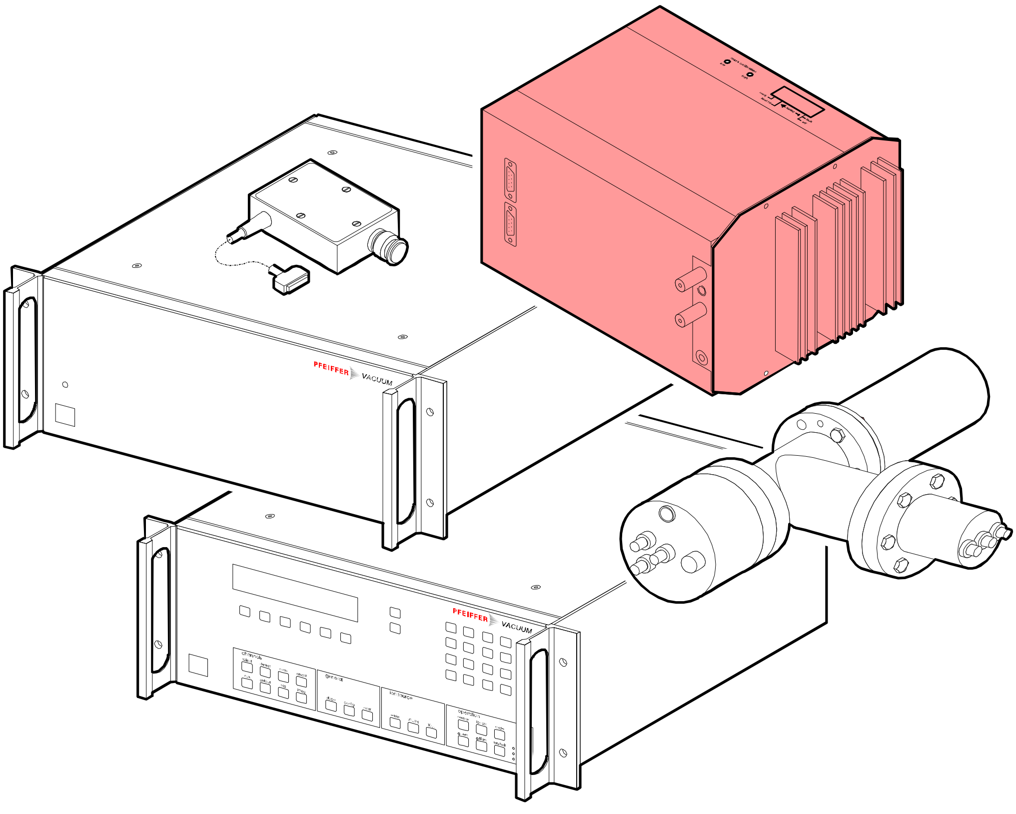
Operating Instructions
Incl. Declaration of Conformity

High frequency generators

QMH 400–1
QMH 400–5
QMH 410–1
QMH 410–2
QMH 410–3



Product Identification

In all communications with Pfeiffer Vacuum, please specify the information on the product nameplate.

Validity

This manual applies to products with part numbers:

PTM23067 (QMH 400-1)
PTM23066 (QMH 400–5)
PTM40566 (QMH 410-1)
PTM40567 (QMH 410-2)
PTM40568 (QMH 410-3)

The part number (No) can be taken from the nameplate.

This document is valid as of the date of publication. With minor deviations it is also applicable to older equipment.

Older analyzers and those that have not been factory tested together with the RF generator may possibly not produce optimum measurement results.

We reserve the right to make technical changes.

Intended Use

The high frequency generators QMH 400 and QMH 410 are components used in conjunction with a Pfeiffer Vacuum quadrupole mass spectrometer system. They generate the RF and DC voltages required for the rod system of the quadrupole analyzer.

The RF generators may be used only as supply units for a Pfeiffer Vacuum **QMA 400, QMA 410 or QMA 430** quadrupole analyzer.

Contents

For cross references within this document, the symbol (→ 🗎 XY) is used, for cross references to other documents, the symbol (→ 🕮 [Z]).

1 Safety

1.1 Symbols Used

DANGER

Information on preventing any kind of personal injury.

WARNING

Information on preventing extensive equipment and environmental damage.

Caution

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

Skilled personnel

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 for this purpose by the custodian of the product.

Waiting, reaction time, duration of test

The lamp/display is lit

The lamp/display flashes

Italic	Title of an operator control element (lamp, potentiometer, etc.)
QMH	Applies to QMH 400 and QMH 410
QMA	Applies to QMA 400, QMA 410, QMA 430
[ ]	Unit of measure for a value used in a formula
M	Mass number, position of a peak on the mass scale
ΔM_{10}	Line width, measured in [u] of a mass peak, measured at 10% peak height
u	ISO abbreviation for (atomic) mass number, expressed in * of the mass of the carbon isotope 12C12 (1u = 1.660 × 10^{-27} kg)
...	Value range between the specified limits.

1.2 Safety Information

- Adhere to the applicable regulations and take the necessary precautions for all work. Also follow the safety information in this document.
- Before you begin to work, find out whether any vacuum components are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling any contaminated parts.

Pass on the safety information to other users.

1.3 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

2 Description

The QMH RF generator produces the voltages required for operating a quadrupole mass filter due to:

- RF component with quartz-stabilized frequency
- superposed DC component

High-quality RF circuits ensure low power consumption and low self-produced heat. A constant-temperature oven minimizes temperature influences.

The QMH must be connected to a precision matched RF load. This is ensured by the supplied RF cables which have an accurately defined capacitance. Manufacturing tolerances can be compensated. The matching condition is monitored during operation and set-up, and signaled by means of LEDs.

The QMH is protected against overheating and destruction by a mismatched RF load, a short circuit or in no-load operation.

The field axis potential is supplied externally.

Two EP 112 or EP 422 electrometer amplifiers can be connected.

The controller supplies the power and control signals and contains the electronics for processing the electrometer signals. The following QMH functions can be performed with this controller:

- Mass number M (RF amplitude)
- Peak width ΔM
- Integral spectrum (DC switched off)
- RF OFF
- Electrometer range
- Electrometer signal 1 or 2

Ready or error state are signaled to the controller.

3 Installation

This document describes only the installation of the RF generator. For installing the overall quadrupole system please refer to the documents of the controller and the other system components.

Do not operate or store the RF generator in an environment that is subject to dust, high humidity, mechanical vibrations, and extreme fluctuations of the ambient temperature.

3.1 Installing the RF Generator

Mounting plane

Install the QMH horizontally or with a maximum inclination of 30° in a vibration-free location. The distance to the QMA can be ≈ 0.5 m (cable lengths 0.7 m).

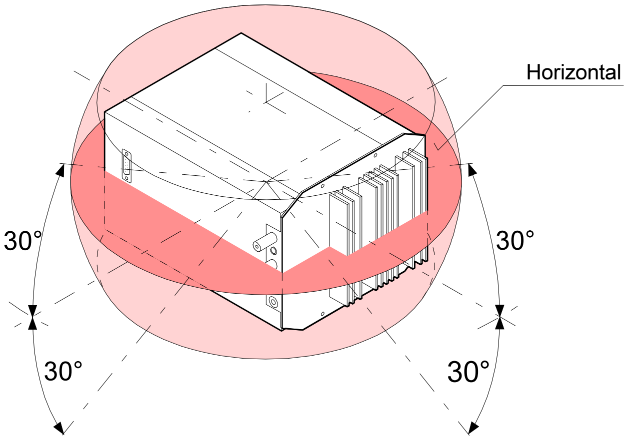


Fig. 1

With the holder belonging to the QMH, the QMH can be fastened to the flange (→ Fig. 3). If possible, mount it in such a way that the potentiometer and the indicator lamps are easily accessible on the top of the housing.

Installation with holder

It is advantageous to preinstall the holder to the QMH on a workbench as follows:

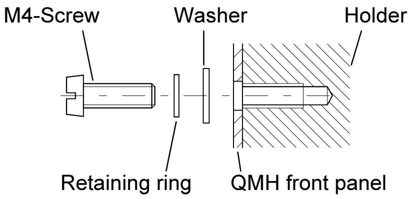


Fig. 2

Now mount the pre-assembled unit to the QMA.

The holder is also suitable for mounting the EP 112.

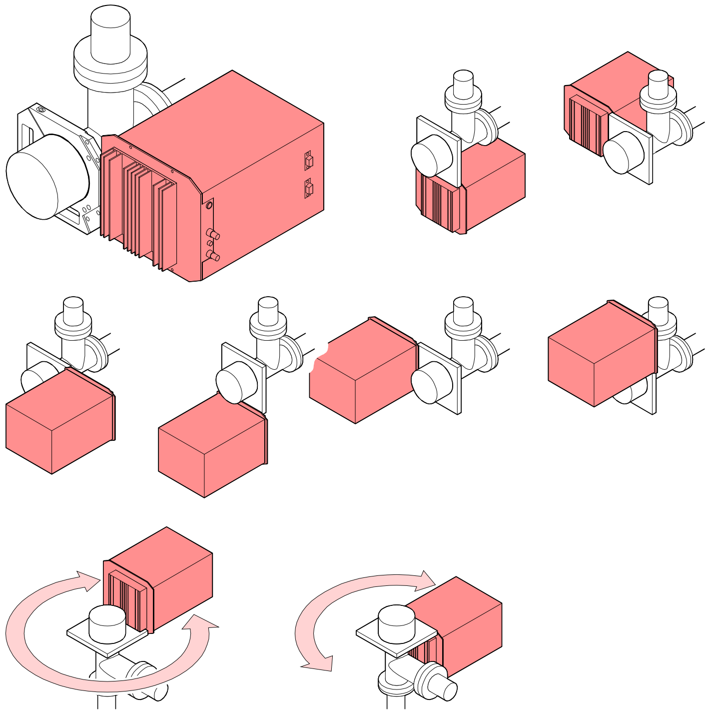


Fig. 3

Temperature conditions

The air surrounding the RF generator should not get hotter than 50°C during operation (measured at a distance of 30 cm).

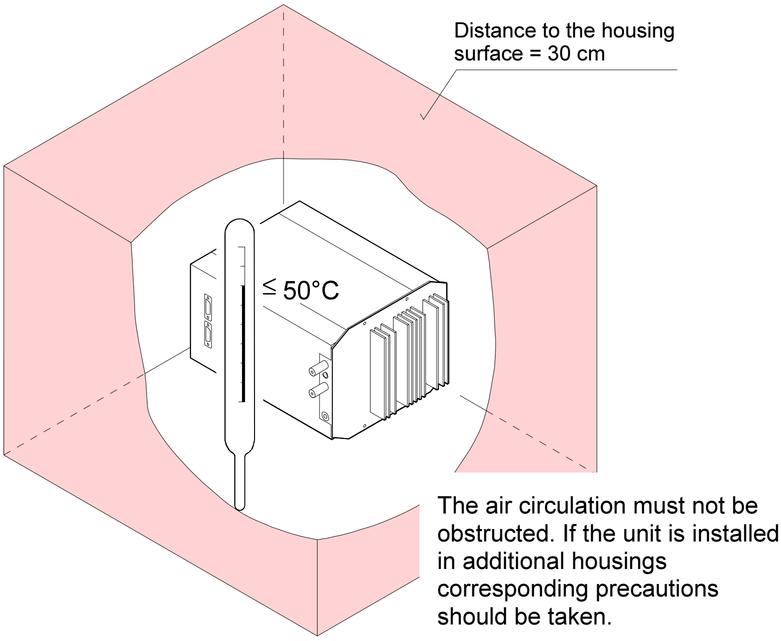


Fig. 4

To achieve optimum measurement accuracy avoid temperature fluctuations.

Splash water protection

WARNING

If water or coolant hoses are routed in the vicinity of the RF generator, drip or splash water protection should be provided.

3.2 Electrical Connections

3.2.1 Ground Connection

The housing of the RF generator must be connected to ground. If the RF generator is mounted with the holder to a properly grounded QMA flange this requirement is fulfilled (→ Figs. 2 and 3).

Skilled personnel

Caution: Incorrectly grounded product

If other mounting methods are used or if the flange of the QMA is not reliably grounded, the QMH must be connected to the protective ground at the M4 screw identified with ⏚. Establish this ground connection with a yellow/green or uninsulated, stranded copper lead:

2.5 mm^2 if mechanically protected (DIN VDE 110T540)
4.0 mm^2 if not protected

Make sure the contact is vibration-proof and use washers and locknuts. (→ Fig. 2).

For trouble-free operation a single, central ground point for all interconnected subsystems (pumping station, controller, computer, recording devices, etc.) is urgently recommended. A common power distributor is highly suitable for this purpose.

⚠ The max. admissible voltage between the QMH and the controller housing is 0.5 V_{peak}.

3.2.2 Control Cable *QC*

⚠ Plug in and detach the ***QC*** control cable of the QMH only when the controller is turned off.

A distance of up to 10 m can be bridged with an extension cable.

3.2.3 Cable *RF+, RF–*

Connect the ***RF+*** and ***RF–*** sockets of the QMH via the two supplied 0.7 m coax cables to the ***RF A*** and ***RF B*** sockets of the QMA.

If the polarity is important, this is indicated on the supplied test report.

Only cables supplied by Pfeiffer Vacuum with a fixed length and capacitance may be used (part number → 🗎 23).

Insert the plug equipped with a Teflon tube into the QMA to ensure bakeability there.

Make sure that the cables are not kinked! If the cables are too short change the installation arrangement.

Skilled personnel

Caution: external voltages

The electrode system of the QMA may not be subjected to hazardous external voltages (due to contact, plasma, ion or electron beams, etc.). Also low weak external voltages can damage the electronics or lead to unreliable measurement results.

If such sources of danger exist in the vacuum chamber, protective measures (e.g. better arrangement, shielding, ground connection, etc.) must be taken that reliably preclude such influences.

3.2.4 Field Axis Voltage *FA*

Normally you connect the ***FA*** sockets to the QMH and QMA by means of the supplied cables. In this way the field axis voltage is supplied via the ion source cable to the controller. The FA voltage setting is specified in the test report of the overall system.

If an external field axis voltage is connected the following rules apply:

- The potential differential may not exceed ±500 VDC relative to chassis.
- The effective field axis potential is 99.9% of the supplied voltage

STOP

For safety reasons the external FA voltage must be limited to max. 2 mA.

If you do not use the supplied cable, a shielded cable is needed. The shield is to be connected to the housing (→ 🗎 27).

3.2.5 Electrometer Amplifier *ep1, ep2*

For measuring with the Faraday cup (positive ions), connect the electrometer amplifier (that fits your controller) to ***ep1 (faraday)***.

For measuring an SEM signal (electrons) connect it to ***ep2 (sem)***.

Both electrometer amplifier may be connected simultaneously.

4 Commissioning

After all electrical connections have been established and all preconditions for the overall system are met (e.g. adequate vacuum), the controller can be switched on.

4.1 Waiting Time *Ready*

...10 min **ready**	After a waiting time of approx. 10 min the green ***ready*** lamp on the top of the QMH lights up. If the ***fault*** lamp does not flash the error signal transmitted to the controller is now removed.
☞	During the waiting time the QMH should not be operated with higher masses (FIRST MASS + SCAN WIDTH ≤½ M_{max}) as this could impair the controller function due to the high load on the power supply.

4.2 Tuning *Tune*

When you put the unit into operation for the first time check the luminous ***tuning*** strip. Its length is a measure of the QMH power reserve.

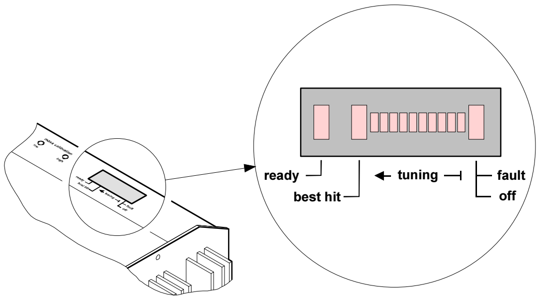


Fig. 5

Set a fixed mass number (no scan) of approx. ½ M_{max}.

best hit — The yellow ***best hit*** lamp indicates that the generator is tuned exactly.

fault — The flashing red ***fault*** lamp indicates that the detuning exceeds the admissible value or that a fault exists (e.g. RF cable not connected). This condition is transmitted to the controller by a fault signal.

fault — The ***fault*** lamp is continually on if the RF has been switched off by the controller (RF OFF).

If ***best hit*** does not light up, align the RF generator at ***tune*** with the aid of a screwdriver.

The tuning range extends over three turns, subsequently the values repeat themselves. For maximum admissible detuning the angle of rotation is approx. 90° for $M=M_{max}$.

1. If the QMH is detuned slowly, turn ***tune*** until ***fault*** stops flashing and the luminous ***tuning*** strip has the greatest length.
2. Immediately adjacent there is the position at which ***best hit*** lights up. When you have found this position the RF generator is accurately tuned.
3. After the waiting time has expired adjust the tuning at the max. mass number.

As long as ***fault*** does not flash the fact that ***best hit*** turns off during operation has no influence.

4.3 Measuring the Spectra

In a complete system with controller and analyzer, he QMH is supplied with a calibrated mass scale and set resolution.

Measured values should be evaluated only after expiration of the waiting time, or better yet, 10 minutes later.

The controller supplies a RESOLUTION signal though which the mass peak width ΔM can be preselected within the range of ΔM_{min} … ΔM_{max}.

For ΔM_{10}=1 u RESOLUTION is set to approx. 25 (20 … 30), (except for QMH 400-1 it is set to approx. 100). The optimum value depends on the ion source type and parameters, on the QMA, and on the polarity of the RF cables. In a complete system always use the values specified in the test report.

4.4 Integral Spectrum

With the INTEGRAL control signal

QMS/QMI 422: Resolution = OFF

an integral (that is, non-resolved) spectrum can be selected.

4.5 Continuous Operation

Continuous operation of the QMH 410 with high masses (limit according to table) subjects the RF cables and connectors to severe stress which can shorten their service life.

RF generator	QMH 410-1	QMH 410-2	QMH 410-3
Continuous operation limit [u]	900	1600	250

For continuous operation with high cable temperatures, e.g. during bakeout, the maximum mass number must be limited to the values shown in the diagram.

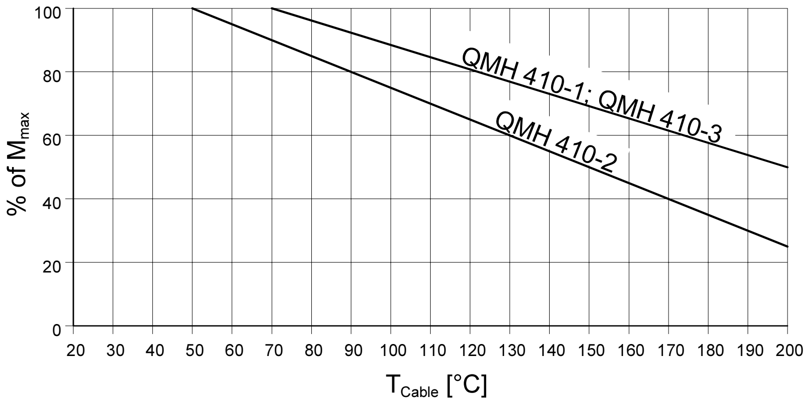


Fig. 6

4.6 Setting the Resolution, *Resolution Coarse*

Due to aging, QMA change or after mechanical shock it may be necessary to correct the resolution. You can again achieve a constant ΔM across the mass range by slightly re-adjusting ***resolution coarse*** .

☞ Do not inadvertently adjust ***resolution coarse!*** A full clockwise turn causes peaks with high mass number to disappear almost completely.

After the controller has been turned on wait until ***ready*** lights up.

Always use the same RF cable polarity.

Under ***tune ion source*** / SCAN-N, for example, note the peak at the calibration point for ***mass calibration low*** (→ Table in Section 4.8) and adjust RESOLUTION on the controller in such a way that ΔM_{10} =1 is obtained. The normal value is 20 … 30 (only with QMH 400-1: approx. 100).

Using the same RESOLUTION setting adjust the peak width at the calibration point for ***mass calibration high*** (→ Table in Section 4.8) with the ***resolution coarse*** potentiometer to ΔM_{10} =1.

The value ΔM_{10} is the width in [u] of a free-standing peak, measured at 10% height (→ Definition in Appendix C).

Viewed across the mass range the values of ΔM can show some scatter. They are also influenced by the ion source settings.

4.7 Adjusting the Resolution for Low Masses, *Resolution Low*

When adjusting to large line width (ΔM_{10} > 1) low masses are resolved as an integral spectrum. This can be corrected with ***resolution low***.

resolution low is preset for $\Delta M \leq 1$.

For measurements with $\Delta M > 1$ turn ***resolution low*** clockwise until low masses are adequately resolved.

If you want to measure with $\Delta M \leq 1$ turn ***resolution low*** counterclockwise again.

4.8 Calibrating the Mass Scale, *Mass Calibration Low / High*

Depending on the desired accuracy the QMA must be heated up for ½ … 5 h (EMISSION ON) before the mass scale corresponds to the calibrated values.

Recalibration may become necessary due to aging or after the QMA has been replaced.

For mass calibration use a gas with known peaks according to the following table:

RF generator		QMH 400-1	QMH 400-5	QMH 410-1	QMH 410-2	QMH 410-3
Preferred calibration points [u]	low approx. high approx.	28 100	28 400	28 800	28 1600	28 250

Choose suitable detector and ion source settings. Set the resolution to ΔM ≈1 u and observed the measured values in a suitable mode, e.g. SCAN-normal.

The selected peaks should be near the nominal mass scale value (deviation <5% from the nominal value M), otherwise an error exists.

Refer to Appendix C for a definition of the mass number.

First adjust the calibration of the lower peak, e.g. M = 28.0.Turn ***mass calibration low*** (clockwise if the peak is too low on the mass scale) until the peak is in the exact location. With ***low*** the mass scale is shifted in parallel; the adjustment range is approx. 1 u.

Subsequently adjust the calibration of the upper peak, e.g. M = 414.0. Turn ***mass calibration high*** clockwise if the peak is too low on the mass scale. With ***high*** the position of the peaks is shifted proportionally to the mass scale.

If necessary recorrect both settings.

4.9 Waiting Times, Before Measurement Result is Valid

20 min … 5 h After a warm-up time of approx. 20 minutes from the start-up of the cold QMH the measurement results can be regarded as conforming to the calibrated values (M and ΔM), provided the warm-up period of the QMA (EMISSION ON) has elapsed which, depending on accuracy requirements is ½ … 5 h.

If there is a sudden jump in the mass number and depending on the magnitude and direction of the jumps and the type of the QMH, it may take several ms before the RF and DC values are stable in their new state. The software of Pfeiffer Vacuum controllers takes this into consideration. With the PAUSE parameter manual optimization of the waiting time is possible (→ Appendix B).

5 Maintenance and care

Under normal condition the RF generator requires no maintenance.

The need for recalibrating the mass scale and resolution is indicated by the analysis of the measured values.

The need for readjusting ***tune*** is indicated by the ***fault*** or ***best hit*** lamps.

If high RF losses (→ Troubleshooting, symptom F4) occur due to storage in high humidity, the problem can be remedied by drying at max. 70 °C or by longer operation with maximum possible saturation.

5.1 Cleaning

STOP DANGER

Caution: Hazardous voltages

Before you clean the RF generator turn off the controller and detach cables.

External cleaning

A slightly damp cloth normally suffices for cleaning the outside of the unit. Do not use any aggressive or scouring cleaning agents.

Make sure that no liquid can penetrate the product. Allow the product to dry thoroughly before putting it into operation again.

Internal cleaning

Severely contaminated units should preferably be cleaned by your nearest Pfeiffer Vacuum service center.

The warranty becomes null and void if the QMH is opened.

If you nevertheless decide to perform the cleaning yourself, remove the dust from the inside of the QMH by carefully blowing it out with compressed air.

The compressed air must meet the following specifications:

- free of oil
- dry
- free of particles >30 µm
- <2 bar (overpressure)

Wires, components, etc. should be neither bent nor moved (they can get damaged or out of adjustment).

6 Troubleshooting

> **DANGER**
>
> Caution: Hazardous voltages
>
> Before you make any manipulations on or inside the RF generator, turn off the controller and detach all cables. The QMH may not be operated while it is open.
>
> Measurements and other work inside the RF generator or on its terminals may only be performed by trained specialists. There is severe high voltage shock hazard.

> **Caution**
>
> We recommend that you have defective products repaired by your nearest Pfeiffer Vacuum service center.
>
> The warranty becomes null and void if the QMH is opened.
>
> Never attempt to make any repairs by exchanging circuit boards or other parts. The circuit boards are precision matched to the other components. Correct alignment is only possible at the factory.

> **WARNING**
>
> Caution: static electricity
>
> Static electricity can damage electronic components.
>
> When the unit is opened, appropriate precautions against static discharges must be taken.

The following guide describes faults, their possible causes and remedy as they can occur when the unit is put into operation for the first time, or after longer periods of operation.

Error symptom	Possible causes, isolation and remedy
F1: ***fault*** continuously flashing, RF ERROR is indicated beginning at approx. 5% of M_{max}	No RF load or incorrect RF load on ***RF+*** and ***RF–*** sockets: Connect the analyzer using the supplied RF cables Tune the RF generator (→ Section 4.2) RF load specifications → 🗎 20
	Defect in RF load: Check RF cables and RF lines in analyzer for interruptions or short circuits Measure the capacitance (inner conductor ***RF A***, ***RF B***)
	Defect in RF circuit of the generator ⇒ Repair by Pfeiffer Vacuum Service
F2: ***fault*** continuously flashing, IS ERR #1 is indicated	Short circuit in RF load circuit: Detach the RF cable at the ***RF+***, ***RF–*** sockets and check for short circuit. Check the RF connections on the QMA analyzer. Detach all cables. On the ***RF+***, ***RF–*** check the insulation to chassis: If < 9 MΩ ⇒ Repair by Pfeiffer Vacuum Service. (→ Also symptom F11)

Error symptom	Possible causes, isolation and remedy
F3: ***fault*** flashes only when higher masses are used, RF ERROR is indicated	RF generator not tuned. ***tune*** (→ Section 4.2)
	Corona discharge due to: Excessive pressure in the analyzer Defective RF cable or RF line in QMA: Visual check, voltage test with 5 kVDC Dust in RF generator (→ 🗎 15). Defect in QMH ⇒ Repair by Pfeiffer Vacuum Service
F4: ***fault*** flashes with highest masses even though ***tune*** *is* o.k. at lower masses, that is, ***best hit*** is on.	Power consumption too high due to: High RF losses in RF load circuit: Wrong or defective RF cable Analyzer not compatible with QMH Moisture penetration (→ 🗎 15). Defect in RF generator ⇒ Repair by Pfeiffer Vacuum Service
F5: ***fault*** flashes occasionally with high mass	Occasional sparkovers in the RF load circuit (→ Symptom F3) Power consumption just at the admissible limit (→ Symptom F3)
F6: ***fault*** continuously on	No fault: RF generator is switched off (controller transmits RF OFF, e.g. with DEGAS)
F7: ***best hit*** is off, ***fault*** does not flash	No fault: Tuning condition can change slightly
F8: All pilot lamps on QMH are off	***QC*** cable not connected or controller turned off
	Blown fuse F1 in QMH: Turn off the controller and detach all cables Unscrew the left-hand hood (with display window) On the power inlet board check fuses F1 and F2 (ratings → Section 9) If the fuse has blown it is likely that additional defects exist in the RF generator ⇒ Repair by Pfeiffer Vacuum Service
F9: ***ready*** is off, ***fault*** does not flash, RF ERROR“ is indicated	RF generator has just been turned on; wait until ***ready*** turns on.
F10: ***ready*** remains off even though the waiting time has expired. ***fault*** continuously flashing, even after tuning. ***best hit*** is on. Peaks do not correspond to expectations.	Blow fuse F2 (→ Symptom F8): Check the line voltage of the controller. Check the supply voltage on ***QC*** cable: Pin assignment → 🗎 25, values: +24 V / –24 V (±0.5 V)
F11: IS ERR #1 is indicated ***fault*** not flashing.	If the error message is resettable by: unplugging the FA cable, check the cable for short circuit unplugging the IS cable, check the IS cable for short circuit S1 on the DC/DC converter board must be open

Error symptom	Possible causes, isolation and remedy
F12: Peaks at higher mass too wide or too narrow, even though on the controller RESOLUTION has been set to ΔM=1 u.	***resolution coarse*** potentiometer setting incorrect. Setting → Section 4.6
F13: Peaks at lower masses too narrow or not visible even though on the controller RESOLUTION has been set to ΔM=1 u.	***resolution low*** potentiometer not set to ΔM=1 u: Setting → Section 4.7
F14: Irregular peak resolution, ragged shape	Field axis voltage on connector ***FA*** not connected Connection → 🗎 10 Field axis voltage setting too high: Adjustment procedure and settings → 🕮 [1] and [2]. Polarity of RF cable on ***RF+***, ***RF–*** incorrect. Interruption on FA feeder line: Check FA cable for continuity (pin assignment → 🗎 27) Unplug FA cable and QC cable: R_{isol} on Pin 1 of socket FA >9 MΩ to chassis. If short-circuited → Symptoms F2 and F11
F15: Measurement signal available but no resolved peaks	Controller in INTEGRAL mode: Setting the operating modes → 🕮 [2] Connector J7 on DC generator board (at FA connector) not plugged in correctly (white conductor on top)
F16: No measured value even though all parameters are set correctly	Electrometer amplifier not connected or connected to wrong connector (***ep1***, ***ep2***) Fault in analyzer cabling

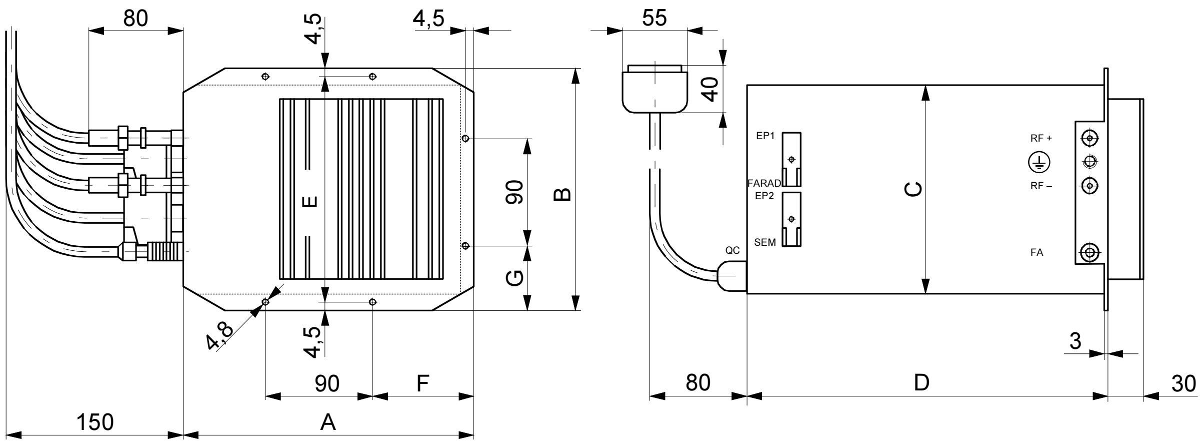
7 Technical Data

Dimension, weight

	QMH 400	QMH 410
Housing dimensions [1] (W×H×D)	≈235 × 193 × 340 mm	≈265 x 203 x 370 mm
Cable lengths		
Control cable	3 m	3 m
Extension	7 m (to total of 10 m)	7 m (to total of 10 m)
RF coaxial cable	0.7 m	0.7 m
Field axis cable	0.7 m	0.7 m
Weight incl. cables unpacked	4.5 kg	6 kg
packed	6.8 kg	8.5 kg

[1] Additional space is required for the cables

Dimension diagram



	A	B	C	D	E	F	G
QHM 400	214	193	165	273	184	67.5	51.5
QMH 410	244	203	175	303	194	82.5	56.5

Mounting plane

horizontal ±30° max. inclination (→ 🗎 7)

Safety, standards, ambient conditions

Standards	
Safety	EN 61010 (IEC 1010), protection class I
EMC	EN 50082-2 / EN 50081-2
Ambient conditions	
Utilization	Only in inside rooms, elevation up to 2000 m NN
Protection class	IP 20
Severity of contamination	2
Admissible temperatures	
Storage	–20 … +60 °C
Operation	0 … +50 °C
RF and FA cable	max. 200 °C
Relative humidity	max. 80% at temperatures up to +31 °C, linearly declining to 50% at +40 °C

Electrical data

<table>
<tr><th></th><th></th><th>QMH 400-1</th><th>QMH 400-5</th><th>QMH 410-1</th><th>QMH 410-2</th><th>QMH 410-3</th></tr>
<tr><td>Frequency</td><td>[MHz]</td><td>2.05</td><td>2.25</td><td>1.7</td><td>1.3</td><td>1.44</td></tr>
<tr><td>RF amplitudes RF+, RF–</td><td>[Vp]</td><td>1.5 … 1890</td><td>1.5 … 2350</td><td>1.5 … 2677</td><td>1.2 … 3130</td><td>1.5 … 2486</td></tr>
<tr><td>DC voltage (Spectrum)</td><td>[±VDC]</td><td>0.5 … 317</td><td>0.5 … 394</td><td>0.3 … 448.5</td><td>0.3 … 525</td><td>0.3 … 416.5</td></tr>
<tr><td>DC voltage (Integral)</td><td>[±VDC]</td><td colspan="2"><0.5</td><td colspan="3"><0.5</td></tr>
<tr><td>RF load between RF+ and RF–</td><td>[pF]</td><td>67 ±3</td><td>52 ±3</td><td>51 ±1.5</td><td>51 ±1.5</td><td>66 ±1.5</td></tr>
<tr><td>Admissible imbalance RF+/RF–</td><td>[pF]</td><td colspan="2">≤3</td><td colspan="3">≤1.5</td></tr>
<tr><td>RF load at cable ends l=0.7 m</td><td>[pF]</td><td>49.5 ±2</td><td>34.5 ±2</td><td>33.5 ±0.5</td><td>33.5 ±0.5</td><td>48.5 ±0.5</td></tr>
<tr><td>Admissible imbalance at cable ends</td><td>[pF]</td><td colspan="2">≤1</td><td colspan="3">≤0.5</td></tr>
<tr><td>Admissible loss factor of the RF load</td><td></td><td>≤0.002</td><td>≤0.0017</td><td>≤0.0017</td><td>≤0.0017</td><td>≤0.002</td></tr>
<tr><td>Apparent power of the RF load max.</td><td>[kVA]</td><td>6.5</td><td>8.1</td><td>8.0</td><td>8.2</td><td>7.5</td></tr>
<tr><td>Supply voltage</td><td>[VDC]</td><td colspan="2">+24 ±0.5 / –24 ±0.5</td><td colspan="3">+24 ±0.5 / –24 ±0.5</td></tr>
<tr><td>Power input (with max. admissible detuning)
Oven cold
Oven warm
with RF OFF</td><td>

[A]
[A]
[A]</td><td colspan="2">

≤2.5
≤2.3
≤0.9</td><td colspan="3">

≤2.7
≤2.5
≤0.9</td></tr>
<tr><td>Inherent power dissipation
Oven warm, with max. admissible detuning</td><td>
[W]</td><td colspan="2">
≤100</td><td colspan="3">
≤110</td></tr>
<tr><td>Temperatures
Overtemperature [2] of the housing surface
Self-heating time
Tripping threshold of the thermostatic overload circuit breaker</td><td>
[°C]
[°C]</td><td colspan="2">
typ. 30
max. 35
≈15 minutes (heat sink)
≈60 minutes (housing)
≈100 °C</td><td colspan="3">
typ. 35
max. 40
≈15 minutes (heat sink)
≈60 minutes (housing)
≈100 °C</td></tr>
</table>

[2] Overtemperature = Increase relative to ambient air temperature

Field axis voltage FA	Max. admissible ±500 V; current must be limited to ±2 mA max.
Electrometer amplifier connections	Integrated power supply, range and signal selection remote controlled
Protection of the RF outputs	Against inadmissible detuning as well as no-load operation and short circuit
Output voltage in no load operation	Field axis potential + RF 50 Vp max.
Fuses	→ Spare parts list 🗎 23
Pin assignment, signals	→ Appendix 🗎 25

Operating data with quadrupole analyzer

RF generator		QMH 400-1	QMH 400-5	QMH 410-1	QMH 410-2	QMH 410-3
Analyzer type		QMA 410	QMA 400 [3]	QMA 400	QMA 400	QMA 410
Rod system	[mm]	16	8	8	8	16
Mass range $M_{min} \dots M_{max}$ [4]	[u]	0.5 … 128	0.5 … 512	0.5 … 1024	0.7 … 2048	0.3 … 341.33
Resolution setting range						
Constant peak width ΔM_{10} Remote controlled with RESOLUTION signal	[u]	0.2 … 2.2	0.3 … 7	0.5 … 5.5	0.5 … 7	0.3 … 4.5
Constant resolution $\Delta M/M$ adjustable: ***resolution coarse***	[%]	0 … 2 (ΔM > 0.2 u)	0 … 2 (ΔM > 0.3 u)	0 … 1 (ΔM > 0.5 u)		
Resolution switched off $\Delta M/M$ remote controlled, INTEGRAL		1.3 (M>10 u)		1.3 (M>10 u)		
For lower masses $\Delta M_{LOW}/M$ adjustable: ***resolution low***		0.1 … 1.3 ($\Delta M_{LOW} \leq \Delta M$)		0.1 … 1.3 ($\Delta M_{LOW} \leq \Delta M$)		
Waiting time after set point jump		→ Appendix B		→ Appendix B		
Error variables dM and dΔM at M_{max} [5]						
Jump drift, $M_{min} \Rightarrow M_{max}$	[u]	≈0.02	≈0.05	≈0.1	≈0.2	≈0.05
Long-time drift, per 100 h	[u]	≈0.01	≈0.03	≈0.05	≈0.1	≈0.03
Short-time drift, per 1 h	[u]	≈0.005	≈0.01	≈0.02	≈0.05	≈0.01
Temperature drift (ambient) per °C	[u]	≈0.005	≈0.01	≈0.02	≈0.05	≈0.01
Mech. shock, drift per 10 G	[u]	≈0.005	≈0.02	≈0.04	≈0.08	≈0.02
Linearity		→ Fig. 7		→ Fig. 7		

3) With QMA 430 the specifications apply only up to mass 300

4) Full peaks up to M_{max} – 1 can thus be represented

5) Without tuning error, stability error, non-linearity of the control signal, measured with QMA 400 or QMA 410 (measurement method → Appendix C)

The error variables relate to voltage values of RF and DC component; they have been adjusted to mass units in order to make them more understandable.

The power-on drift of the analyzers (EMISSION with cold analyzer set to «ON») of

dM = approx. –0.02% / h during 4 … 5 h

as well as additional influences of the analyzer have not been taken into consideration in the information on the error variables dM and dΔM.

The heating of the QMA by the applied RF power increases by a power of 2 relative to the mass number and therefore becomes relevant only in the upper third of the mass scale. It has about the same effect as the heating by the ion source.

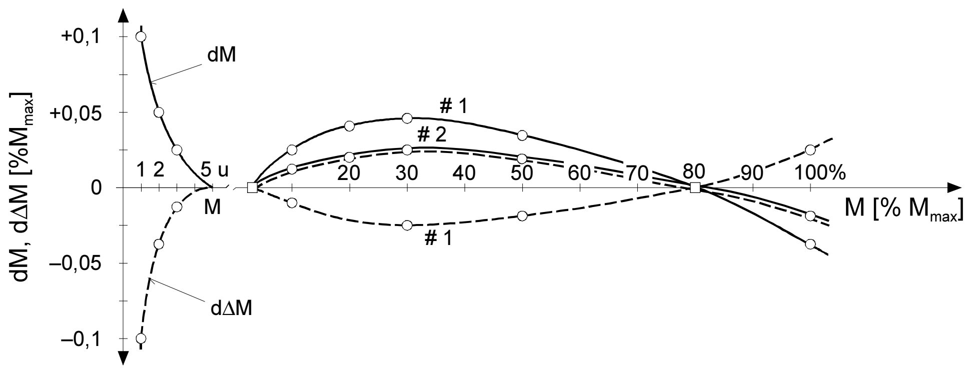


Fig. 7 Linearity deviation of M and ΔM_{10}

8 Accessories

Supplied accessories

2 Fuses, 2.5 A slow, ø5×20 mm
2 RF coaxial cables, 0.7 m
1 Field axis cable, 0.7 m

Available options

	Ordering number	Comment
Control cable extension, 7 m	BG 541 680 -T BG 448 175 -T	Sliding lock Screw lock

9 Spare Parts

When ordering spare parts, always indicate:

- All information on the product nameplate
- Description and ordering number according to the spare parts list

	Ordering number	Comment
Primary fuse, 2.5 A slow, ø5×20 mm	B 4666 444	on CC 400
Control cable, 3 m	BG 541 964 –T BG 448 173 –T	Sliding lock, plugs into QMH Screw lock, plugs into QMH
RF coaxial cable, 0.7 m, 3.5 kV	BG 448 295 –T BG 541 960 –T	for QMH 400–1, QMH 400–5, QMH 410–1 and QMH 410–3 for QMH 410–2 *)
Field axis cable, 0.7 m, 500 V	BG 541 962 –T	

*) As an expedient this cable can be used for all QMH types

10 Returning the Product

When returning a product to Pfeiffer Vacuum, put it in a tight and impact resistant package.

11 Disposal

WARNING

Caution: 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:

Non-electronic components

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

Electronic components

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

Appendix

A: Pin Assignment / Signals

Signal direction: IN: QMH is receiver
OUT: QMH is transmitter

A1: Control Cable *QC*

Connects the QMH to the controller, 25-pin D-sub, male

Pin	Signal	Signal direction	Level	Impedance
1,2,14	–24 V	IN	→ Technical data	Supply
3,15,16	+24 V	IN	→ Technical data	Supply
4,6,17,19	0 V	IN	GND	10 Ω → chassis
5	SCAN+	IN	0 … +10.24 V	100 kΩ
18	SCAN–	IN	0 V	100 kΩ
7	EP+	OUT	0 V	47 Ω
20	EP–	OUT	0 … ±16 V	47 Ω
8	RESOL+	IN	0 … +10.24 V	100 kΩ
21	RESOL–	IN	0 V	100 kΩ
9	RESERVE1 H	IN	Digital CMOS	100 kΩ
10	RF OK L	OUT	Digital CMOS	2,2 kΩ
11	MODE1 H	IN	Digital CMOS	100 kΩ pull down
23	MODE2 H	IN	Digital CMOS	100 kΩ pull down
12	RANGE0 H	IN	Digital CMOS	100 kΩ pull down
24	RANGE1 H	IN	Digital CMOS	100 kΩ pull down
13	EP2 H	IN	Digital CMOS	100 kΩ pull down
22	SCREEN	---	GND	33 Ω → Chassis
25	RESERVE2 H	IN	Digital CMOS	100 kΩ pull down

Digital CMOS level L: 0 … +0.75 VDC
H: +11.0 … +12.7 VDC

Admissible common-mode signal max. ±0.5 V_p for SCAN±, RESOL± and EP±.

Line 0 V may have max. ±0.5 V_p to Chassis GND.

Functions and coding

Signal	Level	Function of the QMH RF generator
SCAN±	0 … +10.24 V	MASS = (SCAN/10.24 V) × M_{max}
RESOL±	0 … +10.24 V	$\Delta M = \Delta M_{min}$ + (RESOL/10.24 V) × ΔM_{max}
EP±	0 … ±10 V	Output signal of EP 112, EP 422

Signal			
RANGE.. H	..1	..0	Electrometer measurement range:
	L	L	10^{-5} A
	L	H	10^{-7} A
	H	L	10^{-9} A (EP 112), 10^{-11} A (EP 422)
	H	H	10^{-11} A (EP 112), 10^{-9} A (EP 422)
EP2 H	L		ep1, faraday
	H		ep2, sem
MODE.. H	..2	..1	Operating mode
	L	L	STANDBY, not used
	L	H	INTEGRAL (DC OFF)
	H	L	SPECTRUM (DC ON)
	H	H	RF OFF
RF OK L	L		QMH o.k.
	H		QMH not o.k.

A2: Connector *ep1 (faraday), ep2 (sem)*

Connection of 2 electrometer amplifiers, 9-pin, D-sub, female

Pin	Signal	Signal direction	Level
1	EP GND	IN	0 V
2	+16 V	OUT	+16 V ±0.2 V / 27 mA_{max}
3	0V EP	OUT	EP GND
4	-16 V	OUT	–16 V ±0.2 V / 12 mA_{max}
5	EXP5 L	OUT	Digital
6	EP OUT	IN	0 … ±16 V
7	SCREEN	---	Chassis GND
8	EXP7 L	OUT	Digital
9	EXP9 L	OUT	Digital

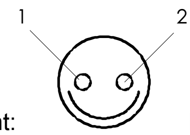
Digital level L: 0 … +0.75 VDC
H: +16.5 … +17.0 VDC with external pull-up >5 kΩ into +16 V.

Die levels are relative to 0V EP.

With the exception of EP OUT and EP GND the two connectors are connected in parallel.

A3: Connector *FA*

Connection of the field axis voltage, 2-pin, Fischer D103Z051



Pin assignment: Front view of connector

Pin	Signal	Signal direction	Level	Impedance
1	FA	IN	max. ±500 V / 2 mA_{max}	9 MΩ
2	not used	---	---	---
Housing	GND	IN	GND, shield	

A4: Connector *RF+*, *RF–*

Connection of the RF voltage, coaxial, SHV

Signal	Signal direction	Level and load
RF+ , RF–	OUT	Matched load → Technical data
Housing	OUT	Shield, GND

B: Behavior as a Function of Time

B1: Step Response

If the mass number changes suddenly from M_1 to the new value M_2, time is required for the new state to stabilize. The measurement signal within the transition range must be eliminated because it has no relationship to the new mass number.

The necessary waiting time depends on M_1 and M_2, on the jump direction, on the QMH type, and on the required measurement accuracy.

Particularly for high measurement speed the waiting time should be optimized through experiments. Only in this way can the best compromise be found between speed and measurement accuracy.

The following approximate values apply to unit resolution (ΔM_{10} = 1u), until the detector signal has attained 98% of the ultimate value. They apply only to the behavior of the QMH. Ion detection delays have not been taken into consideration.

The waiting time t_w required for QMH stabilization is calculated as follows:

$$t_w = t_1 + t_2 \times |M_2 - M_1| \quad \text{[msec]}$$

		QMH 400-1		QMH 400-5		QMH 410-1		QMH 410-2		QMH 410-3	
	M_L	3 u		5 u		6 u		10 u		4 u	
Type of jump		$M_1>M_2$	$M_2>M_1$	$M_1>M_2$	$M_2>M_1$	$M_1>M_2$	$M_2>M_1$	$M_1>M_2$	$M_2>M_1$	$M_1>M_2$	$M_2>M_1$
M_1 and / or $M_2 \geq M_L$	t_1	2	2	2	2	3	3	4	4	1,4	1,4
	t_2	0.02	0.04	0.01	0.02	0.015	0.03	0.02	0.04	0.007	0.014
M_1 and $M_2 < M_L$	t_1	4	4	4	4	6	6	8	8	2.8	2.8
	t_2	1	2	0.5	1	0.75	1.5	1	2	0.35	0.7
$M_2–M_1 < 0{,}5$ u [ms/u]	t_d	0.05		0.15		0.3		0.5		0.1	

For smaller mass jumps ($M_2–M_1$ <0.5 u) the above formula is no longer valid, applicable is the delay t_d caused by the finite change speed of RF and DC signals.

Continuous small jumps ($M_2–M_1$ <0.1 u) have the effect of a linear scan signal ramp.

B2: Fast Mass Scans

In fast mass scans with a linear ramp function the mass scale lags relative to the input signal (dM) and a deviation of the peak width (dΔM) occurs.

At the fastest scan speed of 0.5 ms/u in an upward scan direction ($M_1 < M_2$) the following applies:

	QMH 400-1	QMH 400-5	QMH 410-1	QMH 410-2	QMH 410-3
$dM_{0.5}$ [u]	0.1	0.2	0.3	0.5	0.15
$d\Delta M_{0.5}$ [u]	0.07	0.15	0.2	0.3	0.1

For downward scans the signs become negative.

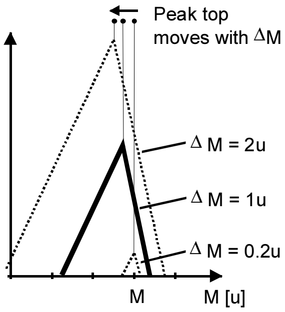
For slower scan speed the formula is:

$$dM = dM_{0.5} \times 0.5 / \text{SPEED} \quad \text{[ms/u]} \quad \text{and}$$
$$d\Delta M = d\Delta M_{0.5} \times 0.5 / \text{SPEED} \quad \text{[ms/u]}$$

C: Calibration Method for Mass Number M and Line Width ΔM

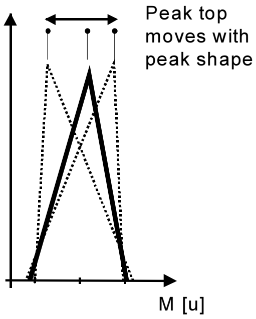
The position of the peak maximum on the mass scale is often used for determining the mass number of a peak. However, this method is subject to error. For more accurate information concerning the mass scale and peak width a definition of the corresponding measurement method is needed.

Apparent peak position and line width



The apparent mass position depends on the line width ΔM (that is, on the resolution). This shift of the peak maxima with the line width is a natural phenomenon of the quadrupole mass spectrometer. For this reason the position of the peak top on the mass scale is not an accurate indicator of the mass number .

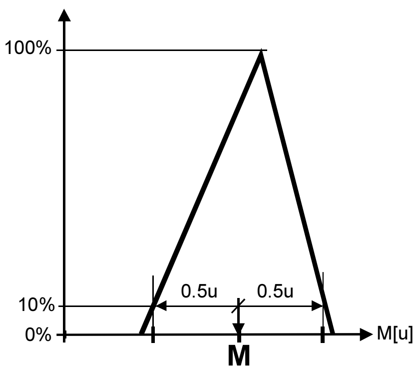
Apparent peak position and peak shape



The apparent position of the peak maximum varies, depending on the peak shape.

Different peak shapes can occur at different positions of the mass scale even if all other parameters remain constant. The peak shape also varies as a function of the mass range, the individual mass filter, or the ion source.

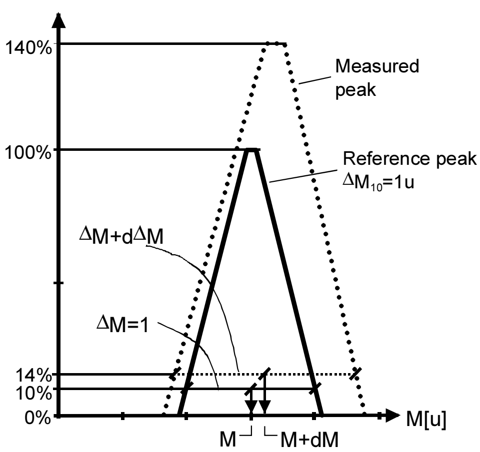
Definition



Calibration method for mass number M and line width ΔM:

- The line width ΔM_{10} = 1 u is measured at 10% of the peak height.
- The mass number is in the middle of the ΔM_{10}-Linie.
- The **middle** of this 10% line is used as the reference value for the mass number.

Deviations of M and ΔM



This diagram illustrates how the deviations from the reference values are determined, where dM is the deviation from the nominal value of mass position M, and dΔM the deviation from the nominal value of the line width ΔM.

D: Literature

📖 [1] www.pfeiffer-vacuum.de
Operating Instructions
Quadrupole analyzer QMA 400
BG 805 983 BE
Pfeiffer Vacuum GmbH, D-35614 Asslar

📖 [2] www.pfeiffer-vacuum.de
Operating Instructions
Quadrupole mass spectrometer QMG 422
BG 805 981 BE
Pfeiffer Vacuum GmbH, D-35614 Asslar

Declaration of Contamination

The service, repair, and/or disposal of vacuum equipment and components will only be carried out if a correctly completed declaration has been submitted. Non-completion will result in delay.
This declaration may only be completed (in block letters) and signed by authorized and qualified staff.

❶ Description of product

Type ______________________

Part number ______________________

Serial number ______________________

❷ Reason for return

____

____

____

❸ Operating fluid(s) used (Must be drained before shipping.)

____

____

❹ Process related contamination of product:

toxic	no ❑ 1)	yes ❑
caustic	no ❑ 1)	yes ❑
biological hazard	no ❑	yes ❑ 2)
explosive	no ❑	yes ❑ 2)
radioactive	no ❑	yes ❑ 2)
other harmful substances	no ❑ 1)	yes ❑

The product is free of any substances which are damaging to health yes ❑

1) or not containing any amount of hazardous residues that exceed the permissible exposure limits

2) Products thus contaminated will not be accepted without written evidence of decontamination!

❺ Harmful substances, gases and/or by-products

Please list all substances, gases, and by-products which the product may have come into contact with:

Trade/product name	Chemical name (or symbol)	Precautions associated with substance	Action if human contact

❻ Legally binding declaration:

I/we hereby declare that the information on this form is complete and accurate and that I/we will assume any further costs that may arise. The contaminated product will be dispatched in accordance with the applicable regulations.

Organization/company ______________________

Address ______________________ Post code, place ______________________

Phone ______________________ Fax ______________________

Email ______________________

Name ______________________

Date and legally binding signature ______________________

Company stamp

This form can be downloaded from our website.

Copies:
Original for addressee - 1 copy for accompanying documents - 1 copy for file of sender

Declaration of Conformity

as defined by the Directive relating to machinery 98/37/EC, Appendix IIb

We, Pfeiffer Vacuum, hereby declare that putting the incomplete equipment mentioned below into operation is not permitted until evidence is given that the system into which that incomplete equipment shall be installed is in conformity with the provisions of the EC Directive relating to machinery.

We also declare that the equipment mentioned below complies with the provisions of the Directive relating to electrical equipment designed for use within certain voltage limits 73/23/EEC and the Directive relating to electromagnetic compatibility 89/336/EEC.

Product

High frequency generators

QMH 400–1
QMH 400–5
QMH 410–1
QMH 410–2
QMH 410–3

Part numbers

PTM23067	(QMH 400-1)
PTM23066	(QMH 400–5)
PTM40566	(QMH 410-1)
PTM40567	(QMH 410-2)
PTM40568	(QMH 410-3)

Standards

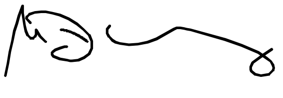
Harmonized and international/national standards and specifications:

- EN 61010 (Safety requirements for electrical equipment for measurement, control and laboratory use)
- EN 50081-2 (Electromagnetic compatibility: generic emission standard)
- EN 50082-2 (Electromagnetic compatibility: generic immunity standard)

Signature

Pfeiffer Vacuum GmbH, Asslar

20 December 2001



Wolfgang Dondorf
Managing director

Notes

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