

Analytical equipment

Mass spectrometers for vacuum and gas analysis



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Analytical equipment

Mass spectrometers for vacuum and gas analysis

Knowing the gas composition is the key to understanding and controlling many vacuum processes. Pfeiffer Vacuum offers an extensive range of analyzers for gas determination in a vacuum process. From residual gas analyzers to complex analysis systems, Pfeiffer Vacuum will work with you to find the right solution for gas analysis in the ultra-high vacuum range right up to atmospheric pressure.

The criteria for selecting an analytical system are based upon application requirements:

- Pressure range of gas to be analyzed
- Mass range of the gases to be detected
- Minimum concentration to be detected
- Speed at which changes in the gas composition must be detected

The analytical equipment is based on quadrupole mass spectrometers; the PrismaPlus® series (QMG 220) for most analytical tasks and HiQuad® (QMG 700) for the highest requirements.



Overview of series and applications

	Analytics	Semiconductors	Coating	Industry	R & D	Page
■ = recommended	Electron microscopy					
	Leak detection					
	Mass spectrometry					
	Surface analysis					
	Plasma monitoring					
	Residual gas analysis					
	Lithography					
	PVD (Physical Vapor Deposition)					
	CVD (Chemical Vapor Deposition)					
	Plasma etching					
	Implantation – source					
	Implantation – beamline					
	Inspection					
	Bonding					
	MBE (Molecular Beam Epitaxy)					
	Load locks, transfer chambers, handling systems					
	Flat panel displays (FPD)					
	LED / OLED					
	Hard disk coating					
	Photovoltaics					
	Glass coating (PVD)					
	CD, DVD, Blu-ray production (PVD)					
	Optical coating (PVD)					
	Wear protection (PVD, CVD)					
	Hard coating					
	Medical technology					
	Industrial leak detection					
	Electron beam welding					
	Insulation vacuums					
	Bulb and tube manufacturing					
	Heat treatment					
	Vacuum drying					
	Vacuum furnaces					
	Nuclear research					
	Fusion technology					
	Plasma research					
	Particle accelerators					
	Space simulation					
	Low temperature research					
	Elementary particle physics					
	Nanotechnology					
	Biotechnology					
Residual gas analysis						
Residual gas analysis in high vacuum						
PrismaPlus® with Faraday detector	■	■	■	■	■	100
Residual gas analysis in ultra-high vacuum						
PrismaPlus® with C-SEM-detector	■	■	■	■	■	100
Residual gas analysis						
Gas analysis in the pressure range of up to 1,000 hPa						
OmniStar	■	■	■	■	■	106
ThermoStar	■	■	■	■	■	106
Gas analysis in the pressure range of up to 50 hPa						
HPA 220	■	■	■	■	■	110
Gas analysis in the pressure range of up to 10⁻² hPa						
SPM 220	■	■	■	■	■	112
Gas analysis in the pressure range of up to 10⁻⁴ hPa						
HiQuad®	■	■	■	■	■	116



Features at a glance

	Inlet		Mass range				Maximum inlet pressure		Ionic source / optics				De-tector	Detection limit										Page																									
	Flange (CF-F)	Capillary	1-100 u	1-128 u	1-200 u	1-340 u	1-300 u	1-512 u	1-1,024 u	1-2,048 u	1 · 10 ⁻⁵ hPa (C-SEM)	1 · 10 ⁻⁴ hPa (Faraday)	10 hPa	50 hPa	1,000 hPa	Axial	Cross-beam	Cross beam, gas tight	Open ion source	Gas tight ion source	Grid ion source	Ion optics	Faraday		Electron multiplier + Faraday	5 · 10 ⁻¹⁶ (SEM 217/Faraday)	1 · 10 ⁻¹⁵ (SEM 217/Faraday)	2 · 10 ⁻¹⁵ (SEM 217/Faraday)	1 · 10 ⁻¹⁴ (C-SEM)	2 · 10 ⁻¹⁴ (C-SEM)	4 · 10 ⁻¹⁴ (C-SEM)	1 · 10 ⁻¹² (Faraday)	2 · 10 ⁻¹² (Faraday)	4 · 10 ⁻¹² (Faraday)	5 · 10 ⁻¹² (Faraday)	1 · 10 ⁻¹¹ (Faraday)	2 · 10 ⁻¹¹ (Faraday)	0.1 ppm (C-SEM)	1 ppm (C-SEM)	20 ppm (Faraday)	40 ppm (Faraday)	100 ppm (Faraday)							
Residual gas analysis																																																	
Residual gas analysis in high vacuum																																																	
PrismaPlus® QMG 220 F1	■	■									■												■																						100				
PrismaPlus® QMG 220 F2	■			■						■													■																							100			
PrismaPlus® QMG 220 F3	■									■													■																							100			
Residual gas analysis in ultra high vacuum																																																	
PrismaPlus® QMG 220 M1	■	■								■	■												■																								100		
PrismaPlus® QMG 220 M2	■				■					■	■												■																								100		
PrismaPlus® QMG 220 M3	■									■	■																																				100		
Residual gas analysis																																																	
Gas analysis in the pressure range of up to 1,000 hPa																																																	
OmniStar GSD 320 O1, 1-100 u		■	■																																													106	
OmniStar GSD 320 O2, 1-200 u		■			■																																											106	
OmniStar GSD 320 O3, 1-300 u		■																																														106	
ThermoStar GSD 320 T1, 1-100 u		■	■																																													106	
ThermoStar GSD 320 T2, 1-200 u		■																																														106	
ThermoStar GSD 320 T3, 1-300 u		■																																														106	
Gas analysis in the pressure range of up to 50 hPa																																																	
HPA 220, 1-100 u	■	■																																														110	
HPA 220, 1-200 u	■																																															110	
HPA 220, 1-300 u	■																																															110	
Gas analysis in the pressure range of up to 10⁻² hPa																																																	
SPM 220, 1-100 u	■	■																																															112
SPM 220, 1-200 u	■																																																112
Gas analysis in the pressure range of up to 10⁻⁴ hPa																																																	
HiQuad®, QMG 700, with QMA 410, 16 mm Mo-rod system, 1-128 u	■		■								■	■																																					116
HiQuad®, QMG 700, with QMA 410, 16 mm Mo-rod system, 1-340 u	■										■	■																																					116
HiQuad®, QMG 700, with QMA 430, 8 mm stainless steel rod system	■										■	■																																				116	
HiQuad®, QMG 700, with QMA 400, 8 mm Mo-rod system	■										■	■	■	■	■	■	■	■	■	■	■	■																										116	

The HiQuad® series is a modular system that can be very flexibly adapted to any given application. PPM plasma monitors are also available on request for energy analysis as are EPD end point detectors for etching processes.





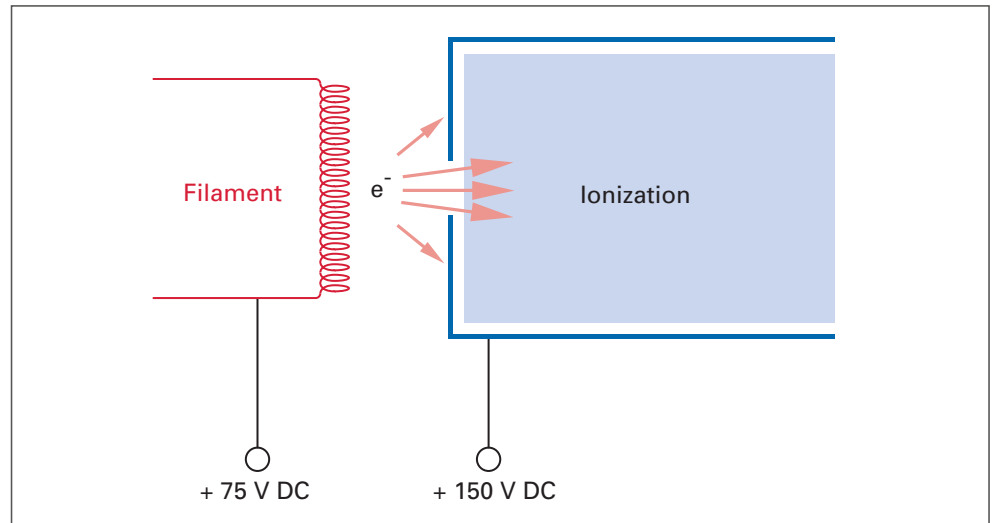
Customer benefits

- Easily adapted to meet a variety of measurement tasks
- Easy to operate even during quantitative gas analysis
- Easy, flexible system integration
- Highly sensitive, quick measurements
- Precise process monitoring



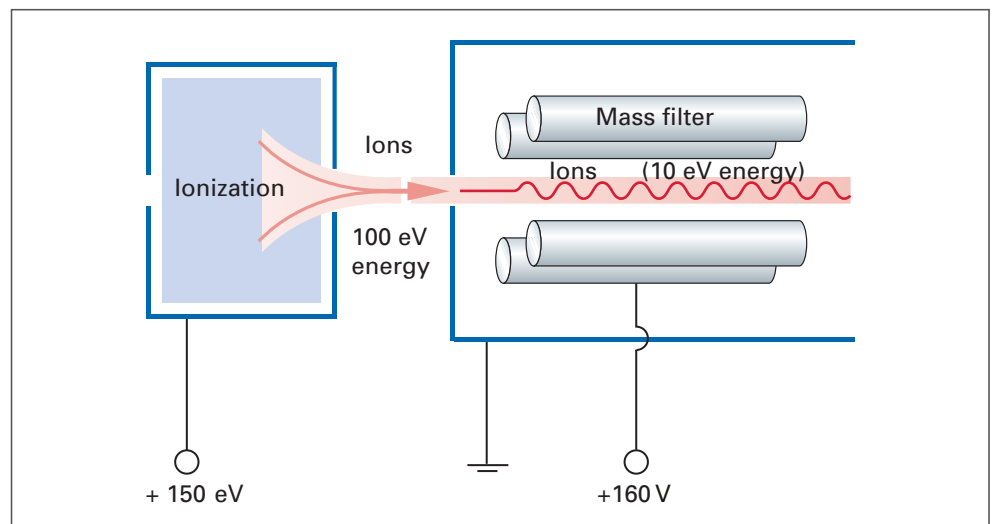
Overview of technologies

With the compact PrismaPlus® and the high-resolution HiQuad®, Pfeiffer Vacuum offers two basic models of quadrupole mass spectrometers, which have excellent technological advantages.



Biased ionization chamber

The high electrical potential of the ionization chamber results in an extremely low background signal. The electron-emitting filament is positively biased relative to ground. This design prevents desorption of gas particles from the chamber walls, and thus the generation of an undesired background signal by electron stimulated desorption.



Field-axis technology

One of the most important factors for the performance of a mass spectrometer is the transfer of ions from the ion source to the mass filter. With the aid of field-axis technology, the ions are able to cross the peripheral fields of the separating system without any noteworthy interaction. It is thus possible to achieve higher sensitivities (A/hPa) without pre and post filters.



QUADERA® mass spectrometer software



Operation of quadrupole mass spectrometers including the display, evaluation and saving of data is carried out on a PC. The QUADERA® software with its modular structure offers a clear and user-friendly platform and pre-configured measuring procedures allowing for the presentation of measured data as well as the handling of parameter settings with a few mouse clicks. Complete measuring procedures can be generated with no programming skills.

QUADERA® can be used with PrismaPlus® and HiQuad® as well as any mass spectrometer systems based on these devices. The PC is connected via Ethernet to the mass spectrometer. It provides networking capacity, freely adjustable line length and the opportunity to operate the mass spectrometer from various PC work stations. The software generates the interface between the mass spectrometer and the user for settings and measurements. The simple, clear controls and ability to display external signals together with mass spectrometer data are what really matters to the user.

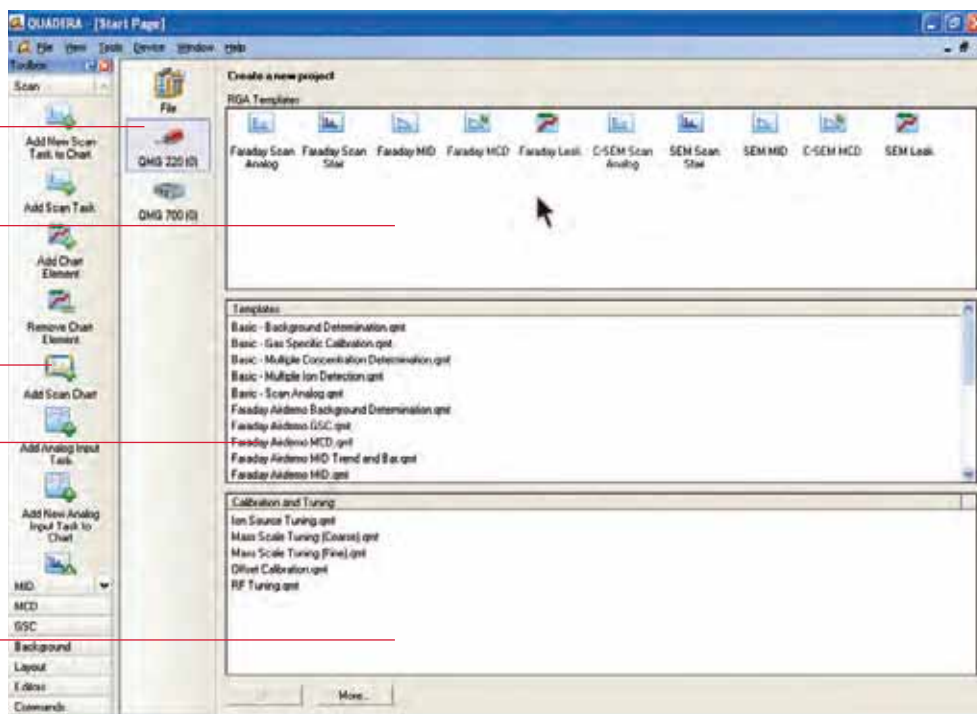
Unit selection

Selection window

Tools, aids

Templates

Calibration and tuning

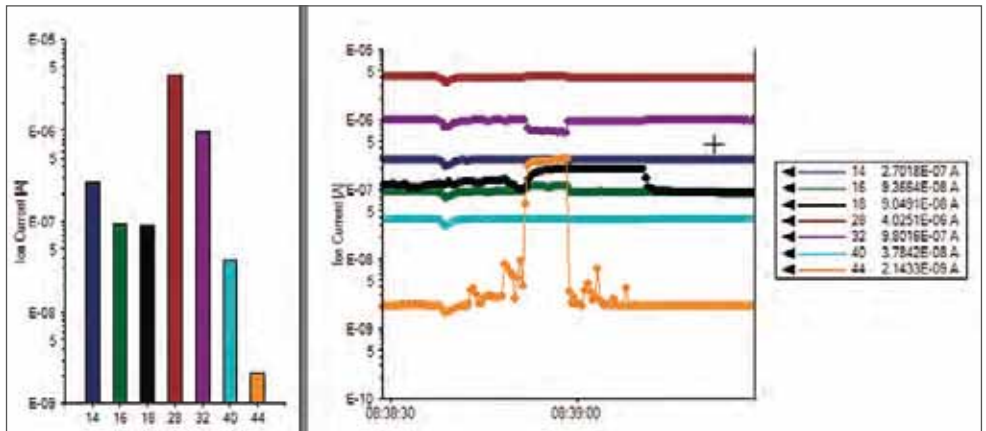


Measurement modes

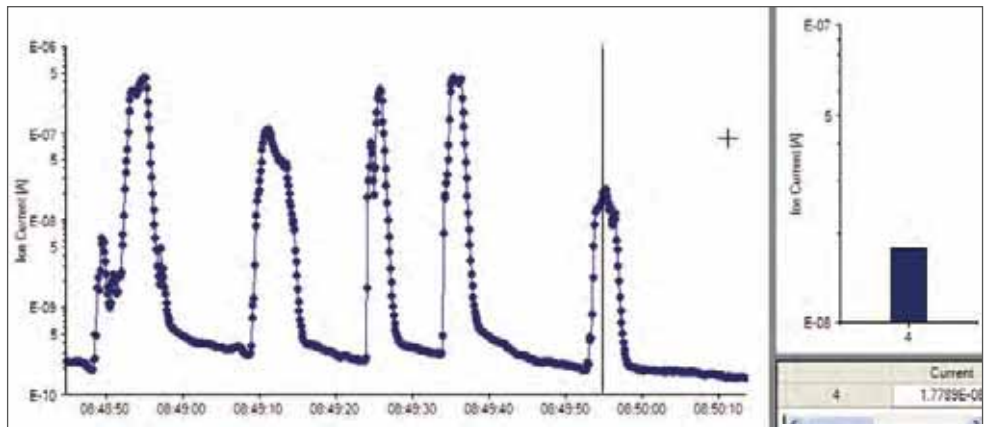
The window interface of the Quadera® software may be freely configured. Different user-defined views of a measurement can be displayed simultaneously. Prepared templates are available at a mouse click for typical measurement tasks such as the scan of a mass range as analog or bar graph, scan of certain masses, residual gas analysis or leak detection.

The mass spectrometer must be calibrated before quantitative analysis can be performed. If this involves recurring processes, such as calibration with subsequent quantitative analysis, these processes can be automated using a scripting language (VSTA = Visual Studio for Applications)*. Since pre-configured modules may be used to do so, an extensive measurement project can be generated quickly.

* Microsoft Copyright

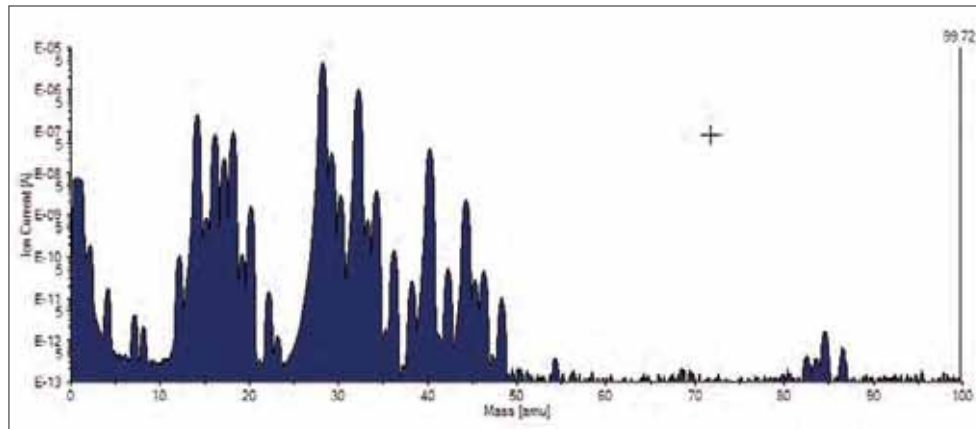
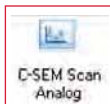


Bargraph portrayal of the ion current and its curve as a function of time

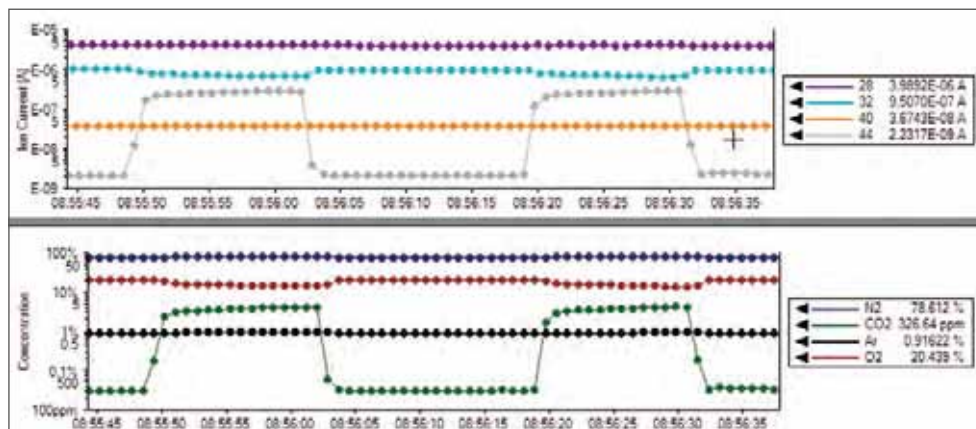


Leak detection with helium – Visualization as a function of time

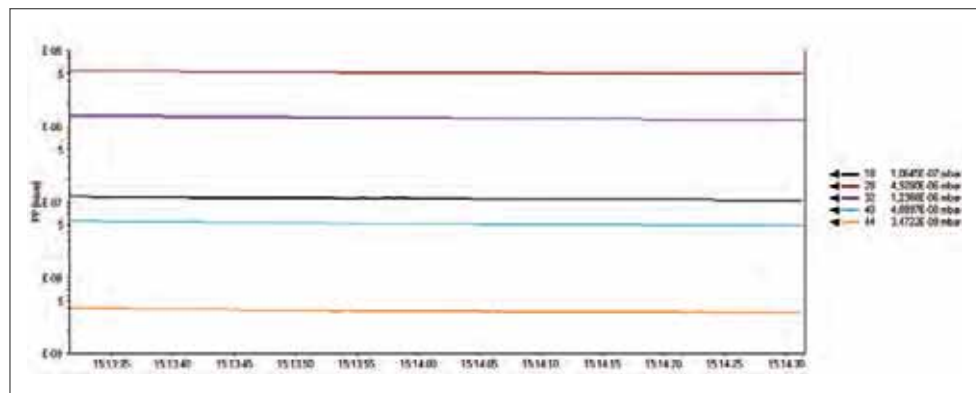




Analog spectrum of air



Analysis of air as ion current and concentration as a function of time



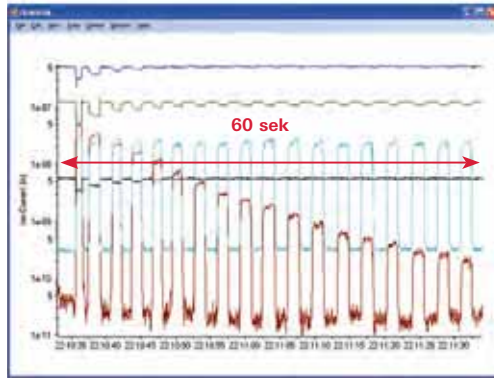
Measurement of different masses vs. time
Display as partial pressure in hPa



Gas analysis

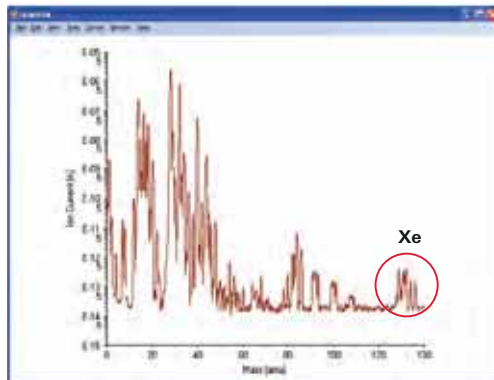
Quadrupole mass spectrometers require a working pressure of less than $1 \cdot 10^{-4}$ hPa under high vacuum. To analyze gases at higher pressures, as are encountered in many vacuum processes, a perfectly coordinated system is required, consisting of a mass spectrometer, a gas inlet with a separation-free pressure reducing valve, vacuum pumping stations and total pressure measurement. With its quadrupole mass spectrometer-based products, Pfeiffer Vacuum provides the perfect solution for analyzing every gas in the ultra-high vacuum range right up to atmospheric pressure.

Owing to the modular design and the use of high-quality, proven components, these instruments can be ideally adapted to cope with practically every measuring task. Our experienced product and applications specialist are available to assist you in selecting a suitable analytical system for your particular application.



High measurement speed – up to 125 $\mu\text{s}/\text{u}$

With the HiQuad[®] mass spectrometer very fast measurements can be made. This example shows the mass spectrometer response during respiration analysis. N_2 , O_2 and CO_2 were detected with a very fast cycle time.



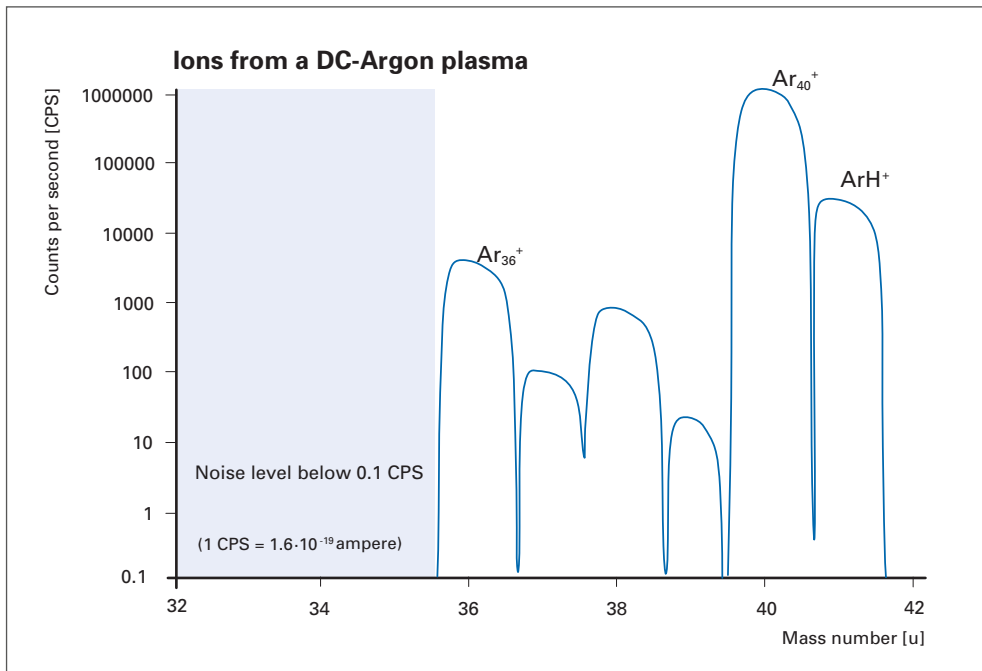
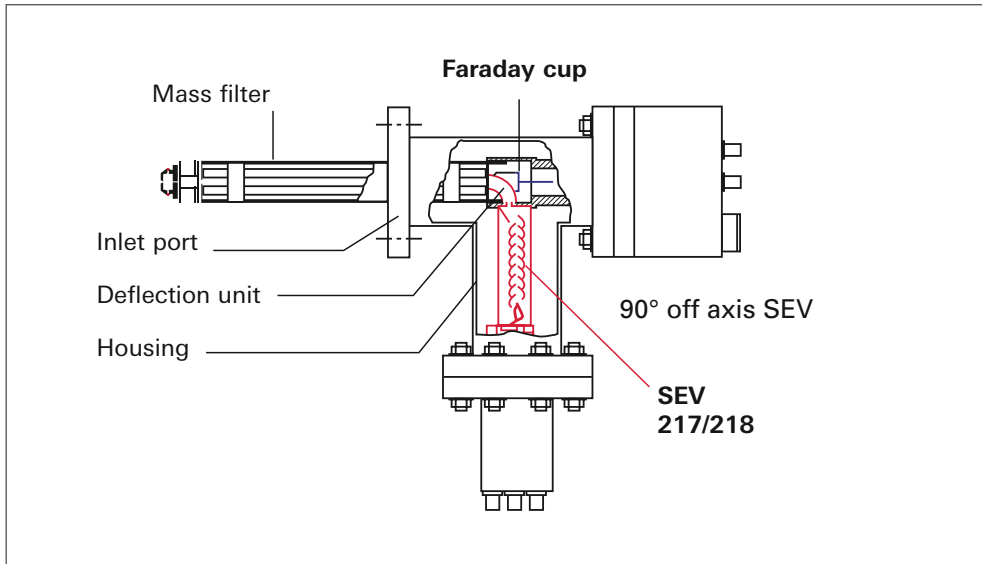
Wide dynamic range

The figure shows a spectrum for air. In addition to the primary components of N_2 , O_2 , Ar and CO_2 even the smallest concentrations of Xe are detected. The ion current at mass 136 is equivalent to a concentration of 7.8 ppb Xe in the air. However, the ion current is several decades above the background noise level, allowing large dynamic range of 10 decades to be achieved.



90° off-axis secondary electron multiplier (SEM)

The task of the secondary electron multiplier is to increase the sensitivity of the mass spectrometer. In the HiQuad®, the multiplier is attached in the vacuum at a right angle to the rod system. This prevents weak X-rays and photons from reaching the detector and generating background noise. In combination with an ion-counting arrangement, it is possible to generate very low background noise level and a wide dynamic range. The spectrum shown displays a very low count of ArH⁺-Ions, which were generated in a plasma.



PrismaPlus®

The perfect solution for mass spectrometry



PrismaPlus®

The combination of high sensitivity, stability and intelligent controls make the PrismaPlus® the perfect solution for mass spectrometry.

Its modular design offers you a variety of application options in industrial and analytical environments, in research & development, in leak detection and semiconductor production, as well as in coating technology.

The PrismaPlus® is the ideal solution for applications ranging from quality assurance and residual gas analysis right through to complex, quantitative tasks.

The wide selection of interfaces such as digital and analog inputs and outputs and the connection facility for DigiLine and ActiveLine transmitters allow for easy system integration.

Customer benefits

- Ideal adjustment capability for wide-ranging measurement tasks
- Easy installation due to its compact dimensions and 90 degree version
- Networkable through Ethernet
- Intuitive operation using QUADERA® software

Typical applications

- Qualification of vacuum systems
- Leak detection on vacuum chambers
- Determination of outgassing rates



Accelerators



Research & Development

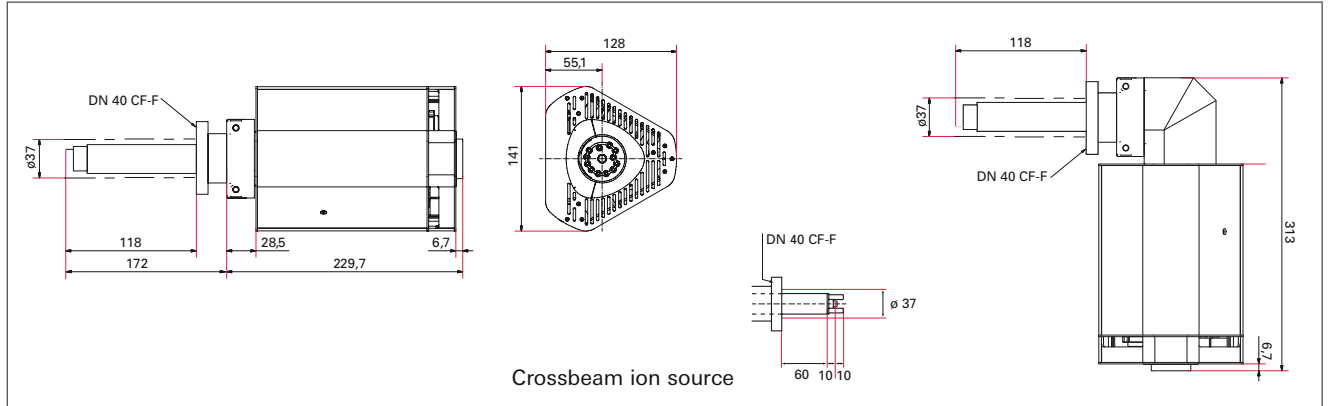




PrismaPlus® QMG 220

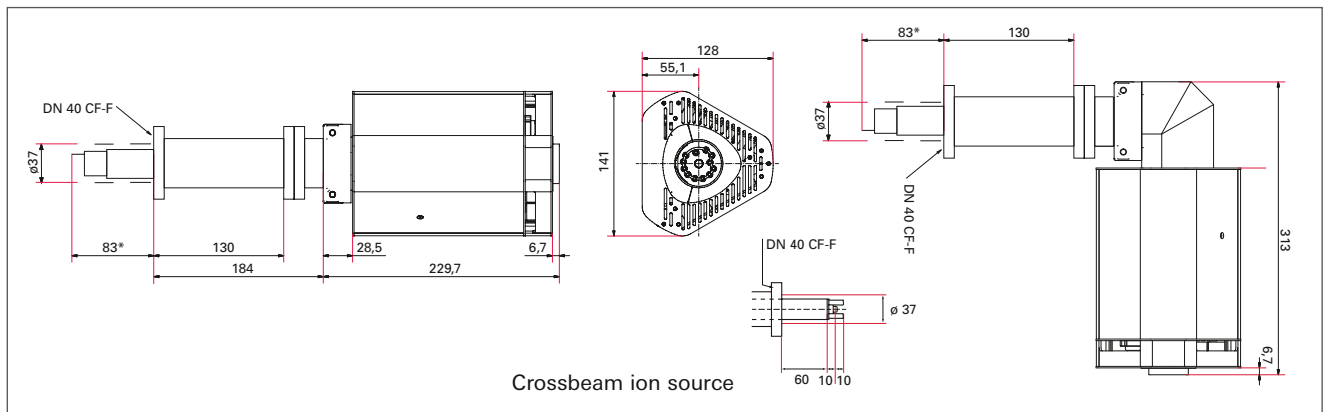
- Robust and economic residual gas analysis and vacuum process monitoring in the high vacuum range
- Interchangeability of analyzers and electronics
- Two filaments mean maximum up-time

Dimensions (in mm)



QMG 220 F 0°

QMG 220 F 90°



QMG 220 M 0°

QMG 220 M 90°

Scope of delivery



I/O-Module 220 (optional)

Electronics unit QME 220 0° or 90° connection

Analyzer QMA 200 Faraday or C-SEM/Faraday

SP 220 power supply including mains cable

Software



Technical data	PrismaPlus® QMG220 F1	PrismaPlus® QMG220 F2	PrismaPlus® QMG220 F3
Detector	Faraday	Faraday	Faraday
Mass range	1–100 u	1–200 u	1–300 u
Rod system, diameter/length	6 mm / 100 mm	6 mm / 100 mm	6 mm / 100 mm
Min. detection limit, Faraday ¹⁾	$1 \cdot 10^{-12}$ hPa	$2 \cdot 10^{-12}$ hPa	$4 \cdot 10^{-12}$ hPa
Ar sensitivity, Faraday ¹⁾	$1 \cdot 10^{-3}$ A/hPa	$6 \cdot 10^{-4}$ A/hPa	$3 \cdot 10^{-4}$ A/hPa
Operating pressure, max. ²⁾ , Faraday operation	$1 \cdot 10^{-4}$ hPa	$1 \cdot 10^{-4}$ hPa	$1 \cdot 10^{-4}$ hPa
Contribution to adjacent mass (40/41) ¹⁾	< 10 ppm	< 30 ppm	< 50 ppm
Operating temperature, analyzer	150 °C	150 °C	150 °C
Operating temperature, electronics	0–40 °C	0–40 °C	0–40 °C
Bakeout temperature, analyzer ³⁾	200 °C/300 °C	200 °C/300 °C	200 °C/300 °C
Connection flange	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution at 10% peak height	0.5–2.5 u	0.5–2.5 u	0.5–2.5 u
Measuring speed, analog/bargraph scan	20 ms–60 s/u	20 ms–60 s/u	20 ms–60 s/u
Measuring speed, Stair	2 ms–60 s/u	2 ms–60 s/u	2 ms–60 s/u
Measuring speed, MID	2 ms–60 s/u	2 ms–60 s/u	2 ms–60 s/u
Number of measuring channels in MID	128 pieces	128 pieces	128 pieces
Reproducibility of peak ratio ³⁾	±0.5%	±0.5%	±0.5%
Interface	Ethernet	Ethernet	Ethernet
Input, digital	External protection, 24 V	External protection, 24 V	External protection, 24 V
Supply voltage	90–260 V AC, 50/60 Hz	90–260 V AC, 50/60 Hz	90–260 V AC, 50/60 Hz
Weight ⁴⁾	2.4 kg	2.4 kg	2.4 kg

Technical data	PrismaPlus® QMG220 M1	PrismaPlus® QMG220 M2	PrismaPlus® QMG220 M3
Detector	C-SEM/Faraday	C-SEM/Faraday	C-SEM/Faraday
Mass range	1–100 u	1–200 u	1–300 u
Rod system, diameter/length	6 mm / 100 mm	6 mm / 100 mm	6 mm / 100 mm
Min. detection limit, Faraday ¹⁾	$5 \cdot 10^{-12}$ hPa	$1 \cdot 10^{-11}$ hPa	$2 \cdot 10^{-11}$ hPa
Min. detection limit, C-SEM ¹⁾	$1 \cdot 10^{-14}$ hPa	$< 2 \cdot 10^{-14}$ hPa	$< 4 \cdot 10^{-14}$ hPa
Ar sensitivity, Faraday ¹⁾	$5 \cdot 10^{-4}$ A/hPa	$3 \cdot 10^{-4}$ A/hPa	$1,5 \cdot 10^{-4}$ A/hPa
Ar sensitivity, C-SEM ¹⁾	200 A/hPa	200 A/hPa	100 A/hPa
Operating pressure, max. ²⁾ , Faraday operation	$1 \cdot 10^{-4}$ hPa	$1 \cdot 10^{-4}$ hPa	$1 \cdot 10^{-4}$ hPa
Operating pressure, max, C-SEM operation	$1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-5}$ hPa
Contribution to adjacent mass (40/41) ¹⁾	< 10 ppm	< 20 ppm	< 50 ppm
Operating temperature, analyzer	150 °C	150 °C	150 °C
Operating temperature, electronics	0–40 °C	0–40 °C	0–40 °C
Bakeout temperature, analyzer ³⁾	200 °C/300 °C	200 °C/300 °C	200 °C/300 °C
Connection flange	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution at 10% peak height	0.5–2.5 u	0.5–2.5 u	0.5–2.5 u
Measuring speed, analog/bargraph scan	20 ms–60 s/u	20 ms–60 s/u	20 ms–60 s/u
Measuring speed, Stair	2 ms–60 s/u	2 ms–60 s/u	2 ms–60 s/u
Measuring speed, MID	2 ms–60 s/u	2 ms–60 s/u	2 ms–60 s/u
Number of measuring channels in MID	128 pieces	128 pieces	128 pieces
Reproducibility of peak ratio ³⁾	±0.5%	±0.5%	±0.5%
Interface	Ethernet	Ethernet	Ethernet
Input, digital	External protection, 24 V	External protection, 24 V	External protection, 24 V
Supply voltage	90–260 V AC, 50/60 Hz	90–260 V AC, 50/60 Hz	90–260 V AC, 50/60 Hz
Weight ⁴⁾	3.8 kg	3.8 kg	3.8 kg

1) For open ion sources

2) For ion currents reduced to 0.2 mA: $1 \cdot 10^3$ hPa

3) Defined by order number

4) For version with electronics and analyzer on one axis (0°)



I/O module - connection options

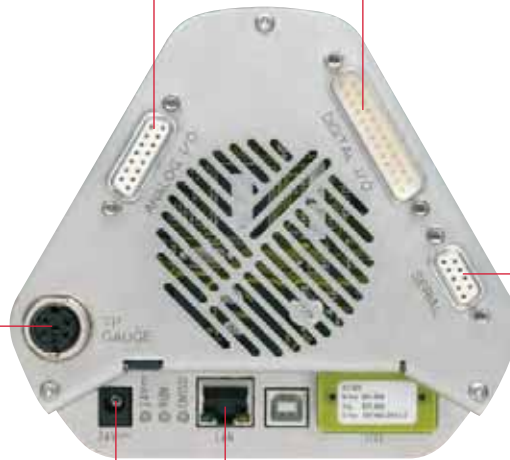
	Analog outputs	Analog input	Digital outputs	Digital inputs
Number	4	5	16	5
Specification	0–10 V	-10–+10 V	$V_{out} = 24 V$	$V_{in} = 24 V$
Resolution	12 bit	14 bit	–	–
Application examples	<ul style="list-style-type: none"> Measured values, e.g. ion currents Ratios (concentrations) Data transfer to higher-level systems 	Reading in external values, e.g. pressure, temperature, gas flow	<ul style="list-style-type: none"> Free assignment of switchpoints Valve actuation 	Starting or stopping of measurement tasks by means of external signal

Analytical equipment

Total pressure measurement with ActiveLine



Total pressure measurement with DigiLine



Ethernet

SP 220 power supply

L x W x H:
145 x 75 x 40 mm

Cable length: 3 m

Weight: 0.7 kg



24 V DC

Voltage: 90–260 V AC
Frequency: 50–60 Hz



Order number matrix
PrismaPlus®
Order number
PT M0 a b c d e f g

Detector version¹⁾	a
Faraday ¹⁾ only for leak detection and high-vacuum residual gas analysis	5
C-SEM/Faraday; C-SEM = Continuous secondary electron multiplier for fast and sensitive residual analysis in the UHV, analytical tasks and leak detection	6
Mass range	b
1–100 u	1
1–200 u	2
1–300 u	3
Ion source	c
Open ion source for high-vacuum residual gas analysis; high sensitivity and good linearity	1
Gas-tight ion source for combination with gas inlet systems; low gas consumption, high signal-to-noise ratio	2
Crossbeam ion source for direct gas beam inlet without interaction with the walls of the ion sources; electron energy adjustable from 0 to 100 eV	3
Grid ion source ²⁾ for UHV residual gas analysis; minimum outgassing and desorption rates	4
Open ion sources for high-vacuum residual gas analysis; high sensitivity and good linearity; electron energy adjustable from 0 to 100 eV	5
Filament	d
Tungsten; for UHV applications	1
Yttriated iridium: low filament temperature; high resistance to air inrushes	2
Bakeout temperature³⁾	e
to 200 °C	1
to 300 °C	2
Connection⁴⁾	f
0° (on one axis)	1
90° off axis	2
I/O interface⁵⁾ and VSTA software extension	g
Without option	0
With I/O module – for control and signal interchange via analog and digital inputs/outputs	1
With VSTA software extension – for programming program sequences and for exchanging commands and data with other programs	2
with I/O module and VSTA software extension	3

¹⁾ Only with open ion source

²⁾ Grid ion source with tungsten filament only

³⁾ Electronics removed

⁴⁾ See dimensions page 100

⁵⁾ See page 102


OmniStar/ThermoStar

Gas analysis at atmospheric pressure



OmniStar/ThermoStar

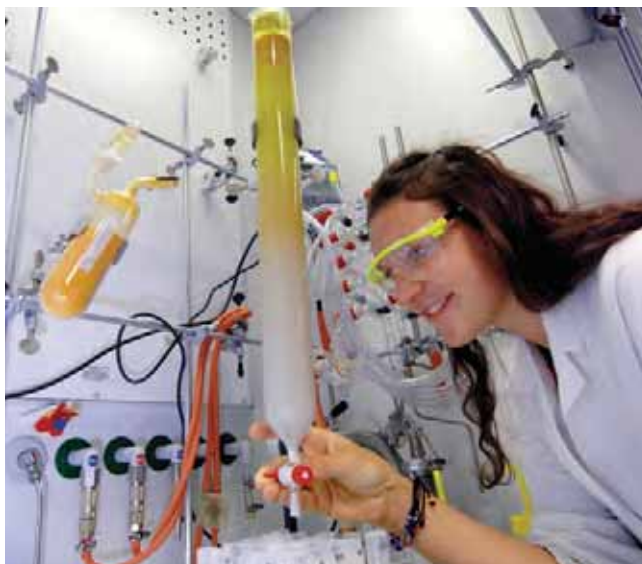
OmniStar and ThermoStar, compact bench top analyzers are two ideal complete solutions for sample gases present at atmospheric pressure. They are based on the PrismaPlus® quadrupole mass spectrometer and a dry pumping station, composed of a diaphragm vacuum pump MVP and a HiPac turbopump. They have a heated and temperature controlled gas inlet system and are suitable for the qualitative and quantitative analysis of gases.

Customer benefits

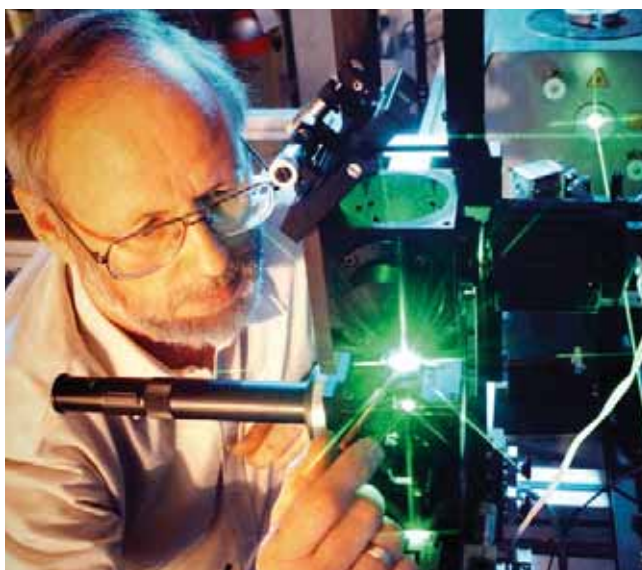
- Qualitative and quantitative gas analysis, connection for calibrating gas inlet
- Low detection limit (< 1 ppm) even for condensable gases
- Compact, easy-to-operate analysis unit
- Heated capillary inlet up to $350\text{ }^{\circ}\text{C}$
- Small footprint
- Easy to use even for quantitative gas analysis
- Gas analysis under varying sample pressures – pressure-regulated gas inlet (optional)

Typical applications

- Chemical analysis
- Fermentation
- Catalysis
- Laser technology
- Environmental analysis
- Fuel cells



Chemical applications



Laser



Thermo balances

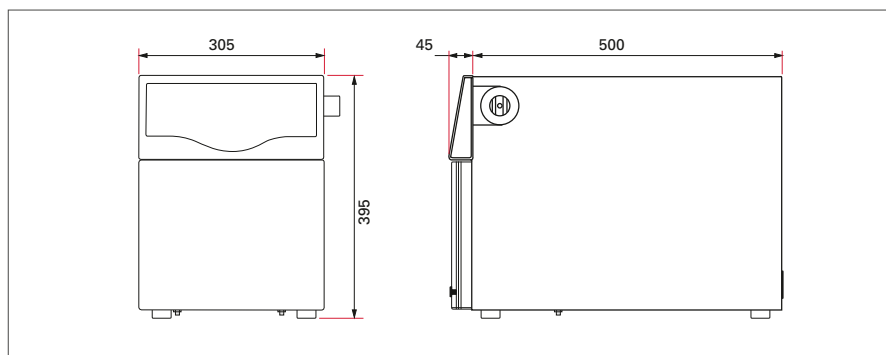




OmniStar/ThermoStar

- Qualitative and quantitative gas analysis, connection port for calibrating gas inlet systems
- Low detection limit (< 1 ppm) even for condensable gases
- Compact, easy-to-operate analysis unit
- Heated capillary inlet up to $350\text{ }^{\circ}\text{C}$
- Bakeable all-metal sealed high vacuum chamber for low backgrounds

Dimensions (in mm)



Technical data	OmniStar	ThermoStar
Mass ranges	1–100 u 1–200 u 1–300 u	1–100 u 1–200 u 1–300 u
Gas connection	Stainless steel capillary	Quartz glass capillaries
Gas inlet	via software or user interface-controlled inlet valve	continuously open
Pressure reduction	2-stage, segregation-free	2-stage, segregation-free
Gas flow rate	1–2 sccm	1–2 sccm
Sample gas pressure	Up to 1,000 hPa	Up to 1,000 hPa
Capillary operating temperature	Up to $350\text{ }^{\circ}\text{C}$	Up to $350\text{ }^{\circ}\text{C}$
Analyzer	QMA 200 M	QMA 200 M
Rod system, material/diameter/length	Stainless steel/6/100 mm	Stainless steel/6/100 mm
Detector	C-SEM/Faraday	C-SEM/Faraday
Mass spectrometer electronics	QME 220 M	QME 220 M
Software	Quadera®	Quadera®
Contribution to neighboring mass: 40 – 41 1–100 / 200 / 300 U	< 10 ppm / < 20 ppm / < 50 ppm	< 10 ppm / < 20 ppm / < 50 ppm
Min. detection limit, C-SEM 1–100 / 200 / 300 U	< 1 ppm / < 1 ppm / < 1 ppm	< 1 ppm / < 1 ppm / < 1 ppm
Min. detection limit, Faraday 1–100 / 200 / 300 U	< 20 ppm / < 40 ppm / < 100 ppm	< 20 ppm / < 40 ppm / < 100 ppm
Resolution, settable at 10% peak height	0.5–2.5 u	0.5–2.5 u
Dimensions (L x W x H)	545 x 305 x 395 mm	545 x 305 x 395 mm
Weight	35 kg	35 kg
Mains requirement: voltage (range)	100 – 230 VAC	100 – 230 VAC
Interface	Ethernet Analog input: 5x ± 10 V / 12 bit Analog output: 4x 0...10 V / 12 bit Digital input: 4x Digital output: 7x optical insulated, 24 V	Ethernet Analog input: 5x ± 10 V / 12 bit Analog output: 4x 0...10 V / 12 bit Digital input: 4x Digital output: optical ins



**Order number matrix
OmniStar/ThermoStar**

Order number

PT M a bc def g h

System	a
OmniStar	8
ThermoStar	9

Analyzer/Filament	bc
Filament: Yttriated iridium, integrated option for mass calibration	01
Filament: Yttriated iridium	02
Filament: Tungsten, integrated option for mass calibration	05
Filament: Tungsten	06
Filament: Yttriated iridium, integrated option for mass calibration, corrosive gas version with inert gas inlet	11
Filament: Yttriated iridium, corrosive gas version with inert gas inlet	12
Filament: Tungsten, integrated option for mass calibration, corrosive gas version with inert gas inlet	15
Filament: Tungsten, corrosive gas version with inert gas inlet	16

Gas inlet system	def
ThermoStar, Quartz, 1 m temperature-regulated gas sampling line, 200 °C	111
ThermoStar, Quartz, 2 m temperature-regulated gas sampling line, 200 °C	112
ThermoStar, Quartz, 1 m temperature-regulated gas sampling line, 350 °C	113
OmniStar, quartz (special), 1 m temperature-regulated gas sampling line, 200 °C	151
OmniStar, quartz (special), 2 m temperature-regulated gas sampling line, 200 °C	152
OmniStar, stainless steel, 1 m temperature-regulated gas sampling line, 200 °C	171
OmniStar, stainless steel, 2 m temperature-regulated gas sampling line, 200 °C	172
OmniStar, stainless steel, 1 m temperature-regulated gas sampling line, 350 °C	173
Pressure-regulated gas inlet, 5 decades, $5 \cdot 10^{-3}$ hPa up to atmospheric pressure	555

Mass range	g
1–100 u	1
1–200 u	2
1–300 u	3

Front panel	h
OmniStar	1
ThermoStar	2

Analytical equipment



Quadera® – An INFICON
VSTA® – A Microsoft® pr



HPA 220 and SPM 220

Gas analysis for vacuum processes



HPA 220 and SPM 220

Many vacuum processes take place in the medium vacuum range. To analyze these processes, Pfeiffer Vacuum offers two compact systems based on the quadrupole mass spectrometer PrismaPlus® and a HiPace® turbopumping station.

Gas analysis up to low vacuum range

The High Pressure Analyzer HPA 220 is a modular and flexible mass spectrometer system with a dry turbopumping station for gas analysis in a vacuum up to pressures of 50 hPa. Depending on its use, with the HPA 220, five different electropneumatic as well as manually operated gas inlet valves can be selected.

Realtime sputter process gas analysis

The Sputter Process Monitor SPM 220 provides the perfect solution for qualitative and quantitative gas analyses of sputter processes. The specially developed SPM ion source enables precise up-to-the-minute process gas analysis up to a pressure of 10^{-2} hPa. An optional version with differentially pumped orifice flange for pressures of up to 10 hPa is available.

Customer benefits

- Exact real time process monitoring
- Easy, flexible system integration
- Excellent detection limits for H_2 , O_2 , H_2O as well as CO_2
- Optimal adaptation to numerous measurement tasks
- Easy, flexible system integration
- Control of several devices via a single PC

Typical applications

- Architecture and optical glass coating
- Thin-film solar cell production
- Semiconductor production
- Hard coatings
- Metallurgy
- Vacuum furnaces
- Research & development



Glass coating



Semiconductors



Metallurgy

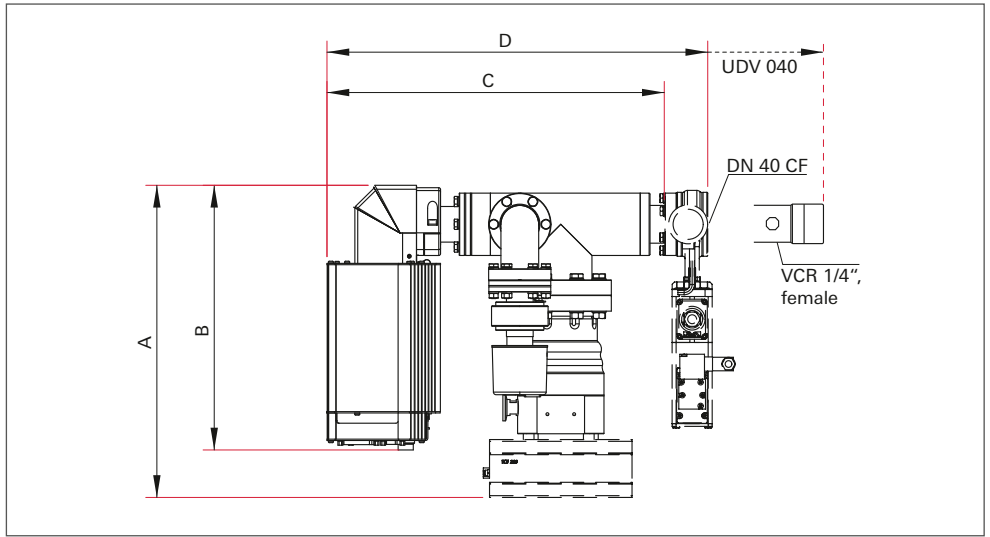


HPA 220



- Provides great flexibility due to its 5 manually or electropneumatically operated gas inlet options for analyzing, monitoring and controlling processes up to a pressure of 50 hPa
- Easy and flexible system integration through a variety of digital and analog inputs and outputs
- Multiplex operation allows data evaluation of several mass spectrometer software systems with a single PC
- Compact dimensions for flexible integration

Dimensions (in mm)



Version	A	B	C	D
HPI 040 H	–	290 mm	380 mm	415 mm
HPI 040, P	350 mm	290 mm	380 mm	415 mm
Double gate valve, manual	–	290 mm	380 mm	446 mm
Double gate valve, pneumatic	350 mm	290 mm	380 mm	446 mm
UDV 040	–	290 mm	380 mm	479 mm

System overview

Mass spectrometer PrismaPlus

- 1–100 u
- 1–200 u
- 1–300 u

Gas inlet system

- 1,2) Valve interface HPI 040
- 3,4) Double gate valve
- 5) Gas dosing valve UDV 040



Vacuum gauge ActiveLine PKR 251
for monitoring the pressure and protecting the filaments

Valve control unit VCU 220
for electropneumatic gas inlet systems

Turbopump HiPace® 80 with TC 110 RS
with 4 accessory ports + backing pump MVP 030-3 (not shown)

19" rack unit BRU 220
Integrated power supply pack TPS 311. Additional options: Heating control, display and control units (not shown) and TPG for vacuum control



Order number matrix

HPA 220

Order number

PT M 5 a b c d

Mass range	a
1–100 u	1
1–200 u	2
1–300 u	3
Ion source and filament	b
Open ion source, filament: yttriated iridium	1
Open ion source, filament: tungsten	2
Gas inlet system	c
HPI 040 P, bellows-sealed gate valve, DN 40 CF, electropneumatically operated, two bypass valves with 0.1 mm and 0.3 mm orifices, 0.03 mm third orifice included	1
HPI 040 P, bellows-sealed gate valve, DN 40 CF, electropneumatically operated, two bypass valves with 0.1 mm and 0.3 mm orifices, 0.03 mm third orifice included	2
Double gate valve, DN 40 CF, manually operated, one gate opens to release full cross-section, one gate with 0.1 mm orifice	3
Double gate valve, DN 40 CF, electropneumatically operated, one gate opens to release full cross-section, one gate with 0.1 mm orifice	4
UDV 040, gas dosing valve, manually operated, VCR 1/4"	5
Cable length and accessory option	d
3 m, without option	0
3 m, with TPG display and control unit	1
3 m, with DCU display and control unit	2
3 m, with TPG and DCU display and control units	3
10 m, without option	4
10 m, with TPG display and control unit	5
10 m, with DCU display and control unit	6
10 m, with TPG and DCU display and control units	7

1, 2) Valve interface HPI 040

Manually or electropneumatically operated. Consists of three valves, a bellows-sealed gate valve with a nominal diameter of DN 40 CF for residual gas analysis or leak detection up to $< 1 \cdot 10^{-4}$ hPa and two valves with exchangeable orifices in the bypass. One 0.03 mm orifice for extending the range to 8 hPa (N_2) is enclosed.

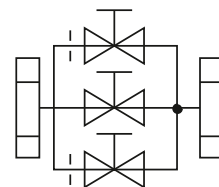
3, 4) Double gate valve

Manually or electropneumatically operated. Consists of two bellows-sealed gate valves which are welded together. One gate with a nominal diameter of DN 40 CF for residual gas analysis or leak detection up to $< 1 \cdot 10^{-4}$ hPa and a second gate with an exchangeable orifice. Delivered ready fitted with a 0.1 mm orifice for the pressure range 0.1 to 1 hPa (N_2).

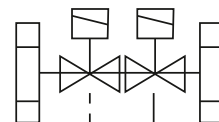
5) Gas dosing valve UDV 040

Manually adjustable gas dosing valve for pressure adjustment up to 50 hPa. The maximum possible and reasonable pressure range is determined particularly by the increasing gas segregation which occurs at progressively high pressures.

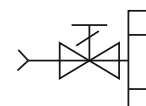
1,2)



3,4)



5)

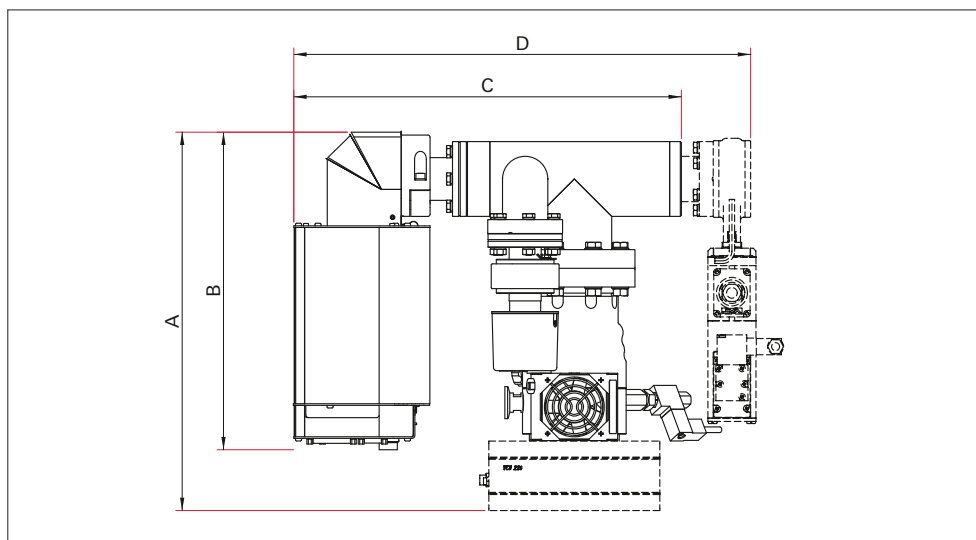


SPM 220



- SPM ion source for instantaneous process monitoring
- Excellent detection limits for H₂, O₂, H₂O and CO₂
- Minimized background influence on the measurement result
- For directly analyzing, monitoring and controlling processes up to 10⁻² hPa
- Differentially pumped version for pressures of up to 10 hPa
- Multiplex operation allows data evaluation of several mass spectrometer software systems with a single PC
- Compact dimensions for flexible integration
- Easy and flexible system integration through a variety of digital and analog inputs and outputs

Dimensions (in mm)



Version	A	B	C	D
without addition	–	290 mm	380 mm	–
with SVV 040 safety valve	350 mm	290 mm	380 mm	416 mm
with a flange with orifice	–	290 mm	380 mm	395 mm

System overview

**Mass spectrometer
PrismaPlus**
1–100 u
1–200 u



**Vacuum gauge
ActiveLine PKR 251**
for monitoring the pressure
and protecting the filaments

**Valve control unit
VCU 220**
for electropneumatic safety
valve SVV 040

**Turbopump
HiPace® 80 with
TC 110 RS**
with 4 accessory ports +
backing pump MVP 030-3
(not shown)

**19" rack unit
BRU 220**
Integrated power supply pack
TPS 311. Additional options:
Heating control, display and
control unit (DCU for turbo-
pumps and gauges)



Order number matrix
SPM 220
Order number
PT M 5 a b c d

Mass range	a
1–100 u	1
1–200 u	2
Ion source and filament	b
SPM ion source, filament: yttriated iridium	3
SPM ion source, filament: tungsten	4
Gas inlet system	c
Without	5
Safety valve SVV 040 PM, electropneumatically operated	6
Differentially pumped DN 40 CF flange with orifice for a pressure range of up to 10 hPa	7
Cable length and accessory option	d
3 m, without option	0
3 m, with TPG display and control unit	1
3 m, with DCU display and control unit	2
3 m, with TPG and DCU display and control units	3
10 m, without option	4
10 m, with TPG display and control unit	5
10 m, with DCU display and control unit	6
10 m, with TPG and DCU display and control units	7



High end mass spectrometer for gas and ion analysis



HiQuad®

HiQuad® is a modular system whose highly precise components can be optimally selected to build a system for gas and ion analysis in many applications. HiQuad® offers the highest sensitivity and a dynamic range of 10 decades allowing simultaneous measurement of ppb 100 x and impressive measurement speeds of up to 125 $\mu\text{s}/\text{mass}$. The QUADERA® software makes it particularly easy to operate the mass spectrometer.

The HiQuad® can be flexibly configured:

- Mass ranges of 1–128 u to 1–2048 u
- Rod systems of various lengths and diameters
- Ion source for UHV, high pressure and beam analysis
- Ion optics for plasma processes
- Secondary electron multiplier and ion counter
- Various interface options

Pfeiffer Vacuum application specialists are happy to put together the best solution for your application.

Customer benefits

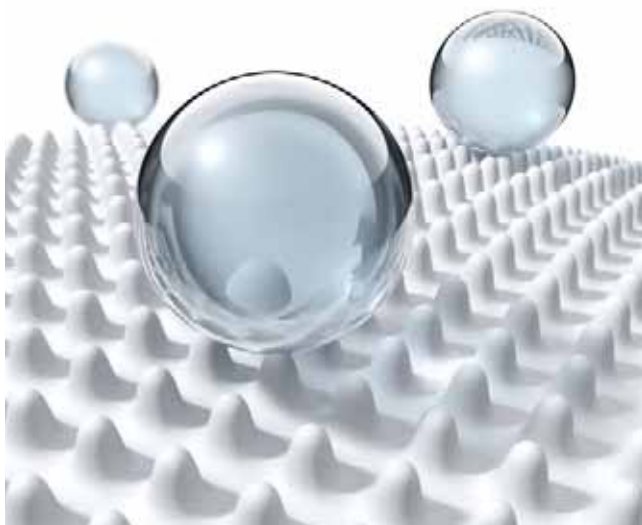
- Highly sensitive measurements
- Wide dynamic range
- High measuring speed
- Excellent long-term stability

Typical applications

- Residual gas analysis in ultra-high vacuum
- Environmental trace analysis
- Pharmaceutical research
- Analysis of plasma processes



Accelerators



Nanotechnology



Pharmaceutics



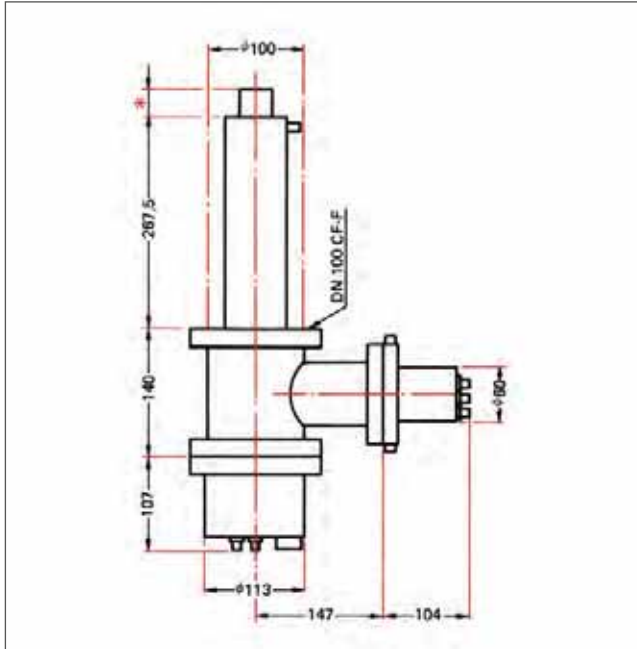
HiQuad® OMG 700



The modular solution for mass spectrometry

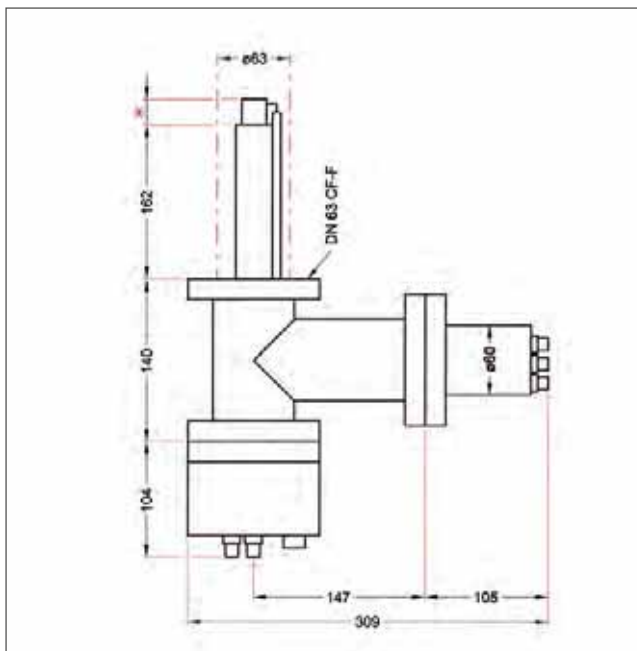
- Modular, flexible design
- Simple operation with Quadara® software
- Extremely high measurement speed
- Maximum sensitivity and wide dynamic range
- Outstanding long-term stability
- Ethernet interface
- Integrated internet browser and OPC server for communication with PC-based programs

Dimensions (in mm)



Analyzer QMA 410 with 90° off axis SEM

- *
- Axial ion source = 26 mm
 - Grid ion source = 27 mm
 - Cross beam ion source = 35.5 mm (23.55 to the center of the sensitive volume)
 - Gas tight cross beam ion source = 48 mm (axial gas connection)
 - Three-lens ion optics = 129 mm
 - Cross beam ion source with axial ion optics = 43.5 mm
 - Cross beam ion source with three-lens ion optics = 171 mm



Analyzer QMA 400, QMA 430 with 90° off axis SEM

- *
- Axial ion source = 26 mm
 - Grid ion source = 27 mm
 - Cross beam ion source = 35.5 mm (23.55 to the center of the sensitive volume)
 - Gas tight cross beam ion source = 48 mm (axial gas connection)
 - Three-lens ion optics = 129 mm
 - Cross beam ion source with axial ion optics = 43.5 mm
 - Cross beam ion source with three-lens ion optics = 171 mm



Technical data	HiQuad® OMG 700 1–128 u	HiQuad® OMG 700 1–340 u	HiQuad® OMG 700 1–300 u
Mass range	1–128 u	1–340 u	1–300 u
Min. detection limit	$5 \cdot 10^{-16}$ hPa	$1 \cdot 10^{-15}$ hPa	$2 \cdot 10^{-15}$ hPa
Ar sensitivity, min ¹⁾	$1 \cdot 10^{-3}$ A/hPa	$5 \cdot 10^{-4}$ A/hPa	$2 \cdot 10^{-4}$ A/hPa
Operating pressure, max. Faraday, max. SEM, max.	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa
Partial pressure ratio with SEM	< 0.3 ppb	< 0.5 ppb	< 1 ppb
Analyzer	QMA 410	QMA 410	QMA 430
Rod system, material/diameter	Mo/16 mm	Mo/16 mm	Stainless steel/8 mm
Radio frequency generator (RF)	QMH 400-1	QMH 410-3	QMH 400-5
Electrometer preamplifier	EP 422	EP 422	EP 422
Operating temperature/analyzer	150 °C	150 °C	150 °C
Bakeout temperature/analyzer	400 ²⁾ °C	400 ²⁾ °C	400 ²⁾ °C
Connection flange	DN 100 CF-F	DN 100 CF-F	DN 63 CF-F

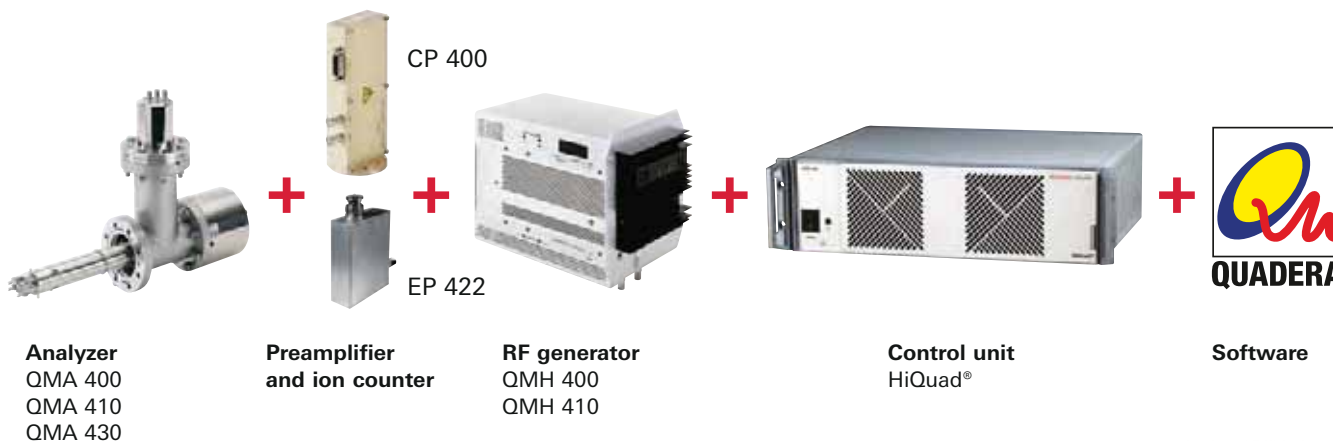
Technical data	HiQuad® OMG 700 1–512 ³⁾ u	HiQuad® OMG 700 1–1,024 u	HiQuad® OMG 700 1–2,048 u
Mass range	1–512 u	1–1,024 u	1–2,048 u
Min. detection limit	$1 \cdot 10^{-15}$ hPa	–	–
Ar sensitivity, min ¹⁾	$5 \cdot 10^{-4}$ A/hPa	$2 \cdot 10^{-4}$ A/hPa	$1 \cdot 10^{-4}$ A/hPa
Operating pressure, max. Faraday, max. SEM, max.	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa	$1 \cdot 10^{-4}$ hPa $1 \cdot 10^{-5}$ hPa
Partial pressure ratio with SEM	< 0.5 ppb	< 5 ppb	< 20 ppb
Analyzer	QMA 400	QMA 400	QMA 400
Rod system, material/diameter	Mo/8 mm	Mo/8 mm	Mo/8 mm
Radio frequency generator (RF)	QMH 400-5	QMH 410-1	QMH 410-2
Electrometer preamplifier	EP 422	EP 422	EP 422
Operating temperature/analyzer	150 °C	150 °C	150 °C
Bakeout temperature/analyzer	400 ²⁾ °C	400 ²⁾ °C	400 ²⁾ °C
Connection flange	DN 63 CF-F	DN 63 CF-F	DN 63 CF-F

¹⁾ Faraday in the deflection unit, standard resolution, cross beam ion source with magnet, emission 1 mA

²⁾ With magnet, max. 300 °C

³⁾ Excellent performance data: Stability < 0.1 % over eight hours, contribution to adjacent mass < 0.1 ppm for the mass 40 and 41 u

System overview



Selection aid – typical applications and solutions

PTQ1	a	bc	d	e	f	g
Applications	Analyzer/mass range	Ion source/ion optics	Filament	Detector and high-voltage power supply	Preamplifier and ion counter	Interface options
General gas analysis	3, 5	01	1, 2, 3	1	1, 4	1, 2, 3
Particle-beam and general gas analysis	2, 3, 4, 5, 6, 7 ¹⁾	02, 03	1, 2	1, 3	1, 4	1, 2, 3
Analysis of gases or gas mixtures; for trace analysis; less residual gas influence than with open ion sources	2, 3, 5	04, 05	1, 2	1, 2	1, 4	1, 2, 3
Plasma technology, SIMS, photoionization	5	11	1, 2	1, 2	1, 2, 3, 4	1, 2, 3
UHV residual gas analysis, desorption measurements	4, 5, 6 ¹⁾	06 ²⁾	1, 2	1	1, 2	1, 2, 3
Thermally desorbed ions, electron-induced desorption, SIMS, photoionization, plasma ions	3, 5, 6	10, 11	0	2	2	1, 2, 3

¹⁾ For the mass range 1 to 2,048 u, analyzer QMA 400 with SEM 218 and HV 702 and EP 422.

²⁾ With tungsten filament only

a – Analyzer/ Mass range

The combination of analyzer and RF generator defines the mass range. The smallest suitable mass range for the application should be selected. The larger-diameter, precision-manufactured rod system affords improved transmission and higher sensitivity.

- **QMA 410:** Molybdenum, ø 16 mm rod system
- **QMA 430:** Stainless steel, ø 8 mm rod system for mass range of up to 300 u
- **QMA 400:** Molybdenum, ø 8 mm rod system

bc – Ion source /ion optics

Selection of the correct ion source is a crucial factor in the measurements.

- **Axial ion source:** High sensitivity and good linearity
- **Cross beam ion source:** For a direct gas beam inlet without wall interaction
- **Cross beam with magnet:** High sensitivity
- **Cross beam gas tight:** Low gas consumption, high signal-to-noise ratio
- **Grid ion source:** Low outgassing and desorption rate
- **Three-lens ion optics with beam stop:** For detection of positive and negative ions
- **Ion optics with cross beam ion source:** For detecting of neutrals and ions

d – Filament

- **Tungsten:** For UHV applications
- **Yttriated iridium:** Low temperatures, high resistance to air inrushes
- **Rhenium:** For residual gas analysis

e – Detector and high-voltage power supply

- **SEM 217 + HV 701:** Secondary electron multiplier in combination with a high-voltage power supply for detecting positive ions
- **SEM 217 + HV 702:** For measuring positive and negative ions
- **SEM 218 + HV 702:** Secondary electron multiplier with conversion dynode to detect high masses

f – Preamplifier and ion counter

- **EP 422:** Fast and sensitive preamplifier
- **CP 400:** Ion counting down to 1 count per 10 seconds, wide dynamic range

g – Interface options

- **IO 700 module** with 8 analog inputs and 8 analog outputs; 0 to 10 V, 12-bit resolution, 32 digital inputs and 32 digital outputs
- **CAN Open Fieldbus**
- **IO 720 module** with 16 digital outputs and 4 digital inputs; 4 analog outputs and 5 analog inputs and 1 connection for ActiveLine transmitter or connection for DigilLine transmitter.



Order number matrix
HiQuad®
Order number
PT Q1 a bc d e f g

Analyzer/mass range	a
QMA 410 / 1–128 u / QMH 400-1	2
QMA 410 / 1–340 u / QMH 410-3	3
QMA 430 / 1–300 u / QMH 400-5	4
QMA 400 / 1–512 u / QMH 400-5	5
QMA 400 / 1–1,024 u / QMH 410-1	6
QMA 400 / 1–2,048 u / QMH 410-2	7

Ion source/ ion optics	bc
Axial ion source	01
Cross beam ion source	02
Cross beam ion source with magnet	03
Gas tight cross beam ion source	04
Gas tight cross beam ion source with magnet	05
Grid ion source	06
Two-lens ion optics	10
Three-lens ion optics	11
Two-lens ion optics with cross beam ion source	12
Three-lens ion optics with cross beam ion source	13

Filament	d
Without	0
Tungsten	1
Yttriated iridium	2
Rhenium	3

Detector and high-voltage power supply	e
SEM 217 + HV 701	1
SEM 217 + HV 702	2
SEM 218 + HV 702	3

Preamplifier and ion counter	f
None	0
EP 422	1
CP 400	2
EP 422 + CP 400	3
2 x EP 422	4

Interface options	g
None	0
IO 700	1
CAN Open	2
IO 720	3

