/amu ¹⁾	32/amu ¹⁾
50 ms/u ... 60 s/amu	64/amu ¹⁾	64/amu ¹⁾

¹⁾ 32 at mass range 2048
64 at mass range 4096

Measurement speeds

	<i>EP 422 or external inputs</i>		<i>Ion counter (CP 400)</i>
<i>mass-MODE</i>	<i>FIX-Range</i>	<i>AUTO-Range</i>	<i>AUTO-Range</i>
<i>SAMPLE</i>	125 μ s ... 60 s	0.5 ms ... 60 s	125 μ s ... 60 s
<i>STAIR</i>	125 μ s/amu ... 60 s/amu	2 ms/amu ... 60 s/amu	0.5 ms/amu ... 60 s/amu
<i>SCAN</i>	125 μ s/amu ... 60 s/amu	5 ms/amu ... 60 s/amu	1.25 ms/amu ... 60 s/amu
<i>PEAK</i>	125 μ s/amu ... 60 s/amu	5 ms/amu ... 60 s/amu	1.25 ms/amu ... 60 s/amu

Detector types

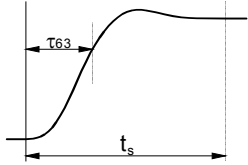
<i>detect-TYPE</i>	
<i>FARAD</i>	Faraday collector, EP 422
<i>SEM</i>	SEM (type configurable), EP 422
<i>ION-CNT</i>	Ion counter CP 400
<i>EXTERN 1</i>	External analog input of QC 700 (EXT IN 1)
<i>EXTERN 2</i>	External analog input of QC 700 (EXT IN 2)
<i>A-INPUT (1 ... n)</i>	Analog signal via IO 700 (analog channels 1 ... n)

Measurement ranges and resolution

Detector type	Measurement ranges	Modes	Resolution
<i>FARAD, SEM</i>	$10^{-12} \dots 10^{-5}$ A fsd	<i>FIX-</i> and <i>AUTO-Range</i>	16 bit ¹⁾ (per range)
<i>EXTERN</i>	GAIN 1: ± 10.240 V GAIN 10: ± 1.024 V	<i>FIX-Range</i>	16 bit ¹⁾
<i>ION-CNT</i>	$10^{-2} \dots 10^8$ cps (meaningful use up to $10^6 \dots 10^7$ cps)	<i>AUTO-Range</i>	in <i>mass-MODE</i> : <i>SAMPLE:</i> 1 / <i>DWELL</i> <i>STAIR:</i> 2 / <i>SPEED</i> <i>SCAN:</i> amu/ <i>SPEED</i>

¹⁾ Further increased by averaging.

Analog filter

Filter type	Two stage low pass Effective for preamp and external inputs
Filter time constant	Automatic or selectable in 9 steps: 5, 18, 85, 400 μ s 1.7, 8, 40, 180, 800 ms
Filter step response	 τ_{63} : filter time constant Settling time to $\pm 1\%$: $t_s \approx 4 \times \tau_{63}$

Digital filter

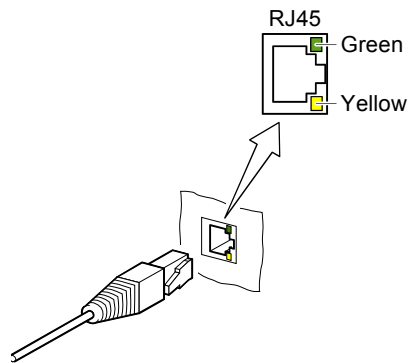
NORMAL (N)	Low pass (average value)
FIR (F)	Finite Impulse Response

Electrical Connections QC 700

QMH connection Connector for RF generators (QMH 4xx) (D-Sub 25 pin, female).

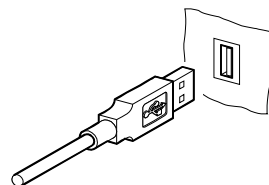
LAN connection Ethernet connector (RJ45).

The interface status is indicated by two LEDs integrated in the RJ45 connector:



LED	Status	Meaning
green	lit	data transfer rate 100 Mbit/s
	dark	data transfer rate 10 Mbit/s
yellow	lit (flickering)	data transfer in progress
	dark	no data transfer (or no connection)

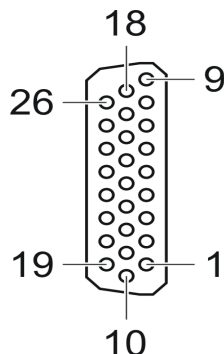
USB connection USB PC connector.



USB connector type B

**CTRL connector,
pin assignment**

HD-Sub, 26 pins



View on QC 700

Pin	Signal	Signal type	Description
1	GND	GND	via 100 Ω to GND
10	GND	GND	via 100 Ω to GND
26	GND	GND	via 100 Ω to GND
2	RUN IN	TTL input	input for external start of measuring cycle, low true, internal pull-up 5.6 k Ω to +5 V
14	SYNC IN	TTL input	reserved for future use, low true, internal pull-up 5.6 k Ω to +5 V
15	IN 0	TTL input	internal pull-up 5.6 k Ω to +5 V (can only be used if jumper J2 is in place)
3	IN 1	TTL input	internal pull-up 5.6 k Ω to +5 V (can only be used if jumper J4 is in place)
16	IN 2	TTL input	internal pull-up 5.6 k Ω to +5 V
23	OUT 0	TTL output	
11	OUT 1	TTL output	
25	SYNC OUT+	TTL output	positive edge marking start of measurement, scope trigger
13	SYNC OUT-	GND	reference point SYNC OUT+, via 200 Ω to GND
4	EXT IN 1+	analog input	terminals for external voltmeter (differentially), max. ± 10 V, with low pass filter/amplifier
17	EXT IN 1-	analog input	
5	EXT IN 2+	analog input	terminals for external voltmeter (differentially), max. ± 10 V, with or without low pass filter/amplifier
18	EXT IN 2-	analog input	
6	ELM OUT+	analog output	output of low pass filter/amplifier, ± 10 V, max 0.1 mA via 200 Ω
19	ELM OUT-	GND	reference point for ELM OUT+, via 200 Ω to GND
7	AO MON 0+	analog output	user configurable output ¹⁾ , ± 10 V, 12 Bit, max. 0.1 mA via 200 Ω
20	AO MON 0-	GND	reference point for AO MON 0+, via 200 Ω to GND
8	AO MON 1+	analog output	user configurable output ²⁾ , ± 10 V, 12 Bit, max. 0.1 mA, via 200 Ω
21	AO MON 1-	GND	reference point for AO MON 1+ via 200 Ω to GND
9	SCO+	analog output	output "mass number", 0 ... +10 V, 16 Bit, max. 0.1 mA, via 200 Ω
22	SCO-	GND	reference point for SCO+, via 200 Ω to GND
12	EP OUT+	analog output	electrometer signal, max. 0.1 mA, via 200 Ω
24	EP OUT-	GND	reference point for EP OUT+, via 200 Ω to GND

¹⁾ Reserved for *Range Code* of detector in monitor mode:

Detector range	Output voltage
1×10^{-5} A	8 V
1×10^{-6} A	7 V
1×10^{-7} A	6 V
1×10^{-8} A	5 V
1×10^{-9} A	4 V
1×10^{-10} A	3 V
1×10^{-11} A	2 V
1×10^{-12} A	1 V

NOTE: In ion counter mode, the output voltage is 0 V.

²⁾ Reserved for intensity signal in monitor mode (various configurations are possible):

- ♦ Linear (± 10 V / decade)
- ♦ Logarithmic (± 10 V FS, 1 ... 10 decades)

3.4 Ion Supply IS 716



General	
Compatibility	System chassis SC 700
Number of slots occupied	4
Modules per system	max. 2
Slot No.	13
Weight	1 kg
Filament power supply	
Voltage	0 ... +10 V
Current	max. 5 A
Power	max. 50 W
Operation modes	Fil 1, Fil 2
Filament protection	0 ... 5 A
Emission	
Normal	0 ... 10 mA
Degas	0 ... 20 mA

Potentials IS 716

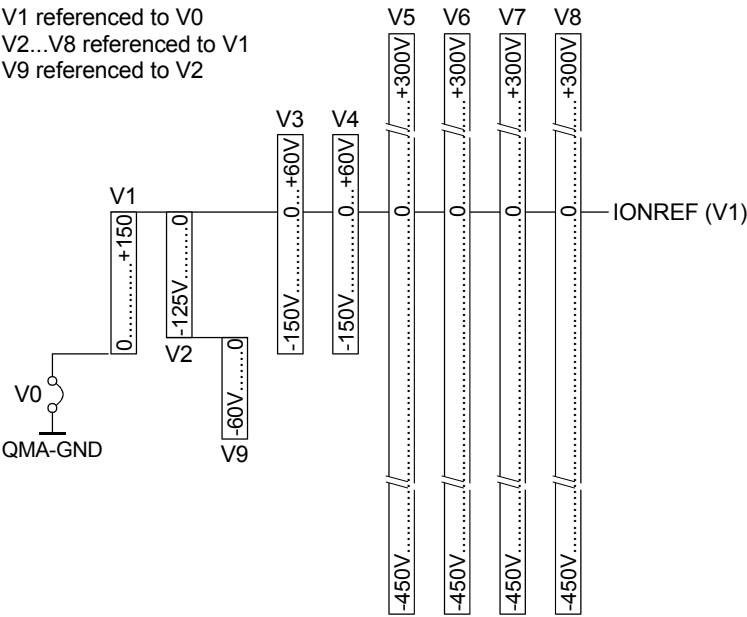
DANGER

The QMS 700 may not be switched on without a correctly connected QMA cable.

DANGER

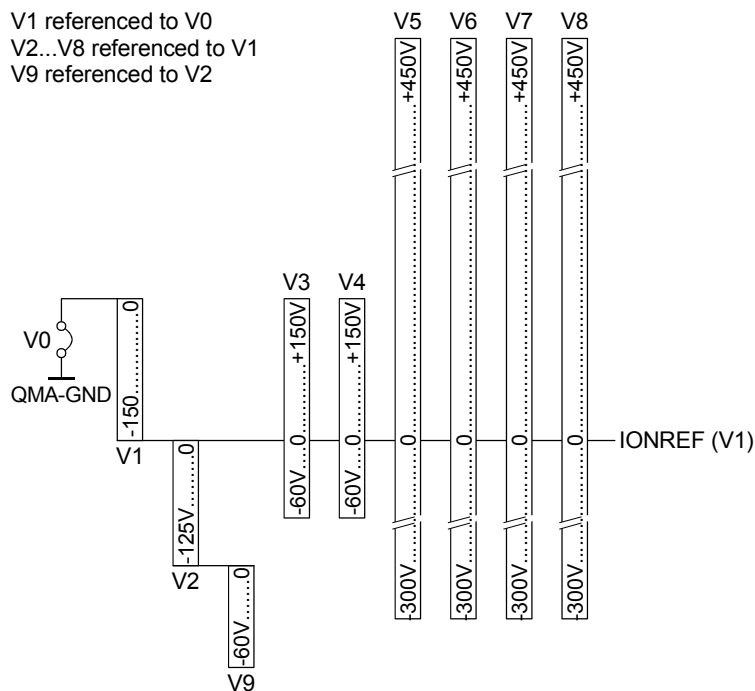
The maximum current of the external voltage source V0 has to be reliably limited to ≤ 2 mA.

Ion potentials at max. pos.
IONREF (+150 V),
positive polarity



Ion potential at max. neg.
IONREF (-150 V),
negative polarity

V1 referenced to V0
V2...V8 referenced to V1
V9 referenced to V2



	Electrode Name	Range	Nominal Current	Resolution	Offset	Gain Error	Potential at Degas ¹⁾
V0		²⁾					
V1	IONREF	- 150 ... +150 V	±2.5 mA	20 mV	±120 mV	1.6%	+550 V
V2	CATH	0 ... -125 V	-10 mA	10 mV	±60 mV	1.6%	+7 V
V3	FOCUS		±3 mA	20 mV	±120 mV	1.6%	0 V
V4	F-AXIS		±3 mA	20 mV	±120 mV	1.6%	0 V
V5	EXTRACT		±100 µA	58.82 mV	±240 mV	1.6%	0 V
V6	DEF-I	³⁾	±100 µA	58.82 mV	±240 mV	1.6%	0 V
V7	DEF-O	³⁾	±100 µA	58.82 mV	±240 mV	1.6%	0 V
V8	Res		±100 µA	58.82 mV	±240 mV	1.6%	0 V
V9	WEHNELT	0 ... -60 V	-500 µA	3.92 mV	±30 mV	1.6%	0 V

¹⁾ Referenced to V0.

²⁾ Normally V0 is connected to QMA GND (vacuum system GND). For special applications V0 may be risen to max. ±200 V respective to QMA GND.

³⁾ In Faraday mode, V6 and V7 are connected to QMA GND.

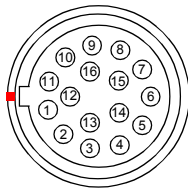
Electrical
Connections IS 716

QMA connector pin
assignment

DANGER

The QMS 700 may not be switched on without a correctly connected QMA cable.

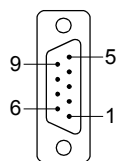
QMA



16 pin LEMO socket, view
on IS 716

Pin	Signal	Description
1	QMA GND	Reference signal for SPEC SRC ON
2	SPEC SRC RET	
3	V6, inner Deflection	
4	V3, Focus	
5	V9, Wehnelt	
6	V5, Extraction	
7	Filament +	
8	Filament – / Cathode	
9	Filament Common	
10	V4, Field Axis	
11	V0, Ref GND	
12	Screen	+24 V if activated, max. 200 mA
13	V8, Reserve	
14	V1, Ion Ref	
15	SPEC SRC ON	
16	V7, outer Deflection	

AUX I/O connector pin assignment



D-Sub 9 pin, female
view on IS 716

Pin	Signal	Signal type	Description
1	EXT PROT	24 V digital input	filament protection input ¹⁾ ²⁾
2	GND	GND	
3	DI RES 1	TTL input	
4	DI RES 3	TTL input	
5	DO RES 1	TTL input	
6	DO RES 2	TTL input	
7	DO RES 3	TTL input	
8	DO RES 4	TTL input	
9	n.c.	—	

¹⁾ Must be connected to GND via a floating contact while Extern_Protection is activate (internal pull-up resistor 5.6 KΩ to +24 V), otherwise the emission will be switched off.

²⁾ Reserved for future use.

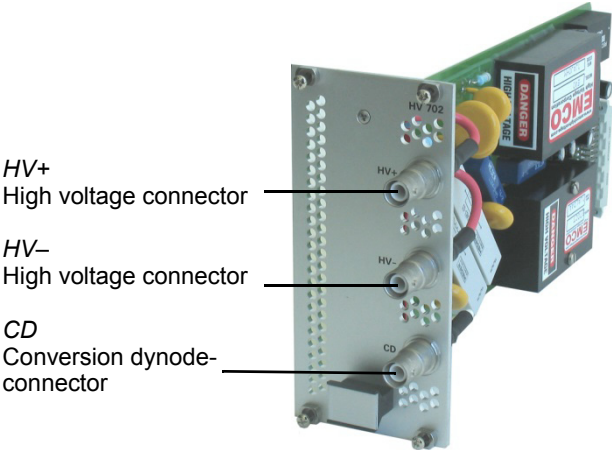
3.5 High Voltage Supply HV 701

HV–
High voltage connector



General	
Compatibility	system chassis SC 700
Number of slots occupied	1
Modules per system	max. 4
Slot No.	33
Weight	0.3 kg
High voltage power supply	
SEM voltage HV–	–30 ... –3500 V (ripple 10 mV typical)
Resolution	219 mV
Load	≥15 MΩ
Current limit	≤1 mA
Source impedance	≈0 Ω
Settling time	0.3 s (0.1%, switching on, R _L = 15 MΩ)
Admissible voltage difference (between chassis and QMA GND)	≤0.5 V

3.6 High Voltage Supply HV 702



General	
Compatibility	system chassis SC 700
Number of slots occupied	3
Modules per system	max. 2
Slot No.	8 ... 10
Weight	0.54 kg

High voltage power supply

	SEM voltage supply (U_{SEM}) ¹⁾	CD voltage supply (U_{CD}) ¹⁾	Bias voltage supply (U_{BIAS}) ¹⁾
Voltage	-100 V ... -3500 V	-100 V ... -7000 V	+1500 ... +3500 V -1500 ... -3500 V
Ripple (typ.)	30 mV pp	20 mV pp	20 mV pp
Resolution	219 mV	438 mV	438 mV
Load	$\geq 15\text{ M}\Omega$	$\geq 100\text{ M}\Omega$	$\geq 100\text{ M}\Omega$
Current limit	$\leq 0.6\text{ mA}$	$\leq 0.3\text{ mA}$	$\leq 0.3\text{ mA}$
Settling time	0.3 s ²⁾	0.3 s ³⁾	0.3 s ³⁾
Admissible GND voltage difference ⁴⁾	<0.5V	<0.5V	—

¹⁾ Configuration and wiring depends on operation mode (p. 23).

²⁾ 1%, switching on, $R_L = 15\text{ M}\Omega$

³⁾ 1%, switching on, $R_L = 100\text{ M}\Omega$

⁴⁾ Between chassis and QMA GND

Operation modes

Configuration and wiring of the HV 702 depends on operation mode:

Operation mode	Description	HV 702 connections	Principal diagram
0	SEM	HV+ Shorting plug installed ¹⁾ HV- ⇒ SEM CD not used	
1	SEM + CD	HV+ Shorting plug installed ¹⁾ HV- ⇒ SEM CD ⇒ CD	
2	SEM positive bias voltage applied, detection of negative ions	HV+ ⇒ SEM HV+ HV- ⇒ SEM HV- (pos. bias voltage) CD not used	
3	SEM negative bias voltage applied, detection of positive ions	HV+ ⇒ SEM HV+ HV- ⇒ SEM HV- (neg. bias voltage) CD not used	

¹⁾ HV+ connector electrically connected to QMA-GND.

3.7 I/O System IO 700

NOTE

Digital and analog input/output sub-modules made by WAGO® are used in the IO 700 (detailed description → block diagram and connection diagram in appendix).



General	
Compatibility	System chassis SC 700
Number of slots occupied	6
Modules per system	Max. 3
Slot No.	No. 13 ... 18 ¹⁾
Weight	1.4 kg
External system power supply	
Voltage	24 VDC (–15% ... +20%)
Current	Max. 10 A
Digital outputs	
Sub-module type used	WAGO 750-530
Number of outputs	32
Output voltage	0/+24 V (source)
Load	Max. 0.5 A (short-circuit-proof)
Sum of currents per module	Max. 10 A
Admitted load types	Resistive, inductive, incandescent lamps
Refresh rate	10 ms
Digital inputs	
Sub-module type used	WAGO 750-430
Number of inputs	32
Input voltage	0/+24 V
Input current	2.8 mA
Input filter	Time constant 3 ms
Refresh rate	10 ms

¹⁾ Position stated applies only to chassis 1 (in case of optional system expansion).

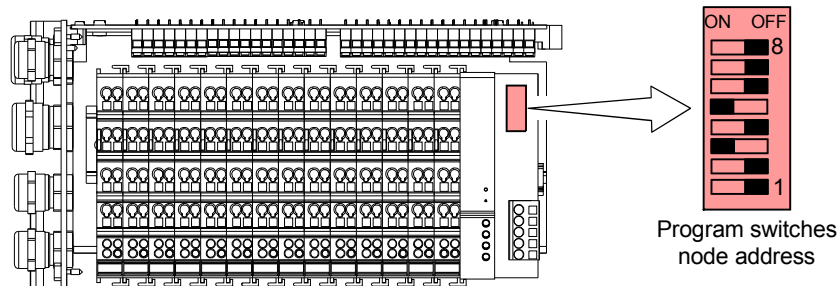
²⁾ Only for digital I/Os, analog I/Os do not require an external voltage.

Analog outputs	
Sub-module type used	WAGO 750-559
Number of channels	8
Output voltage	0 ... +10 V
Resolution	12 bit
Load impedance	$\geq 5 \text{ k}\Omega$
Conversion time	10 ms
Refresh rate	10 ms
Reference potential	GND terminals are connected together in groups of four channels.
Analog inputs	
Sub-module type used	WAGO 750-459
Number of channels	8
Resolution	12 Bit
Input impedance	100 k Ω
Conversion time	10 ms
Refresh rate	10 ms
Reference potential	GND terminals are connected together in groups of four channels.

I/O module address setting

The node address of an I/O module is programmed on DIL switches located inside the IO 700 as shown below (top view of IO 700):

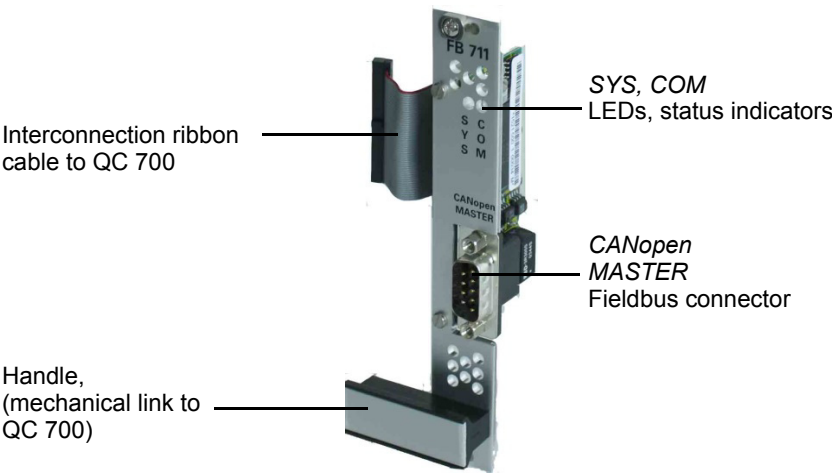
IO 700



Module address setting	
Node address	<p>First IO 700 module:</p> <p>14_{Hex}, (20_{Dec}), switches 3 and 5 in position ON</p> <p>Following IO 700 modules (option chassis expansion):</p> <p>15_{Hex}, (21_{Dec}), switches 1, 3 and 5 in position ON</p> <p>16_{Hex}, (22_{Dec}), switches 2, 3 and 5 in position ON</p>

3.8 Field Bus FB 711

The FB 711 module is an optional interface, providing Fieldbus access to the QC 700.

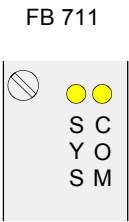


General	
Compatibility	system chassis SC 700
Number of slots occupied	1
Modules per system	1
Slot No.	3 (to the right of QC 700)
Weight	0.08 kg

Status indicators SYS, COM

The communication status of the QMS 700 in a Fieldbus environment can be monitored on two status indicator LEDs (SYS and COM) located on the FB 711 rear panel.

LED	Color	Status, flashing rate	Meaning
SYS	yellow	cyclic (1 Hz)	FB 711 in <i>bootloader -mode</i> , waiting for <i>firmware-download</i>
		cyclic, (5 Hz)	<i>firmware-download</i> in progress
		acyclic, 3× (5 Hz) 8× (≈0.75 Hz)	fatal <i>hardware error-</i> or <i>runtime</i> error detected ⇒ contact a Pfeiffer Vacuum service center.
	green	cyclic, (5 Hz)	no error detected FB 711 is ready for operation and makes attempts to communicate in the network but is not yet connected to a Fieldbus device.
		acyclic, 3× (5 Hz) 8× (≈0.75 Hz)	<i>Power Up:</i> configuration of FB 711 missing <i>Runtime:</i> <i>critical link</i> error found (e.g. <i>host watchdog timeout</i>)
		lit	FB 711 has established at least one Fieldbus connection
		dark	FB 711 supply voltage missing
COM	yellow	lit	FB 711 transmits a CAN telegram
		dark	FB 711 has concluded the CAN telegram transmission
	red	lit	FB 711 has detected a communication problem with at least one CAN node (device) <i>connection timeout</i> .



CAN connector

D-Sub 9 pin, male, pin assignment according to CAN bus standards.

3.9 Electrometer Preamplifier EP 422



General	
Location	Directly connected to analyzer
Interfaces	QMH and QMA
Modules per system	Max. 2
Weight	0.15 kg
Power supply	(Provided by QMS 700)
Voltage	± 16 V (0.2 V, ≤ 10 mV ripple)
Current	± 10 mA

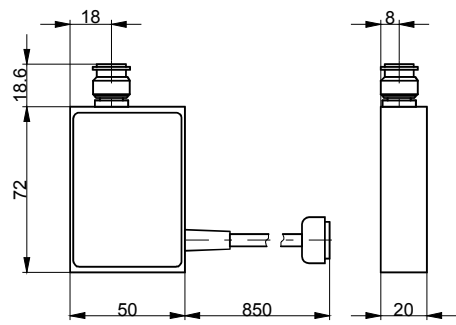
Amplifier specifications EP 422

Input/output	
Input current	→ Table below
Input impedance	100 k Ω
Output voltage	-10 ... +10 V
Output current	≤ 2 mA
Drift	Offset doubling per 10 °C temperature increase
Noise	Typically 2×10^{-13} A _{pp} (unfiltered)

Range	Sensitivity	Tolerance at 25 °C	Rise time 10 ... 90%	Offset at 25 °C
$\pm 10^{-5}$ A	10^{-6} A/V	$\pm 1\%$	50 μ s	± 0.5 mV
$\pm 10^{-7}$ A	10^{-8} A/V	$\pm 1\%$	90 μ s	± 0.5 mV
$\pm 10^{-9}$ A	10^{-10} A/V	$\pm 2\%$	1.9 ms	± 2 mV
$\pm 10^{-11}$ A	10^{-12} A/V	$\pm 2\%$	2.6 ms	-50 ... +150 mV

Connectors	
Input	Connector type: TNC coaxial connector
Output	D-Sub 9 pin, male
Ambient, temperatures	
Storage	-40 ... +70 °C
Operation	0 ... +50 °C

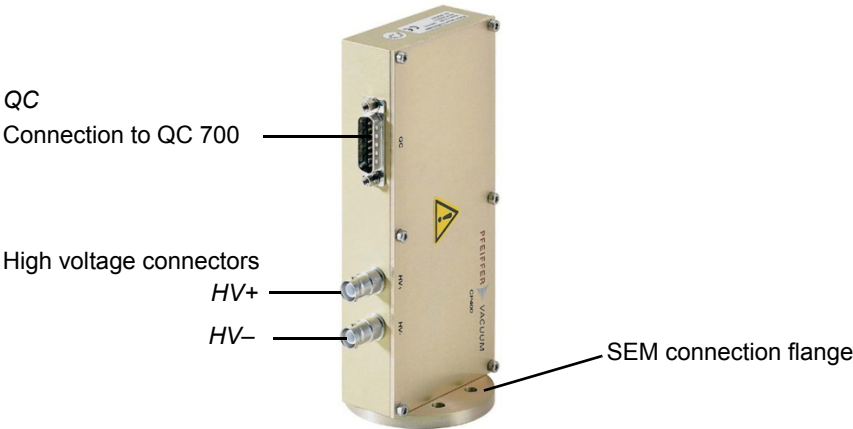
Dimensions [mm]



3.10 Ion Counter Preamplifier CP 400

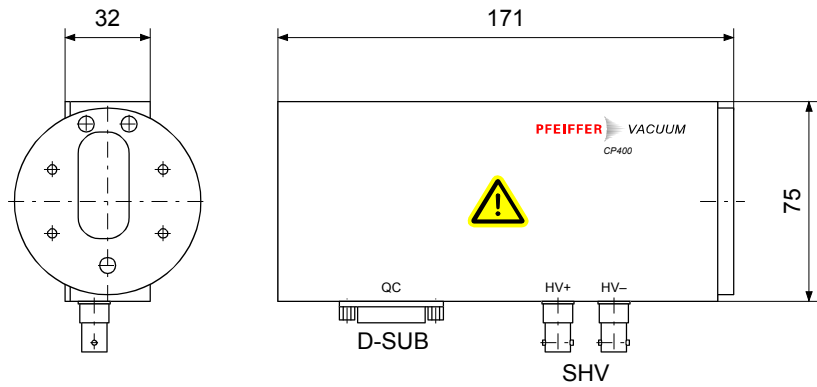
NOTE

Function and technical data of the CP 400 are described separately.

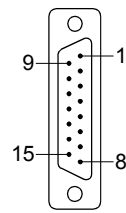


General	
Compatibility	QMG 700 system
Location	SEM feedthrough at QMA
Interfaces	QMA, QC 700 and HV 701/HV 702
Modules per system	1
Weight	0.5 kg

Dimensions [mm]



QC connector pin assignment



D-Sub, 15 pin, male
view on CP 400

Pin	Signal	Signal type, description
1	QMA GND	GND
2	Identification	–
3	OUT–	ECL output
4	OUT+	ECL output
5	V+	Supply voltage
6	LEVEL–	Threshold voltage
7	LEVEL+	Threshold voltage
8	V–	Supply voltage
9 ... 15	not connected	–

4 Installation

General

DANGER

Putting a product which presents a visible damage into operation can be extremely hazardous. If the product presents a visible damage do not put it into operation and make sure it is not inadvertently put into operation.

DANGER

The local line voltage ratings must correspond to the nominal voltage of the product (→ product nameplate).

A 3-conductor power cable with protective ground must be used. The power outlet must have a protective ground contact. Extensions without protective ground conductor are inadmissible.

To ensure continuity of the protective ground, always connect the power cable before all other cables. Conversely, unplug all other cables before the power cable.

NOTE: Do not yet switch on the equipment.

WARNING

In rack installations the temperature inside the rack must not exceed 40° C. Ensure adequate air circulation.

The air filters inside the unit should be periodically checked and serviced.

In desktop installation the air should be able to enter through the front panel inlets and exit through the rear panel slots without obstruction.

NOTE

Make sure all screws and strain relieves are tightened to ensure reliable contact of connectors.

4.1 QMG 700 Overall System

Install peripheral components such as the analyzer, RF generator, etc. in accordance with the information in the respective operation instructions.

All components involved must be grounded to a single point. Utilization of a single power distributor is recommended. The only exception is the PC.

NOTE

Make sure that the QMA, vacuum chamber, and equipment is always connected to the protective ground.

Hazardous voltages up to 600 V are present on the QMA. If this unit can be touched by the user when the vacuum system is open, additional protection is required, e.g.:

- 1 Mechanical protection against contact.
- 2 Forced disconnection of the QMG 700 line voltage by means of a door contact.

The electrode system of the QMA must not be subjected to hazardous external voltages (from direct contact, arcing, plasma, ion or electron beams, etc.). If such danger hazards exist in the vacuum system, appropriate protection measures must be taken there (arrangement of components, shielding, grounding, etc.) that reliably preclude such influences.

Refer to the standards applicable to your system.

NOTE

When the QMA is in operation, hazardous voltages up to 600 VDC are present. Under unfavorable conditions other built-in components in the vacuum chamber (e.g. gauge heads) can be subjected to this voltage. If as a result such components become dangerous to touch (also take into consideration the lines and the connected equipment!), they must be arranged or protected in such a way that no contact, no arcs, and no charge carrier flow can occur.

4.2 Installation of the System Chassis

The system chassis can be built into a 19 inch rack frame or alternatively be used as a desktop unit.

Rack installation

The chassis is designed for installation in a 19 inch rack frame according to DIN 41 494 standard.

DANGER

DANGER: Protection category of the rack.

If the product is installed in a rack, it is likely to lower the protection category of the rack (protection against foreign bodies and water) e.g. the EN 60204-1 regulations for switch cabinets.

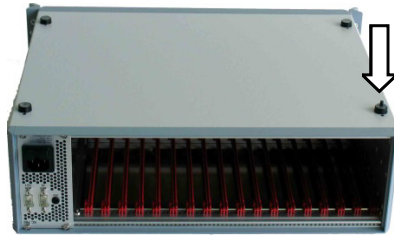
Take appropriate measures for the rack to meet the specifications of the protection category.

Use as a desktop unit

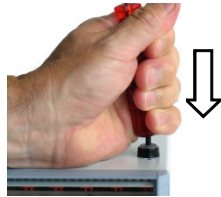
For use as a desktop unit, four plastic feet (supplied with the unit) have to be fitted to the bottom panel of the unit.

Installation of plastic feet

- 1 Turn over the unit and plug the plastic feet into the four holes as shown.



- 2 Push in the protruding plastic pins completely with a screwdriver handle or a similar tool of appropriate size.



- 3 The feet are now locked in the bottom plate. Turn the unit back to the upright position.

NOTE

Select a location where the admissible maximum ambient temperature is not exceeded (e.g. due to sun irradiation).

4.3 Installation/Replacement of Modules in the System Chassis

DANGER

Work on an open unit may only be performed by skilled personnel.

Switch off the unit before any manipulations on the equipment. Wait 60 seconds and detach all cables (power cable last). For commissioning perform these steps in reverse order.

WARNING

Work may only be performed on ESD protected benches while observing appropriate working methods.

The modules should always be stored in antistatic packages.

Defects caused by the disregard of this warning will void the warranty.

Required tool

- ♦ Screw driver type "Pozidriv", size1

NOTE

Modules are installed in the order shown below (standard configuration).
All screws must be tight for a firm mechanical support and reliable electrical contact.
Unused slots must be covered with correctly fitting blank panels to ensure safety and adequate ventilation of the unit.



Chassis configuration with HV 701:

QC 700	FB 711	IS 716	Blank panel	HV 701	Blank panel	Blank panel 8U	IO 700	Power supply SC 700
	1)		2)	2)			3)	

Chassis configuration with HV 702:

QC 700	FB 711	IS 716	HV 702	Blank panel 8U		IO 700	Power supply SC 700
	1)					3)	

- 1) Optional, if FB 711 is not built in, the slot must be covered (4U blank panel).
- 2) To the right of the IS 716 module, always install a 4U blank panel (expection: if the HV 702 is used, no blank panels are required).
To the left of the IS 716 an optional FB 711 or a 4U blank panel has to be installed.
- 3) Optional, if the IO 700 is not equipped, the slots must be covered (3 × 8U blank panels).

4.4 Installation of the Fieldbus FB 711

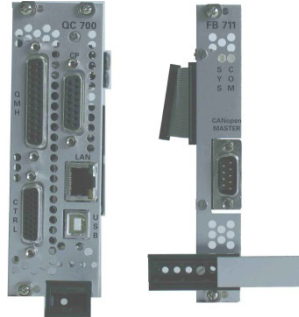
The optional Fieldbus interface can be added according to the following description.

Required tool

Screwdriver size 2

Procedure

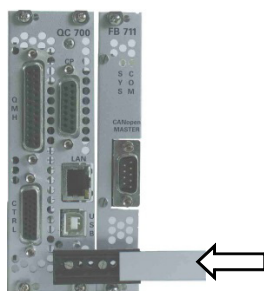
- 1 Remove the QC 700 from the system chassis.
- 2 Slide out the cover plates of QC 700 and FB 711 handles.



- 3 Remove the handle of the QC 700.
- 4 Bend the ribbon cable of the FB 711 to the shape shown.



- 5 Plug the ribbon cable carefully into the corresponding socket on the QC 700 board.
- 6 Screw the handle of the FB 711 to the QC 700 rear panel and slide the cover plate of the FB 711 back into the handle.



- 7 QC 700 and FB 711 form a single module now. Reinstall the complete module into the system chassis.

4.5 Electrometer preamplifier EP 422

The EP 422 is located directly at the analyzer.

- 1 Connect the EP 422 into the corresponding connector at the QMA.
- 2 Make sure the EP 422 is not touching adjacent connectors.
- 3 Fasten the knurled nut.
- 4 Connect the control cables to the connectors *ep1* and/or *ep2* at the QMH 4xx.
Lock the connectors.

NOTE

For optimum signal stability, the EP 422 must be protected from vibrations, temperature fluctuations, high temperature, humidity, and strong magnetic alternating fields.

4.6 Ion counter preamplifier CP 400

DANGER

The CP400 may not be operated with a high voltage supply that can deliver hazardous voltages or currents.

Switch the unit off and detach all cables before you open the cover.

Operation of the equipment with the cover removed is not allowed.

CAUTION

The inside of the CP 400 may not be touched or contaminated. Finger smudges can cause noise pulses or even arcing.

NOTE

The installation/de-installation of the CP 400 is described in detail in a separate operating manual: Ion Counter Preamplifier CP 400

4.7 HF-Generator QMH 4xx

NOTE

The installation of RF generators QMH 4xx is described in detail in a separate operating manual: RF Generator QMH 400 / 410

4.8 Analyzer QMA 4x0

NOTE

The installations of the analyzers QMA 4x0 is described in detail in a separate operating manual: Analyzer QMA 400 / 410 / 430

4.9 System Wiring

System wiring depends on the operation mode. On the following pages, wiring and material requirements of three operation modes are described.

NOTE

90°-SEM and CP operation modes each require supplementary wiring to the basic wiring described below.

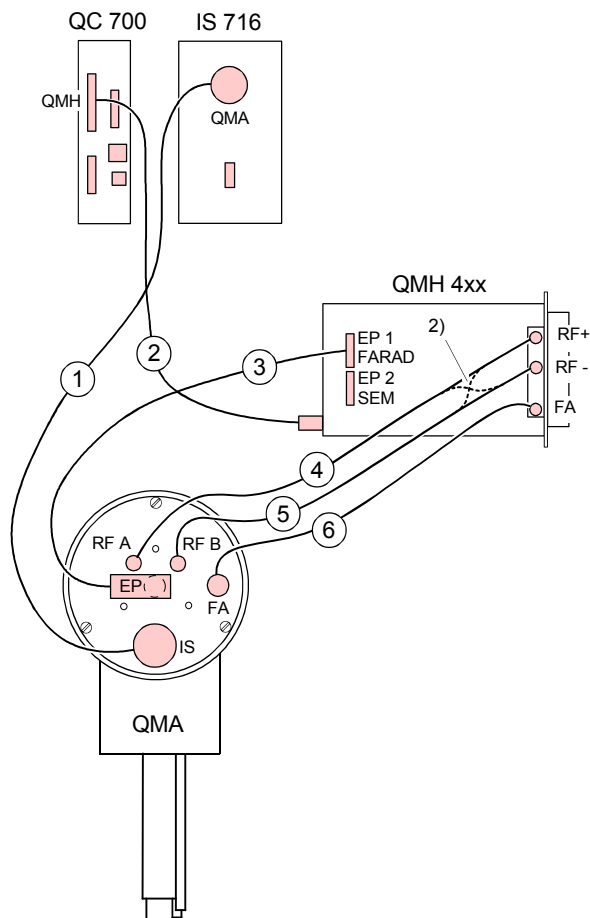
Basic wiring Faraday operation mode

(Valid for HV 701 and HV 702 installations.)

Required cables

	Cable	Length	Order number
①	Interconnection IS 716 – QMA 4x0	3 m 10 m	BG548082-T BG548083-T
②	Interconnection QC 700 – QMH 4xx	7 m	BG448175-T
③	Interconnection EP 422 (1) – QMH 4xx	0.85 m	_ 1)
④	RF interconnection QMH 4xx – QMA 4x0	0.7 m	BG541960-T
⑤	RF interconnection QMH 4xx – QMA 4x0	0.7 m	BG541960-T
⑥	Interconnection QMA 4x0 – QMH 4xx	0.7 m	BG541962-T

1) Permanently fixed to the EP 422.



2) It may be necessary to cross the cables ④ and ⑤ → Test protocol.

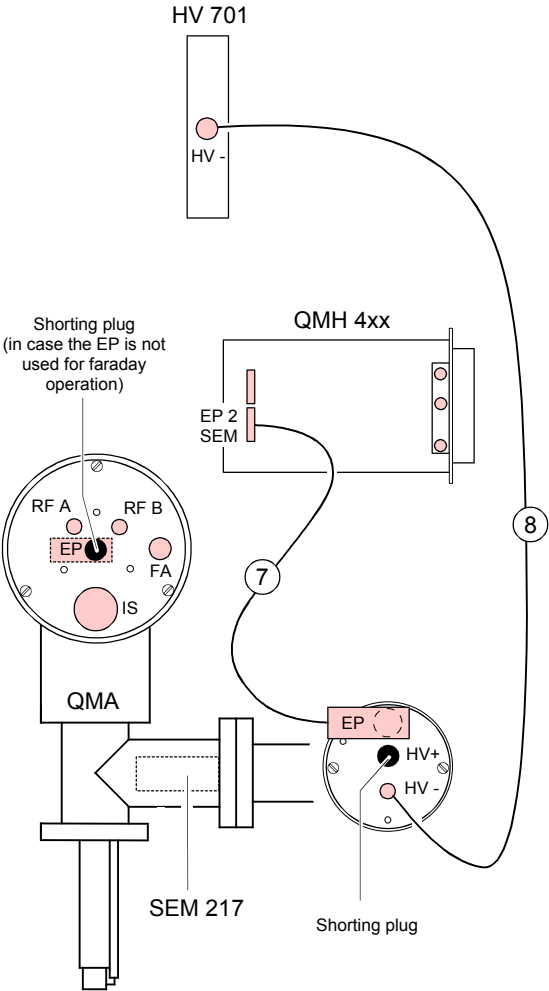
Wiring 90° SEM
operation mode
(with HV 701)

Required cables and
shorting plugs

NOTE	
The 90° SEM operation mode also requires the basic wiring described previously.	

	Cable	Length	Order number
⑦	Interconnection EP 422 (2) – QMH 4xx	0.85 m	– 1)
⑧	HV interconnection HV 701 – QMA 4x0 (HV–)	3 m	BG541978-T
		10 m	BG541979-T
	EP shorting plug (type TNC)	–	B4728138BC
	HV shorting plug (type SHV)	–	B4728891B9

1) Permanently fixed to the EP 422.



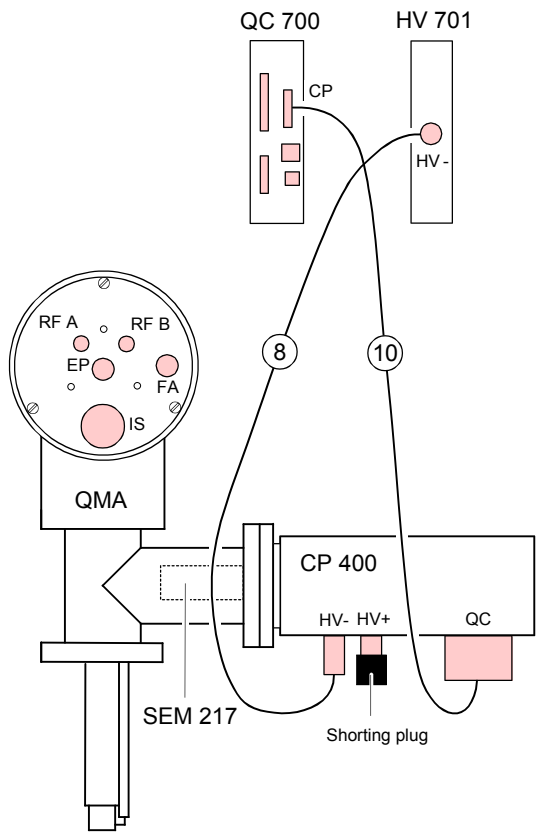
Wiring CP operation mode (ion counter) (with HV 701)

NOTE

The CP operation mode also requires the basic wiring described previously.

Required cables and shorting plug

	Cable	Length	Order number
8	HV interconnection HV 701 – CP 400	3 m 10 m	BG541978-T BG541979-T
10	Interconnection QC 700 – CP 400	3 m 10 m	BG448134-T BG448199-T
	HV shorting plug (type SHV)	–	B4728891B9



Wiring 90° SEM operation mode (with HV 702, operation mode 0)

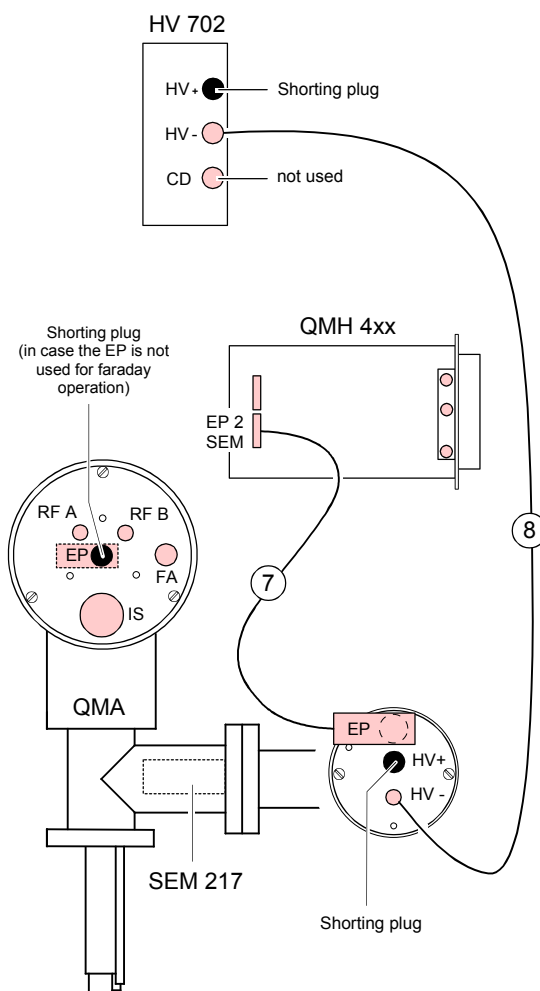
Required cables and shorting plugs

NOTE

The 90° SEM operation mode also requires the basic wiring described previously.

	Cable	Length	Order number
⑦	Interconnection EP 422 (2) – QMH 4xx	0.85 m	_ 1)
⑧	HV interconnection HV 702 – QMA 4x0	3 m	BG541978-T
		10 m	BG541979-T
	EP shorting plug (type TNC)	–	B4728138BC
	HV shorting plugs (type SHV)	–	B4728891B9

¹⁾ Permanently fixed to the EP 422.



Wiring CD operation mode (with HV 702, operation mode 1)

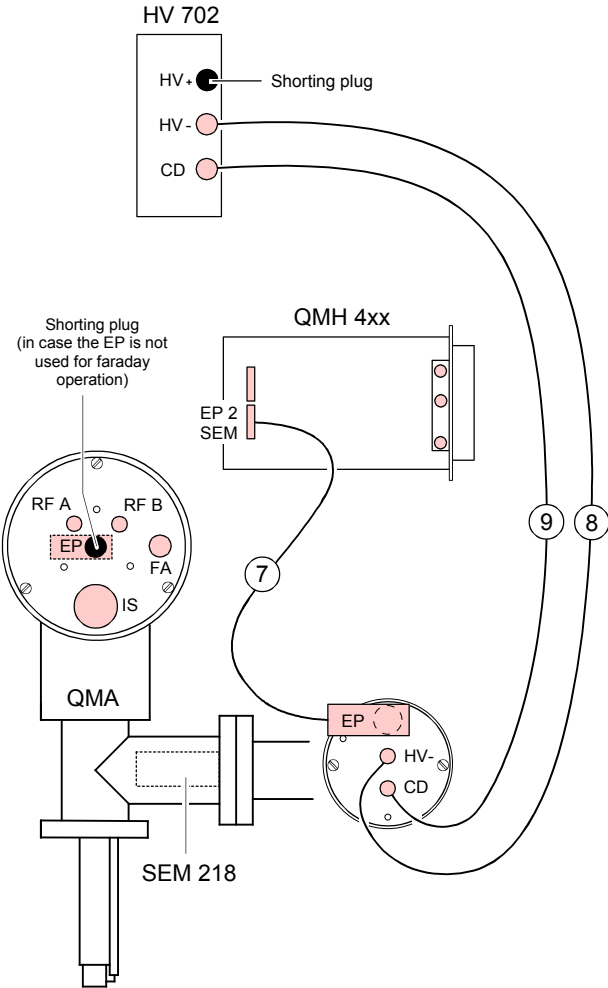
NOTE

The conversion dynode (CD) operation mode also requires the basic wiring described previously.

Required cables and shorting plugs

	Cable	Length	Order number
⑦	Interconnection EP 422 (2) – QMH 4xx	0.85 m	– 1)
⑧	HV interconnection HV 702 – QMA 4x0 (HV–)	3 m	BG541978-T
		10 m	BG541979-T
⑨	HV interconnection HV 702 – QMA 4x0 (CD)	3 m	BG541978-T
		10 m	BG541979-T
	HV shorting plug (type SHV)	–	B4728891B9

1) Permanently fixed to the EP 422.



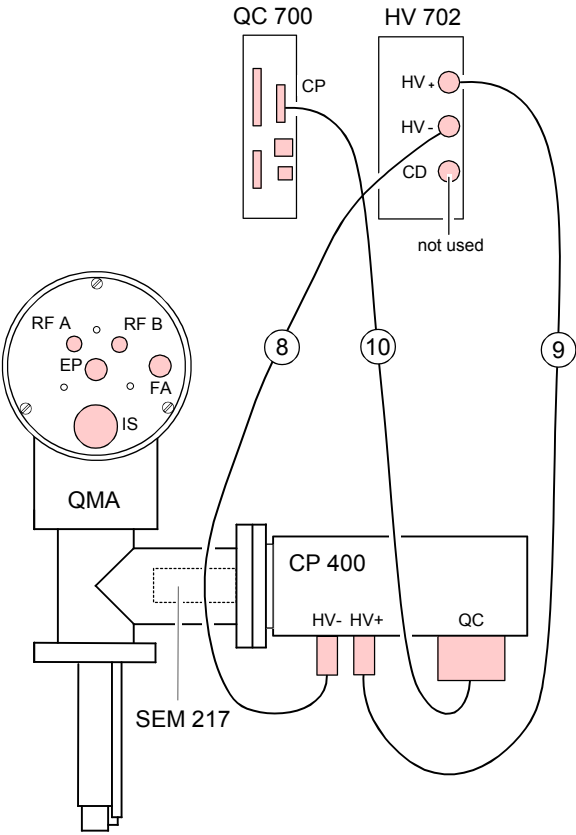
Wiring CP operation mode (ion counter) (with HV 702, operation mode 2 and 3)

Required cables and shorting plugs

NOTE

The CP operation mode also requires the basic wiring described previously.

	Cable	Length	Order number
⑧	HV interconnection HV 702 – CP 400	3 m	BG541978-T
		10 m	BG541979-T
⑨	HV interconnection HV 702 – CP 400	3 m	BG541978-T
		10 m	BG541979-T
⑩	Interconnection QC 700 – CP 400	3 m	BG448134-T
		10 m	BG448199-T



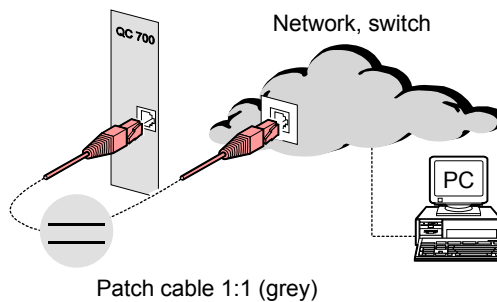
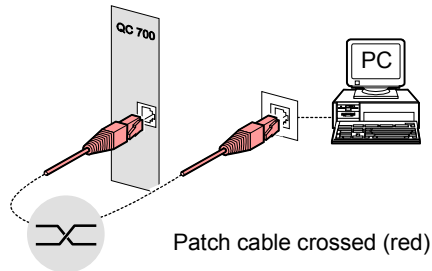
4.10 PC Connection

Since the QMS 700 does not have a local control panel, it is operated via a PC interface or as a device in a network.

There are various ways to interconnect a QMS 700 (QC 700) and a PC:

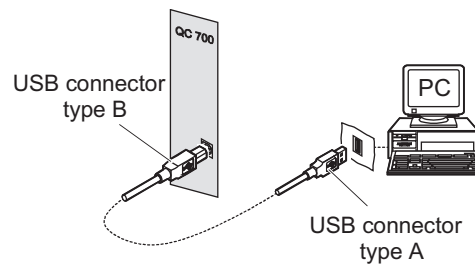
LAN interface

- ♦ For a direct link between a QC 700 and a PC the 8 core, crossed patch cable supplied with the QC is used (red, length 3 m, RJ45 connectors on both sides).
- ♦ For an interconnection via switch or in a network situation, the straight (1:1) patch cable is used (gray, length 3 m, RJ45 connectors on both sides, also supplied with the QC).



USB interface

In case of a USB link between the QC 700 and a PC, a regular USB cable with a type A connector on one end and a type B connector on the other end can be used.



4.11 IO 700 Wiring

Options are factory installed if they have been ordered together with the system. They can also be installed in the field at any time.

DANGER

Work on an open unit may only be performed by skilled personnel.

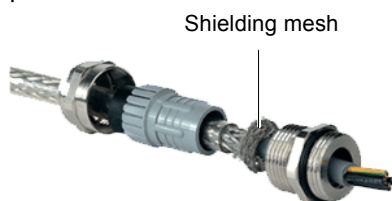
Switch off the unit before any manipulations on the equipment. Wait 60 s and detach all cables (power cable last). For commission perform these steps in reverse order.

Cables are directly wired to the connection terminals on the I/O sub-modules inside the IO 700.

Detailed information can be found in the connection diagram delivered with the IO 700.

Up to six cables ($3 \times \varnothing 5 \dots 9 \text{ mm}$ and $3 \times \varnothing 9 \dots 13 \text{ mm}$) can be accommodated at the rear panel of the IO 700 module through six EMC-proof cable glands. For EMC reasons, shielded cables have to be used exclusively. The shielding mesh has to be sufficiently exposed in order to ensure reliable conductive clamping to chassis potential of the rear panel.

A partly disassembled cable gland and the treatment of the cable end and the shielding mesh is shown in the figure below. Pay attention to the correct assembling order of the parts.



Cables and individual cores have to be strain relieved inside the IO 700 module.

4.12 Two and More Chassis

QMS 700 versions with the option "chassis expansion" installed will be delivered in the correct configuration and supplementary documentation is added.

NOTE

In a multi chassis system, slot assignment has to meet the following requirements:

- ♦ If the system comprises more than one chassis, all chassis have to be of the expansion type.
- ♦ The QC 700 must be installed in chassis No. 1, slot No.1 (left side of chassis, view on rear panels).
- ♦ In chassis No. 2, 3 and 4 slot No.1 must always contain an HV 701 or an IS 716 in order to satisfy the automatic configuration recognition. The user can freely choose the rest of the chassis content and order of modules in the chassis (spaces between modules are permitted, but must be covered with blank panels).
- ♦ Power supplies of chassis No. 2, 3 and 4 must be switched on before (or at least together with) the power supply of chassis No. 1, otherwise the internal module recognition routine is not working correctly.

5 Operation

5.1 Initial Start Up

DANGER

Verify the correct installation of all system components and compliance with technical data before equipment is switched on.

Note before start up

Before the system is started, check the following:

- ♦ Mains switch of QMS 700 is in OFF (O) position
- ♦ Correct installation of all system components and modules
- ♦ Correct condition of vacuum/process chamber
- ♦ Correct wiring of system components
- ♦ LAN- or USB link to PC (directly or via network) installed
- ♦ Interconnections between all QMS 700 chassis checked (only in case of optional expansion)
- ♦ Mains cable to QMS 700 installed
- ♦ PC ready for operation according to software instructions

NOTE

Consult operating instructions of all system components involved before you start up the system.

In complete (factory configured) systems, settings and parameters have been optimally aligned. Do not change them unfounded.

Switching on

After the conclusion of the checks listed above, the system can be switched on.

- 1 Switch mains switch on QMS 700 front panel to ON (I). The LED *DC* next to the mains switch lights up. The QMS 700 is ready for operation.
- 2 Switch the PC on and start the QUADERA® application software. A flickering yellow LED in the RJ45 LAN connector socket (QC 700 rear panel) indicates that data communication is in progress.

NOTE

If this LED remains dark, a communication error has to be suspected. In this case, check the cables and components along the communication path. Also check the PC for correct configuration and installation (application software, firewall status etc.).

- 3 QUADERA® will then guide the user through the subsequent steps of the start-up procedure (configuration, measurement range, etc.).

6 Maintenance

6.1 Maintenance of the Air Filter

The QMS 700 draws ventilation air through a set of openings in the front panel. The air filter in front of these openings has to be cleaned/replaced before excessive dust accumulation restricts the air circulation.

NOTE

Intervals depend on the results of regular optical inspections and the local dust production.

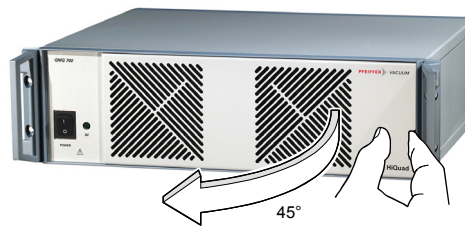
Cleaning the filter

In most cases an occasional vacuum cleaner treatment of the dust filter through the filter cover front panel grid will be adequate.

Replacing the filter

In case of severe dust filter it is recommended to replace it.

- 1 Lift the notched side of the filter cover and swing it open to an angle of approximately 45°.



- 2 Unhook the filter cover.



- 3 Remove the old dust filter mat from the filter cover and dispose according to local regulations.
- 4 Insert the new dust filter mat into the filter cover.
- 5 Reinstall the filter cover on the QMS 700.

7 Repair

General

DANGER

Work on an open unit may only be performed by skilled personnel.

The relevant safety instructions given in the corresponding chapters must be conscientiously followed.

Protection against electrostatic discharges (ESD) is absolutely essential, otherwise the Pfeiffer Vacuum warranty becomes null and void.

7.1 Replacing the Mains Fuse

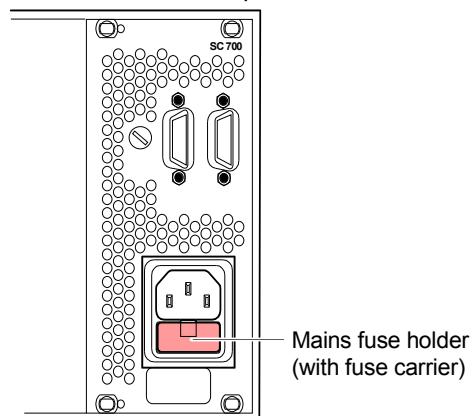
A defective mains fuse will cause the LED *DC* to stay dark even if mains voltage is applied and the mains switch is in ON position (I).

NOTE

Usually a defective mains fuse indicates a serious problem in the unit or in the system. If after replacement the fuse blows again, it is strongly recommended to contact a Pfeiffer Vacuum service office.

Replacing the fuse

View on SC 700 rear panel



- 1 Switch QMS 700 off and remove its mains cable.
- 2 Open the fuse carrier of the mains fuse holder.
- 3 Replace defective fuse (6.3 AT HBC, 5×20 mm) and push the fuse carrier back into the mains fuse holder.
- 4 Make sure the mains switch *Power* is in position OFF (O).
- 5 Reconnect the mains cable.
- 6 Switch on the system.

8 Accessories

When ordering, always indicate:

- ♦ all information on the product name plate
- ♦ description and ordering number according to list

	Ordering number
Replacement dust filter	451-067
Blank panel 4U (20 mm)	46-0022
Blank panel 8U (40.3 mm)	46-0023
Blank panel 28U (141.9 mm)	46-0024
Screws for blank panels	30-0017
Patch cable RJ45 1:1 grey 3 m	45-0006
Patch cable RJ45 crossed red 3 m	45-0007

9 Storage

CAUTION

Electronic component.

Inappropriate storage (static electricity, humidity etc.) can damage electronic components.

Store product in antistatic container. Observe the corresponding specifications in the Technical Data.

10 Returning the Product

WARNING

Forwarding contaminated products.

Contaminated products (e.g. radioactive, toxic, caustic or biological hazard) can be detrimental to health and environment.

Products returned to Pfeiffer Vacuum should preferably be free of harmful substances. Adhere to the forwarding regulations of all involved countries and forwarding companies and enclose a duly completed declaration of contamination *).

*) Form under www.pfeiffer-vacuum.com

Products that are not clearly declared as "free of harmful substances" are decontaminated at the expense of the customer.

Products not accompanied by a duly completed declaration of contamination are returned to the sender at his own expense.

11 Disposal

DANGER
Contaminated parts. Contaminated parts can be detrimental to health and environment. Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.
WARNING
Substances detrimental to the environment. Products or parts thereof (mechanical and electric components, operating fluids etc.) can be detrimental to the environment. Dispose of such substances in accordance with the relevant local regulations.

Separating the components

After disassembling the product, separate its components according to the following criteria:

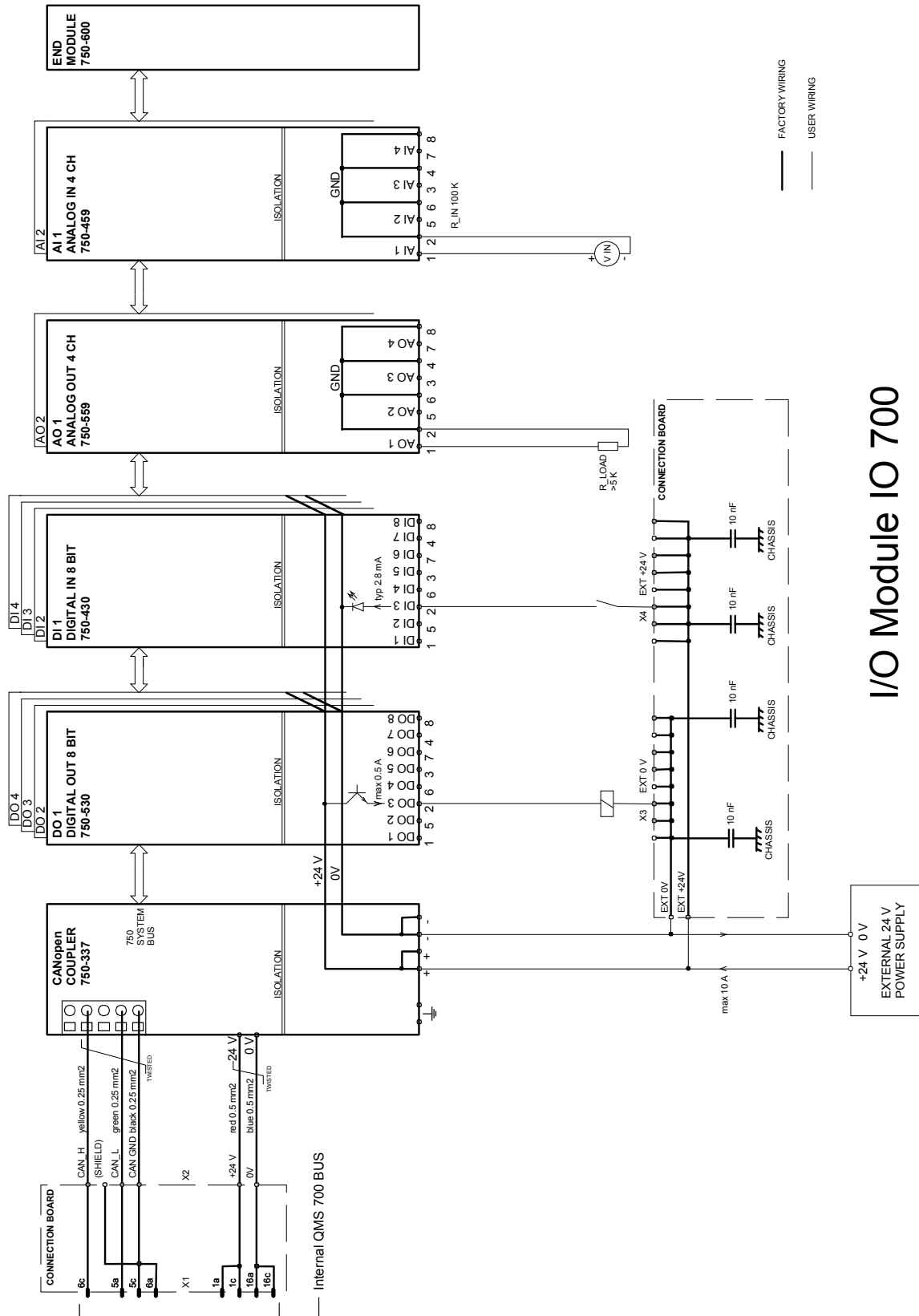
Contaminated components

Contaminated components (radioactive, toxic, caustic or biological hazard etc.) must be decontaminated in accordance with the relevant national regulations, separated according to their materials, and disposed of.

Other components

Such components must be separated according to their materials and recycled.

Appendix A Connection Diagram



I/O Module IO 700

Figure A-1 QMG 700 IO Connection Diagram

Appendix B Literature

www.pfeiffer-vacuum.com

- ♦ Operating instructions
RF Generator QMH 400 / 410
BG 5982 BEN
Pfeiffer Vacuum GmbH, 35614 Asslar, Germany
- ♦ Operating instructions
Analyzer QMA 400 / 410 / 430
BG 5983 BEN
Pfeiffer Vacuum GmbH, 35614 Asslar, Germany
- ♦ Operating instructions
Ion Counter Preamplifier CP 400
BG 5812 BEN
Pfeiffer Vacuum GmbH, 35614 Asslar, Germany
- ♦ Software documentation
QUADERA®
Pfeiffer Vacuum GmbH, 35614 Asslar, Germany



Declaration of Conformity

We hereby declare that the product cited below satisfies all relevant provisions according to the following **EC directives**:

- **Low Voltage Directive 2014/35/EU**
- **Electromagnetic Compatibility 2014/30/EU**
- **Restriction of the use of certain Hazardous Substances 2011/65/EU**

HiQuad™

QMG 700 Quadrupole Mass Spectrometry System

Harmonised standards and national standards and specifications which have been applied:

Safety: EN 61010-1:2010

Emissions: EN 61326-1:2013
EN 55011:2009 + A1:2010 / CISPR 11:2009 + A1:2010
Radiated and Conducted Electromagnetic Emissions
FCC Title 47 Part 15 Class B emission requirements
ICES-001 Issue 4 ISM emission requirements

EN 61000-3-2: 2014 Electromagnetic compatibility, Limits for harmonic currents

EN 61000-3-3: 2013 EMC; Limitation of voltage changes, voltage fluctuations and flicker

Immunity: EN 61326-1:2013 (General EMC)
Class A
EMC - Measurement, Control & Laboratory Equipment

RoHS: Due to the classification of this product it is currently exempt from the RoHS directive until 2017.

Signatures:

Pfeiffer Vacuum GmbH
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35614 Asslar
Germany

(Dr. Ulrich von Hülsen)
Managing Director

2016-05-17

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