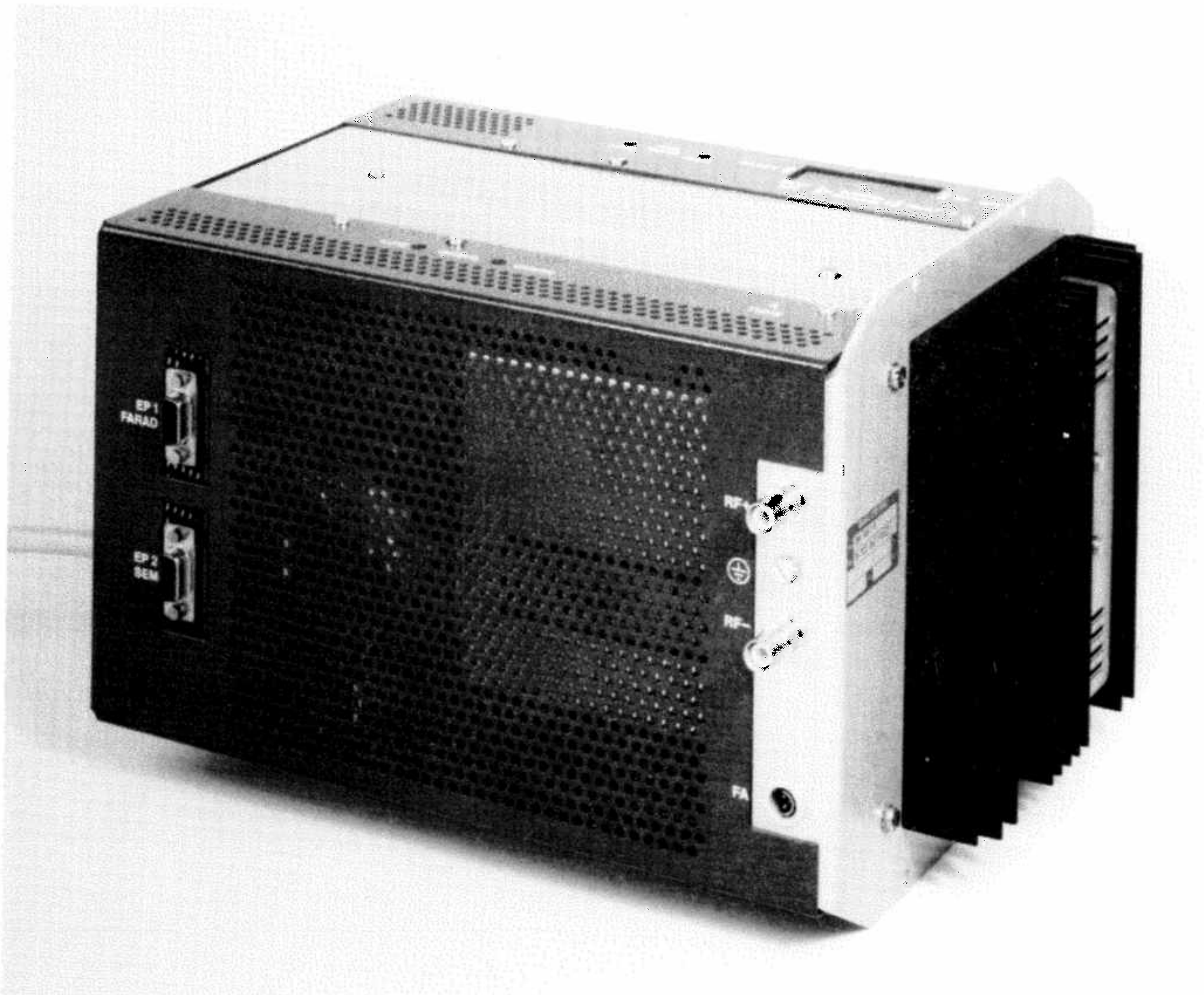
BALZERS

OPERATING INSTRUCTIONS

RF Generator

QMH 400 - 1
QMH 400 - 5



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1. INTRODUCTION

The QMH 400 radio frequency generators are an integral part of a quadrupole mass spectrometer. They generate the RF and DC voltages (applied via RF cables to the rod system of the quadrupole analyzer) required to generate a spectrum.

By using a QMH 400-5 RF generator together with a QMA 400 analyzer (8mm rod system), peaks across the mass range 1 to 511 u can be generated.

When the QMA 410 analyzer (16 mm rod system) is operated with the QMH 400-1 RF generator, peaks in the range of 1...127 can be measured with increased sensitivity and accuracy.

The RF generators feature a compact design and small dimensions and their power consumption is low. They must be installed close to the analyzer.

2. FEATURES

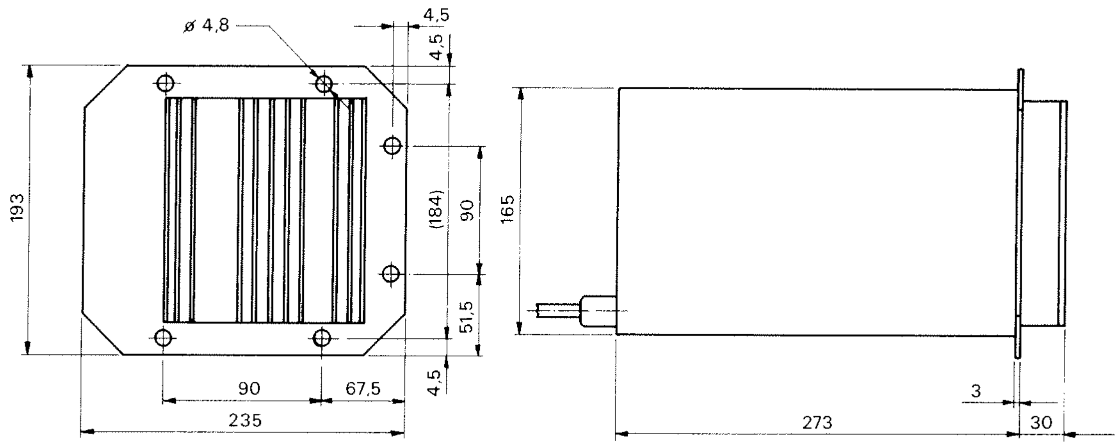
- Control and supply via the QMS control unit by means of a control cable that can be up to 10 m long
- Shipped ex factory with calibrated mass scale and resolution (if ordered together with QMA analyzer)
- Remote control of the mass number M and resolution ΔM for constant peak width from the control unit
- The generation of an INTEGRAL spectrum can be selected on the control unit.
- Linear, reproducible mass scale and constant, stable resolution value achieved through the use of precision components and a constant-temperature oven.
- Connection facility for two EP 112 electrometer amplifiers.
- Separately supplied field axis potential from the QMS control unit or from an external voltage source.
- Visual indication of exact tuning, margin from top level, and inadmissible detuning for simplified operation and fault detection.
- Expanded admissible detuning range by means of radio frequency circuit with Hi-Q technique and PHI network.
- Manufacturing tolerance of the cables and analyzers can be compensated as an RF generator load from externally operable trimmer potentiometers.
- The end of the preheating time and the status "inadmissible detuning" are signalled to the control unit.
- Overloading caused by mismatching, including short circuit and open circuit of the RF outputs, is prevented by an electronic guard circuit.

3. SPECIFICATIONS

General

Designation	QMH 400-1	QMH 400-5
Parts list/Order No.	BG M23 064	BG M23 063

Dimensions	
Housing	200 x 165 x 305 mm (W x H x D)
Overall	235 x 195 x 340 mm



Weight	4.5 kg, including cables
Connections	
Control cable	3 m, fixed to the housing
Extension cable	7 m, for a total of 10 m
RF coaxial cable	0.7 m
Field axis cable	0.7 m (standard length)
Thermal resistance	both cables up to +200 °C

Electrical data

	QMH 400-1	**QMH 400-5**
Frequency	2.05	2.25 MHz
RF amplitude, RF+, RF−	1.5 .. 1890	1.5 .. 2350 V_p
DC component, SPECTRUM	±0.5 .. ±317	±0.5 .. ±394 VDC
INTEGRAL	<±0.5	<±0.5 VDC

The polarity of the DC component can be reversed internally

Field axis voltage FA	±500 V admissible, must be limited to a max. current of ±5 mA
Electrometer amplifier	Built-in supply, range, and signal selection

	QMH 400-1	QMH 400-5
RF load on RF+, RF− socket	67 ± 3	52 ± 3 pF
Admissible asymmetry on RF+, RF−	3	3 pF max.
RF load on cable ends l = 0.7 m	49.5 ± 2	34 ± 2 pF
Admissible asymmetry on cable ends, l = 0.7	1	1 pF max.
Admissible loss factor for the RF load	D ≦ 0.0022	D ≦ 0.0017
Apparent power of RF load	S ≦ 6.5	S ≦ 9.0 kVA

Protection of RF outputs	Against inadmissible detuning as well as open circuit and short circuit
Open-circuit output voltage	Field axis potential + RF amplitude 50 V_p max.
Type of protection	
RF connections	Against direct contact
RF generator	Grounding on earth terminal ⏚ (M4) required
Supply via control unit	U_s = +24 VDC −24 VDC, ± 0.5 VDC
Power consumption	
Oven cold, max. adm. detuning	≦ 2.5 A
Oven warm, max. adm. detuning	≦ 2.3 A
With RF OFF	≦ 0.9 A
Internal power dissipation	
Oven warm, max. adm. detuning	≦ 100 W
Fuses	2, built-in, each 2.5 A slow, 5 x 20 mm
For pin assignment, signal level	refer to Appendix A.

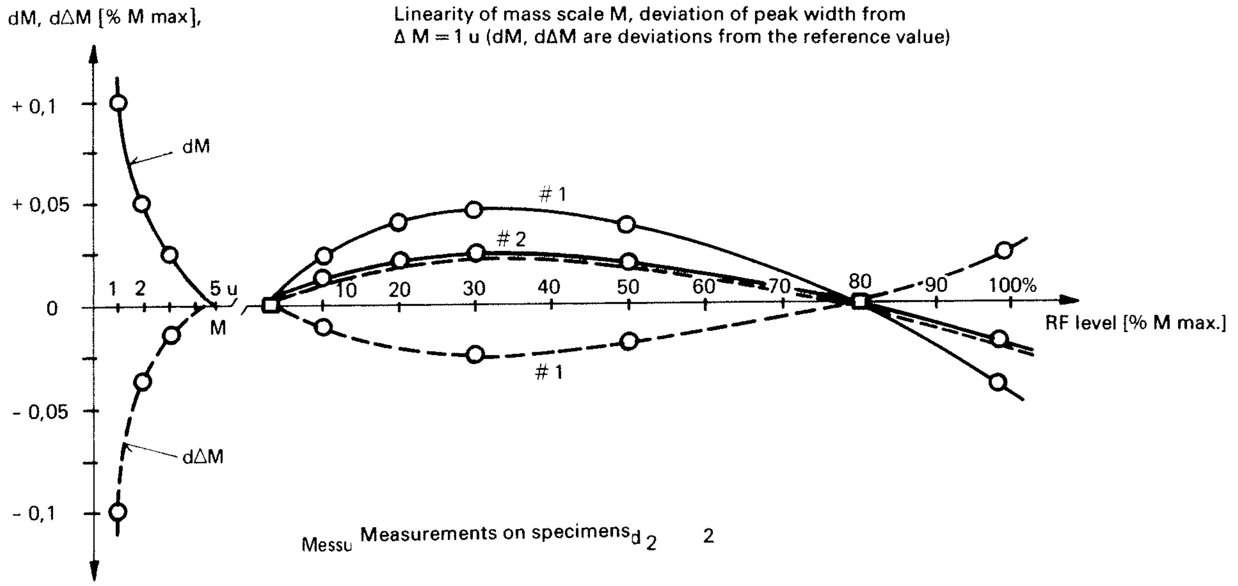
Operating data

Tuning (TUNE)	Variable capacitor, reduction ratio 6:1
Tuning indicators	
BEST HIT	yellow LED
TUNING MARGIN	yellow LED strip
FAULT (inadm. detuned)	red LED flashes
RF switched off	red LED
Waiting time after supply power ON	approx. 10 minutes
Expiration of waiting time	green LED (READY)
Mounting position	horizontal ± 30° inclination
Heating up, temperature	
Admissible ambient temperature	Operation: 0 ... +50 °C Storage: −20 ... +60 °C

Self-heating, temperature rise of housing surface	max. 35 °C
Self-heating time	T1 approx. 15 min (heat sink) T2 approx. 60 min (housing)
Trip point of overload protection thermostat	approx. 100 °C
Admissible relative humidity in operation	≦ 80% for $\vartheta = 40$ °C (annual mean)

Operating data with quadrupole analyzer

RF generator **Analyzer type** **Rod system**		**QMH 400-1** **QMA 410** **16 mm**	**QMH 400-5** **QMA 400** **8 mm**
Mass range	M min... M max	0.5 .. 128 u	0.5 .. 512 u
Resolution adjustment range			
constant peak width (remote controlled, RESOLUTION)	ΔM	0.2 .. 2.2 u (at 10% peak height)	0.3 .. 8 u (at 10% peak height)
constant resolution (adjustable, RESOL coarse)	ΔM/M	0 .. 4% (ΔM > 0.2 u)	0 .. 3% (ΔM > 0.3 u)
Resolution switched off (remote controlled, INTEGRAL)	ΔM/M	1.3 (M > 10 u)	1.3 (M > 10 u)
For low masses, (adjustable, RESOL LOW)	ΔM LOW/M	approx. 0.1 .. 1.3 (ΔM LOW ≦ ΔM)	(ΔM LOW ≦ ΔM)
Sensitivity for argon, etc.		Refer to QMA operation inst.	Refer to QMA operation inst.
Waiting time after set point step M1 → M2 [ms]	approx.	2 + 0.04 x [M2 − M1]	2 + 0.02 x [M2 − M1]
Error magnitudes of M, ΔM at M max		dM, dΔM =	dM, dΔM =
Step drift,	M1 → M2 = 0 → M max	approx. 0.03 u	approx. 0.1 u
Long term drift	per 100 h	approx. 0.03 u	approx. 0.05 u
Short term drift	per 1 h	approx. 0.01 u	approx. 0.02 u
Temperature drift (ambient) per	°C	approx. 0.005 u	approx. 0.02 u
Mech. shock, drift	per 10 G	approx. 0.005 u	approx. 0.02 u



The error values are referenced to the voltage values for RF and DC components measured at the RF test load.

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

dM = approx. –0.02% / h during 3 to 4 hours

as well as other influences of the analyzer are not taken into consideration in the specifications concerning the error quantities dM and dΔM.

4. DESCRIPTION

The compact RF generator produces the voltages required for operating the mass filter:

– RF component with crystal stabilized frequency as well as
– Superposed DC component.

The QMA analyzer is connected to the generator output via a fixed– length RF cable and is part of the RF load.

The field axis potential is supplied externally (connector and FA cable). Connectors are available for operating two EP 112 electrometer preamplifiers without switching plugs.

The RF generator which is to be installed in the vicinity of the analyzer(such as on the pumping station), is connected to the control unit via the (QC) control cable, the length of which can be selected by the user. The control unit supplies the power and the control signals and contains the electronics for evaluating and processing the electrometer signals.

The following RF generator functions can be remote controlled by means of the signals supplied by the control unit:

– RF amplitude ≙ mass number M	(SCAN signal)
– Constant peak width ΔM	(RESOL signal)
– DC component switched off ≙ INTEGRAL	(MODE signal)
– RF amplitude switched off ≙ M = 0	(MODE signal)
– Electrometer range (both EPs parallel)	(RANGE signal)
– Selection of electrometer signal 1 or 2	(EP2 signal)
– Ready feedback of RF generator to control unit	(RF OK signal)

The RF generator is equipped with high-precision components that ensure accuracy and stability. An example is the constant temperature oven which minimizes the influence of self-heating and ambient temperature. The waiting time required for heating is indicated visually (READY lamp) and the ready-to-measure status is signalled to the control unit.

HI-Q technology RF circuits ensure favorable power consumption and low self-heating of the generator.

In the event of mismatching they are protected from overheating and destruction, including open circuit and short circuit.

In order to produce the high RF voltages, a matched RF load must be connected to the RF+ and RF– sockets. This is ensured when the QMA analyzers are connected using the RF cables included in the scope of supply. Manufacturing tolerances can be compensated on the TUNE potentiometer.

Load changes occurring in operation can reach a certain magnitude without influence on the functioning of the generator.

The electronic circuitry for monitoring the matching conditions turns on the BEST HIT LED when the tuning is optimal and signals the admissible detuning range. If this range is exceeded, the FAULT LED starts to flash and a signal is supplied to the control unit. An LED strip indicates the TUNING MARGIN of the RF generator. Error conditions which cause excessive RF losses in the generator or in the load (e.g. storage at high humidity) are also detected.

5. INSTALLATION

The installation of the QMH RF generator normally also requires the following components:

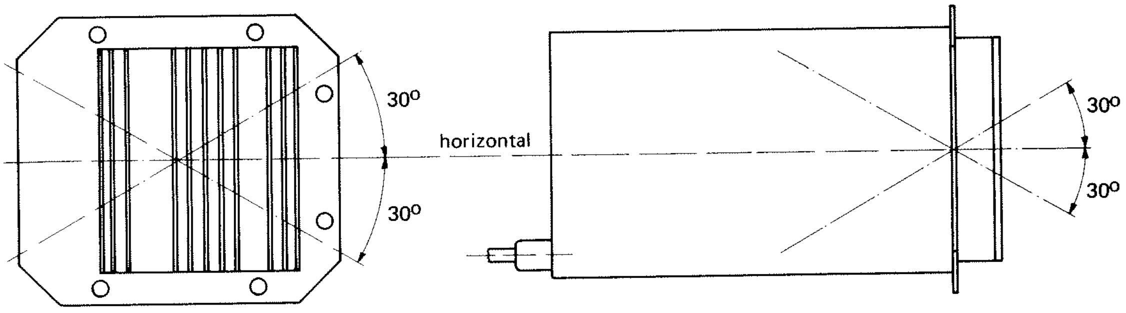
- RF connection cable
- Field axis connection cable
- QMA quadrupole analyzer
- Holder
- QMA 420 control unit
- Ion source connection cable
- EP 112 electrometer amplifier

For analyzers with SEM:

- High voltage cable
- SHV shorting plug
- Possibly additional electrometer amplifier

5.1. Installing the RF generator

Install the RF generator in horizontal position or with an inclination of max. 30° in a location subject to only minimal vibrations. The distance to the QMA analyzer can be up to 0.5 m (cable length 0.7 m).



The RF generator can be mounted directly to the pumping station by means of the holder supplied with the analyzer. From the feasible mounting methods, select one that permits good access to the trimmer potentiometers on the top of the housing. For this purpose the RF generator can be fixed to the holder with M4 screws on one of the three protruding sides of the back panel.

The electrometer amplifier can also be mounted to this holder.

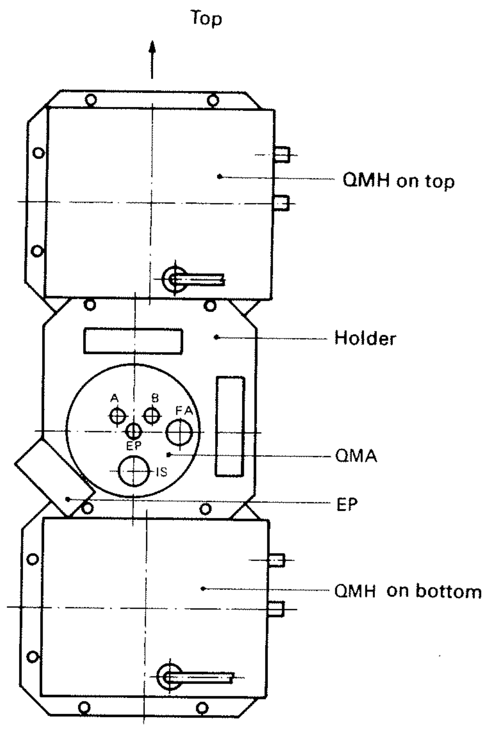
The air around the RF generator should not exceed +50 °C in normal operation (measured at a distance of 30 cm from the surface of the generator housing).

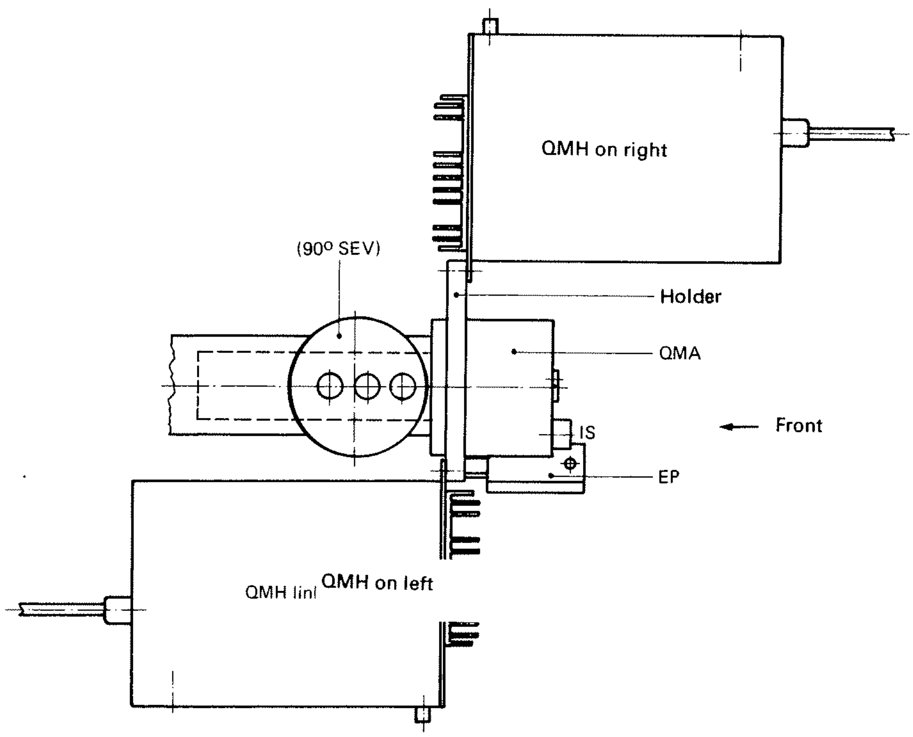
Best measuring results are achieved if the temperature fluctuations are kept to a minimum.

In continuous operation at maximum level some parts of the housing increase in temperature by up to 35 °C.

Installation with holder

QMA, horizontal

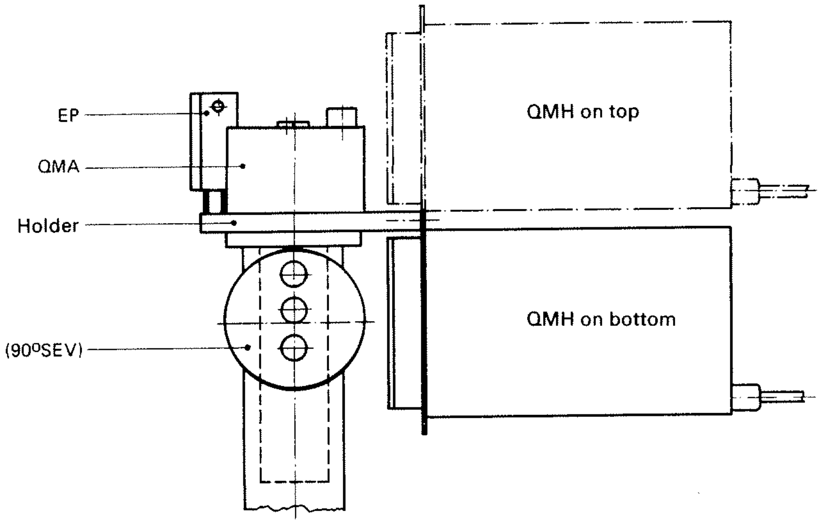




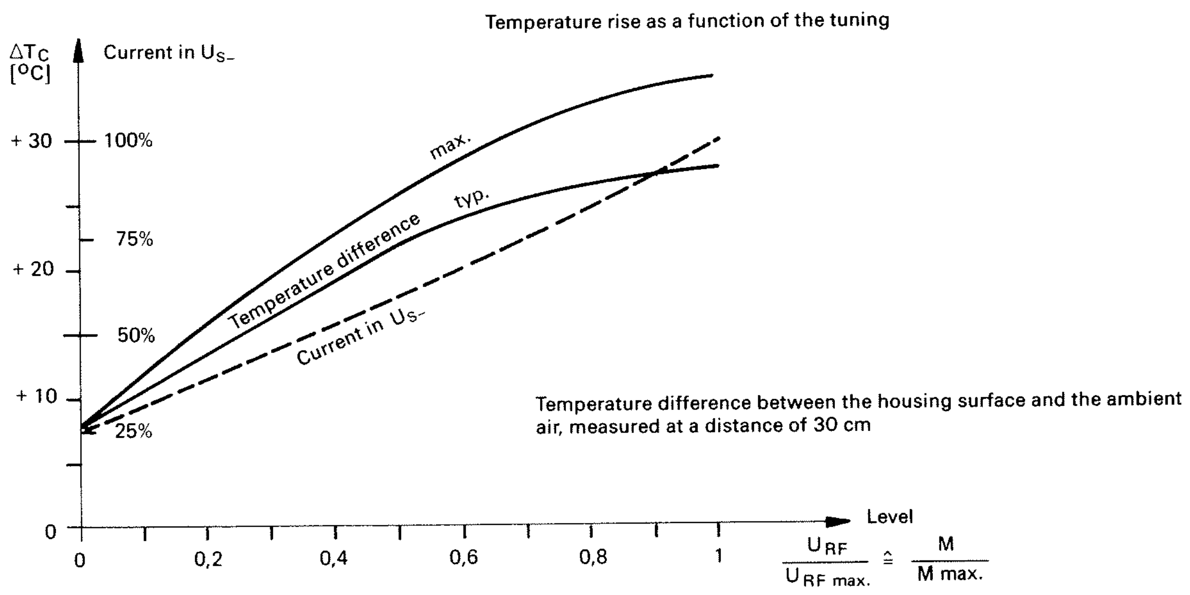
If no continuous operation is required, the generator can also be installed vertically. In this case the heat sink on the back panel must point upward. The temperature of the housing must not increase by more than 25 °C in actual operation.

Installation with holder

QMA, vertical



Power consumption and self-heating of the RF generator as a function of the amplitude level in continuous operation



5.2. Electrical connections

5.2.1. Ground connections

The RF generator conforms to the regulations on electrical safety if it is connected to the protective ground terminal marked with ⏚ . Ensure that the connection cannot be loosened by vibrations.

The ground connections should be as short as possible and the conductor cross-section sufficiently large in order to minimize the radiation of RF energy.

The maximum admissible voltage difference between the RF generator housing and the control unit housing is 0.5 V_p in actual operation.

5.2.2. QC control unit

Only connect or disconnect the QC control cable attached to/from the RF generator to the QMH/QME socket when the control unit is off. An extension cable can be used to extend the distance to approx. 10 m.

5.2.3. RF load, RF+, RF–

For connecting the RF voltage, link the RF+ and RF– generator sockets to the RF A and RF B sockets of the analyzer using the 0.7 m coaxial cable supplied. If the polarity is important, it can be determined from the supplied test report. Only the BALZERS cables supplied of the specified type and length may be used for connecting the RF voltage.

Connect the cable ends equipped with the protective rubber sleeve to the RF generator sockets in order to ensure that the cable ends on the analyzer are bakable.

5.2.4. Field axis voltage FA

This voltage is applied to the FA socket. If no special field axis supply is configured, interconnect the FA sockets on the RF generator and the analyzer by means of the field axis cable supplied. In this way the field axis voltage is applied from the control unit via the ion source supply cable.

For connection of an external field axis supply refer to Section 6.10.

5.2.5. Electrometer amplifier EP1, EP2

Electrometer amplifiers of the appropriate type are connected to the EP1 FARAD or EP2 SEM sockets respectively.

If you want to measure the signal of a Faraday cup (positive ions), connect the electrometer amplifier to the EP1 FARAD socket. For measurements with an SEM signal (electrons) connect the electrometer amplifier to the EP2 SEM socket.

5.2.6. Quadrupole analyzer

Depending on the selected measurement equipment, additional connections have to be established which connect a quadrupole analyzer to the required supply voltages. A chart can be found in Appendix A. For detailed information refer to the Operating Instructions for the analyzer.

6. START-UP PROCEDURE

After the electrical connections have been established, you can put the RF generator into operation by switching on the control unit.

6.1. Waiting time READY

After a waiting time of approximately 10 minutes the green READY LED in the window on the top of the RF generator turns on. If the red FAULT LED does not flash, the error signal transmitted to the control unit has been reset.

During the waiting time the RF generator should not be operated in the upper half of the mass range (FIRST MASS + SCAN WIDTH $\leqq$ 1/2 M max.), otherwise the functioning of the control unit can be adversely affected because of the higher load on the power supply.

6.2. Tuning indicators BEST HIT, TUNING MARGIN, FAULT

When you put the equipment into service for the first time, please check the tuning of the RF generator which is indicated by the TUNING MARGIN LED strip in the window on the top of the generator. The length of the LED strip is a measure of the RF generator power margin. The yellow BEST HIT LED on the left of this strip lights to indicate exact tuning. On the right-hand side the red FAULT LED flashes if the detuning has exceeded the admissible value (as when the RF cable is not connected). This status is transmitted as an error signal to the control unit. The FAULT LED lights continuously when the RF amplitude is switched off (RF OFF) by the control unit (MODE signals).

6.3. TUNE adjustments

If necessary you can align the RF generator by adjusting the "TUNE ▷" control with a screwdriver.

The adjustment range is approximately three turns after which the settings repeat themselves. The angle of rotation for the admissible detuning is approximately 90° at maximum level (M=M max.).

If the RF generator is detuned, turn "TUNE ▷" slowly to the point where FAULT stops flashing and then further to where the LED strip is the longest. Right next to this you will find the position at which the BEST HIT LED turns on. When you have found this position, the RF generator is tuned exactly.

Also check the tuning at maximum level (M max) after the waiting time has elapsed.

As long as the FAULT LED is not flashing, the BEST HIT LED can turn off during operation without implying a malfunction of the RF generator. The admissible detuning range declines with increasing level.

6.4. Measuring spectra with RESOLUTION, INTEGRAL

Since the RF generator is part of a measurement system comprising control unit and analyzer, it is supplied with a calibrated mass scale and a resolution adjustment device.

In normal operating mode (SPECTRUM) the control unit supplies a signal (RESOLUTION) with which the mass peak width ΔM can be preselected within the range of ΔM min ..ΔM max. An unresolved spectrum can be selected with an additional control signal (INTEGRAL).

The measured values should reach the specified accuracy about 10 minutes after the waiting time has elapsed (READY lamp).

6.5. Correcting the resolution: RESOL coarse

The resolution setting may require correction due to aging of the components or displacement caused by mechanical vibrations.

You can reestablish a constant ΔM across the mass range by slightly changing the setting of the RESOLUTION potentiometer by means of a screwdriver. Its identification with lower case letters signifies that you should not inadvertently change the setting of this potentiometer since a full clockwise turn can cause a peak with high mass number and with ΔM=1u to virtually disappear (ΔM changed to 0).

After the control unit has been switched on, wait until the READY LED turns on.

By turning the "coarse" potentiometer counterclockwise you can select a resolution setting in which ΔM increases with the increasing mass numbers for the peaks. In this case the peak width is

$$\Delta M = \Delta M1 + \Delta M2$$

where $\Delta M1$ is the constant component preselected by the control unit.

$\Delta M2$ is the component set with "coarse" and is given by

$$\Delta M2 = K \times M$$

M is the mass number, K a factor which you can set with "coarse" within the range of approximately −1 to +3%. K=0 corresponds to a constant $\Delta M = \Delta M1$. The value ΔM in this case is the width of a free-standing peak, measured at 10% height. The values of ΔM can deviate by $d\Delta m$ when viewed across a mass range. They are also influenced by the ion source setting.

6.6. Adjusting the resolution for low masses: RESOL LOW

The RESOL LOW potentiometer is located next to "coarse". This potentiometer is preset for $\Delta M<=1$. If you perform measurements with $\Delta M>1$ and if you also need correctly measured peaks for low masses, you can turn the LOW potentiometer clockwise, otherwise the components of high masses will falsify the measurements in the range of low mass numbers. The correct setting of LOW depends on ΔM. The principle of operation is influenced by the RESOLUTION signal supplied by the control unit but not by the "coarse" setting.

Turn LOW counterclockwise again if you intend to perform measurements predominantly with $\Delta M <= 1$ afterwards.

6.7. Calibrating the mass scale, CAL MASS LOW, HIGH

Depending on the desired accuracy, the quadrupole analyzer must be allowed to warm up for 1/2 to 3 hours (EMISSION ON), before the mass scale corresponds to the calibration values.

The mass calibration may require correction due to aging of the components or after the analyzer has been replaced.

For mass calibration use a gas that produces a first known peak at mass $\approx$ 20 and a second peak at approximately 80% of M max.

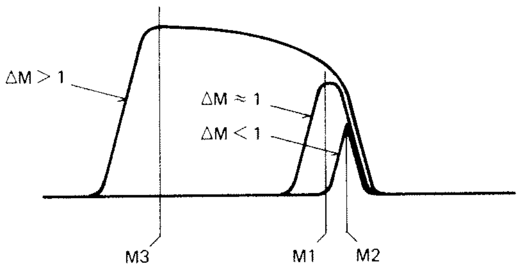
Establish suitable detector and ion source settings and transmit a $\Delta M \approx$1u via the control unit. The selected peaks should already be in the vicinity of the mass scale reference value (deviation of max. ±5% from reference value M), otherwise an error exists.

First transmit the mass reference value of the lower peak, for example 18.0. Now turn the CAL MASS LOW potentiometer clockwise, if the peak is too low relative to the mass scale (otherwise turn it counterclockwise) until the detector signal indicates the peak maximum. With LOW the entire mass scale is shifted in parallel, the adjustment range is dM1 approx. 1u.

As a next step transmit the upper reference value, for example M=414.0. Now turn the CAL MASS HIGH potentiometer in the direction of the necessary correction, i.e. clockwise if you want to shift the peak to a higher mass number on the scale, until the detector indicates the peak maximum. With HIGH the position of the peaks on the mass scale is shifted proportionally to the mass number, the adjustment range in this case is dM2 approx. 5% of M.

The position of the peak maximum depends on the resolution setting ΔM.

The correct position is attained at ΔM approx. 1u. A resolution with ΔM> 1 does not produce a pronounced peak maximum.



6.8. Waiting time before measurement result is valid

After a preheating time of approximately 20 minutes after the cold RF generator has been switched on, the results of the measurements can be considered as corresponding to the calibration values (M and ΔM), provided the preheating time of the analyzer has also been observed.

If the mass scale reference value is stepped from one M1 value to a second M2 value, a certain time must be allowed to elapse before the RF generator has attained the set point (M and ΔM) and the detector signal reaches its final value.

Step response time t = t1 + t2 x [M2 – M1] [msec]

Required values of t1 and t2 before the detector signal reaches X% of the final value (values for QMH 400–5):

Step to ...		Peak slope		Peak slope		Peak maximum	
X% of final value		85%		98%		98%	
Mode for step		M1>M2	M2>M1	M1>M2	M2>M1	M1>M2	M2>M1
M1 and/or M2≧5u	t1	2	2	2,5	2,5	2	2
	t2	0,01	0,02	0,02	0,04	0,01	0,02
M1 and M2 <5u	t1	4	4	5	5	4	4
	t2	0,5	1	1	2	0,5	1

Note: The values for M1, M2 are to be multiplied by 2 for the QMH 400–1.

6.9. Polarity of the RF lines

In many QMA analyzers the peak shape can be influenced by the polarity of the RF cable (link between RF+, RF– socket and RF A or RF B sockets) or the DC line internal to the generator. Should this be the case, the correct polarity is noted in the test report for the analyzer.

If the user finds it necessary to also change the polarity of the DC component, proceed as follows:

CAUTION! HAZARDOUS HIGH VOLTAGE!

– Switch control unit off and unplug the QC cable. Also unplug the FA cable. The RF generator is no longer under voltage.

– Remove the right–hand hood of the RF generator (side with EP terminals). 6 sheet metal screws diam. 2.9 x 6.5.

– The DC cable is located on the bottom right near the FA connector. It is attached to blade terminal J7 on the DC generator pc board (refer to Section 6.11.).

  Normal polarity: white conductor connected to pin 7 (top)

  Reversed polarity: white conductor connected to pin 1 (bottom)

– Do not shift the position of the DC cable connector when you change the polarity!

– Reinstall the hood correctly and tighten the screws.

– Reconnect the FA and QC cables before you switch on the control unit.

6.10. Connecting an external field axis supply

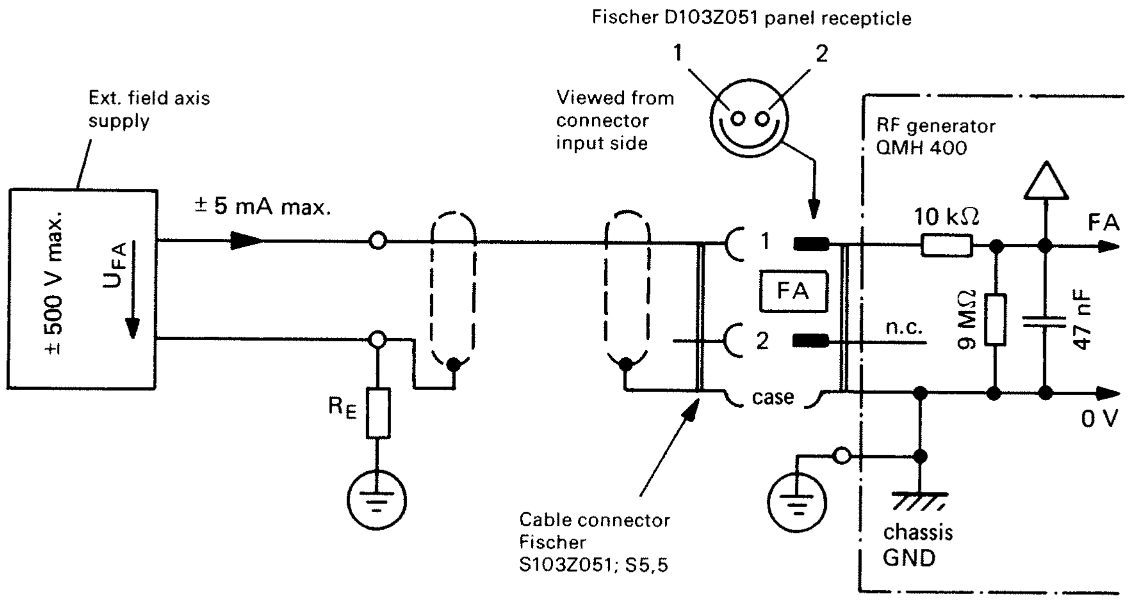
An external FA supply can be linked via the FA connector. The effective field axis potential differs slightly from the supplied potential and is:

$$U_{FA} = U_{FA\ supplied} \times 0.999$$

In order to preserve the short circuit protection on the RF outputs, the current of the external FA supply must be limited to 5 mA. The voltage must not exceed ±500 VDC relative to chassis potential.

Ground currents are suppressed by resistor $R_E \geqq 10$ Ohm.

Connection diagram

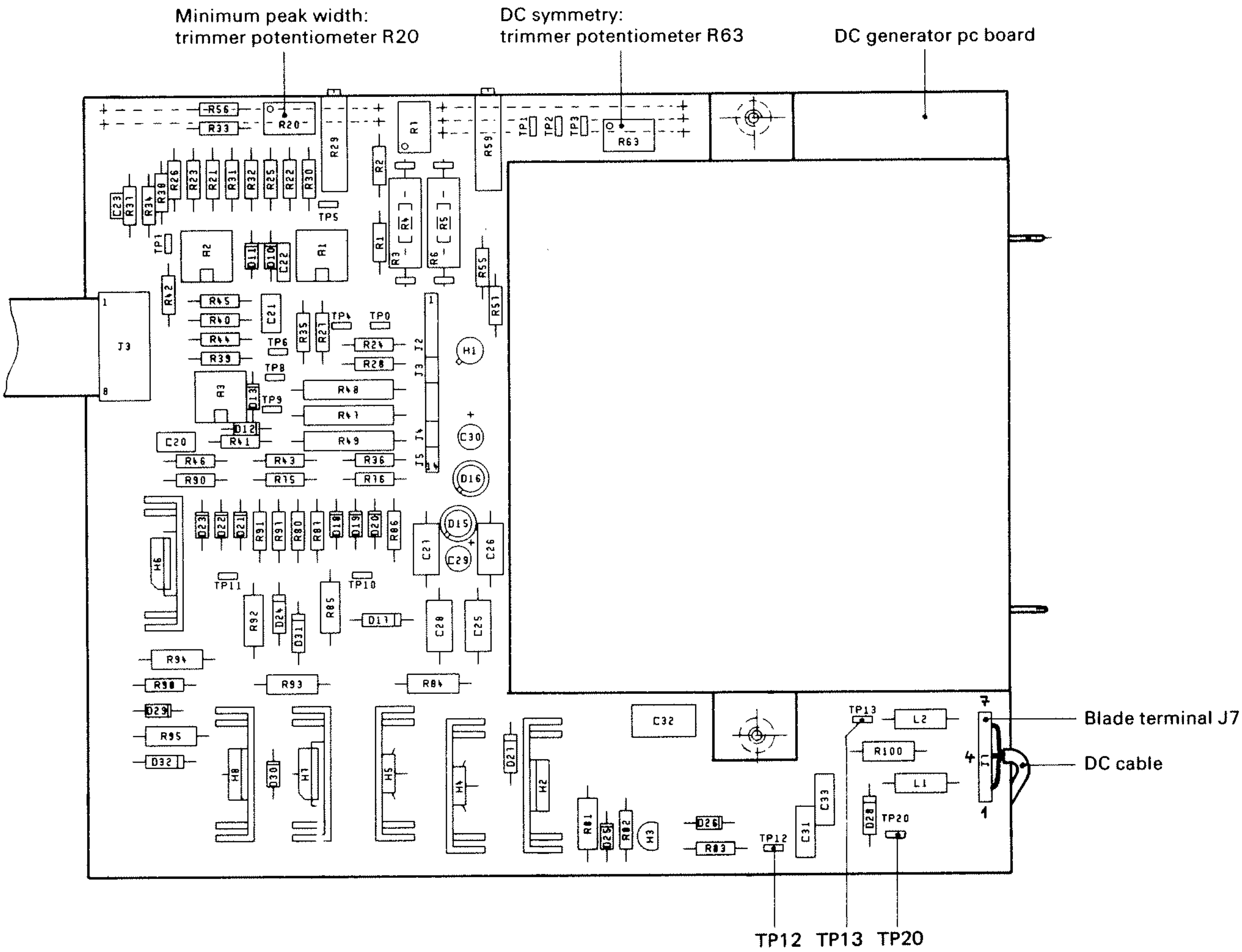


6.11. Adjusting the DC symmetry

An asymmetrical DC component may be advantageous for certain analyzers (such as those with an axial ion source). However, the asymmetry must be selected in accordance with the ion polarity. In changeover mode between the two ion polarities the DC component should be set to symmetry.

IMPORTANT
This adjustment should only be performed by qualified service personnel!

1. Open the right–hand hood of the generator after the control unit has been switched off and the QC cable has been disconnected, i.e. the RF generator must not be under voltage.
2. The location of the "cal DC symmetry" potentiometer (R63) as well as test points TP12, TP13, and TP20 on the DC generator pc board is as follows :



3. Close U–link S1 on connection pc board or DC/DC converter (FA cable disconnected, supply of RF generator interrupted).
4. **CAUTION! THE RF GENERATOR IS UNDER HAZARDOUS HIGH VOLTAGE!**
   Incorrect measurements if switch S1 is open!

Connect QMH to the control unit and switch the power on. Set the SCAN set point to full–scale deflection (Example: FMASS = 511.99, SCAN mode to SAMP–N, i.e. no INTEGRAL).

RF load connected, if necessary adjust with TUNE until BEST HIT LED turns on.

5a. Symmetrical alignment

Connect the DVM LOW to TP20 and the DVM HIGH to TP13 at the approx. 500 VDC range. Note the negative measured value.

Now connect the DVM HIGH to TP12. The value measured will be positive and of approximately the same absolute magnitude.

With trimmer potentiometer R63, adjust the voltage on TP12 to the absolute value for TP13 $\pm$ 0.1 V (clockwise rotation: voltage increases).

5b. Asymmetrical alignment

As in 5a determine the voltage on TP13 and connect the DVM to TP12.

– For positive ions adjust the voltage on TP12 with R63 to a value that is lower by 1% .

– For negative ions adjust the voltage on TP12 with R63 to a value that is higher by 1%.

The asymmetry can be set to any value from 0 to 1%, if required; higher values are inadmissible.

Example: QMG 400–5, negative ions, asymmetry 1%

DVM on TP13 measures –394.0 V

Adjust with R63 TP12 to
+394.0 V + (396.0 V x 0.01), i.e. to
+394.0 V + approx. 4.0 V = +398.0 V.

6. Switch the supply off. Reopen the U–link S1 on the DC/DC converter. Screw on the hood of the QMH. Reconnect the FA cable.

7. If the DC symmetry has been readjusted, the setting for constant peak width ΔM must be corrected on trimmer potentiometer "RESOL coarse" (refer to Section 6.5.).

6.12. Adjusting the minimum peak width

The RESOL LOW trimmer potentiometer must be in the ccw limit position. The minimum peak width (RESOLUTION = 0, "RESOL coarse" set to constant ΔM) can be readjusted with trimmer potentiometer R20 after the right-hand hood has been opened (for location of R20 refer to Section 6.11.).

Turn R20 clockwise: ΔM min. becomes lower.

Adjust ΔM min in such a way that the peaks 1u and 2u are still visible, approx. 0.1 to 0.2 u. Other peaks: ΔM min. is approx. 0.3 u.

6.13. Functional check with RF test load

The RF test load can be used for checking the correct functioning of the RF generator as part of the maintenance work. This test load is not included in the scope of delivery.

The following functions can be checked with the test load, independently of a QMA analyzer and a vacuum system:

– Settability of the RF amplitude and the superposed DC component (functional test).

– Zero, full-scale deflection, linearity and stability of the RF voltage and DC component.

– Symmetry of RF voltage and DC component

– Voltage values and curve shape of the RF amplitude.

– Adherence to the specified load matching.

For determining the measured values the following are also required:

1 DVM,	4 or 5 digits, range 10 VDC and ≧ 500 VDC, R_i = 10 MOhm, accuracy class 0.01%
1 Oscilloscope,	with 2 channels if possible, probes 10:1, R i ≧ 1 MOhm, approx. 10 pF, vertical deflection 0.1 V/DIV and 1 V/DIV, AC and DC coupling

In this way faults can be localized not only in the control unit and the RF generator but also in the analyzer and the signal detector.

7. MAINTENANCE

Under normal operating conditions the RF generator requires no maintenance as such. The readjustments for mass calibration and resolution, necessitated by the aging of components and ambient conditions, are determined by the analysis of the measured values. Any readjustment of the TUNE matching is signalled by the LEDs FAULT or BEST HIT.

Operation or storage of the RF generator at high humidity in a dusty atmosphere,strong mechanical vibrations, and extreme fluctuation of the ambient temperature should be avoided.

Should dust have settled inside the equipment, it can be removed by carefully blowing it out with compressed air after the control unit has been opened. In persistent cases the equipment should preferably be cleaned by a BALZERS service center.

If high RF generator losses occur because of storage at high humidity, this problem can be solved by drying the generator at temperatures up to 70 °C or by extended operation at maximum possible level.

8. TROUBLESHOOTING

This section describes in table form possible faults, their probable causes, and their remedies applicable to equipment that is put into service for the first time, or after prolonged operation.

For checks using a test load refer to Section 6.13 as well as the separately available Engineering Manual.

WARNING

Measurements on the circuits inside the RF generator should only be performed by qualified service personnel. Severe shock hazard from HIGH VOLTAGES exists when the RF generator is opened!

8.1. Fault locating

List of described fault groups:

Section 8.1.1.	Tuning indicators FAULT and BEST HIT LED strip TUNING MARGIN RF load matching
Section 8.1.2.	READY pilot lamp RF ERROR message on control unit (on the QMS = **RF420 ERR**, RF OK L signal carries low H-level)
Section 8.1.3.	DETECTOR signal path (peak signals) Resolution adjustments Field axis potential Electrometer connection

8.1.1. Tuning indicators, RF load matching

Fault symptom	Possible cause, localization, and remedy
F1: FAULT LED flashes continuously, RF ERROR message appears on control unit (but only at level of >5% of M max)	A11: No or incorrect RF load connected to sockets RF+ and RF-: - Connect analyzer with the cables supplied - For data on RF load refer to Section 3. For connection of RF load refer to Section 5.2.3. - For tuning of RF generator refer to Section 6.3.
	A12: Defects in RF load: - Check RF cable and RF supply line in the analyzer for short or open circuits (see A21). Measure the capacitance (poles:center conductors of RFA, RFB). ***************** WARNING *************** Do not touch the internal contact of the RF sockets RF+, RF-. They may be on HIGH VOLTAGE !
	A13: Defects in the generator's RF circuit : - Trace by connecting an RF test load (refer to Section 6.13 and Engineering Manual). To be tested by trained personnel.

Fault symptom	Possible cause, localization, and remedy
F2: LED FAULT flashes continuously, the **IS ERR #1** report appears on display	A21: Short circuit in RF load circuit - Unplug the RF cable from RF+, RF- and check for short circuits. Also check the RF connections on the QMA analyzer - Disconnect the RF generator from the control unit. Unplug the connector on the FA. The RF generator is now not on voltage. Now check the resistance between the pins and chassis ground in sockets RF+, RF- : R_{isol} >9MOhm. Also refer to A31 in Section 8.1.2
F3: FAULT LED flashes only in the upper level range (error message also on control unit)	A31: RF load connected correctly but RF generator not tuned. For TUNING refer to Section 6.3.
	A32: Corona discharge due to - Pressure in analyzer too high: Full level possible only at $p<10^{-3}$ mbar - Defective RF cable or RF supply line in analyzer: Visual check or voltage check for flashovers with 5 kVDC - Defects or deposited dust/contamination in RF generator (also refer to MAINTENANCE Section). To be checked by trained specialists.
F4: FAULT LED flashes in top level range even though TUNE can be aligned with lower level i.e. BEST HIT LED is on.	A41: Power consumption of RF generator too high because - Excessive RF losses in RF load circuit: incorrect and defective cables connected or analyzer not compatible with QMH 400, or moisture absorbed by the load circuits. - Excessive RF losses in RF generator: Moisture absorption due to incorrect storage or unfavorable operating environment (refer to MAINTENANCE Section). - Defect in RF generator.
F5: FAULT LED flashes occasionally with high Level	A51: Occasional flashovers in RF load circuit: refer to A32.
	A52: Power consumption just at the upper admissible limit: see A41.
F6: FAULT LED continuously on = RF OFF	A61: RF generator has been set to OFF by the control unit (RF amplitude is consequently set to min.): no fault

Fault symptom	Possible cause, localization, and remedy
F7: BEST HIT LED turns off after a while or with different levels but FAULT LED does not flash	A71: Tuning condition changes slightly during operation: no fault
F8: All indicators remain dark even though the RF generator is connected to the control unit and the latter is switched on.	A81: Fuse F1 blown: - Switch control unit off or disconnect QC control cable - Unfasten the left-hand hood on the RF generator (6 sheet metal screws, diam. 2.9 x 6.5) - Check fuse F2 at the same time (same rating as F1). If the fuse has blown there are probably other defects in the RF generator.

8.1.2. READY status indicator, RF ERROR message

Fault symptom	Possible cause, localization, and remedy
F1: RF ERROR is indicated on the control unit, but FAULT LED does not flash, i.e. the RF generator is tuned. READY LED is not on.	A11: RF generator has been switched on only recently: - Allow waiting time to expire, i.e. until READ LED turns on (refer to Sections 5.1 and 6.8).
F2: READY LED stays dark even after the waiting time has expired. FAULT LED flashes continu-ously, even during tuning. LED BEST HIT lights Peak signals do not meet expec-tations.	A21: Fuse F2 blown: refer to Section 8.1.1, Point A81
	A22: The U_S supply voltage is too low. - Check the set point on the QC cable (see appendix for pin assignment) Values : +24 V ± 0.5 V -24 V ± 0.5 V - Check the control unit mains voltage
F3: **IS ERR#1** appears on the control unit. The FAULT LED does not flash.	A31: Short circuit in the FA supply line (However, the error message can be reset when the FA cable is unplugged) - Check the FA cable for short circuits - Check that switch S1 on the DC/DC converter is open (refer to Section 6.11

8.1.3. DETECTOR signal path (peak signals)

Fault symptom	Possible cause, localization, and remedy
F1: Mass peaks in upper level range are much too wide or too narrow, even though the control unit has transmitted a resolution for ΔM=1u.	A11: Setting of "RESOL coarse" trimmer potentiometer has been changed: - For adjustment refer to Section 6.4. ff.
F2: Mass peaks in lowest control range are much too narrow or not visible even though RESOLUTION has been set to ΔM=1u.	A21: Trimmer potentiometer "RESOL LOW" is not in the standard position for $\Delta M1$=1u: - For adjustment refer to Section 6.6.
F3: Mass peaks are resolved unevenly and their shape is fringed	A31: Field axis voltage not applied via FA connector: - For connection refer to Sections 5.2.4 or 6.10.
	A32: Field axis voltage too high: - For adjustment and settings refer to the Operating Instructions for the control unit and the QMA analyzer.
	A33: The RF cables have been connected to the RF+ and RF- sockets with incorrect polarity: - For polarity refer to Section 6.9.
	A34: Break in the FA supply line: - Check the FA cable for continuity (Pin Nr. 1) - Unplug the FA cable and the QC control cable (RF generator is now not on voltage). R_{isol} on pin 1 of recepticle FA 9 MOhm to the chassis. Also refer to Section 6.10. In the event of a short circuit, refer to F2 in Section 8.1.1, and F3 in Section 8.1.2.

Fault symptom	Possible cause, localization, and remedy
F4: Intensity of the mass peaks in upper control range is inade- quate, even though peak width _M and the ion source parameters have been selec- ted correctly.	A41: DC symmetry set incorrectly: - For verification and adjustment refer to Section 6.11.
F5: High DETECTOR signals avail- able that do not produce resolved peaks.	A51: Control unit in INTEGRAL mode: - For adjustment of the modes refer to the Operating Instructions for the control unit
	A52: After internal DC pole reversal, connector was inserted incorrectly or not at all. -Refer to Section 6.9.
F6: DETECTOR signal remains on 0 V even though the operating parameters for the ion sources, RF generator, and detector have been set correctly on the control unit.	A61: Electrometer attached to the wrong connector (EP1 or EP2 respectively) or not at all.
	A62: Error in the analyzer cabling: - Refer to Section 5.2 and Appendix A

9. DETAILED DESCRIPTION

A detailed description of the individual assemblies in the RF generator provided for service purposes can be found in the separate Engineering Handbook.

10. SPARE PARTS

Spare parts are to be ordered based on the enclosed spare parts list. On all orders please specify the equipment model and serial number engraved on the name plate.

Example:
1 pc. Control cable, 2x12P+S, 3.0 m, Order Nr. BG 541 964 -T
according to spare parts list BG 800 273 E, item 7

11. ACCESSORIES

Accessories included in scope of delivery:
Fuses RF coaxial cable 0.7 m, 2 pcs. Field axis cable 0.7 m, 1 pc.

Optionally available accessories	Order No.
Control cable extension 2x12P+S 7.0 m	BG 541 680 -T

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
		1			
2	Fuse, 2.5 AT, 5 x 20 mm	2	B 4666 444		on CC 400
		3			
8	Jumper , 65474-004	4	B 4713 102 AD		
		5			
		6			
1	Control cable, 3 m, 2 x 12P + S	7	BG 541 964 -T		can be plugged into QMH
2	RF coaxial cable, 0,7 m, 3,5 kV	8	BG 541 960 -T		
1	Field axis cable, 0,7 m, 500 V, 2 P + S	9	BG 541 962 -T		

Spare Parts for / Ersatzteile zu

RF Generator QMH 400 -1 / QMH 400 - 5

BALZERS

BG 800 273 E

A 1. CABLE CONNECTIONS

The following chart gives an overview of the cable connections for the most frequently used measurement equipment. The total connection length consists of the sum of the segments specified in A 1.1.

A 1.1. Frequently used measurement equipment

Analyzer version QMA 400, QMA 410	Mode	Segment
without SEM	(Faraday)	1, 2, 5
with SEM, axial	SEM active1, 4a, 5	
with SEM, axial	SEM passive	1, 3, 5
	SEM active	1, 4a, 4b, 5
with SEM, 90°	SEM passive	1, 3, 5
with SEM, off axis	Faraday	1, 2, 5
	SEM + Faraday (2 electrometer preamplifiers)	1, 2, 4a, 5

A 1.2. Chart of electrical connections

Segment	Connection type	From device	Connect.	To device	Connect.	Connector pins	Connector Type	Cable length
1	Control cable	QMH	QC	QMS/QC	QMH/QME	25	D	3..10m
	Field axis cable	QMH	FA	QMA	FA	2	rund	0,7m
	RF lines	QMH	RF+,RF-	QMA	RFA,RFB	Koax	SHV	0,7m
2	Electrometer 1	EP 112	Kabel	QMH	EP1 FARAD	9	D	0,8m
	Input	EP 112	BNC	QMA	EP (FARAD)	Koax	BNC/SHV	0,1m
3	Electrometer 1	EP 112	Kabel	QMH	EP1 FARAD	9	D	0,8m
	Input	EP 112	BNC	QMA	HV+	Koax	BNC/SHV	0,1m
	Shorting plug			QMA	HV-	Koax	SHV	
4a	Electrometer 2	EP 112	Kabel	QMH	EP2 SEM	9	D	0,8m
	Input	EP 112	BNC	QMA	EP (SEM)	Koax	BNC/SHV	0,1m
	High voltage	QMS/HV	HV-	QMA	HV-	Koax	SHV	3m,10m
	Shorting plug			QMA	HV+		SHV	
4b	Shorting plug			QMA	EP (FARAD)	Koax	SHV	
5	Ion sources	QMS/IS	QMA	QMA	IS	16	rund	3m,10m

A 2. PIN ASSIGNMENTS / SIGNAL LEVEL

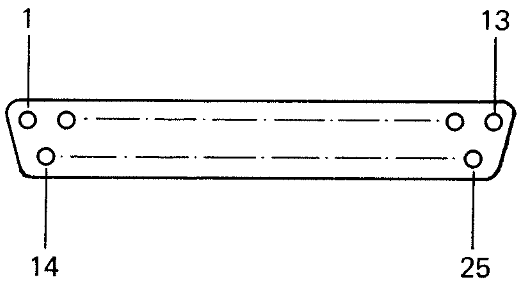
This section handles the electrical connections accessible from the outside.

Information on the signal direction: IN → QMH is receiver
OUT → QMH is the transmitter

A 2.1 QC control cable

Connection: Connection on the control unit
Type: 25 pole D-sub/pins

Contact configuration



View from the recepticle side

Pin	Signal	Input/ Output	Pegel/Level	Impedance
1	-24 V	IN	*	Speisung/supply
2	-24 V	IN	*	Speisung/supply
3	+24 V	IN	*	Speisung/supply
4	0 V	IN	GND	100 Ohm → Chassis
5	SCAN+	IN	0..+10,24 V	100 kOhm
6	0 V	IN	GND	10 Ohm → Chassis
7	EP+	OUT	0V	47 Ohm
8	RESOL+	IN	0..+10,24 V	100 kOhm
9	RESERVE1 H	IN	Digital CMOS	100 kOhm
10	RF OK L	OUT	Digital CMOS	2,2 kOhm
11	MODE1 H	IN	Digital CMOS	
12	RANGE0 H	IN	Digital CMOS	100 KOhm
13	EP2 H	IN	Digital CMOS	100 KOhm
14	-24 V	IN	*	Speisung/supply
15	+24 V	IN	*	Speisung/supply
16	+24 V	IN	*	Speisung/supply
17	0 V	IN	GND	10 Ohm → Chassis
18	SCAN-	IN	0V	100 kOhm
19	0 V	IN	GND	100 Ohm
20	EP-	OUT	0..+/-16 V	47 Ohm
21	RESOL-	IN	0V	100 KOhm
22	SCREEN	---	GND	33 Ohm → Chassis
23	MODE2 H	IN	Digital CMOS	100 kOhm
24	RANGE1 H	IN	Digital CMOS	100 kOhm
25	RESERVE2 H	IN	Digital CMOS	100 kOhm

* See SPECIFICATION for values

Note: "Digital CMOS" means the following potentials:

L level : 0...+0.75 VDC
H level : +11.0 .. +12.7 VDC

broken signal line establishes L level

SCAN, RESOL and EP can carry a superposed common mode signal of max. ±20 V.

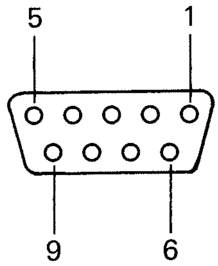
However, for precise measurements and to hold to the values given in the specification, the common mode signals must be kept low, max. ± 0.5 V_p for SCAN +/−

The 0 V line must not deviate more than ± 0.5 v_p from the chassis potential.

A 2.2 Connector EP1 (FARAD), EP2 (SEM)

Connection: 2 electrometer preamplifiers
Type of connector: 9 pole D-sub/recepticle

Contact arrangement



View from the recepticle side.

Pin	Signal	Input/ Output	Pegel/Level	Impedance
1	EP GND	OUT	0V	(47 Ohm)
2	+16 V	OUT	+16V +/-0,2V	27 mA max
3	0V EP	IN	EP GND	1 kOhm → Chassis
4	-16 V	OUT	-16V +/-0,2V	12 mA max
5	EXP5 L	OUT	Digital	22 kOhm
6	EP OUT	IN	0..+/-16,2 V	(0 Ohm)
7	SCREEN	---	Chassis GND	0 Ohm → Chassis
8	EXP7 L	OUT	Digital	22 kOhm
9	EXP9 L	OUT	Digital	22 kOhm

Note: "Digital" means the following potentials:

L level : 0..+0.75 VDC
H level : +16.5 ...+17.0 VDC

External pull-up resistor > 5 kOhm to +16 V.

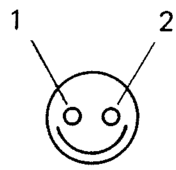
The signal levels are referenced to 0 V EP.
0 V EP common mode range is max. ±20 V to the chassis potential.

The pins in both connectors(with the exception of EP OUT and EP GND) are connected in parallel.

A 2.3 Connector FA

Connection: Field axis voltage connection
Type of connector: 2 pole, Fischer

Contact arrangement



View from the recepticle side

Pin	Signal	Input/ Output	Pegel/Level	Impedance
1 2	FA n.c.	IN ---	max. +/-500V ---	10 kOhm + 9 MOhm ---

Housing connects cable screen used as signal return to the chassis

A 2.4 Connectors RF+,RF-

Connection: RF voltage connection
Type of connector: Coaxial, SHV

Signal	Input/ Output	Pegel und Last siehe SPEZIFIKATION Level and load see SPECIFICATION
RF+ bzw. RF-	OUT	angepasste Last erforderlich matched load required

Housing connects the cable screen to the chassis.

A 2.5 Control signal functions and codings

Signal	Pegel/Level	Funktion des HF-Generators QMH Function of RF generator QMH
SCAN+/-	0..+10,24 V	MASS = (SCAN/10,24V) x M max
RESOL+/-	0..+10,24 V	ΔM = [(RESOL/10,24V) x ΔM max] + ΔM min
EP+/-	0..+/-10 V	INTENSITY = (EP/+10,0V) x RANGE *

* applies for EP 112

The values for M max., ΔM max and ΔM min are given in the SPECIFICATION for the mass range and for the programmable constant peak width ΔM.
To conform to the data, the signals must not exceed the following error tolerances(referenced to FSD full scale deflection):

Signal	Nullpunkt/Offset	Verstaerkung/Gain	Linearity
SCAN+/- RESOL+/-	0,02 % 0,2 %	0,1 % 1 %	0,01 % 1 %

Signal	Code		Funktion des HF-Generators QMH Function of RF generator QMH
RANGE ..	1 H	0 H	RANGE: (EXP of EP Electrometer) *
	L L H H	L H L H	10^{-5} A 10^{-7} A 10^{-9} A 10^{-11} A
EP2 H	L H		EP1, FARAD Electrometer selected EP2, SEM Electrometer selected
MODE ..	2 H	1 H	MODE function:
	L L H H	L H L H	STANDBY, not used in QMH 400 INTEGRAL (DC component off) SPECTRUM (DC component on) RF OFF (overrides SCAN)
RF OK L	L H		QMH operation ready QMH operation not ready
RESERVE1 H RESERVE2 H	L/H L/H		reserved for future use reserved for future use

* applies to EP 112