Mass S

Spectrometers

New mass spectrometers

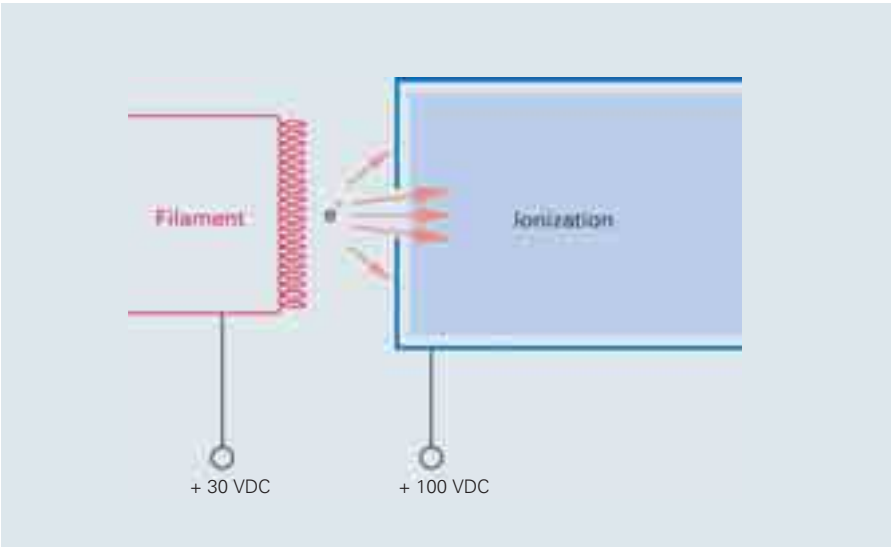
Pfeiffer Vacuum supplies a broad portfolio of mass spectrometers, ranging all the way to high-performance mass spectrometers for plasma analysis.

The gas composition in a production system can be determined with the aid of a mass spectrometer. Because in the manufacturing process, it is not only important to know "how much" is in it, but also "what it is."

Pfeiffer Vacuum offers two basic mass spectrometer models:
- The PrismaPlus compact mass spectrometer
- The HiQuad high-resolution mass spectrometer

Overview of technologies

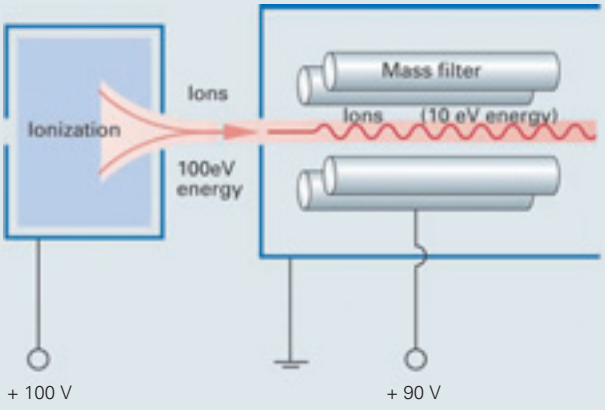
Biased ionization chamber
Biasing the ionization chamber results in an extremely low background signal. The electron-emitting filament is positively biased relative to ground. This design prevents desorption of gas particles from the chamber walls, and thus the generation of an undesired background signal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



Biased ionization chamber

Field-axis technology

One of the most important factors in the performance of a mass spectrometer is the transmission of the ions from the ion source into 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. This enables a high level of sensitivity (A/mbar) to be achieved without the need for pre and post filters.



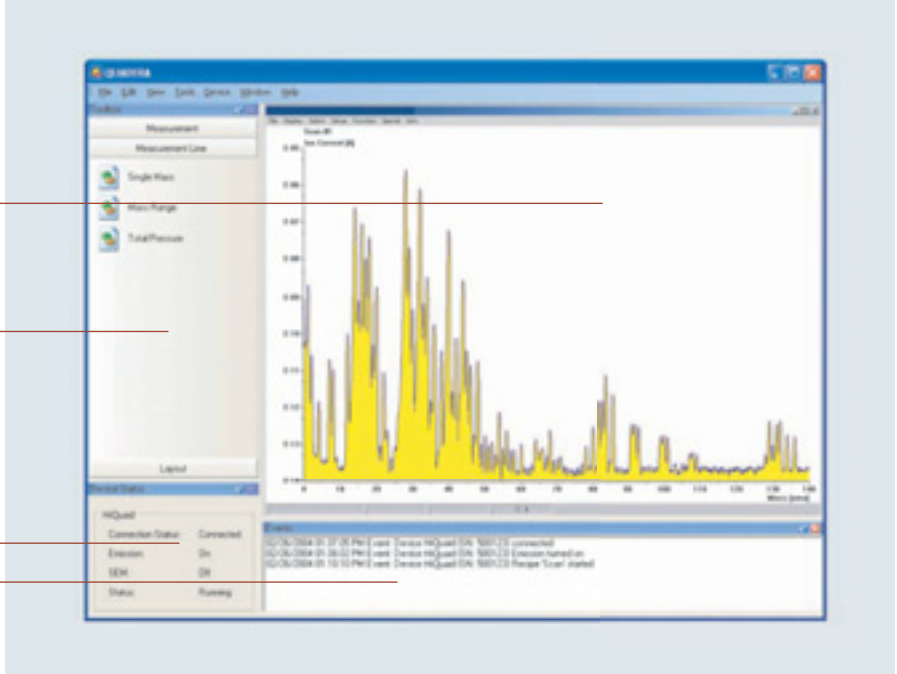
Field-axis technology

Quadera® mass spectrometer software

With its modular design, Quadera® software offers an easy-to-understand and operate platform for recording and presenting both measurement data as well as parameter records. Complete measurement procedures can be programmed.This is why operation, data analysis, presentation and data storage are handled by means of a PC and Quadera® software.

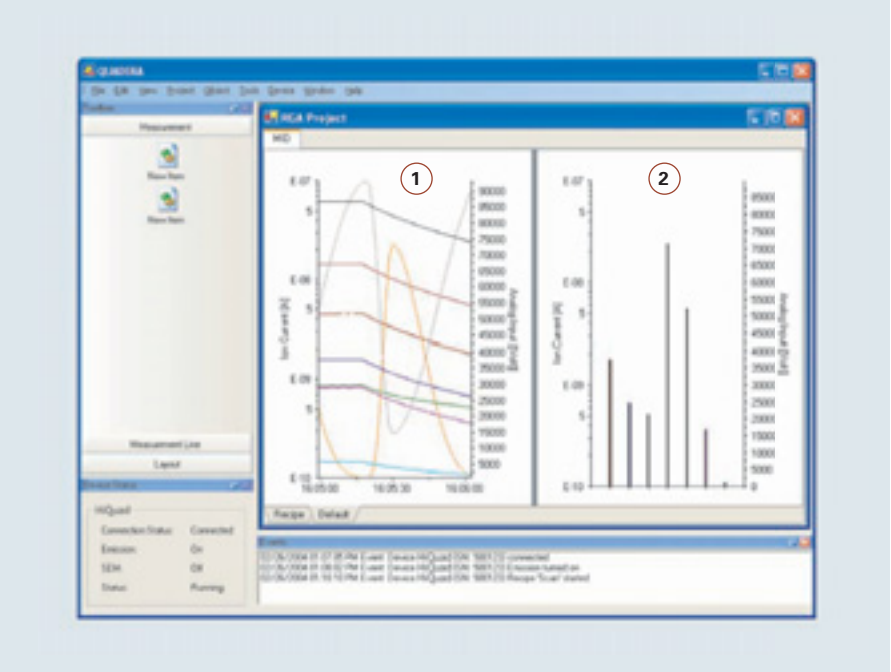
Pfeiffer Vacuum Quadera® mass spectrometer software is a modular system. Quadera® can be employed with the PrismaPlus and HiQuad devices and their newly developed electronics. The PC can be connected with the PrismaPlus or HiQuad via an Ethernet. Quadera® serves as the interface between the mass spectrometer and the user. It offers impressively simple, easy to understand operation. Repetitive measurement tasks can be automated by creating recipes and using program sequences.

- Predefined recipes available, e.g. spectrum, trend, bar graph
- Easy-to-understand presentation of mass spectrometer system functions
- Automated measurement sequences programmable by means of integrated Visual Basic script editor
- Can be adapted for special applications through exchange with other programs



The measurement data are presented in the center of the screen. Tools and links, as well as the status of the device, are shown at the bottom left. Important messages are displayed as plain text.

It is easy to display the data from the mass spectrometer together with such external data as temperature, workpiece weight, etc. The illustration shows an example of the mass spectrometer coupled with a thermobalance.



① Presentation over time
② Momentary intensity of the various masses

Differing user-defined views of a measurement can be displayed simultaneously.

Such typical measurement tasks as residual gas analysis or leak detection are preprogrammed and can be launched with a mouse click.

The mass spectrometer must be calibrated beforehand if quantitative analysis is to be performed. Repetitive procedures, e.g. calibration followed by quantitative analysis, can be programmed by means of VSTA (Visual Studio for Applications). No programming skills are required, as prefabricated modules are used for this purpose.

To solve complicated measurement tasks, Quadera® has a library available containing fractal distributions for various frequently encountered gases and compounds.

PrismaPlus™

The New Mass Spectrometer with the Added Plus!
Modular Design. Powerful Software.
Wide Range of Applications.

What is PrismaPlus?

This is a compact, powerful device that unites the following features:

- 100, 200 and 300 amu mass ranges
- A Faraday cup and a C-SEM are available as detectors
- Equipped with various ion sources and filaments
- The analyzer can be baked out at up to 150 °C

The optimum combination of high sensitivity, maximum stability and intelligent operation is the added plus in our new mass spectrometer – a true innovation!

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.

Our product and service professionals around the world stand ready to provide you with application assistance on the implementation of the PrismaPlus. Long years of customer and applicationspecific experience make Pfeiffer Vacuum your ideal partner.
The added plus for gas analysis!

Advantages at a glance

- Modular design offers optimum adaptability
- Compact size yet high performance
- A variety of interfaces make for simple systems integration
- Networkable through Ethernet
- High measurement speed, stability and resolution
- Interchangeability of analyzers and electronics
- Two filaments mean maximum up-time
- Lowest detectable partial pressure $1 \cdot 10^{-14}$ mbar
- Connectable Pfeiffer Vacuum total pressure gauge
- Intuitive operation of the Quadera® software
- World-class support and worldwide on-site service

High pressure analyzer

PrismaPlus™ on a coating system

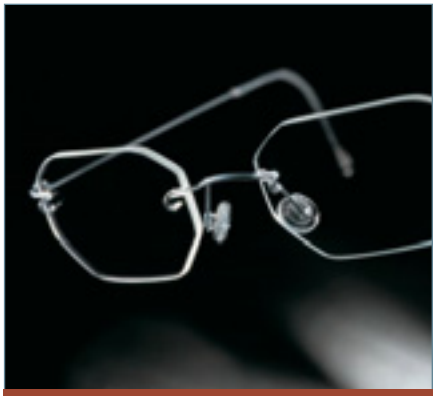
Accelerator

Research & Development

Applications

The PrismaPlus can be optimally employed for leak detection, residual gas analysis or complex, quantitative analyses:

- Metallurgy
- Vacuum furnaces
- Accelerators
- Sputter process analysis
- Semiconductor production
- Glass coating
- Research & development
- Vacuum process systems



Coating

Metallurgy

Notes

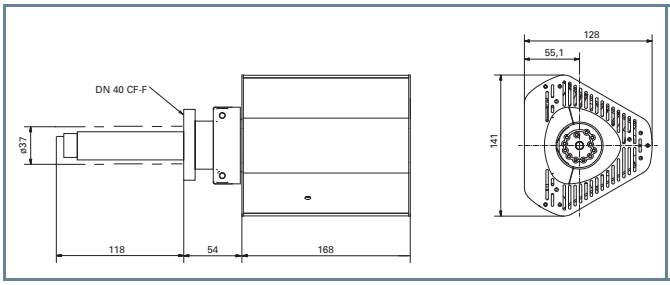
Prisma Plus™

Residual gas analysis in high vacuum

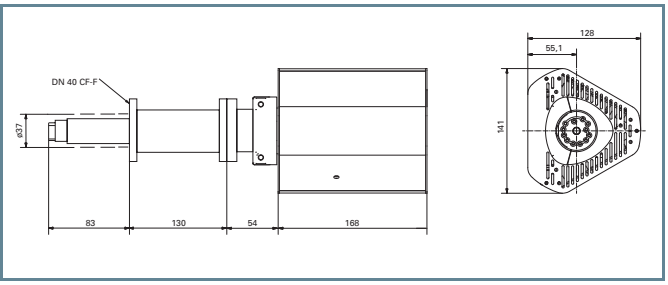
PrismaPlus™

- Robust, cost-effective residual gas analysis and vacuum process monitoring in the high vacuum range
- Interchangeability of analyzers and electronics
- Optimum availability thanks to two filaments

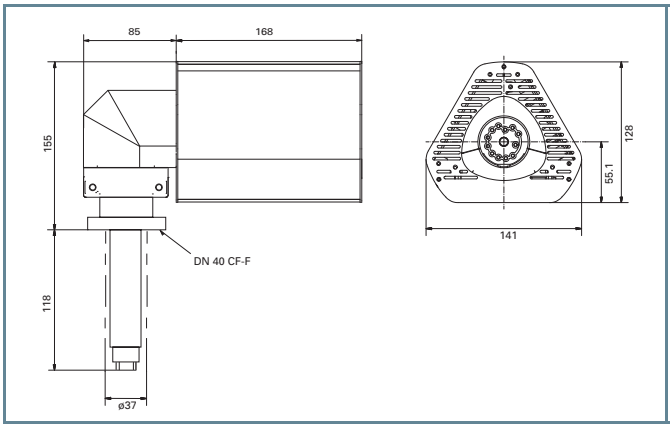
Dimensions



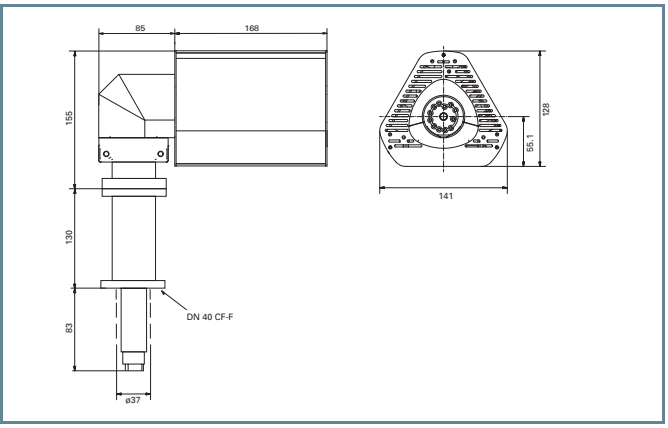
QMG 220 F1, PrismaPlus™
0°



QMG 220 M1, PrismaPlus™
0°



QMG 220 F1, PrismaPlus™
90°



QMG 220 M1, PrismaPlus™
90°

Scope of delivery

Analyzer
QMA 200
Faraday,
C-SEM/Faraday

Electronics unit
QME 220
0° or 90° connection

I/O module 220
(optional)

SP 220 power supply
inclusive mains cable

Software

Technical data	QMG 220 F1, PrismaPlus™	QMG 220 F2, PrismaPlus™	QMG 220 F3 PrismaPlus™
Detector	Faraday	Faraday	Faraday
Mass range	1-100 amu	1-200 amu	1-300 amu
Rod system: Diameter	6 mm	6 mm	6 mm
Rod system: Length	100 mm	100 mm	100 mm
Detection limit	$1 \cdot 10^{-12}$ mbar	$2 \cdot 10^{-12}$ mbar	$4 \cdot 10^{-12}$ mbar
Sensitivity for Ar	$1 \cdot 10^{-3}$ A/mbar	$6 \cdot 10^{-4}$ A/mbar	$3 \cdot 10^{-4}$ A/mbar
Operating pressure max.	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Contribution to neighboring mass: 40 to 41	<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
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution, adjustable at 10 % peak height	0.5-2.5 amu	0.5-2.5 amu	0.5-2.5 amu
Scan speed: scan analog	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: scan bargraph	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: MID	2 ms - 60 s/amu	2 ms - 60 s/amu	2 ms - 60 s/amu
Measuring channels	128 pieces	128 pieces	128 pieces
Peak ratio reproducibility	± 0.5 %	± 0.5 %	± 0.5 %
Interfaces	Ethernet	Ethernet	Ethernet
Input: Digital	Ext_Protection, 24 V	Ext_Protection, 24 V	Ext_Protection, 24 V
Supply: Voltage	90 ... 260 V AC	90 ... 260 V AC	90 ... 260 V AC

Technical data	QMG 220 M1, PrismaPlus™	QMG 220 M2, PrismaPlus™	QMG 220 M3, PrismaPlus™
Detector	C-SEM/Faraday	C-SEM/Faraday	C-SEM/Faraday
Mass range	1-100 amu	1 - 200 amu	1-300 amu
Rod system: Diameter	6 mm	6 mm	6 mm
Rod system: Length	100 mm	100 mm	100 mm
Detection limit min.: Faraday	$5 \cdot 10^{-12}$ mbar	$1 \cdot 10^{-11}$ mbar	$2 \cdot 10^{-11}$ mbar
Detection limit min.: C-SEM	$<1 \cdot 10^{-14}$ mbar	$< 2 \cdot 10^{-14}$ mbar	$< 4 \cdot 10^{-14}$ mbar
Sensitivity for Ar: Faraday	$5 \cdot 10^{-4}$ A/mbar	$3 \cdot 10^{-4}$ A/mbar	$1{,}5 \cdot 10^{-4}$ A/mbar
Sensitivity for Ar: C-SEM	200 A/mbar	200 A/mbar	100 A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: C-SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Contribution to neighboring mass: 40 to 41	<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
Flange (in)	DN 40 CF-F	DN 40 CF-F	DN 40 CF-F
Resolution, adjustable at 10 % peak height	0.5-2.5 amu	0.5-2.5 amu	0.5-2.5 amu
Scan speed: scan analog	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: scan bargraph	20 ms - 60 s/amu	20 ms - 60 s/amu	20 ms - 60 s/amu
Scan speed: MID	2 ms - 60 s/amu	2 ms - 60 s/amu	2 ms - 60 s/amu
Measuring channels	128 pieces	128 pieces	128 pieces
Peak ratio reproducibility	± 0.5 %	± 0.5 %	± 0.5 %
Interfaces	Ethernet	Ethernet	Ethernet
Input: Digital	Ext_Protection, 24 V	Ext_Protection, 24 V	Ext_Protection, 24 V
Supply: Voltage	90 ... 260 V AC	90 ... 260 V AC	90 ... 260 V AC

Selection aid – Order number structure

PT M0a bcd efg

a – Detector version[1]
5 – Faraday only
for leak detection and high-vacuum residual gas analysis
6 – C-SEM/Faraday
C-SEM = Continuous Secondary Electron Multiplier for fast, sensitive UHV residual gas analysis, analytical applications and leak detection

b – Mass range
1 – 1–100 amu
2 – 1–200 amu
3 – 1–300 amu
The smallest suitable mass range for the application should be selected.

c – Ion source[2]
1 – open ion source
for high-vacuum residual gas analysis; high sensitivity and good linearity
2 – gas-tight ion source
for use in combination with gas inlet systems; low gas consumption, high signal-to-noise ratio
3 – Crossbeam ion source
For direct gas beam inlet, without interaction with the walls of the ion source
4 – Grid ion source
for UHV residual gas analysis; minimum outgassing and desorption rate

g – I/O module and VBA software extension
0 – without option
1 – with I/O module
for control and signal interchange via analog and digital inputs/outputs
2 – with VBA software extension
for programming program sequences and for exchanging commands and data with other programs
3 – with I/O module and VBA software extension

f – Connection
Electronics and analyzer
1 – 0° (on one axis)
2 – 90° off axis

e – Bakeout temperature[3]
1 – up to 200 °C
2 – up to 300 °C

d – Filament
1 – Tungsten
2 – yttriated iridium

[1] Faraday version with open ion source only
[2] Grid ion sources with tungsten filament only
[3] Electronics removed

I/O module – Connection options

	Analog outputs	Analog inputs	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	• Measured values, e.g. ion currents • Ratios (concentrations) • Data transfer to higher-level systems	Reading in external values, e.g. pressure, temperature, gas flow	• Free assignment of switchpoints • Valve actuation	Starting or stopping measurement tasks by means of external signal

Total pressure measurement with ActiveLine

Total pressure measurement with DigiLine™

Ethernet

SP 220 power supply

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

Cable length: 3 m

Weight: 0.7 kg

24 VDC

Voltage: 90–260 VAC
Frequency: 50–60 Hz

HiQuad™

High-End Mass Spectrometer!
Fast, Flexible and Easy to Operate.

What is HiQuad?

With the new HiQuad mass spectrometer, Pfeiffer Vacuum combines high performance, flexibility and ease of operation. As a stand-alone unit, the HiQuad can be optimally integrated into your application. Depending upon the application in question, it is possible to select:

- Mass ranges
- Rod diameters
- Ion sources
- Detectors
- Interfaces

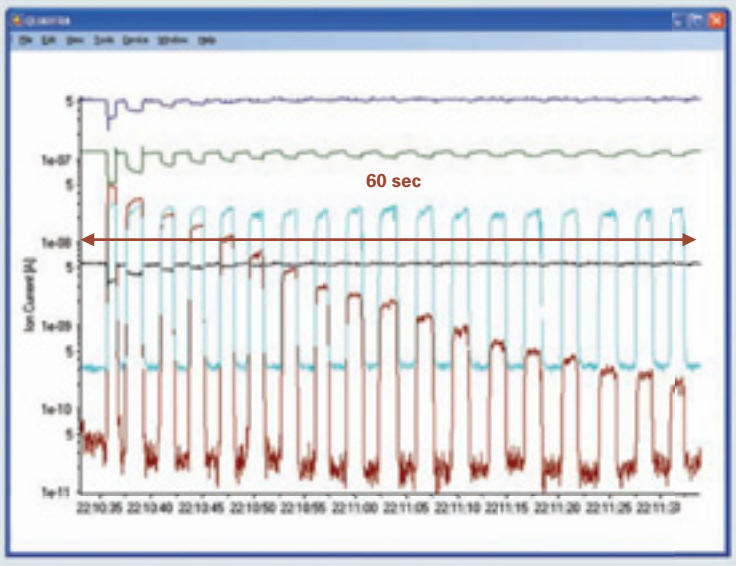
This mass spectrometer achieves extremely high measurement speeds of up to 125 µs/amu. It is characterized by the highest sensitivity and a wide dynamic range. This mass spectrometer is easy to operate with the aid of the Quadera software.
These characteristics make the HiQuad suitable for both research & development applications as well as for integration into analytical systems.
We compile the right solution for your individual application!

Advantages at a glance

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

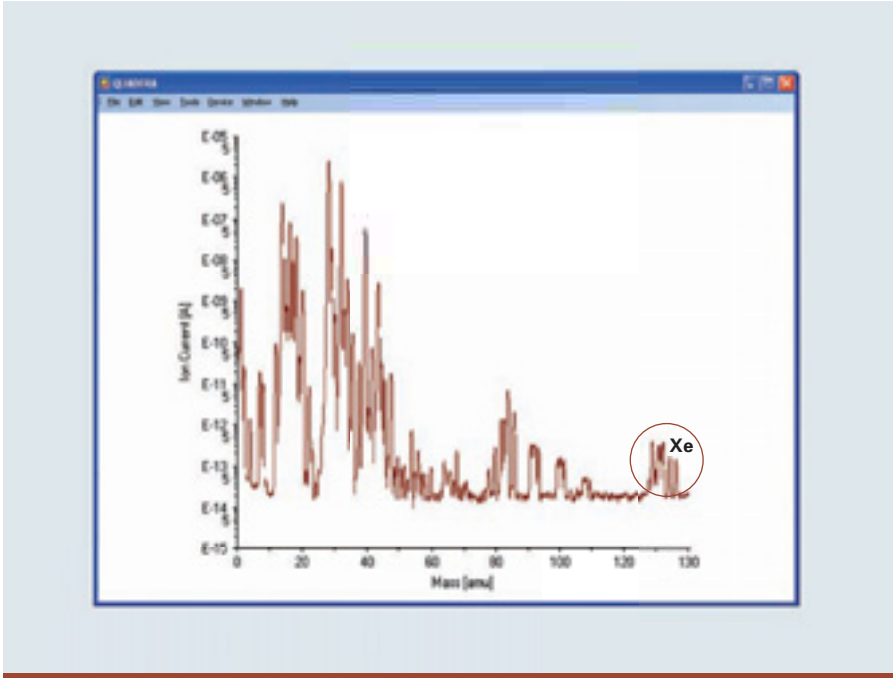
Applications

- High measurement speed – up to 125 µs/amu



Very fast measurements can be performed with the HiQuad™ mass spectrometer. This example shows the mass specresponse during respiration analysis. N_2, O_2 and CO_2 were detected with a very fast cycle time.

- Wide dynamic range

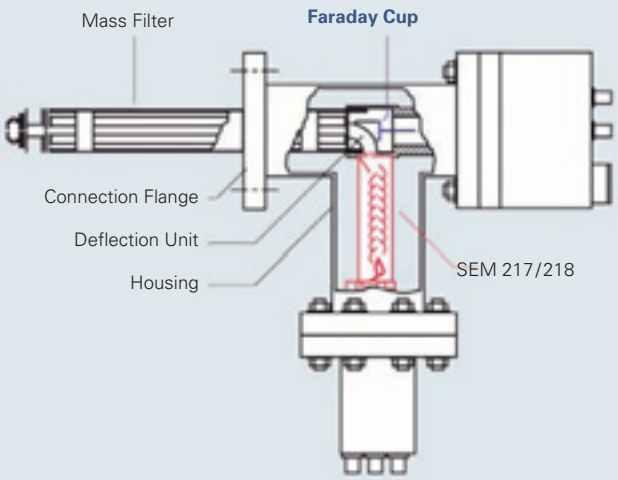


Xe in air

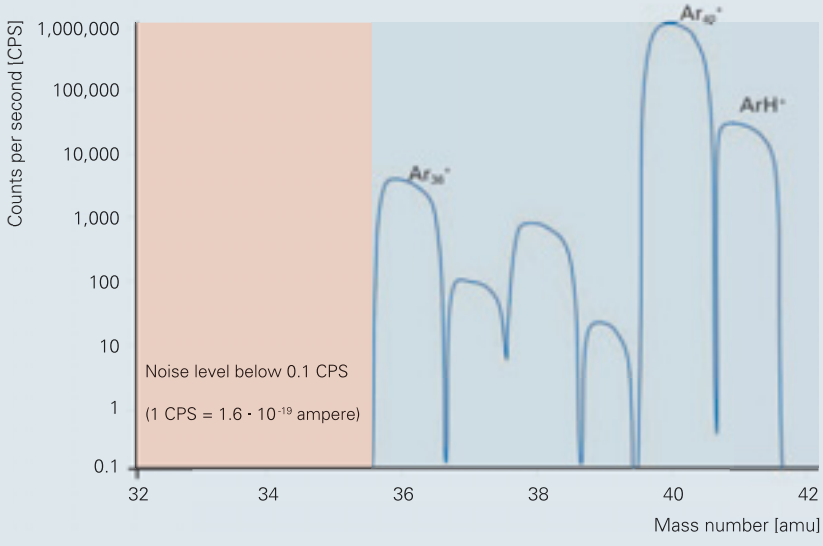
This scan shows a spectrum for air. In addition to the primary components, consisting of N_2, O_2, Ar and CO_2 even minute concentrations of Xe are detected. The ion current at mass 136 is equivalent to a concentration of 7.8 ppb of Xe in air. And it is decades above the background noise level, enabling a widedynamic 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 any radiation from the ion source reaching the detector and thus generating background noise.

In combination with an ion-counting arrangement, it is also possible to achieve a wide dynamic range in addition to a low background noise level. The example illustrated below shows a very low background count ratewhile measuring ArH^+ ions generated in a plasma.



Design of the detectors in a QMA 400 HiQuad™ analyzer with Faraday cup and SEM

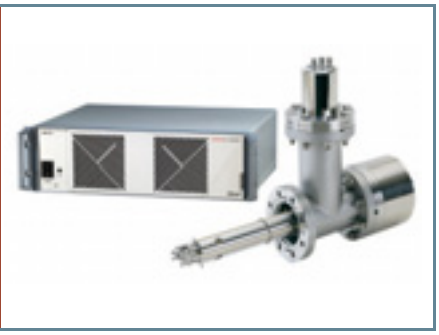


Ions from a DC-Argon plasma

HiQuad™

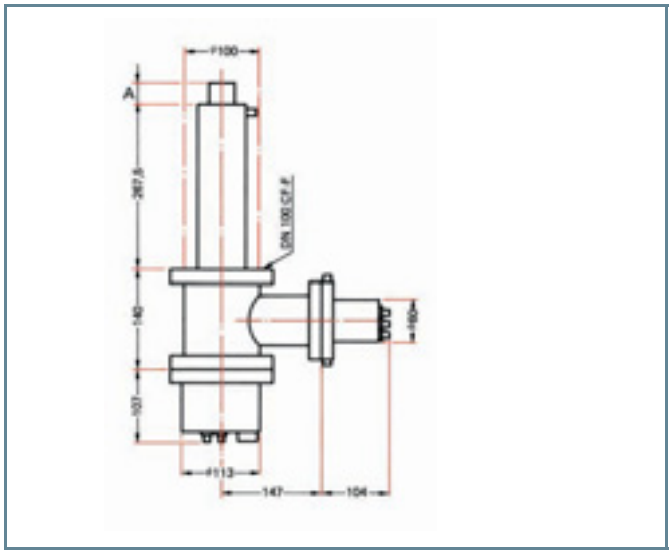
QMG 700, HiQuad™

HiQuad™

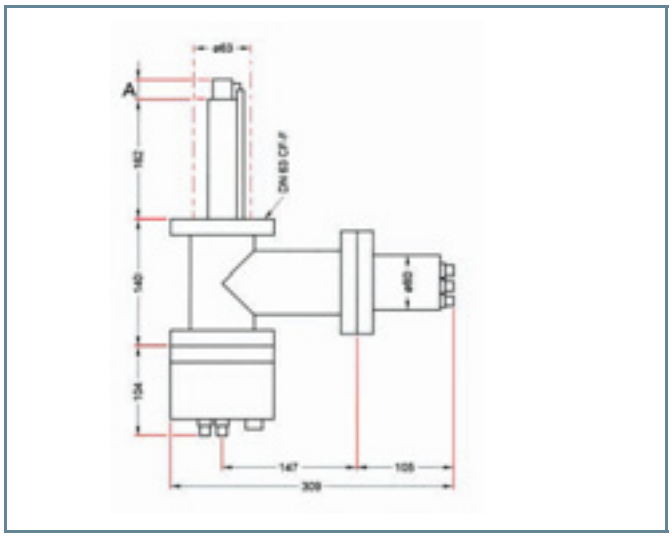


- HiQuad mass spectrometer system with user-friendly Quadera software. Comes with HiQuad control unit, HF generator and QMA 410 analyzer with 16 mm molybdenum rod system and 90° off-axis secondary electron multiplier (SEM). Available for 1-128 amu and 1-340 amu mass ranges. The system with the lowest suitable mass range for the application in question should be chosen.
- Maximum sensitivity and broad dynamic range
- Outstanding long-term stability
- Extremely high measuring speed
- Optimum resolution, mass separation and transmission

Dimensions



QMA 410



QMA 400
QMA 430

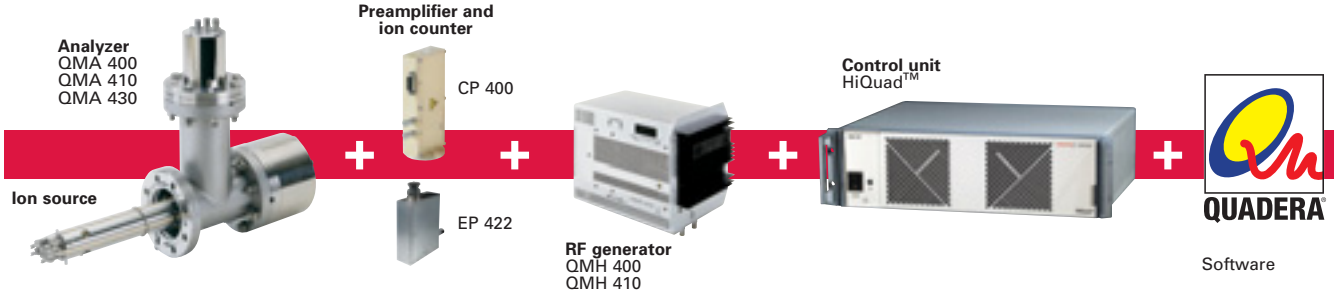
A	Axial ion source = 26 mm; Grid ion source = 27 mm; Cross-beam ion source = 35.5 mm (23.5 mm to the center of the sensitive volume); Gas-tight cross-beam ion source = 48 mm (axial gas connection); Three-lens ion optics = 129 mm; Cross-beam ion source with axial ion optics = 43.5 mm; Cross-beam ion source with three-lens ion optics = 171 mm

Technical data	1-128	1-340	1-300
Detection limit	$5 \cdot 10^{-16}$ mbar	$1 \cdot 10^{-15}$ mbar	$2 \cdot 10^{-15}$ mbar
Sensitivity for Ar: Faraday	$1 \cdot 10^{-3}$ A/mbar	$5 \cdot 10^{-4}$ A/mbar	$2 \cdot 10^{-4}$ A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Partial pressure ratio with SEM	< 0.3 ppb	< 0.5 ppb	< 1 ppb
Analyzer	QMA 410	QMA 410	QMA 430
Rod system: Diameter	16 mm	16 mm	8 mm
Rod system: Length	300 mm	300 mm	200 mm
Rod system: Material	Molybdenum	Molybdenum	Stainless steel
RF generator	QMH 400-1	QMH 410-3	QMH 400-5
Pre-amplifier	EP 422	EP 422	EP 422
Operating temperature: analyzer	150 °C	150 °C	150 °C
Bakeout temperature: analyzer	400 °C	400 °C	400 °C
Flange (in)	DN 100 CF-F	DN 100 CF-F	DN 63 CF-F

Technical data	1-512	1-1024	1-2048
Detection limit	$1 \cdot 10^{-15}$ mbar	-	-
Sensitivity for Ar: Faraday	$5 \cdot 10^{-4}$ A/mbar	$2 \cdot 10^{-4}$ A/mbar	$1 \cdot 10^{-4}$ A/mbar
Operating pressure max.: Faraday	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar	$1 \cdot 10^{-4}$ mbar
Operating pressure max.: SEM	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar	$1 \cdot 10^{-5}$ mbar
Partial pressure ratio with SEM	< 0.5 ppb	< 5 ppb	< 20 ppb
Analyzer	QMA 400	QMA 400	QMA 400
Rod system: Diameter	8 mm	8 mm	8 mm
Rod system: Length	200 mm	200 mm	200 mm
Rod system: Material	molybdenum	Molybdenum	Molybdenum
RF generator	QMH 400-5	QMH 410-1	QMH 410-2
Pre-amplifier	EP 422	EP 422	EP 422
Operating temperature: analyzer	150 °C	150 °C	150 °C
Bakeout temperature: analyzer	400 °C	400 °C	400 °C
Flange (in)	DN 63 CF-F	DN 63 CF-F	DN 63 CF-F

Bakeout temperature for analyzer for ion source and magnet: 300 °C

Scope of delivery



Selection aid – Typical applications and solutions

PTQ1	a	bc
Applications	**Analyzer/mass range**	**Ion source/ion optics**
General gas analysis	3, 5	01
Particle-beam and general gas analysis	2, 3, 4, 5, 6, 7[1]	02, 03
Analysis of gases or gas mixtures; for trace analysis; less residual gas influence than with open ion sources	2, 3, 5	04, 05
Plasma technology, SIMS, photoionization	5	11
UHV residual gas analysis, desorption measurements	4, 5, 6[1]	06[2]
Thermally desorbed ions, electron-induced desorption, SIMS, photoionization, plasma ions	3, 5, 6	10, 11

[1] For mass range of 1 to 2048 amu, Analyzer QMA 400 with SEM 218 and HV 702 and EP 422
[2] With tungsten filament only

Ordering example:

PT Q 1 5 02 1 1 1 1

5	–	QMA 400 / 1 – 512 amu
02	–	Cross-beam ion source
1	–	Tungsten
1	–	SEM 217 + HV 701
1	–	EP 422
1	–	IO 700

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, 16 mm dia. rod system
- QMA 430: Stainless steel, 8 mm dia. rod system for mass range of up to 300 amu
- QMA 400: Molybdenum, 8 mm dia. 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 direct gas beam inlet, without wall interaction
- Cross-beam with magnet: High sensitivity
- Gas-tight cross-beam: Low gas consumption, high signal-to-noise ratio
- Grid ion source: Low outgassing and desorption rate
- Three-lens ion optics with beam stop: For detecting positive and negative ions
- Ion optics with cross-beam ion source: For detecting neutrals and ions

d	e	f	g
Filament	Detector and high-voltage power supply	Preamplifier and ion counter	Interface options
1, 2, 3	1	1, 4	1, 2
1, 2	1, 3	1, 4	1, 2
1, 2	1, 2	1, 4	1, 2
1, 2	1, 2	1, 2, 3, 4	1, 2
1, 2	1	1, 2	1, 2
0	2	2	1, 2

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 for detecting high masses

f – Preamplifier/ion counter
- EP 422:
  Fast, sensitive preamplifier
- CP 400:
  Ion counting down to 1 count per 10 seconds, wide dynamic range

g – Interface options
- IO 700 board 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

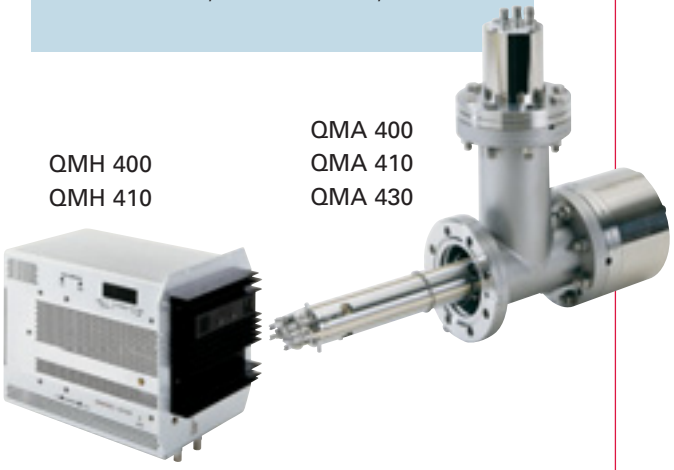
Order number structure

PT Q 1 a bc d e f g

a - Analyzer/mass range
2 - QMA 410 / 1 – 128 amu / QMH 400-1
3 - QMA 410 / 1 – 340 amu / QMH 410-3
4 - QMA 430 / 1 – 300 amu / QMH 400-5
5 - QMA 400 / 1 – 512 amu / QMH 400-5
6 - QMA 400 / 1 – 1024 amu / QMH 410-1
7 - QMA 400 / 1 – 2048 amu / QMH 410-2

QMH 400
QMH 410

QMA 400
QMA 410
QMA 430



bc - Ion source
01 - Axial ion source
02 - Cross-beam ion source
03 - Cross-beam ion source with magnet
04 - Gas-tight cross-beam ion source
05 - Gas-tight cross-beam ion source with magnet
06 - Grid ion source

Ion optics
10 - Two-lens ion optics
11 - Three-lens ion optics
12 - Two-lens ion optics with cross-beam ion source
13 - Three-lens ion optics with cross-beam ion source


Axial ion source


Cross-beam ion source


Grid ion source


Three-lens ion optics

g - Interface options
0 - None
1 - IO 700
2 - CAN Open

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


EP 422


CP 400

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

d - Filament
0 - None
1 - Tungsten
2 - Yttriated iridium
3 - Rhenium

Notes