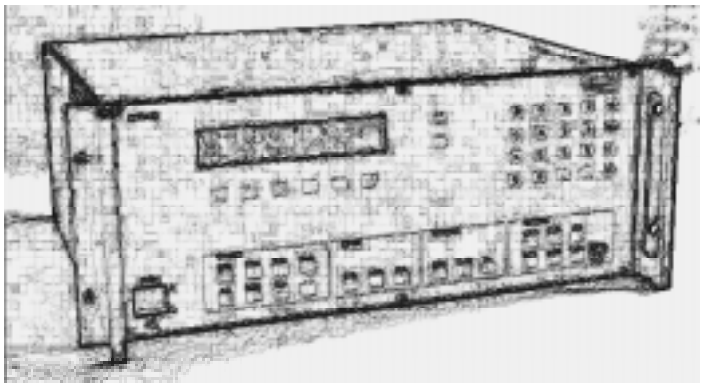
balzers
Instruments

Quadrupole mass spectrometer system

QMG 422



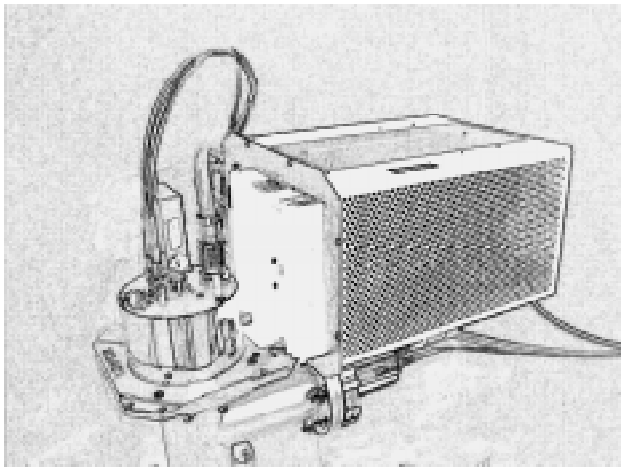


Table of contents

Validity

This document applies to QMG 422 systems with QMS 422 and QMI 422 control units equipped with the modules listed on page 56, some of which come with their own operating instructions.

It is valid for firmware numbers:

DSP / PRG No. **BG 509 732 -..**
QMS / PRG No. **BG 509 733 -..**
CS 422 / PRG No. **BG 509 734 -..**

The above numbers can be read out with *config-TEST* or the Balzers Quadstar™ 422 software. The letter (A...Z) at the end of the number represents the modification index which indicates the firmware level. This operating manual remains valid as long as only the index changes. In most cases the function is enhanced but also additional functions may be included that are not described in this edition.

We reserve the right to make engineering changes without notice.

1 Safety

1.1 Symbols used

DANGER

Information on preventing any kind of personal injury.

WARNING

Information on preventing extensive equipment and environmental damage.

Note

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

Skilled personnel

Instructions marked with this symbol may only be carried out by persons who have suitable technical training and the necessary experience to do it safely

italic-ITALIC:ITALIC *Function-PARAMETERNAME:PARAMETERVALUE*
Example: *mass-FIRST:12* (starting mass 12 of the mass scan)

1.2 Intended use

The QMG 422 is a mass spectrometer designed for gas analysis in the high vacuum range. It may be used only for this purpose. The instructions in this user's guide and in those of the accessories must be conscientiously followed.

DANGER

The QMG 422 is not intended to produce measurement results on which the safety of persons or large assets depend. For such applications the safety must be ensured by additional measures.

1.3 Safety information

Adhere to the applicable regulations and take the necessary precautions for the process media used.

When returning products that have been exposed to the vacuum for maintenance or repair, enclose a declaration of contamination (form VDMA No. 2121).

Adhere to the forwarding regulations and prescriptions of the countries and forwarding agencies concerned.

Before handling any used instruments or components, find out whether they are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

Pass on the safety information to other users.

1.4 Liability and warranty

Balzers assumes no liability and the warranty becomes null and void if the custo - dian or third parties

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

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

1.5 Courses

Courses

Balzers offers application, operating and maintenance courses for the best use of this product. Please inquire with your local Balzers partner.

2 Overview

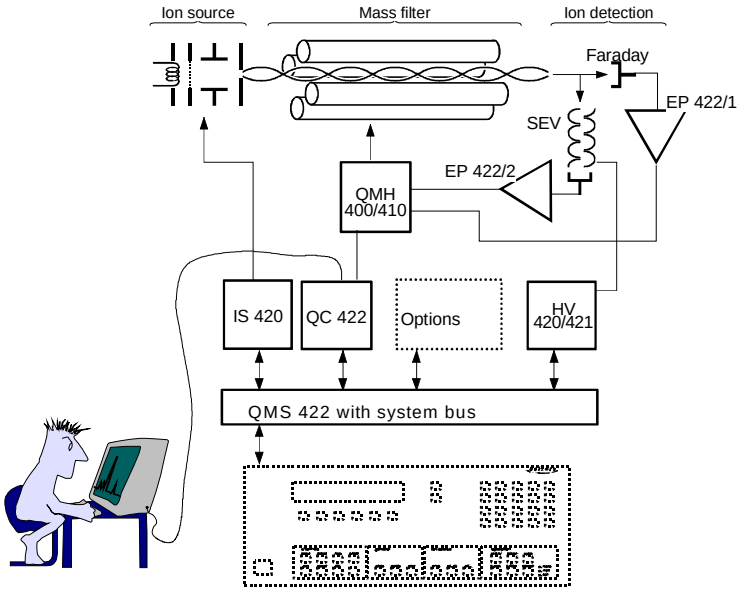
Basic information on the quadrupole mass spectrometer can be found in [1].

The QMG 422 comprises two equipment families:

Family 400

In the family 400 the analyzers QMA 400 and QMA 430 (8 mm rod diameter) and QMA 410 (16 mm rod diameter) and the HF generators QMH 400/410 with mass ranges of 128 to 2048 u are used.

400 This symbol refers to information that is applicable only to Series 400 components.



For an explanation of the abbreviations see Sections 2.3 to 2.7

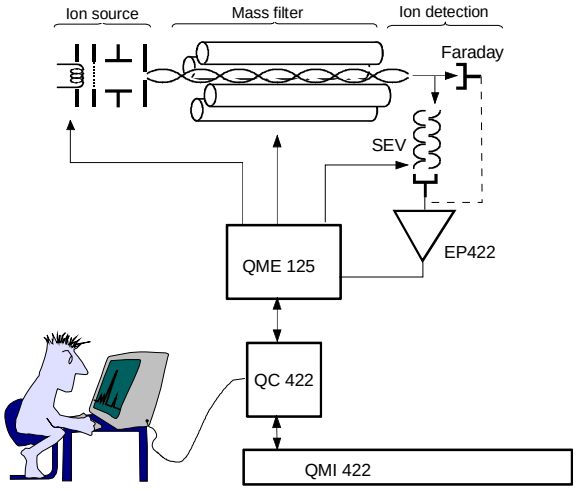
For ion counting the CP 400 ion counter preamplifier rather than the EP422/2 electrometer is used.

With a QMI 422 rather than QMS 422 no system bus, IS 420 ion source supply, HV 420/421 high voltage supply and options are available.

Family 125

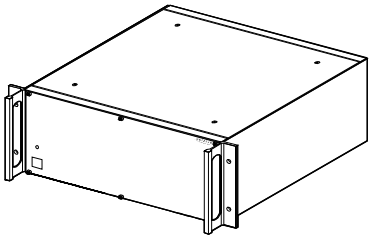
The family 125 uses the QME 125 mass filter electronics with the mass ranges 100 and 200 u and QMA 125 analyzers with 6 mm rod diameter.

125 This symbol refers to information that is applicable only to Series 125 equipment



With QMS 422 rather than QMI 422 the system bus and consequently the options are also available for this family.

2.1 QMS 422 control unit

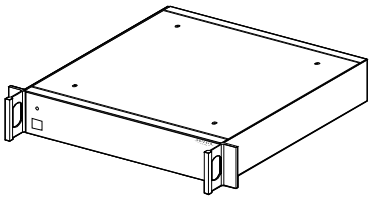


The basic unit comprises the power supply, QC 422 quadrupole controller and the system bus.

For family 400 components the IS 420 and HV 420 or HV 421 are installed.

Input/output modules can be installed in either family.

2.2 QMI 422 control unit

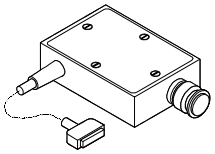


The QMI 422 comprises the power supply and QC 422 quadrupole controller and allows computer operation of family 125 equipment.

QMH/QMA 400 can be operated, but without ion source and SEM supply.

The only option available is the AO 421 analog output or IC 421 ion counter.

2.3 EP 422 Electrometer preamplifier



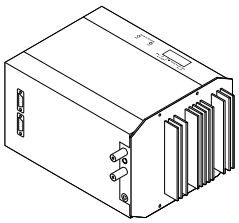
The EP 422 amplifies the very small ion current signals of the analyzer to voltage levels that are suitable for further processing. It is installed directly on the analyzers in order to minimize parasitic noise.

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

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

2.4 Family 400 components

QMH 400/410

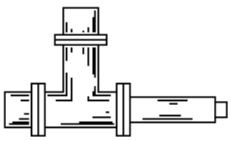


The HF generator produces the high-frequency voltage required for mass separation. [3]

QMH type	Range [u]	QMA type	Rod ø [mm]
QMH400-1	128	QMA410	16
QMH400-5	300	QMA430	8
QMH400-5	512	QMA400	8
QMH410-1	1024	QMA400	8
QMH410-2	2048	QMA400	8
QMH410-3	340	QMA410	16

Note: In the following QMH 400 or QMA 400 always refers to all types if nothing else is specified.

QMA 400



The 400 analyzer comprises the ion source, mass filter, ion collector and housing. [5]

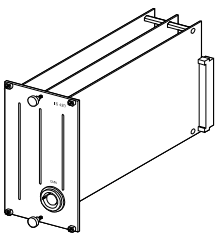
Ion collector types:

SEM 217: 90° off-axis with integrated Faraday

SEM 218: 90° off-axis with integrated Faraday and separate conversion dynode CD

On request: Faraday collector only

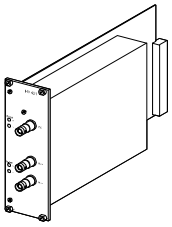
IS 420



The ion source supply is installed in the QMS 422. and supplies the ion source with the necessary operating voltages.

- Programmable potentials, short-circuit-proof.
- Polarity reversible for positive and negative ions
- Normal mode/degas mode
- Suitable for all ion source type of the QMA 400

HV 420 / HV 421



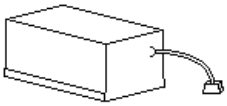
The high-voltage supply is installed in the QMS 422 and supplies the SEM with the necessary high voltage.

HV 420: For positive ions with SEM 217

HV 421: For positive and negative ions with SEM 217 or for positive ions with the separate conversion dynode of the SEM 218.

2.5 Family 125 components

QME 125

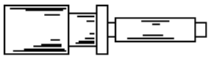


The mass filter electronics QME 125 [4] comprises the ion source supply, high frequency generator and SEM high voltage supply.

QME 125-1: Mass range 100
QME 125-2: Mass range 200

A special version with 6 m cable between QME 125-1 and QMA 125 is available.

QMA 125

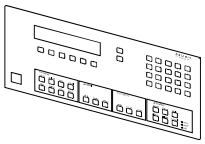


The QMA 125 analyzer [6] comprises the ion source, mass filter, ion collector and housing.

3 Ion collector types are available:
Faraday, Faraday/Channeltron, 90° SEM

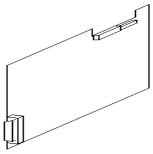
2.6 Options

CS 422



The operator console of the CS 422 is installed in the QMS 422 and allows manual operation.

AO 421 / IC 421

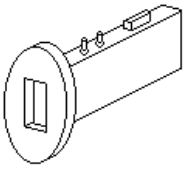


The AO 421 analog output supplies 12 analog signals. These can be measured values of the QC 422 or values calculated and transmitted by the PC.

In addition to the counter the IC 421 ion counter contains the 12 analog outputs of the AO 421.

It is installed directly (without system bus) into the QC 422.

CP 400



The ion counter preamplifier comprises the pulse coupling, amplifier and pulse height discriminator with adjustable threshold.

It is installed directly on the QMA with 90°off-axis SEM and is connected to the IC 421.

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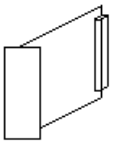
Input/Output

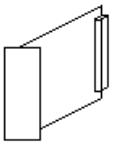


AI 421: 16 channel analog input module

DI 420: 32 bit digital input module

DO 420A: 32 bit digital output module

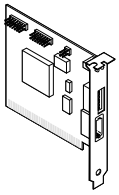
Vacuum measurement



PI 420: Dual Pirani module for coarse and fine vacuum [9]

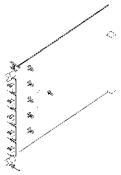
PE 420: Penning module for high vacuum [10]

OPA 200



OPA200 network controller board for the ARCNET® local area network (LAN). It is installed in the PC [7].

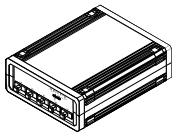
OH 421



5-Port optical hub (star distributor) for the ARCNET® local area network (LAN)

Up to 255 nodes can be cascaded

OHA 200



5 or 10 port optical hub (star distributor) for the ARCNET® local area network (LAN) [8].

3 Technical data

3.1 General

This information applies to all components unless specified otherwise.

Ambient conditions

Temperature	Storage: -40°... +65°C / Operation: +5°C ...+40°C
Relative humidity	max. 80% up to +31°C, decreasing linearly to 50 % at +40°C
Use	indoors, altitude up to 2000 m
Type of protection	IP 30: protection >2.5 mm against particles no protection against water

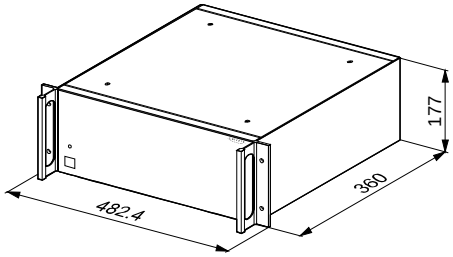
Standards

Safety	EN 61010-1: Protection class 1, pollution degree 2, overvoltage category II
EMC	EN 50081-2, EN 50082-2

3.2 QMS 422 control unit

Power: 90 ... 265 VAC, 47 ... 63 Hz, 300 W_{max}

Dimensions:



Weight: 9.6 kg with QC 422 (without additional modules)

Number of slots: Total 17, used by QC 422: 3

3.3 CS 422 operator console

Matching to QMS 422

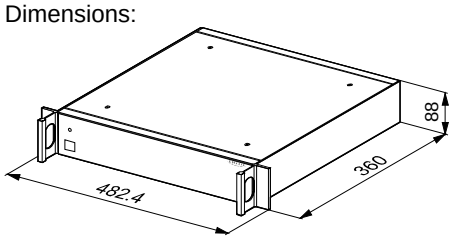
Backlit LCD display, 4 lines of 40 characters each, 5 status LEDs, membrane keyboard

Weight: 0.75 kg

3.4 QMI 422 control unit

Power: 90 ... 265 VAC, 47 ... 63 Hz, 200 W_{max}

Dimensions:



Weight: 6.5 kg with QC 422

3.5 QC 422 quadruple controller

Slots	3 (with and without AO 421 or IC 421)
Number per unit	1
Weight	0.67 kg without / 0.9 kg with AO/IC421
Number of measurement channels	64
Operating modes	*MONO* / *MULTI* channel
Measurement cycles	1 ... 10'000, or *REPEAT*
Channel switching time	1.5...3 ms (with min. *PAUSE*)

Mass scan modes

mass-*MODE*	Purpose
SCAN-N	Analog scan normal
SCAN-F	Analog scan with FIR filter for measured value
STAIR	Scan Bargraph
SAMPLE	Single mass and MID (Multiple Ion Detection)
PEAK-L	Peak search with level criterion
PEAK-F	Peak search with FIR FILTER

Mass scale resolution

	STEPS per mass 1)	
SPEED	*FIX*-Range	*AUTO*-Range
0.5... 1 ms/u	16/u	---
2 ...5 ms/u	32/u	---
10...20 ms/u	64/u[2)]	16/u
50...100 ms/u	64/u[2)]	32/u
0.2...60s/u	64/u[2)]	64/u[2)]

[1)] See STEPS page 36 [2)] 32 at mass range 2048

Measurement speeds

	EP 422 or ext. input		Ion counter
mass-*MODE*	*FIX*-Range	*AUTO*-Range	*AUTO*-Range
SAMPLE	0.5 ms ... 60 s	0.5 ms ... 60 s	1 ms ... 60 s
STAIR	0.5 ms/u ... 60 s/u	2 ms/u ... 60 s/u	2 ms/u ... 60 s/u
SCAN	0.5 ms/u ... 60 s/u	10 ms/u ... 60 s/u	20 ms/u ... 60 s/u
PEAK	0.5 ms/u ... 60 s/u	10 ms/u ... 60 s/u	20 ms/u ... 60 s/u

Detectors

detect-*TYPE*	
FARAD	Faraday collector, EP 422
SEM	SEM (type configurable), EP 422
ION-CNT	Ion counter, CP 400 / IC 421
EXTERN	External analog input of the QC 422
PIRANI	Pirani
PENNING	Cold cathode
A-INPUT	Analog signal via AI 421 module

Measurement ranges and resolution

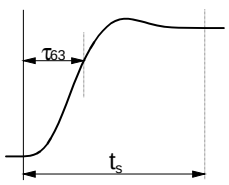
Detector type	Meas. ranges	Modes	Resolution
FARAD,SEM	10^{-12} ...10^{-5} A fsd	*FIX*- and *AUTO*-Range	16 bit * (per range)
EXTERN	GAIN 1: ±10.240V GAIN 10: ±1.024V	*FIX*-Range	16 bit *
ION-CNT	10-2...108 cps, meaning full use up to 106...107 cps	*AUTO*-Range	in mass-*MODE*: *SAMPLE*: 1/*DWELL* *STAIR*: 2u/*SPEED* *SCAN*: *STEPS/SPEED*

*) Further increased by averaging

Analog filter

Type	Two-stage lowpass, effective for electrometer and external input
Filter time constant	automatic or selectable in eight steps: 18 , 85 , 400 µs / 1.7, 8, 40, 180, 800 ms

Filter step response



τ_{63}: Filter time constant

Settling time to ±1‰:

$t_s \approx 4 \times \tau_{63}$

Digital filter

NORMAL (N)	Low pass (average value)
FIR (F)	Finite Impulse Response
AVERAGE	Average formed across several measurement cycles

Ion sources

400 — Also refer to p. 12

Types	Axial, cross beam, grid, sputter process monitor, Spec+, Spec-
Parameter sets	4 per ion source
Potentials	V1 ... V9

125 — Also refer to [4]

Types	Axial, cross beam, grid, sputter process monitor
Emission	Standard: 0.07 ... 2 mA; Degas: 0.7 ... 20 mA / 500 V

Switching functions

trip-TYPE: ABS	2 absolute switching functions per channel
trip-TYPE: HYST	1 hysteresis switching function per channel
Reaction time with DO 420A	<1 ms after measurement is completed

RS-232-C interface

Detailed description	Also refer to [2]
Measured data buffer	256 kB
Protocol	ASCII or binary protocol (according to SECS-1 standard) 1 start, 8 data, 1 stop bit, no parity
Connector	9 pin D-sub, see p.19
Baud rate	300*, 1200, 2400, 4800, 9600, 19200 baud
Cable length	≤ 15 m, shielded for baud rate 19200 baud > 15 m, shielded at reduced baud rate

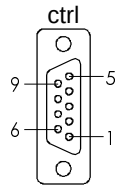
*) Only in conjunction with ASCII protocol

LAN interface

Type	ARCNET® with fiber optics
Connection	JIS F07 / TOSLINK
Type of fiber	PCF 200/230 or 200/300 or APF 980/1000 µm
Distance	See p.20
Baud rate	2.5 Mbit/s
Wavelength	800 nm
Length of fiber-optic conductor	0...1000m
Transmission distance	3000 m_{max} (cascaded)

Connections on QC 422

Connector **ctrl**



View towards QC
D-Sub, 9-pin female

Pin	
5	ELM OUT +
9	ELM OUT –
4	EXT IN –
8	EXT IN +
3	RUN IN
7	--
2	EXT PROT
6	GND D
1	GND D

Analog output of the electrometer signal
0 ... ±10,24 V, R_{out} : 2× 200 Ω, short-circuit proof

Analog input in place of electrometer signal.
± 10,24 V, common mode signal: ± 2 V_{max}, R_{in} = 2× 50 kΩ
see detect-*TYPE:EXTERN* page 37

Input for ext. measurement cycle start
TTL, int. pull-up 4.7 kΩ to + 5 V.
see cycle-*TRIG* page 36

Input for filament and SEM protection
TTL, int. pull-up 4.7 kΩ to + 5 V.
see config-*CTRL/SEM+FIL* page 35

RS 232
Serial interface, see p.19

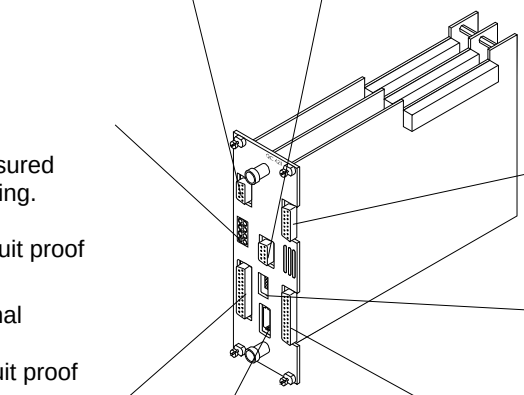
sync
Trigger signal for recording instrument
TTL, R_{out} >1 kΩ

elm
see above
connector **ctrl**: ELM OUT

mon (Monitor)
Analog output of the measured value after digital processing.
0 ... ±10,24 V
R_{out} : 2× 200 Ω, short-circuit proof

scan
Analog mass number signal
0 ... +10,24 V
R_{out} : 2× 200 Ω short-circuit proof

Laboratory sockets, ø 2 mm



CP (Option)
Connection for CP 400

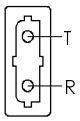
key
(not used)

AO (Option)
12 Analog outputs
0 ... ±10,24 V, 1mA_{max}
12-Bit, monotonic
Gain: ± 1.7%, Offset: ±21mV_{max}
Rout : 2× 200 Ω, short-circuit proof
Rise time: 10µs to 99%

QMH/QME
Connector for QMH 400/410 or QME 125

LAN
Fiberoptic network interface for high transmission rates and long distances

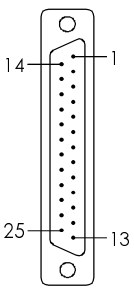
TOSLINK TODX 296, duplex
Typ JIS F07



T Transmit
R Receive

View towards QC

D-Sub
25 pin male



View towards QC

Pin		Pin	
1	CH 1+	14	CH 1–
2	CH 2+	15	CH 2–
3	CH 3+	16	CH 3–
4	CH 4+	17	CH 4–
5	CH 5+	18	CH 5–
6	CH 6+	19	CH 6–
7	CH 7+	20	CH 7–
8	CH 8+	21	CH 8–
9	CH 9+	22	CH 9–
10	CH 10+	23	CH 10–
11	CH 11+	24	CH 11–
12	CH 12+	25	CH 12–
13	open		

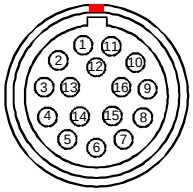
Important: For EMC reasons only shielded cables may be used on D-Sub connectors. The shield must be connected to chassis ground. The opposite end may not have a different ground potential.

3.6 IS 420 Ion source supply

Slots	5	
No. of IS 420 per unit	max. 1	
Supply	5 V / 0.6 A; ±24 V / 2 A (2.4 A with Degas)	
Fuses	F1, F2	See p.56
Filament supply	0...10 V / 5 A_{max} / 50 W_{max}	with Fil1+2: 1.4...2 V on Fil2
Filament modes	1 / 2 / 1+2 (1 in operation, 2 preheated)	
Protection	0...5 A	Resolution 10 mA
Emission normal	0...2 mA	Resolution 10 µA
Emission Degas	0...20 mA	Resolution 0.1 mA
Signal SPEC SRC ON	23 V / 70 mA	R_i = 110 Ω
Ion source cable	Connector PEEK +260°C	Cable SIR -25...+180°C
Weight	1.45 kg	

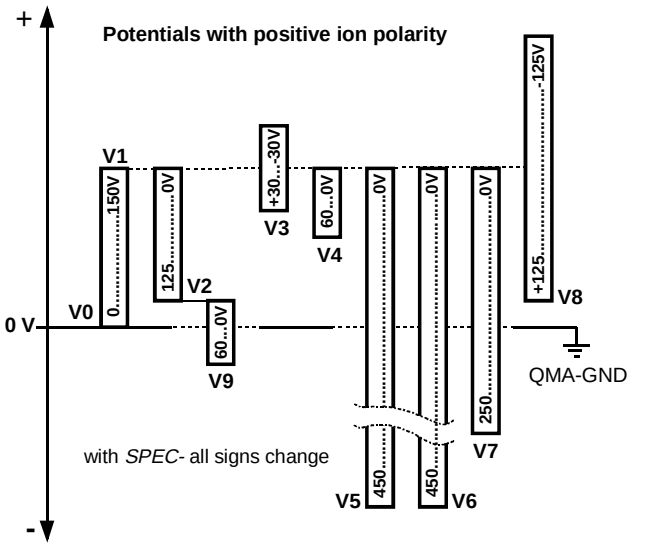
With ion src- *TYPE*:*SPEC*± and *EMISS:OFF* SPEC SRC ON becomes active. A relay for changing over the ion source lines can be actuated.

Connector towards IS 420



1	QMA GND	9	Filament common
2	SPEC SRC RET	10	V4, Field axis
3	V6, Deflection inner	11	V0, Ref.Gnd
4	V3, Focus	12	Screen
5	V9, Wehnelt	13	V8, Reserve
6	V5, Extraction	14	V1, Ionref
7	Filament +	15	SPEC SRC ON
8	Filament – / Cathode	16	V7, Deflection outer

	Electrode name	Ref. direction	Range [V]	Increm. [V]	Current [mA_{max}]	Degas potential to V0 [V]
V1	*IONREF*	V1-V0	0 ... 150	1	±2	+550
V2	*CATH*	V1-V2	0 ... 125	0.5	+2	+7
V3	*FOCUS*	V1-V3	-30...+30	0.25	±2	+550
V4	*F-AXIS*	V1-V4	0 ... 60	0.25	±0.5	0
V5	*EXTRACT*	V1-V5	0 ... 450	2	±0.1	0
V6	*DEF-I*	V1-V6	0 ... 450	2	±0.1	0
V7	*DEF-O*	V1-V7	0 ... 250	1	±0.1	0
V8	---	V1-V8	-125 ... +125	1	±0.1	0
V9	*WEHNELT*	V2-V9	0 ... 60	0.25	±0.1	+7



Voltage tolerances: ±1.8% of the value ±1‰ of the range

With *detect-TYPE*:*FARAD*, V6 and V7 are at QMA-GND.

V0 may be connected to an external potential of max. ±200 VDC to GND.

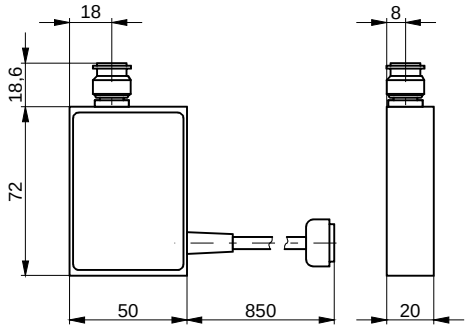
DANGER

The external voltage source for V0 must be reliably limited to 2 mA_{max} and isolated for 750 V.

The relay connected to SPEC SRC ON and SPEC SRC RET incl. lines must be isolated for 750 V and be protected against accidental contact.

3.7 EP 422 Electrometer

Interface to	QMH 400/410, QME 125
Voltage supply	± 16 VDC, ± 0.2 V / 10 mA_{max} / ripple 10 mV_{max}
Output	± 10 V / 2 mA_{max}
Input impedance	100 kΩ
Input connector	Type TNC
Output connector	D-Sub 9-pin
Temperature	Operation: 0 ... 50°C, Storage: -40 ... +70°C
Weight	150 g



Measurement range	Sensitivity	Tolerance at 25 °C	Rise time 10...90 %	Offset at 25 °C
$\pm10^{-5}$ A	10^{-6} A / V	± 1 %	50 µs	± 0.5 mV
$\pm10^{-7}$ A	10^{-8} A / V	± 1 %	90 µs	± 0.5 mV
$\pm10^{-9}$ A	10^{-10} A / V	± 2 %	1.9 ms	± 2 mV
$\pm10^{-11}$ A	10^{-12} A / V	± 2 %	2.6 ms	- 50...+ 150 mV

Drift	Offset doubles with each 10°C of temperature increase
Noise	typ. 2×10^{-13} A_{pp} unfiltered

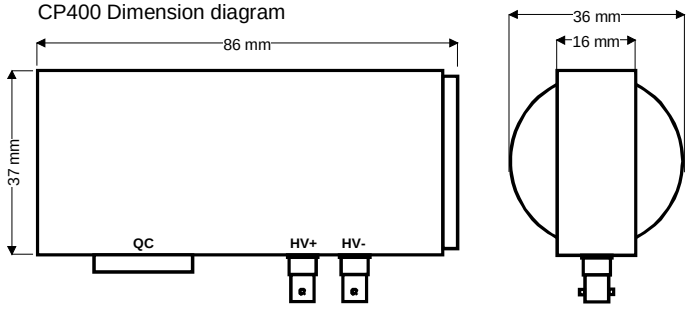
3.8 CP 400 Ion counter preamplifier

Input	Installed directly on SEM feed-throughs of the QMA Pulse width 10 ns_{typ} / pulse height 1...5 mV Impedance 50 Ω / double pulse resolution ≤20 ns Protection against arcs in SEM with HV 420/421, QME 125
High voltage	SHV connector HV+ and HV- HV+: 6.7 kV to GND HV–: 6 kV to GND SEM: 3.5 kV between HV+ and HV–
Output	ECL level complementary
Discriminator threshold	Control voltage LEVEL+ to LEVEL– 0.1...1 V corresponds to pulse height 1...5 mV; common mode ±0.5 V_{max}

QC connector D-Sub 15 male				
	Pin 1	QMA-GND	Pin 5	V+ (+12...15V / 0.12 A)
	2	Identification	6	LEVEL–
	3	OUT–	7	LEVEL+
	4	OUT+	8	V– (-12...15 V / 0.05 A)
			9...15	not connected

Weight	0.5 kg

CP400 Dimension diagram



3.9 HV 420 High voltage supply

Slots	2	
Number per unit	max. 1	not simultaneously with HV 421
Supply	5V / 0.4 A ; +24V / 0.15 A ; -24 V / 0.05 A	
Fuse F1	See p.56	
SEM voltage HV-	0...-3500 V	Resolution 1V, ripple < 10mV$_{pp}$
Admissible load	15 MΩ	Current limitation < 1mA
Internal resistance	620 kΩ	
Settling time	0.8 s to 0.1%	
HV connector	SHV	Signal ground from QMA via HV cable
HV test connection	1 V pro 1 kV	R_i = 2 kΩ
Potential isolation	0.5 V_{max}	Between chassis and QMA-GND
Weight	0.42 kg	

3.10 HV 421 High voltage supply

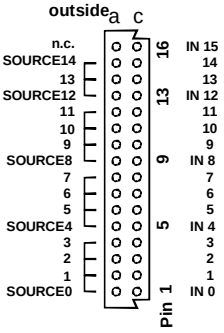
Slots	3	
Number per unit	max. 1	not simultaneously with HV 420
Supply	5V / 0.2 A ; +24V / 0.2 A ; -24 V / 0.2 A	
HV connector	SHV	
SEM voltage HV–/HV+	0 (-750[1])...-3500V	Resolution 1V, ripple < 10mV$_{pp}$
Admissible load	17 MΩ	Current limitation 0.8 mA
Settling time	< 0.7 s	to 1%
CD voltage to GND	-6300 V	Adjustable -4.7...-6.4 kV Ripple < 10mV$_{pp}$
Admissible load	100 MΩ	Current limitation < 0.5 mA
Bias voltage HV–	+3.1 / -3.1 kV	For *SPEC– / SPEC+* adjustable 2.4...3.2 kV
Test terminals	1 V per 1 kV	CD Test also for HV–
Weight	1.7 kg	

[1] In *SPEC+* mode

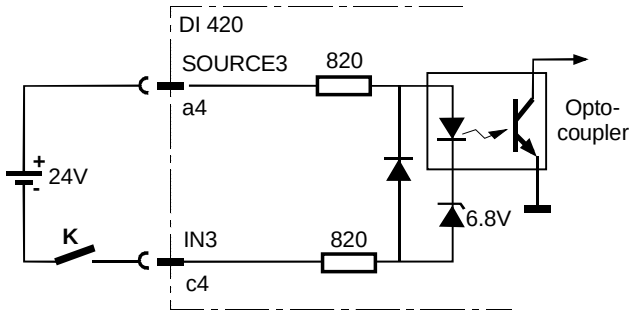
3.11 DI 420 Digital Input

Slots	1
Number per unit	max. 2
Supply	5V / 0.45 A
Number of inputs	32
Input signals	24 VDC ±25% / 10 mA, low true
Switching threshold	10.6...16 V$_{typ}$
Insulation	30 V$_{eff}$ / 60 VDC to GND and between input groups
Protection	+35 V / -30 V continuous; 100 V max. 1s
Connector	2, 16 inputs each, 32-pin DIN 41612 type C/2
Weight	0.24 kg

J1/J2 pin assignment viewed from outside



Example: Input N3 controlled with contact K

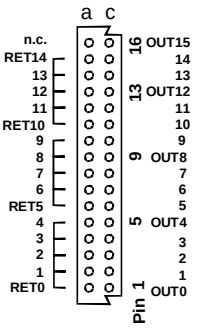


SOURCE0..3 / 4...7 / 8...11 / 12...15 are internally connected, common plus poles of the 4 insulated input groups. SOURCE15 has no pin of its own.

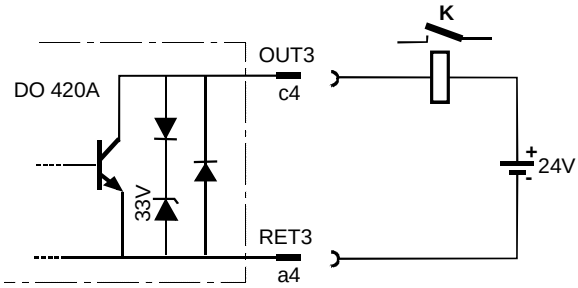
3.12 DO 420A Digital Output

Slots	1
Number per unit	max. 3
Supply	5V / 0.4 A
Outputs	32, open collector Darlington drivers
Output signal	max. 28 VDC / 100 mA, U_{sat}<1.7 V @ 100 mA, low true
Protection	Zener diode 33V/1W and parallel diode 1A
Insulation	30 V_{eff} / 60 VDC to GND and between groups
Connector	2, 16 outputs each, 32-pin DIN 41612 type C/2
Weight	0.24 kg

J1/J2 pin assignment viewed from outside



Example: Relay control with output OUT3

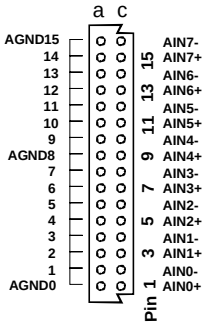


RET0..4 / 5...9 / 10...15 are internally connected, common negative poles of the 3 insulated outputs groups. RET15 has no pin of its own.

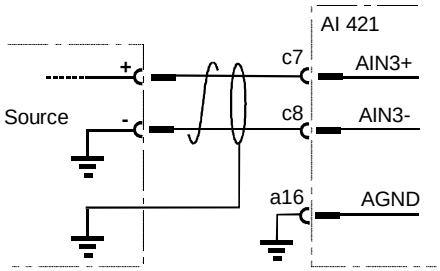
3.13 AI 421 Analog Input

Slots	1
Number per unit	max. 1
Supply	5V / 1 A
Inputs	16, differential, I_{in} < ±150 nA @70°C
Measurement range	-10.24...+10.235 VDC, linear -10.0...+10.0 V
Resolution	12 bit monotone
Accuracy	±0.1% FSR
Measurement interval	40 ms for all 16 inputs
Protection	70 V to AGND, max. 8 inputs simultaneously
Insulation	30 V_{eff} / 60 VDC between AGND and GND
Connector	2, 8 inputs each, 32-pin DIN 41612 type C/2
Weight	0.3 kg

J1/J2 pin assignment viewed from outside



Example: Connection to input AIN3



Analog ground AGND must be connected to an admissible potential (see above "Insulation"), preferably to ground.

The cable must be shielded. Ground the shield, but not to AGND.

Twisted-pair conductors for each input provide the best signal-to-noise ratio. Open inputs produce unpredictable values.

3.14 OH 421 Optical Hub

Slots	1
Number per unit	any
Voltage supply	+5 V ±2,5%, 200 mA typical
Connection points	5
Optical interfaces	See page 10
Weight	0.17 kg

4 Installation

4.1 QMS/QMI 422

DANGER

Before you connect the equipment make sure that the line voltage corresponds to the specifications on the nameplate.

A 3-conductor power cable with protective ground must be used.

The power outlet must have a protective ground contact.

Extensions without protective ground conductor are inadmissible.

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

Do not yet switch on the equipment!

WARNING

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

The air filters inside the unit should be periodically checked and serviced (refer to page 55).

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

4.2 Overall system

Install peripheral components such as the analyzer, QMH 400/410, QME 125 etc. in accordance with the information in the respective user's guides.

All components involved must be grounded to a single point. Utilization of a single power distributor is recommended. The only exception is the computer, but only if it is connected to the QC 422 by means of a fiber-optic link.

Skilled personnel

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

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

- Mech. protection against contact
- Forced disconnection of the QMS/QMI 422 line voltage by means of a door contact

The electrode system of the QMA must not be subjected to hazardous external voltages (from contact, arcing, plasma, ion or electron beams, etc.). If such danger hazards in the vacuum system appropriate protection measures must be taken there (arrangement, shielding, grounding, etc.) that reliably preclude such influences. In addition the QMS/QMI 422 must have a permanent ground connection (no plug!). On the QMS 422 the ground terminal is located behind the power inlet, on the QMI 422 there is an M4 thread on the rear panel. Prepare this ground connection from yellow/green stranded copper wire:

- 2.5 mm^2 if mech. protected (according to DIN VDE 110 T540)
- 4.0 mm^2 if unprotected

Also refer to the standards applicable to your system.

Skilled personnel

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

4.3 EP 422

Connect the EP 422 to the corresponding connector on the QMA. Position it in such a way that it does not touch the surrounding connectors and firmly tighten the knurled nut.

Connect the control cable to the **EP** connector of the QME 125 (see p.19) or the **ep1** or **ep2** connector (see p.18) of the QMH 400. Lock the connector with the slide.

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

The Teflon cable (max. 200°C, see p.56) allows remote operation if the temperature on the QMA is too high. The EP 422 must be mounted outside the hot area (M3 threads on the housing). The cable must not be subjected to vibrations. Increased noise levels must be expected.

125 The same applies for the QME 125-1 with 6 m cable length, however the maximum cable temperature is 70°C.

4.4 CP 400

DANGER

The CP 400 may not be operated with a high voltage supply that can deliver hazardous voltages or currents.

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

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

Note

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

Remove the SEM connector plate of the QMA, see [5], [6].

Remove the 6 screws A and the cover of the CP 400.

Unfasten the 3 screws C so that the full cross-section of the sockets is exposed. Caution, do not lose the screws!

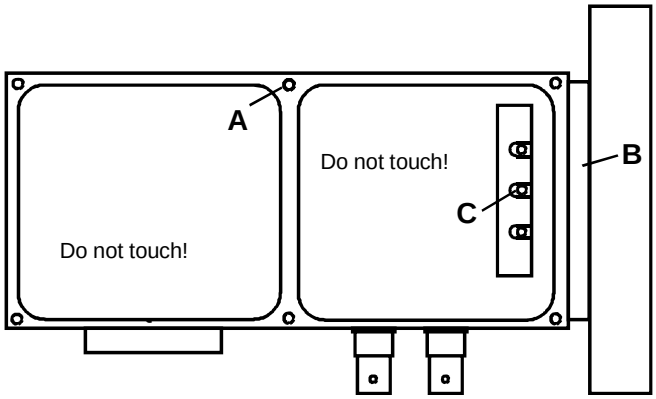
Carefully slide the CP 400 over the feedthroughs; the latter must not be stressed because they can break!

Fix the CP 400 with the 4 screws B.

Tighten the 3 screws C.

Fasten the cover with all 6 screws A including washers.

For conversion to EP 422 operation perform the above steps in reverse order.



4.5 Cabling with QMA 400

Cable the system in accordance with the following tables
Short TNC and short SHV = short circuit plugs

1. Faraday cup

Configuration config-SYSTEM-DETECT:FARAD

Module	Connector	Connection	l [m]	Module	Connector	Comments
QC422	QMH	control cable QMH	3	QMH	(QC)	Optional extension 7m
IS420	QMA	Ion source	3	QMA	IS	or 10m
QMH	RF+ RF–	Radio frequency	0.7	QMA	RF A RF B	Polarity see test report
QMH	FA	Field axis	0.7	QMA	FA	
EP422	Input	Meas. signal	---	QMA	EP(FARAD)	
	---	control cable	0.8	QMH	ep1/farad	

2. SEM 217, HV 420 or HV 421

In addition to 1. Configuration config-SYSTEM-DETECT:SEM

Module	Connector	Connection	l [m]	Module	Connector	Comments
HV42x	HV–	High voltage	3	QMA	HV–	or 10 m
HV421	HV+	short SHV	---	---	---	
	CD	remains open				
---	---	short HV	---	QMA	HV+	
EP422	Input	Meas. signal	---	QMA	EP(SEM)	
	---	control cable	0.8	QMH	ep2/sem	
		short TNC	---	QMA	EP(FARAD)	if only 1 EP

3. SEM 218 (CD-SEM)

In addition to 1. Configuration config-SYSTEM-DETECT:CD-SEM

Module	Connector	Connection	l [m]	Module	Connector	Comment
HV421	CD	High voltage CD	3	QMA	CD	or 10 m
	HV–	High voltage	3	QMA	HV–	or 10 m
	HV +	short SHV	---	---	---	
EP422	Input	Meas. signal	---	QMA	EP(SEM)	
	---	control cable	0.8	QMH	ep2/sem	
		short TNC	---	QMA	EP(FARAD)	if only 1 EP

4. SEM 217, HV 420 and ion counter

In addition to 1. Configuration config-SYSTEM-DETECT:SEM

Module	Connector	Connection	l [m]	Module	Connector	Comments
HV420	HV–	High voltage	3	CP400	HV–	or 10 m
---	---	short SHV	---	CP400	HV+	
		shrot TNC	---	QMA	EP(FARAD)	if no EP
QC422	CP	control cable	3	CP400	QC	or 10 m

5. SEM 218, HV 421 and ion counter

In addition to 1. Configuration config-SYSTEM-DETECT:H-SEM

Module	Connector	Connection	l[m]	Module	Connector	Comments
HV421	CD	remains open				
	HV–	High voltage	3	CP	HV–	or 10 m
	HV+	High voltage	3	CP	HV+	or 10 m
		short TNC	---	QMA	EP(FARAD)	If no EP
QC422	CP	control cable	3	CP400	QC	or 10 m

4.6 Cabling with QMA 125

Note

The **polarity** switch on the QME 125 must be in the "+" position

1. Faraday cup

Configuration config-SYSTEM-DETECT:FARAD

Module	Connector	Connection	l [m]	Module	Connector	Comments
QC422	QME	control cable QME	3	QME	QMS	or 10/20 m
QME	QMA	Analyzer	0.2	QMA	QME	ev. 6 m
EP422	Input	Meas. signal	---	QMA	EP	ev. 6 m
	---	control cable	0.8	QME	EP	

2. Channeltron

In addition to 1. Configuration config-SYSTEM-DETECT:CH-TRON

Module	Connector	Connection	l [m]	Module	Connector	Comments
QME	HV -	High voltage	0.3	QMA	HV -	ev. 6 m

3. 90° SEM

In addition to 1. Configuration config-SYSTEM-DETECT:SEM

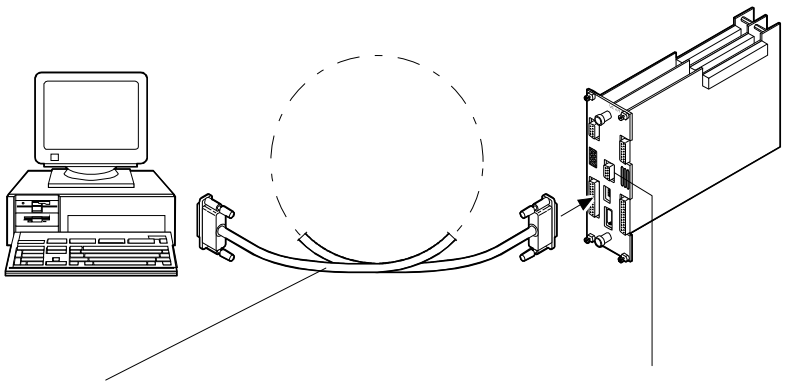
Module	Connector	Connection	l [m]	Module	Connector	Comments
QME	HV -	High voltage	0.3	QMA	HV -	ev. 6 m
EP422	Input	Meas. signal short TNC	---	QMA	EP(SEM) EP	in SEM mode
EP422	Input	Meas. signal short TNC	---	QMA	EP EP(SEM)	in Faraday mode
	---	control cable	0.8	QME	EP	

4. 90°SEM and ion counter

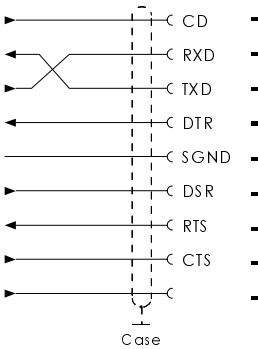
In addition to 1. Configuration config-SYSTEM-DETECT:SEM

Module	Connector	Connection	l [m]	Module	Connector	Comments
QME	HV -	High voltage	0.3	CP	HV -	ev. 6 m
		short SHV	---	CP	HV +	
QC422	CP	Ion counter	3	CP	QC	
EP422	Input	Meas. signal	---	QMA	EP	
		short TNC	---	QMA	EP	without EP422
d.o	---	control cable	0.8	QME	EP	

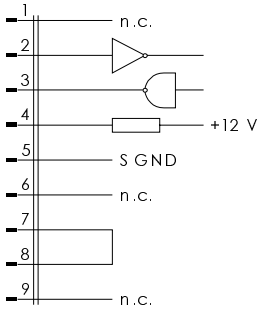
4.7 RS-232-C interface



RS-232-C Link cable 9-pin (Null modem)

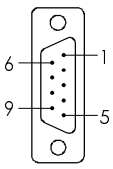


Circuit in QC 422



D-Sub connector

9-pin, male



Front view of QC

Pin assignment

1 not connected
2 Received Data
3 Transmitted Data
4 Data Terminal Ready
5 Signal Ground
6 not connected
7 Pin 8
8 Pin 7
9 not connected
Case=shield

4.8 LAN interface

Configuring the transmission distance

On the QC 422 check the setting of jumper X20 and correct it, if necessary. Installation/removal of QC 422 see p.23

X20 determines the **Transmission power**, it is determined by the **receiver of the remote station** and the type of fiber-optic (FO) conductor..

The factory default setting **medium** provides a broad compatibility range when old and new FO modules are mixed.

Procedure:

Determine the length and type of the FO conductor (glass fiber PCF or plastic fiber APF).

Determine the FO module types to be interconnected:

Modules with serial number: ....W.... or higher ("W" is increased annually) are equipped with the new FO module type (applies to all component types)

In case of doubt (e.g. after a module has been replaced) open the unit and read off the FO module type, that is, No. TODX 29? on the FO connector.

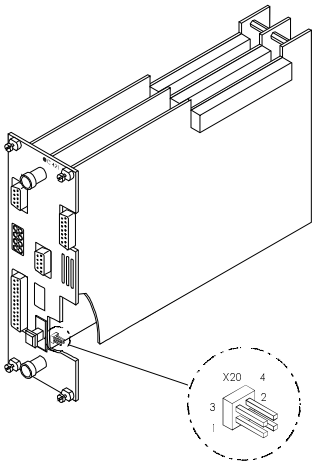
This is necessary because the receivers of earlier LAN modules can be overdriven in short distances, with the new modules this is no longer the case.

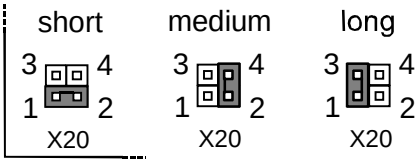
Set jumper X20 on the **transmitter side** as shown in the table and the diagram:

Setting X20	New FO module TODX 296	Old FO module TODX 294	Old PC interface with SMA connectors
short	0...500 (0...1.4) m	0...150 (0...1.2) m	not allowed
medium *)	0...750 (0...2.2) m	0...400 (0...2.0) m	0...50 m
long	0...1000 (0...3.0) m	400...700 (0...3.0) m	0...300 m

These values apply to PCF glass fibers, the values in (...) for APF plastic fibers.

*) Factory setting



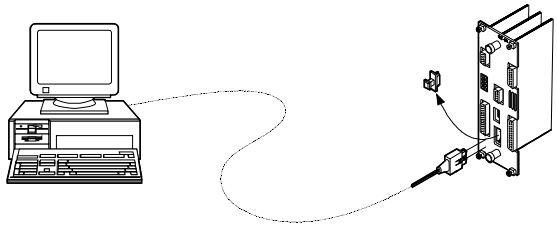


In case of transmission problems test the adjacent setting in order to compensate possible atypical attenuation of the FO conductor.

Cabling PC-QMG

Install the PC interface board into the PC according to its Operating manual.

Remove the protective caps from the fiber optic connectors and establish the fiber optic link.



WARNING

Do not kink the fiber optic conductor. The minimum bending radius is 15 mm !

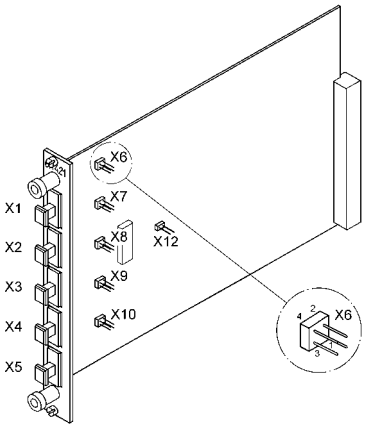
OH 421

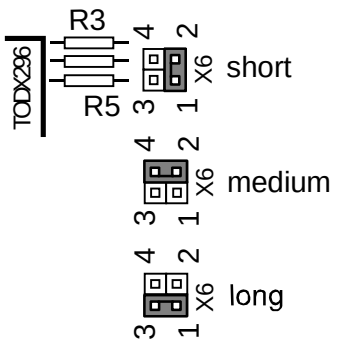
Installation/removal, see p. 23, there is no address setting.

Settings:

Jumper	Function	Purpose
X12: IN *)	Central hub	First hub directly linked to the PC FO connectors X1...X5 are peer-to-peer
X12: OUT	Expansion hub	Connected to other hub Connect X1 always in the direction toward the PC! FO connectors X2...X5 are peer-to-peer
X6...X10	Transmitter distance setting for connectors X1...X5 For FO lengths refer to table on page 20	

*) OH 421 No. BG 442 455-T without X12 can only be used as central hub.



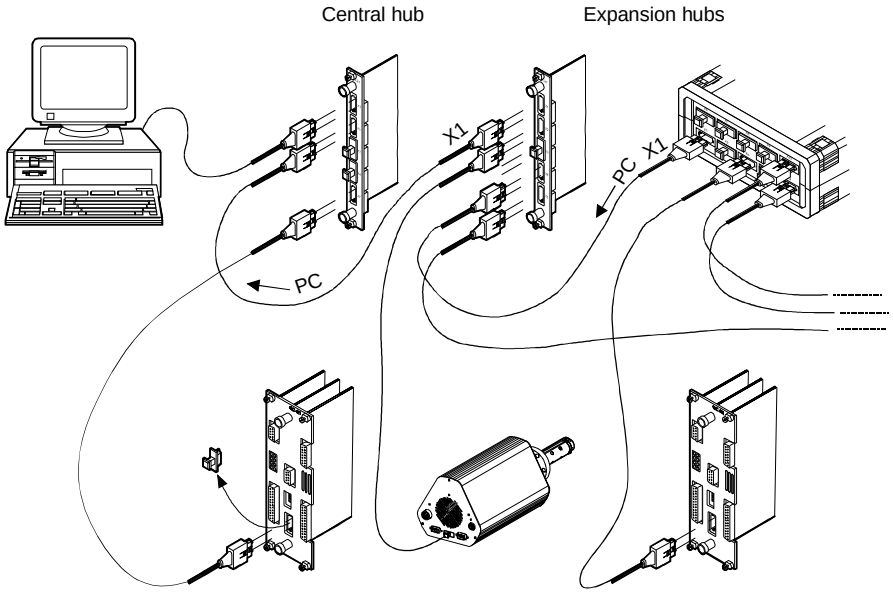


X7...X10 same as X6

Network

Note

Unused FO connectors should always be closed off with a dummy plug to prevent disturbance by parasitic light.



QC 422, QC 421, QMS 200, OH 421, OHA 200, OH 200 and OPA 200 are compatible.

Note the technical specifications concerning FO conductor lengths and total transmission distance.

Set up all transmitters according the table on page 20.

The 1st hub must be configured as the central hub, all others as expansion hubs.

4.9 Installing/removing options

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

Skilled personnel

Work on open equipment may only be performed by specialists.

Switch off the unit before any manipulations on the equipment. Wait 10 s and detach all cables (power cable last). For commission perform these steps in reverse order.

WARNING

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

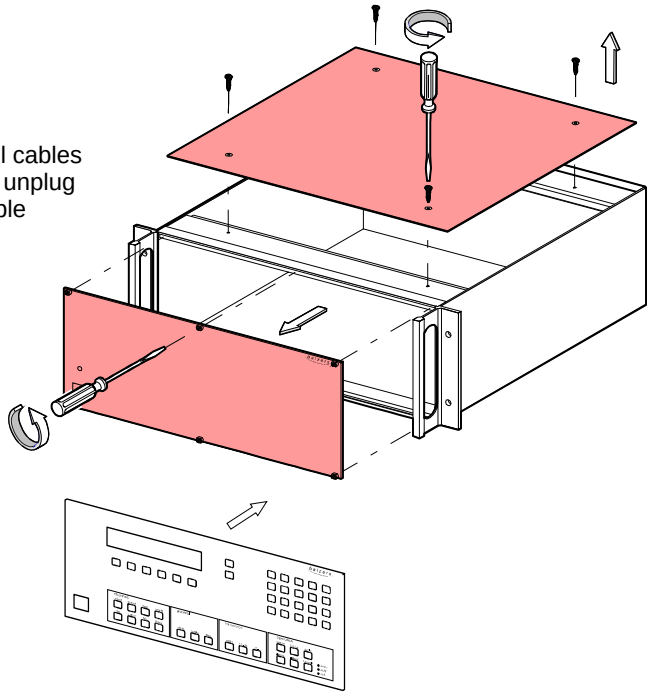
The modules should always be stored in antistatic bags.

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

CS 422

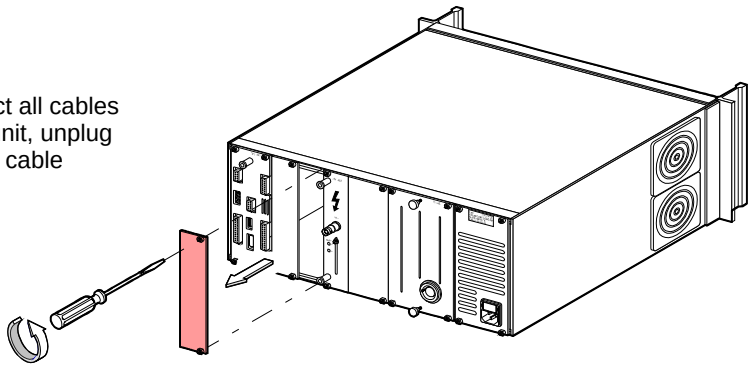
1. Detach the power plug on the QMS 422, wait 10 s
2. Remove the cover panel
3. Unfasten 6 screws of the front panel.
4. Detach the electrical connections of the front panel:
   - Ground connection
   - Flat-pin terminal on the power switch (note the pin assignment)
   - LED connection of the bus board (connector J20)
5. Establish the electrical connections on the CS 422:
   - Ground connection (sequence: head of screw, lock washer, plain washer, cable lug, plain washer
   - Wiring to the power switch, same pin assignment as before.
   - Flat cable to bus board (connector J20)
6. Fasten the front panel
7. Mount he cover panel

Disconnect all cables from the unit, unplug the power cable



Bus modules

Disconnect all cables from the unit, unplug the power cable



Note

To prevent damage to the connectors the module to be installed must be accurately pushed into the circuit board guides.

Firmly tighten the screws. Loose screws cause malfunctions.

DANGER

As hazardous voltages are present inside the unit empty slots must be closed off with blanking plates (see p. 56).

Never connect or detach cables while the equipment is switched on.

Never install or remove modules when the equipment is switched on. After power off wait 10 s before you touch or move any modules.

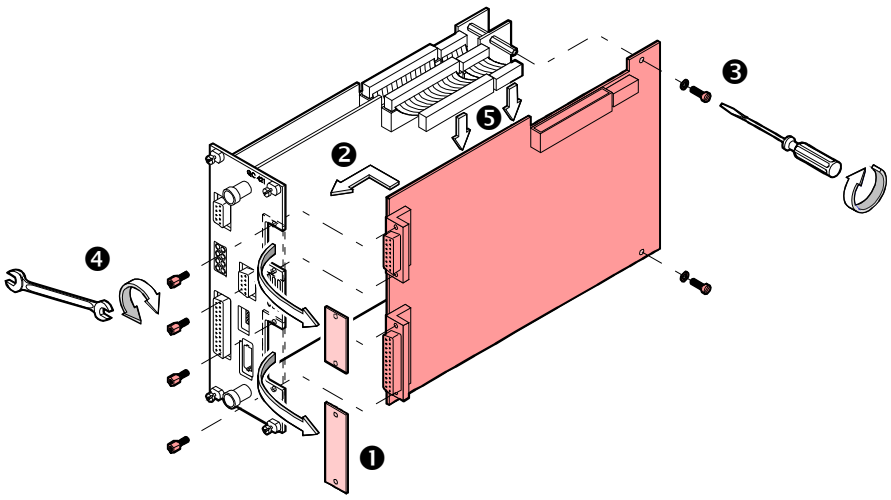
Always tighten the screws firmly!

Before installation check the module address according to the specifications of the individual modules.

AO 421 / IC 421

The QC 422 quadrupole controller can be expanded with the AO 421 analog output or the IC 421 ion counter.

- Disconnect power cable, wait 10 sec.
- Install/remove QC 422 as described above
- Remove connector cover(s) ❶ according to the option to be installed.
- Install the AO/IC 421 as shown in the illustration. The hexagon pins ❹ are installed without washers and secured with Loctite, if possible.

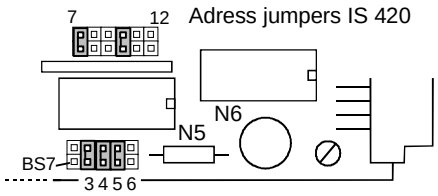


IS 420

Check address setting:

Address 175 500(octal)

Jumpers A3,4,5,7,10 inserted on IC 420

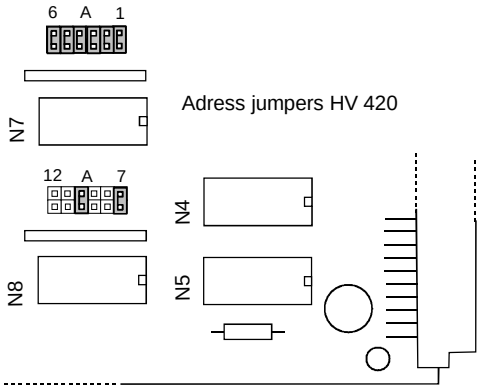


HV 420

Check address setting:

Address 175 400(octal)

Jumpers A1,2,3,4,5,6,7,10 inserted



HV 421

The address 175 404 is fixed. Jumpers: X6 all OUT, X7 IN, X8:2-4 connected.

Jumper plugs are inserted on the SHV terminals, depending on the operating mode of the SEM, see page 18.

Setting the CD voltage

The CD or bias voltage can be set with trimmer R4. Measure the value with a DVM on **CD-test**. Before making any adjustments switch off the unit and remove the HV 421. One counterclockwise rotation reduces the CD voltage by approx. 150 V or the bias voltage by approx. 80 V. Reinstall, re-measure and correct the setting, if necessary. Do not change the settings of any other trimmers!

DI 420

Up to 2 DI 420 can be installed.

Address setting: Jumpers A6, 9, 10 inserted

DI 420 #1	174 600(octal), rotary switch position 0
DI 420 #2	174 604(octal), rotary switch position 1

For connecting the inputs see technical specifications p. 14

DO 420A

Up to 3 DO 420A can be installed. (DO 420 is not suited)

Address setting: Jumpers A9,10 inserted

DO 420 #1	174 700(octal), rotary switch position 0
DO 420 #2	174 704(octal), rotary switch position 1
DO 420 #3	174 710(octal), rotary switch position 2

For connecting the outputs see technical specifications p. 15

AI 421

One AI 421 can be installed (AI 420 is not suited)

Jumper setting:

Jumpers: A6, 7, 9, 10, B, C, D, E inserted

Address 174 400(octal), rotary switch position 0

For connecting the inputs see technical specifications p. 15

PI 420 / PE 420

PI 420: Address: 174 000, see also [9]

PE 420: Address: 174 100, see also [10]

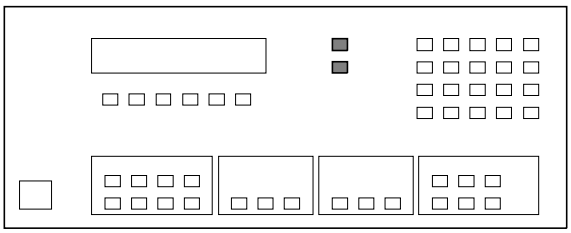
5 Description

5.1 Operator console

In the basic version of the QMS 422 and on the QMI 422 the front panel contains only a power switch and the corresponding LED.

The CS 422 operator console is available as an option. It can easily be retrofitted and is highly recommended for learning purposes, e.g. for software development. Even if you do not have a CS 422 you should carefully read the following information. This will enhance your understanding also in computer mode.

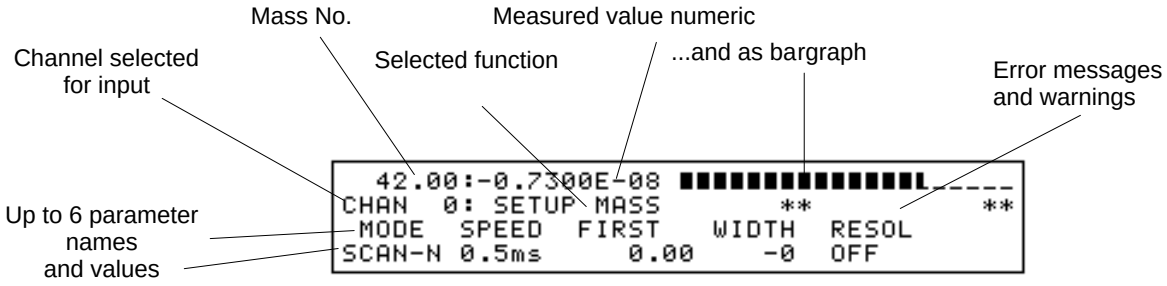
Contrast setting



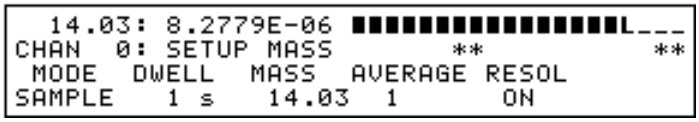
With the   keys you can optimize the display contrast.

Parameter display

After a function has been selected, e.g. (*mass* key) the function (SETUP MASS), its parameters (here *MODE*, *SPEED*...*RESOL*) and parameter values and the measured value of the selected channel are displayed.



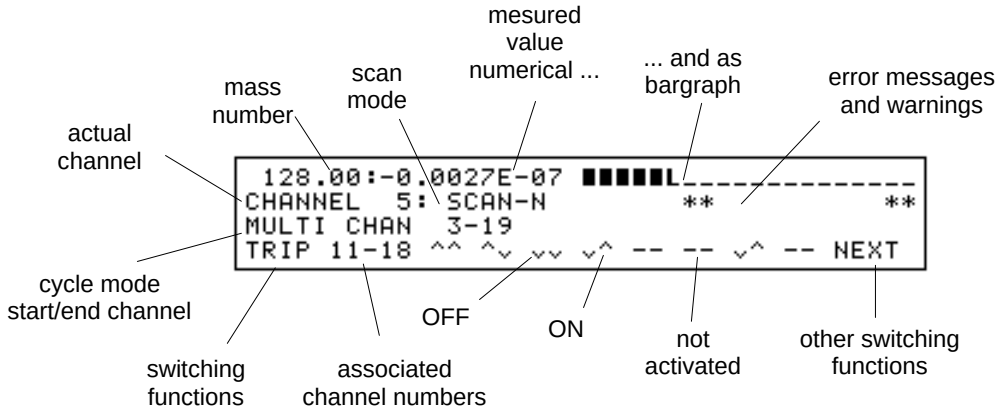
Parameter menus depend on the parameter state; in the picture below a changeover to *MODE:SAMPLE* has been made



In computer mode the parameters are displayed for approx. 30 s when a key is pressed. Input operations are disabled. Subsequently the measured value display reappears automatically.

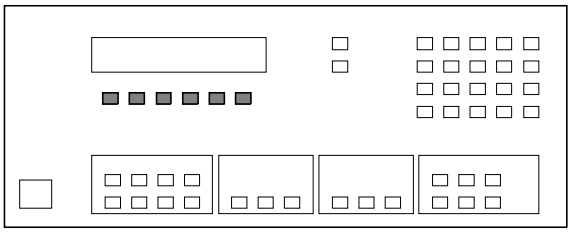
Measured value display

After the start (**run** key) of the measurement cycle the measured value of the momentary measurement channel is displayed. In multichannel mode (*cycle-MODE:MULTI*) the progression of the channels can be seen (possibly with gaps in fast processes)



In computer mode the display is updated for monitoring purposes.

Softkeys

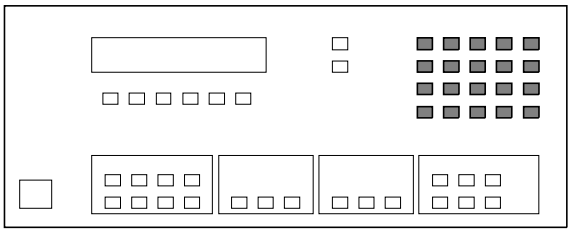


Choose the parameter to be entered with one of the 6 softkeys. After the key has been pressed the parameter value flashes.

If the parameter has only two values (e.g. ON/OFF or ×1/×10) you can change it by simply pressing the soft key again.

Parameter values are entered or changed via the numeric keypad.

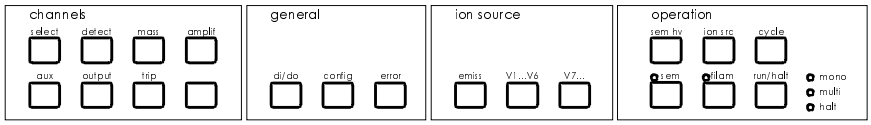
Number pad



0 ... 9	numeric keys
.	decimal point
del	cancel and return to measured value display
^ v	Change parameters in small increments ...
^^ vv	... and in large increments. When the keys are pressed continuously the entire value range is scanned. The new value becomes effective without ↵
+/–	change sign
exp	exponential entry
↵	Accept new value (Enter)

Function groups

The operation is subdivided into four **function groups:**



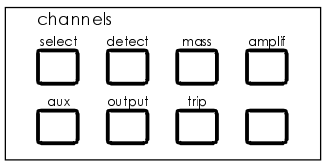
Their function is described in the next Chapter.

Each group comprises several function keys for calling a function (e.g. *mass* in the *channels* group). Each function contains up to 6 parameters.

5.2 Functions

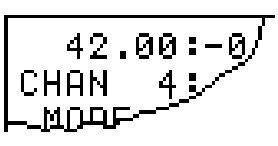
Parameters for operating the mass filter and for ion detection can be stored in up to 64 channels. When the measurement is performed the channels are processed sequentially and cyclically.

Channels group



Control keys for all parameters of a measurement channel

select



Choose a channel for parameter input.

All values entered under **channels** relate to this **selected** channel.

detect

Determines the signal source (detector, e.g. Faraday or SEM).

mass Mass scan parameters such as mass number, speed, etc.

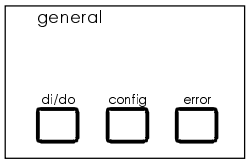
amplif Measurement amplifier parameters, measurement ranges, Autorange/Fixrange....

aux Enable or skip the channel during the measurement operation and copy parameter sets to different channels.

output Parameters for analog output of measured values, e.g. linear or logarithmic.

trip Parameters of the switching functions of each measurement channel.

General group



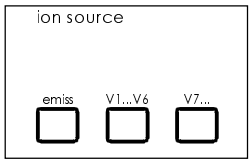
Keys for general settings such as configuration, initialization, maintenance and service, and processing of error messages.

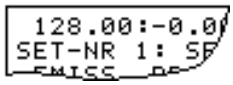
di/do Operation of DI-/DO-Bits.

config Input and display of system and equipment configuration.

error Error messages are displayed here in detail.

ion source group





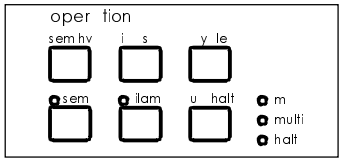
Parameters of the selected ion source set. The set is chosen under *operation-ion src* and displayed here.

emiss 400 Emission current and filament protection

v1...v6 400 Ion source voltages V1...V6.

v7... 400 Ion source voltages V7...V9.

operation group



Control keys for operation of:

- SEM
- ion source
- measurement process

sem hv *sem hv* defines the global SEM high voltage. It is effective in all channels for which no individual voltage is specified.

sem Switch SEM high voltage on/off

The *sem* LED is on when the high voltage is switched on and flashes when it is inhibited by the EXT-PROT signal on the **ctrl** connector.

ion src 400 Ion source mode: Filament selection, degas, etc.

The ion source parameters are channel-independent and are selected as a complete set. This allows fast parameter change.

The ion source parameters of the set belonging to the active filament can be reviewed in the *ion source* group.

125 Control of ion source supply for QME 125

filam Switch filament on/off

The *filam* LED is on when the emission is on and flashes when it is inhibited by the EXT-PROT signal on the **ctrl** connector.

cycle Choose measurement cycle mode or offset or adjustment measurement. Input of the corresponding parameters.

run/halt START / STOP of the measurement defined under *cycle.*

The *mono* or *multi* LED is on while the measurement cycle is running and flashes while waiting for external triggering by the RUN-IN signal on the **ctrl** connector.

The *halt* LED is on when the measurement cycle is stopped and flashes if the measurement cycle has been stopped by external triggering.

5.3 Parameter list

The parameters below are listed in alphabetic order by name.

Notation:

DETECT (config-SYSTEM)

Parameter — of the function — possibly subfunction(s)

Additional information on the utilization, the advantages and disadvantages of individual settings can be found in Chapter 6.

ADJ-TYP (cycle)

ADJ-TYP	Type of search with *cycle-FUNCT:ADJUST*
COARSE	Coarse search, see p.44
FINE	Fine search, see p. 45.

AI-CH (detect)

AI-CH	Only with *detect-TYPE:A-INPUT*
0 ... 15	AI 421 channel number to be measured

AO-CH (output)

AO-CH	Not with *detect-TYPE:PIRANI, PENNING, A-INPUT*
1 ... 12	Output channel of AO 421 or IC 421 for the measured value of the selected channel.
NONE	No analog output assigned

In *halt* condition the outputs are set to 0 V, except when they are seized by computer outputs.

AO-MODE (output)

Format selection for analog output to AO / IC 421 and ***mon***, see p.46.

Electrometer in Fix-Range:

AO-MODE	*amplif-MODE:FIX* and *detect-TYPE:FARAD,SEM,EXTERN*
LIN	Linear output in selected measurement *RANGE*
LOG 3D	Logarithmic, 3 decades, 3⅓ V / dec. within *RANGE*

Electrometer in Auto-Range:

AO-MODE	*amplif-MODE:AUTO, AUTO-D* and *detect-TYPE:FARAD,SEM*
LIN	Linear output within range selected with *O-RNG*
LOG 3D	Logarithmic, 3 decades, 3⅓ V / dec. within range selected with *O-RNG*
*LOG 8D**	Logarithmic, 8 decades, 1.25 V / dec. across all ranges

*) With *mass-MODE:SCAN* or *PEAK* and *SPEED* < 100 ms/u, with *STAIR* < 10ms/u a changeover to 3 decades occurs automatically

Ion counter:

AO-MODE	*LOG-DEC*	*detect-TYPE:ION-CNT*
LIN	-----	Linear output within the range selected with *O-RANGE*
LOG	*3 DEC*	Logarithmic, 3 decades, 3⅓ V / dec. within the range selected with *O-RANGE.*
LOG	*10 DEC**	Logarithmic, 10 decades, 1 V / dec. 10^{-1}...10^{8} cps

*) With *mass-MODE:SCAN* or *PEAK* and *SPEED* < 50 ms/u a changeover to 3 decades occurs automatically.

AVERAGE (mass)

Moving average across measurement cycles, see p. 42

AVERAGE	Only with *mass-MODE:SAMPLE* and *detect-TYPE:FARAD,SEM,ION-CNT,EXTERN*
1	No averaging across measurement cycles
2, 4, 8... ...512, 1024	Number of measurement cycles for forming average

BAUD (config-CTRL)

BAUD	Only with *config-CTRL-MODE:ASCII, BIN and MODEM*
300, 1200, 2400 4800, 9600, 19200	Baud rate of the RS232 interface, can always be set on the CS 422 (300 baud only with ASCII protocol)

BEGIN (cycle)

BEGIN	With *cycle-FUNCT:CYCLE and cycle-MODE:MULTI*
0 ... 63	Start channel of the measurement cycle with *cycle-MODE:MULTI*

BIT (di/do-DIG-OUT)

See *DIG-OUT*

CALIB (amplif)

CALIB	Calibration factor for measured value.
±1E^{-10} ... ±9,99E^{+10}	The raw measured value is multiplied times *CALIB*

Can be used for either normalizing a measured value, e.g. from 7.7 V to 10 V (100%) or for conversion from [A] to [mbar].

In the following cases multiplication takes place only with the mantissa of *CALIB*:

- For the computer interface with *amplif-MODE:FIX* or *detect-TYPE:EXTERN* and *mass-MODE:SCAN* or *PEAK*
- Always for the analog signals on the AO/IC 421 and *mon*

CATH (v1...v6)

See *V2*

CLEAR (di/do-DIG-OUT)

See *DIG-OUT*

CLEAR (error)

Deletes all pending error messages

CLEAR (cycle-FUNCT-OFFSET)

Sets all offset values to zero and consequently disables offset correction

COPY TO CH (aux)

COPY TO CH	Copies parameters of the selected channel to another channel
0 ... 63	Target channel for copying process
SURE ?	Confirm copy function by pressing ↵

COPY TO ALL (aux)

COPY TO ALL	Copies the parameters of the selected channel to the channels *cycle-BEGIN...-END*.
SURE ?	Confirm copy function by pressing ↵

COPY TO SET (ion src)

COPY TO SET	Copies the IQ set activated under *ion src-FIL1 or FIL2*
SET 0 ... SET 3	Target set for the copying process (only with *ion src-MODE:NORMAL)*

CP-LEV (amplif)

CP-LEV	Only with *detect-TYPE:ION-CNT*
0.10 ... 1.00 V	Response threshold of the CP 400, see p.13

CS 422 (config)

See under *TEST*

CTRL (config)

See *BAUD, MODE, NODE* or *SEM+FIL*

CTRL (ion src)

CTRL	Only with *ion src-MODE:DEGAS*
STOP	Switch Degas off
START	Switch Degas on
SURE ?	Confirm Degas activation with ↵
RUN	Degas switched on

CYCLES (cycle)

CYCLES	With *cycle-FUNCT:CYCLE*
REPEAT (0)	The measurement cycle is repeated endlessly.
1 ... 10'000	Number of measurement cycles to be executed

D-EMIS (ion src)

400 *D-EMIS*	With *ion src-MODE:DEGAS*
0.0 ... 20.0 mA	Emission current in Degas mode.

D-PROT (ion src)

400	*D-PROT*	With *ion src-MODE:DEGAS*
	0.00 ... 5.00 A	Maximum filament current in Degas mode

D-TIME (ion src)

D-TIME	With *ion src-MODE:DEGAS*
MANUAL (0)	Degas runs until stop command is given
1 ... 99 min	Degas duration. The remaining time is displayed.

DEF-I (v1...v6)

Deflection inside, see *V6*

DETECT (config-SYSTEM)

	DETECT	Specification of the existing signal source (ion collector)
	FARAD	Faraday collector
	SEM	90° SEM
400	*CD-SEM*	90° SEM with conversion dynode
400	*H-SEM*	High SEM, only with *config-SYSTEM-OPTION:CP*
125	*CH-TRON*	Channeltron/Faraday combination

DIG-IN (di/do)

Status indication of the DI 420 input bits, not dependent on measurement channel. *NEXT* switches to the next 32 bits.

DIG-OUT (di/do)

Display / manual operation of the DO 420A output bits, not dependent on measurement channel.

BIT	Choose DO bit to be operated
SET	Set DO bit
CLEAR	Clear DO bits
NEXT	Advance to next 32 DO bits

DISP-T (config)

See *TEST-CS 422*

DO-A, DO-B (trip)

Assignment of a switching function A or B to any bit of a DO 420A. If several switching functions are assigned to the same bit they are combined in an AND function, see Section 6.14.

DO-A, DO-B	With *mass-MODE:SAMPLE or detect-TYPE:PIRANI, PENNING; A-INPUT*
OFF	No assignment, output remains high impedance
0 ... 95	Assignment of the switching functions to the DO 420A output bit

The DO 420A outputs can also be operated manually or via interfaces.

DSP (config)

See *TEST*

DWELL (mass)

Measurement time on mass number *MASS* with *mass-MODE:SAMPLE*

Electrometer or Extern:

DWELL	*detect-TYPE:FARAD, SEM or EXTERN*
0.5, 1, 2, 5, 10, 20, 50 ms *0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 60 s*	The measured value is determined by averaging across the DWELL time.

Ion counter:

DWELL	*detect-TYPE:ION-CNT*
1 ms ... 60 s	Counting rate = pulse count / *DWELL*

E-PROT (emiss)

400	*E-PROT*	Filament protection
	0.00 ... 5.00 A	When the set current threshold is exceeded the filament is switched off and an error message is output.

EMI-CUR (ion src)

125	*EMI-CUR*	Switch between displaying emission current and electrometer value.
	OFF	Display electrometer value
	ON	Display emission current

The measurement cycle must be stopped (halt).

EMISS (emiss)

400 EMISS	Emission current set point
OFF	Emission switched off
0.01 ... 2.00 mA	Emission current

END (cycle)

END	With *cycle-FUNCT:CYCLE and cycle-MODE:MULTI*
0 ... 63	Ending channel of the measurement cycle with *cycle-MODE:MULTI*

EPROM-T (config)

See *TEST-CS 422, TEST-DSP* and *TEST-QMS*

EXTRACT (v1...v6)

See *V5*

F-AXIS (v1...v6)

See *V4*

FIL1, FIL2 (ion src)

Assignment of an ion source parameter set to filament 1 or 2. Applies also to the assignment with *SPEC±* (without filament).

FIL1, FIL2	With *ion src-MODE:NORMAL*
SET 0 ... SET 3	Assignment of the ion source parameter set

FILAM (ion src)

Filament selection for ion sources containing two filaments

400 FILAM	Not with *config-SYSTEM-IS-TYP:AXIAL*
1	Filament 1
2	Filament 2
1+2	Filament 1 in operation, filament 2 is pre-heated. If filament 1 is defective filament 2 is automatically activated. This results in a brief fading of the emission.

125 FILAM	**filament select** switch on QME 125 [4] set to **remote** !
1	Filament 1 in normal operation / 1+2 with DEGAS
2	Filament 2

FILTER (amplif)

Time constant of the analog filter for the electrometer signal

FILTER	With detect-TYPE:FARAD, SEM and EXTERN
18 µs ... 800 ms	Manual setting for special requirements. Choose a filter value that is appropriate to the measuring speed.
AUTO	The analog filter is automatically set as follows:

SPEED [ms/u] *DWELL* [ms]	*FILTER*	*SPEED* [s/u] *DWELL* [s]	*FILTER*
0.5 / 1	18 µs	0.2 / 0.5	8 ms*
2 / 5	85 µs	1 / 2	40 ms**
10 / 20	400 µs	5 / 10	180 ms
50 / 100	1.7 ms	20 / 60	800 ms

*) Minimum value in *RANGE* 10^{-11} **) Minimum value in range *RANGE* 10^{-12}

With *amplif-MODE:AUTO* or *AUTO-D* an optimum filter is automatically used.

With *mass-MODE:SAMPLE* (MID mode) a fast filter results in faster settling times which means that *PAUSE* can be shortened.

Signals above the maximum range of ±10.24 V (e.g. noise) are clipped. In this case the subsequent processing (e.g. averaging) may possibly be incorrect. In critical cases the electrometer signal must be analyzed with an oscilloscope or with Quadstar in *mass-MODE:SCAN-N* so that it can be optimized.

With *mass-MODE:SCAN-F* the FIR filter provides for additional filtering.

FILTER (config)

See *TEST-SERVICE*

FIRST (mass)

Starting mass number of the mass scan

FIRST	With *mass-MODE: SCAN, STAIR* and *PEAK*
0.00 ... max. 2047.99	The maximum value depends on the mass range

The mass number is displayed as a decimal value; internally steps of 1/64 u are used. At high *SPEED* the resolution decreases to 1/32 or 1/16, see p.9.

FOCUS (v1...v6) See *V3*

F.S.+/ F.S.– (config) See *TEST-SERVICE*

FUNCT (cycle)

FUNCT	Measurement cycle mode, can only be changed in *halt* condition
CYCLE	Normal measurement operation
ADJUST	Adjustment to peak top with *mass-MODE:SAMPLE,* see 6.12
OFFSET	Offset correction of the EP 422 see p. 39

GAIN (amplif)

GAIN	With *detect-TYPE:EXTERN*
×1, ×10, ×-1, ×-10	Post-amplification factor for the Extern signal

INIT (config)

RESET	Load standard parameters (according to *config-SYSTEM)* see p.57
FACTORY	Load standard parameters set by pressing ↵
SURE ?	Confirm with ↵ , the old parameters are irretrievably lost!

IONREF (v1...v6) See *V1*

IS-TYP (config)

IS-TYP	Specify the ion source installed in the QMA.
AXIAL	Axial ion source
CB	Cross-beam ion source
GRID	Grid ion source
SPM	Sputter process monitor ion source
400 *SPEC+*	Special ion source positive ions
400 *SPEC–*	Special ion source negative ions

KEY-T (config) See *TEST-CS 422*

LEVEL-A, -B (trip) Threshold values of the switching functions

LEVEL-A *LEVEL-B*	*TYPE*	With *mass-MODE:SAMPLE or* *detect-TYPE:PIRANI,PENNING,A-INPUT*
1×10^{-24}.....	*ABS*	Threshold value of the switching function A or B
.....$9{,}99\times10^{+24}$	*HYST*	Upper (A) and lower (B) threshold
	OFF	Switching function off

If with *TYPE:HYST* : LEVEL-A < 1.1×LEVEL-B this minimum hysteresis is automatically set.

LOG-DEC (output) See AO-MODE: ion counter p.28

MASS (cycle) With *cycle-FUNCT:ADJUST* and *cycle-MODE:MONO*, See below *MASS(mass)*

MASS (mass) In SAMPLE (MID) mode measurement takes place on this mass number during the measurement time *DWELL* and the average value of the measurement signal is formed.
The measurement resolution is up to 24 bits (mantissa)

MASS	With *mass-MODE:SAMPLE*
0.00 ... max. 2047.99	The maximum value depends on the mass range

MASS-R (config-SYSTEM) Configuration specification of the existing measurement rage (HF generator)

MASS-R	*QME-Typ*	*MASS-R*	*QMH-Typ*	*MASS-R*	*QMH-Typ*
100	*QME 125-1*	*128*	*QMH 400-1*	*1024*	*QMH 410-1*
200	*QME 125-2*	*512*	*QMH 400-5*	*2048*	*QMH 410-2*
		300	*d.o.+QMA 430*	*340*	*QMH 410-3*

MODE (amplif) Operating mode of the electrometer amplifier

MODE	With *detect-TYPE:FARAD* and *SEM*
AUTO	Automatic changeover across all measurement ranges, very universal
AUTO-D	Automatic changeover down to the lower search limit *RANGE-L*.
FIX	Manual range selection for fastest measurements

MODE (config-CTRL)

MODE	Controlling interface
CS 422	Console CS 422
ASCII	RS-232-C in ASCII format
BIN	RS-232-C in binary format
MODEM	RS-232-C with modem in binary format
LAN	Arcnet interface

Each interface can switch to itself and thereby interrupt others.

MODE (config) See *TEST-SERVICE*

MODE (cycle)

MODE	Measurement cycle mode. The cycle is started/stopped with *run/halt*
MONO	Single channel measurement in selected channel
MULTI	Measurement of the channels between *BEGIN* and *END*. Channels that are in *aux-STATE:SKIP* state will be skipped.

MODE (ion src)

MODE	Ion source mode
NORMAL	Normal operation with the parameters defined in the ion source set.
DEGAS	Degas mode. The necessary parameters are entered directly.

MODE (mass) Mass scan mode, for details refer to p. 42

MODE	Not with *detect-TYPE:PIRANI, PENNING* and *A-INPUT*
SCAN-N	Normal spectrum from the start mass *FIRST* across the scan width *WIDTH* at the speed set with *SPEED.*
SCAN-F	Same, with FIR filter.
STAIR	Spectrum with integer mass jumps
SAMPLE	Measurement on mass *MASS* with averaging across *DWELL* time.
PEAK-L	Peak search (Level criterion) from *FIRST* via *WIDTH* with the speed *SPEED.* Significant data reduction because only the intensities and mass number of detected peaks are output.
PEAK-F	Same, with FIR filter.

MONITOR (output) Format of the measured value at the analog output *mon*

MONITOR	Not with *detect-TYPE:PIRANI, PENNING* and *A-INPUT*
LIN / LOG	See *AO-MODE*
RNG-CODE	Range-Code: E-12=1V.. E-5=8V (only for test purposes)

NEG (config) See *TEST-SERVICE*

NEXT (di/do) Display next 32 bits with *DIG-IN* and *DIG-OUT*

NEXT (error) Next error message, if more than one exists.

NODE (config-CTRL)

NODE	Only with *config-CTRL-MODE:LAN*
1 ... 255	ARCNET node address

OFFSET (config) See *TEST-SERVICE*

OFFSET (cycle-FUNCT) Offset correction, see *FUNCT(cycle)*

OPTION (config-SYSTEM)

OPTION	Configuration input for CP 400 ion counter preamplifier
NO	No CP 400
CP	CP 400 exists

O-RNG (output) Output-Range of AO 421 and *mon*, see *AO- MODE*

O-RNG	with *detect-TYPE:ION-CNT* or *amplif-MODE:AUTO, AUTO-D*
E-1 ... E+8	In ion counter mode
E-5 ... E-12	In electrometer mode

PAUSE (amplif) Measurement pause during channel change, see p. 41.

Not with *detect-TYPE:PIRANI, PENNING* and *A-INPUT*.

The actual pause time is displayed if it can be calculated. AUTO is displayed with *amplif-MODE:AUTO* or *AUTO-D*. However, *P-CAL* is still effective.

Press the *PAUSE* soft key to get to the *P-CAL* submenu.

P-CAL (amplif-PAUSE)

P-CAL	
0.0 ... 9.9	Pause time calibration factor, see p. 41

PE-CTRL (detect)

PE-CTRL	With *detect-TYPE:PENNING*
OFF	Penning switched off
ON	Penning switched on (wait for ignition, pressure dependent)

PI-CH (detect)

PI-CH	With *detect-TYPE:PIRANI*
0 / 1	Pirani channel to be measured

POS (config) See *TEST-SERVICE*

PRG-NR (config) See *TEST-CS 422, -DSP* and *-QMS*

QMA (config-SYSTEM)

QMA		Configuration input of the QMA type based on which the unit recognizes the family
125	125	QMA with 6 mm rod system
400	400	QMA with 8 mm rod system
410	400	QMA with 16 mm rod system
430	400	QMA with 8 mm rod system (stainless steel)

QMS (config) See *TEST*

QMS-HW (config) The unit detects its modules automatically, as far as possible, and displays them.

RAM-T (config) See *TEST-CS 422, -DSP* and *-QMS*

RANGE (amplif)

RANGE	With *amplif-MODE:FIX* and *detect-TYPE:FARAD* or *SEM*
E-12 ... E-5	Manual electrometer range selection

RANGE-L (amplif)

RANGE-L	With *amplif-MODE:AUTO-D* and *detect-TYPE:FARAD* or *SEM*
E-12 ... E-5	Lower search limit with *AUTO-D*

RESET (config) See *INIT*

RESOL (mass) 400 Setting of the mass peak separation (resolution)

RESOL	With *detect-TYPE:FARAD, SEM, ION-CNT, EXTERN*
OFF (0)	Integral mass spectrum (DC OFF)
1 ... 255	Mass peak separation. The peak width is approximately proportional to the set number. Unit resolution at 20...30 (with QMH 400-1: ≈100)

Often unit resolution suffices, that is, resolution of the adjacent peaks.

Decreasing the mass peak separation (larger number!) causes wider peaks and higher sensitivity.

125	RESOL	Changeover Spectrum/Integral
	OFF	Integral mass spectrum (DC OFF)
	ON	Normal mass spectrum (DC ON)

RETURN (....) Return from a submenu to the preceding menu

SELF (config) See *TEST-SERVICE*

SELF/CH (config) See *TEST-SERVICE*

SEM (detect) Channel related SEM high voltage

SEM	With *detect-TYPE:SEM, ION-CNT, EXTERN*
SEM-HV (0)	The global value entered with *sem hv-SEM-VOLTAGE* is applicable.
1 ... 3500 V	Individual SEM high voltage for the selected measurement channel.

The individual SEM high voltage leads to long settling times and makes sense only in special cases.

With High SEM (*config-SYSTEM-DETECT:H-SEM*) the minimum value is 750 V, see p.14.

SEM+FIL (config-CTRL)

SEM+FIL	Control of filament and SEM supply
INTERN	Control with CS 422 or interface.
EXTERN	Control with EXT-PROT signal on **ctrl** connector: • Contact open: SEM+FIL switched off. • Contact closed: SEM+FIL switched on.
EXT-PROT	Switch-off with EXT-PROT signal on **ctrl** connector: • Contact open: Switch-off and inhibition of switch-on. • Contact closed: Enables switching on SEM+FIL via CS 422 or interface.

SEM-VOLTAGE (sem hv) Global SEM high voltage. It is valid for all measurement channels for which no individual setting has been defined with detect-SEM:SEM-HV.

SEM-VOLTAGE	Not with *config-SYSTEM-DETECT:FARAD*
0 ... 3500 V	Global SEM high voltage

With High SEM (*config-SYSTEM-DETECT:H-SEM*) the minimum value is 750 V, see p.14

SERVICE (config) See *TEST*

SET (di/do) See *DIG-OUT*

SET (ion src) See *FIL1, FIL2*

SIMUL (config)

SIMUL	Simulation spectrum for test purposes, see p. 40.
OFF	Simulation switched off.
INTERN	Simulation via QC internal measurement path.
EXTERN	Simulation via QC external connection. Only for factory use, additional hardware required.

If no error message exists the warning SIMULATION is displayed.

SPEED (mass) Speed for mass scan

SPEED	Not with *mass-MODE:SAMPLE* or *detect-TYPE:PIRANI, PENNING, A-INPUT*
0.5, 1, 2, 5, 10, 20, 50 ms/u *0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 60 s/u*	With detect-TYPE:FARAD, SEM, EXTERN and *amplif-MODE:FIX*
10 ms/u ... 60 s/u	With detect-TYPE:FARAD, SEM, EXTERN and *amplif-MODE:AUTO, AUTO-D*
2 ms/u ... 60 s/u	With *detect-TYPE:ION-CNT* and *mass-MODE:STAIR*
20 ms/u ... 60 s/u	With *detect-TYPE:ION-CNT* and *mass-MODE:SCAN* and *PEAK*

STATE (aux)

STATE	Enable or skip a channel in multichannel mode
SKIP	Skip channel.
ENABLE	Measure channel.

STEPS Reduces the number of measured values/u transmitted via the interface with *mass-MODE:SCAN* to ½ or ¼*;* this parameter can only be operated via the interface.

SYSTEM (config) From the system configuration defined here the unit determined the possible operating modes and parameter sets.

Expansion with bus modules is detected automatically by the unit.

See sub menus *QMA, MASS-R, IS-TYP, DETECT, OPTION.*

TEST (config) Test and alignment programs for service purposes.

The individual tests are initiated with the soft keys, endless tests are terminated with del. During a test the word BUSY is displayed, the result in shown in the status line for approximately ten seconds.

CS 422 Test of the CS 422 console with:

DISP-T Endless test of the LC display. After the test has been canceled the Display-RAM test result is displayed.

EPROM-T After the EPROM test the result is displayed and the checksum is displayed at the soft key.

KEY-T Endless test of the keyboard. Consecutively press all keys to display the corresponding value.

PRG-NR The program number of the installed firmware (program version) is displayed.

RAM-T After the RAM test the result is displayed.

DSP-... Test of the signal processor: EPROM-T, PRG-NR, RAM-T as above

QMS-... Test of the system controller:: EPROM-T, PRG-NR, RAM-T as above

SERVICE Test programs only for factory use

THRESH (mass) With *mass-MODE:PEAK-L* and *PEAK-F* or with *cycle-FUNCT:ADJUST*

THRESH (...ADJUST) Minimum intensity at which a peak is detected by the peak processor and adjust algorithm.

THRESH	*amplif-MODE:FIX and detect-TYPE:FARAD, SEM or EXTERN*
0.01, 0.03, 0,1... 30 % f.s.d	With Fixrange in % of the full scale deflection

THRESH	*amplif-MODE: AUTO or AUTO-D and detect-TYPE:FARAD, SEM*
1E-15, 1E-14.... 1E- 8	With Autorange in [A]

THRESH	*detect-TYPE:ION-CNT*
1E0, 1E1.... 1E7	In ion counting mode in counts per seconds [cps]

TRIG (cycle)

TRIG	Selection of measurement cycle start
INTERN	Start/Stop is performed via CS 422 or interface.
EXT-AUTO	Start on positive slope of the ext. start signal RUN-IN (see p 11). The cycle runs until terminated with *halt* or the specified number of measurement cycles has been attained.
EXT-NORM	Start on positive edge of RUN-IN. The cycle runs as long as RUN-IN is high, or until it is terminated with *halt* or the number of measurement cycles specified with *CYCLES* has been attained.
EXT-SNGL	Start on positive edge of RUN-IN. The unit must first be armed with *run*. The cycle runs until it is terminated with *halt* or the number of measurement cycles specified with *CYCLES* has been attained.

TYPE (detect)

TYPE	Selection of signal source, depends on the configuration
FARAD	Electrometer signal from Faraday collector
SEM	Electrometer signal with SEM
ION-CNT	Ion counter
EXTERN	External analog signal in place of EP 422 signal. Filter and processing functions of the QC 422 are used.
PIRANI	Total pressure measurement with Pirani module
PENNING	Total pressure measurement with Penning module
A-INPUT	Analog signals on AI 421. Filter and processing functions of the QC 422 are not used.

TYPE (ion src)

400 Changeover to special ion sources. The electrode names are replaced by "V1...V9" and all potentials are made accessible.

TYPE	With *ion src-MODE:NORMAL*
xyz	Normal ion source according to *config-SYSTEM:IS-TYP*
SPEC+	Special ion source, detection of positive ions
SPEC–	Special ion source, detection of negative ions. The potentials of the IS 420 and the bias voltage of the HV 421 with *config-SYSTEM-DETECT:H-SEM* are inverted.

With *SPEC±* and *EMISS* = 0 the SPEC-SRC-ON signal on the *QMA* connector of the IS 420 is active. In this way an external relay for changing over the ion source electrodes can be controlled.

TYPE (trip)

TYPE	Mode of switching functions (see 6.14)
OFF	Switching function not active. The DO bit is available for other applications.
ABS	A and B are independent switching functions with one threshold value each.
HYST	A and B form a switching function with hysteresis. status changes when the upper or lower threshold value is exceeded.

V1... V9

400 The V... designations appears with *ion src-TYPE :SPEC±,* with standard ion sources the electrode names are displayed.

See tech. data p. 12

WEHNELT (ion src)

See *V9*

WIDTH (mass)

Mass scan width of the measurement channel

WIDTH	Not with *mass-MODE:SAMPLE* or *detect-TYPE:PIRANI, PENNING, A-INPUT*
-2047 ... +2047	The maximum value depends on the mass range

Negative *WIDTH* results in a backward scan. In this way small peaks that are 1 mass above a very large peak can be measured more effectively.

6 Operation

The following description is applicable to units equipped with CS 422 operator console. They apply analogously also without CS 422.

6.1 Initial start up

DANGER

Before you switch on the power make sure that all components have been installed correctly (see Chapter Installation) and that the installation conforms to the technical data, See p. 8 subseq.

The main power switch is located in the lower left-hand section of the front panel.

After power on the unit performs a self-test and after a few seconds responds with a beep. Press any key to activate the measurement or parameter display.

Note

In complete (factory aligned) systems the values that have been determined as optimal are stored in the controller. Do not modify these, go directly to 6.4.

After a change of the ion source setting, a filament change, replacement of components, etc. the following steps should be performed.

Configuration

Configure the unit as follows if the system you are putting into service has not been factory aligned.

- In the function group *general* press the *config* function.
- Choose *SYSTEM* with the corresponding softkey.
- Press QMA softkey and enter your QMA type with by pressing ^ v.
- Press *MASS-R*, enter the mass range by pressing ^ v.
- Under *DETECT* enter the ion collector type of your analyzer and under *IS-TYP* enter the existing ion source type.
- If you use the CP 400 set *OPTION* to *CP* with ^.
- Confirm the configuration input by pressing the *RETURN* softkey.

QMH 400/410

Please refer to the QMH 400/410 user's guide [3].
Complete factory supplied systems have already been optimally aligned. Do not change any settings without valid reason. Optimize **tune** if **best hit** does not light up.

QME 125

Please refer to the user's guide of the QME 125 [4] and QMA 125 [6], but do not change any factory settings.

Set the **filament select** switch to **remote** and **polarity** to **"+"**[4].

6.2 Filament protection

400 Optimize the filament current cut-off point for optimum protection of the filament.

a) Switch off the emission: press *filam*, the *filam* lamp goes out
b) Ensure that the pressure is $\leq 10^{-4}$ mbar.
c) Switch on *filam: filam* light turns on.
d) If *Emission error* *) is displayed continue with f).
e) If this is not the case, switch off *filam*, reduce *emiss-E-PROT* with vv by 0.1 A and turn *filam* on again; repeat until *Emission error* appears.
f) *Switch off filam*, increase *emiss-E-PROT* with ^^ by 0.1 A and turn *filam* on again; repeat until *Emission error* no longer appears.

*) In case of **ERROR** press the *error* key to read out the type of error.

Note

If the switching threshold is abnormally high a fault exists in the ion source, the vacuum system, or the unit. Investigate the cause in order to prevent destruction of the filament.

If a new filament has been installed re-optimize after a few hours.

The *D-PROT* cut-off point for DEGAS is set analogously.

6.3 Degas

Please refer to the user's guide of the QMA and the ion sources. Switch to Degas only if the conditions specified there are fulfilled.

400 Optimize the filament protection for Degas mode as described above, however with *ion src-D-PROT* rather than *emiss-E-PROT.*

Switch on Degas with *ion src-CTRL:START* and confirm with ↵.

125 See [6] and [4]

6.4 Offset correction

The EP 422 is an amplifier for very small currents. Its zero (offset) must be corrected occasionally. This is intentionally not performed automatically to prevent periodic dead times in data acquisition.

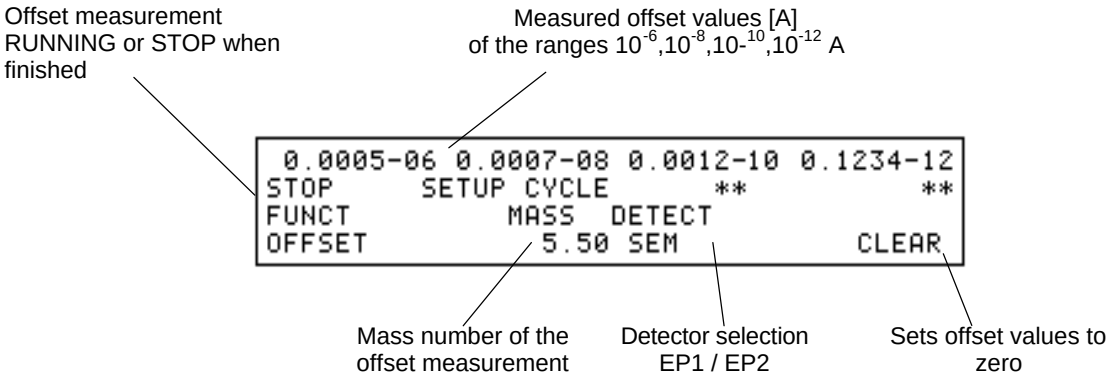
Perform an offset correction when the system is put into service for the first time, after the system (particularly the EP 422) has attained a stable temperature.

Subsequent repetition is advisable if deviations from the zero line occur.

Zero line shifts are often caused by ion and electron currents; the offset correction does not compensate these.

Choose *cycle-FUNCT:OFFSET* and start the offset measurement with *run* .

The following appears:



Perform the measurement for SEM and Faraday if both EP 422 are installed. If only one EP 422 exists choose DETECT according to the current operating mode.

The mass number should be selected in such a way that no ion current occurs.

With *CLEAR* you can disable the offset correction; the offset values are set to zero.

The values of the ranges 10^{-5}, 10^{-7}, 10^{-9}, 10^{-11} A are not displayed, they are available at the interfaces.

400 For offset measurement the SEM voltage is switched off automatically, *RESOL* = 1, *F.A.* = 0 V and *EMISS* = 10 µA are set. If you switch *filam* off, measurement takes place without emission.

125 For offset measurement the SEM voltage and the emission are switched off automatically.

6.5 Ion counter

With the IC 421 and CP 400 ion counter the measured value is displayed as a quasi-logarithmic bar across ten decades. The range is always selected automati - cally; for linear analog output the display range is selected with O -*RNG*.

The discriminator threshold of the CP 400 preamplifier is set with *amplif-CP-LEV*. Recommended value: 0.1...0.3 V with *SEM-VOLTAGE : 2500 V*.

The ion polarity is selected by choosing the ion source type *ion src-TYPE:SPEC+* for positive ions or *SPEC–* for negative ions.

6.6 Extern input

With *detect-TYPE:EXTERN* you can capture analog measured values of a different unit in place of the EP 422. Connect the signal to the EXT IN pins of the **ctrl** connector on the QC 422 (see p.11)

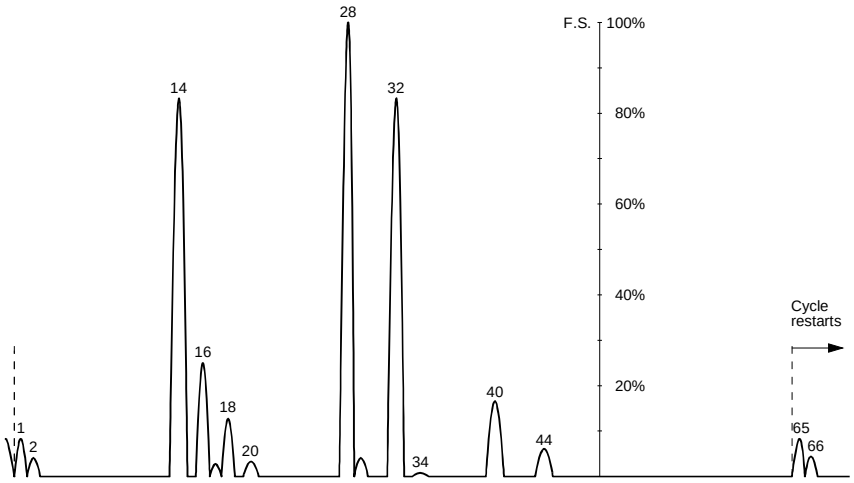
amplif-GAIN determines the gain (×±1/×±10).

6.7 Simulation

For experiments and tests a simulated spectrum according to the following diagram is available with *config-SIMUL:INTERN*. Use it to familiarize yourself with the operating procedures. For this purpose you do not need a vacuum system and also no equipment such as QMH or QMA.

The spectrum is generated as an HF generator control signal **scan** and inserted into the QC 422 electrometer signal path. It can be used in all *mass modes*.

> **Note**
>
> For normal measures the simulation must be switched off: *config-SIMUL:OFF*.
>
> Only the detector types *FARAD* and *SEM* are admissible.
>
> *config-SIMUL:EXTERN* is reserved for factory tests.



The peak intensities for *RANGE* 10^{-5}, 10^{-7}, 10^{-9} and 10^{-11} are identical. The intensity is amplified by a factor of 10 for the intermediate ranges. The spectrum is repeated periodically from mass 64.

6.8 Measurement cycle

With *cycle-MODE* choose single channel *(MONO)* or multichannel *(MULTI)* mode.

The measurement cycle is started and stopped with *run/halt* and its state is indicated with the *mono, multi* and *halt* LEDs.

The number of measurement cycles is chosen with *cycle-CYCLES:* 1...10000 or repeating (0).

You can choose external control with *cycle-TRIG.*

HALT The measurement cycle is stopped. The unit measures in *mass-MODE:SAMPLE* (even if a different *MODE* has been entered) in the selected channel on the mass defined with *MASS* (or *FIRST)* at the speed selected with *DWELL* (or *SPEED)*.

The switching functions are OFF, the signals on ***elm, mon*** and ***AO*** are available.

MONO Single channel mode: enter *cycle-FUNCT:CYCLE* and *cycle-MODE:MONO*.

The unit measures in the measurement channel chosen with *select*. If the channel is changed in the *run* state the measurement is cancelled and the new channel is started.

MONO is suitable for measurement tasks in manual mode. A separate channel is programmed for each task. This means that the parameters are continually avail - able. You can quickly change the measurement task by changing the channel.

MULTI Multichannel mode: enter *cycle-FUNCT:CYCLE* and *cycle-MODE:MULTI*

The 64 channels can be programmed with any parameters. The channels located between *cycle-BEGIN* and *cycle-END* are processed sequentially if they are not set to *STATE:SKIP.*

It is advantageous to first optimize each channel involved in MONO mode.

With the *aux-COPY* function load additional channels with the parameters of the first optimized channel. Subsequently you only need to adapt a few parameters of the individual channels.

To achieve the shortest measuring time the channels with identical detector type, electrometer range and SEM voltage should directly follow each other.

The measurement cycle time CYCLE-TIME consists of the measurement and pause times of the involved channels. It is measured by the built-in clock.

The clock starts with *run*, stops with *halt* and is displayed by pressing *cycle*. With *cycles-CYCLES:1* (no. of cycles =1) you measure the time for one cycle.

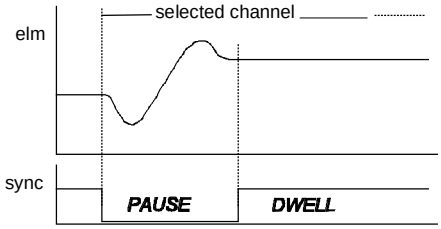
PAUSE

When the channel is changed in MULTI channel mode the data acquisition must pause until the new measured value is stable. The pause time is set automatically by the QC 422 based on *RANGE*, *FILTER*, *MASS*, *SEM* voltage and *detect-TYPE*.

The pause time is displayed under the softkey *amplif-PAUSE*. If you want to achieve shorter cycle times or greater accuracy you can optimize it with *amplif-P-CAL*. The minimum value is 1 ms with *P-CAL:0.0*.

You can reduce *P-CAL* in each channel until its measured value deviates inadmissibly. The preceding channel should not have a measured value that is almost identical, otherwise there is practically no transient response and the value of *P-CAL* would be too small. Change e.g. *MASS* of the preceding channel by ½ u to determine whether or not its measured value is without influence on the one of the selected channel.

With the oscilloscope (triggering on the falling slope of **sync**) the transient response during the pause can be observed at **elm** and (see also p.46).



6.9 Electrometer modes

The range of the electrometer preamplifier can be selected in 3 different ways:

AUTO

With *amplif-MODE:AUTO* the electrometer range is set automatically across all decades. This results in a huge dynamic response of over 10 decades or 200 dB. Use *AUTO* whenever possible. In this way you achieve the best resolution of the measured value and no overdriving of the amplifier can occur.

AUTO-D

With *amplif-MODE:AUTO-D* (Auto down) the range is limited in the downward direction. This is usefully for noisy measurement signals and can lead to faster measurements. You can define the available dynamic response with *RANGE-L.*

FIX

With *amplif-MODE:FIX* choose the measurement range with *RANGE* manually. This allows fastest measurements with a limited dynamic response.

With Scan-*SPEED* < 10 ms/u there is only Fixrange.

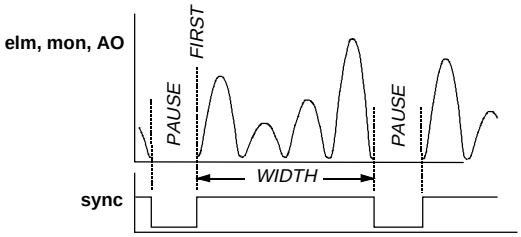
For the most accurate measurements (e.g. isotope ratios) Fixrange is recommend - ed because the mutual tolerances of the measurement ranges are eliminated or can be calibrated.

In the following diagram of the measurement signals the raw signal ***elm*** (see p.46) is represented always in *FIX*-RANGE because it is difficult to follow in *AUTO*-RANGE.

In all operating modes the measured values (except on **elm**) are multiplied times *CALIB* before they are output.

6.10 Mass scan modes

SCAN-N The *mass-MODE:SCAN-N* (SCAN-Normal) mode is used for recording an analog spectrum across the range defined with *FIRST* and *WIDTH.*



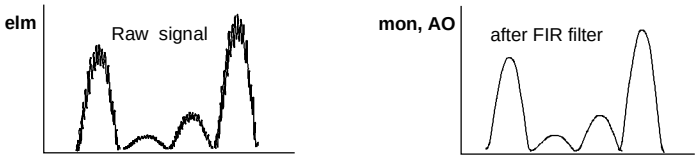
The number of steps per mass depends on *SPEED* and the mass range, see p. 9.

With *SCAN-N* the average value of the mass signal is output with each mass step.

Example: With *SPEED* 100 ms/u and mass scale resolution 1/64 u there is an integration time per step of 100 ms/u × 1/64 u = 1.56 ms

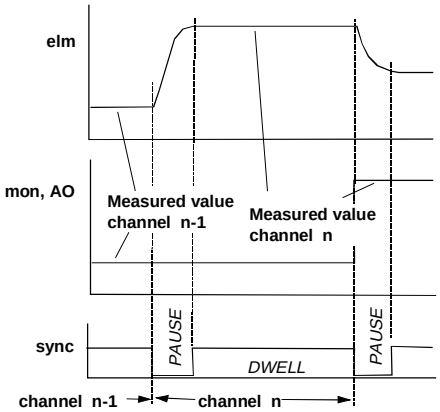
With *SCAN-N* you obtain a direct image of the measured values captured by the measuring amplifier or the ion counter. This mode is particularly suitable for analyzing raw data, e.g. for optimizing parameter values.

SCAN-F With SCAN-F the measured values are additionally subjected to an FIR filter algorithm (Finite Impulse Response).



The FIR filter largely eliminates noise and interference so that also very small peaks can be detected against the background. Statistical intensity fluctuations which on account of the 90° SEM arrangement frequently account for the major portion of the noise are particularly well suppressed by the FIR filter. For this reason you should always use *SCAN-F*, except in the few special cases were raw data are actually required.

SAMPLE With *mass-MODE:SAMPLE* the measurement is performed on the constant mass number *MASS*. In most cases it will be set to a peak top (*ADJUST,* see 6.12



After the *DWELL* time has expired the measured value averaged across this time is output

AVERAGE With *AVERAGE >1* a moving average (M) is formed across the number (n) of measurement cycles since *RUN*. Beginning with the first measurement cycle it supplies a value that becomes more stable with increasing number of cycles. In this way *DWELL* can be shortened without significant impairment of the filter effect (faster settling time).

The following recursive formulas apply:

a) $n < AVERAGE : M_{new} = M_{old} + (M_{new} - M_{old}) / n$

b) $n \geq AVERAGE : M_{new} = M_{old} + (M_{new} - M_{old}) / AVERAGE$

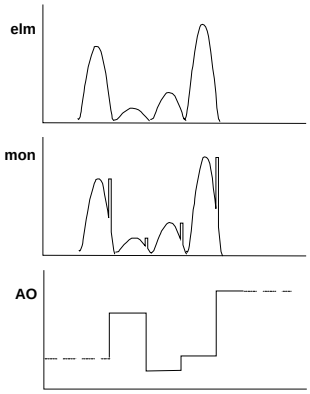
Time constant of the averaging: $\tau \approx AVERAGE \times$ cycle time

PEAK The *mass-MODE:PEAK* (peak processing) is an intelligent data reduction process which searches the spectrum for peaks in real time mode. Instead of 64 measured values/u only the **intensity and mass number** of detected peaks are output on the computer interface.

Mass scan is same as with *SCAN*

The marker at **mon** means that a peak of the displayed height has been detected

The value at **AO** remains until a new peak is detected



Peak Processing runs with all *SPEED* settings. The peak search extends across the range defined with *FIRST* and *WIDTH.* The peak criteria of *ADJ-TYP:COARSE* apply, see Section 6.12.

There are two methods:

- With ***PEAK-L*** (Level) the peak processing algorithm is applied to the normal spectrum (*SCAN-N*).
- With ***PEAK-F*** the peak processing algorithm is applied to the measured values processed with the FIR filter. This is advantageous because parasitic signals have largely been removed from the measured values so that a very low *THRESH* can be used.

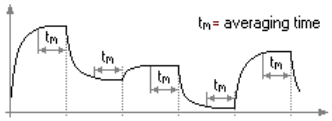
STAIR

With *mass-MODE:STAIR* integer mass jumps across the range *FIRST... WIDTH* are performed. A bargraph spectrum is created.

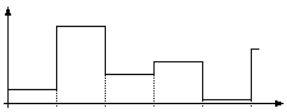
After each mass jump the average value across approx. half the dwell time is formed.

Example: With *SPEED* 100 ms/u the averaging time is ≈ 50 ms

elm



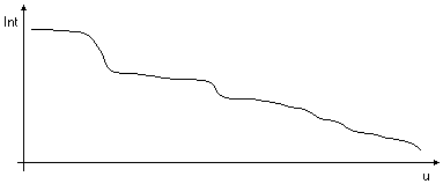
AO, mon
The measured value appears after the average has been formed, that is, delayed by one mass



The start mass of each channel must be on a peak maximum. See ADJUST p. 44. If the peak maximums are not hit, large measuring errors are unavoidable. For this reason you should limit *WIDTH* per channel to approx. 10% of the mass range. In this way you can compensate deviations of the mass scale by correcting the corresponding starting mass *FIRST*.

6.11 Integral spectrum

With *mass-RESOL:OFF* an integral spectrum is created that can be used, e.g. for total pressure measurement. See [1]



6.12 Adjust

With *cycle-FUNCT:ADJUST* you can automatically optimize the mass number *MASS* to the peak maximum in *SAMPLE* (or *STAIR*) mode.

The measurement channel must be set to *aux-STATE:ENABLE*.

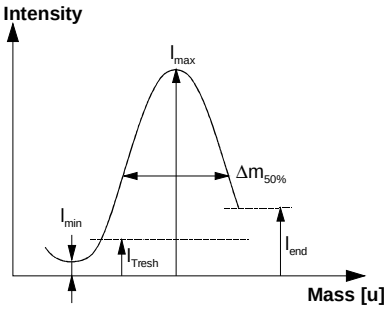
This possibility is advantageously used, for example, to optimize the system after turn on and particularly after several parameters have been changed.

Adjust COARSE

With *ADJ-TYP:COARSE* a range of ±½ u around the mass number *MASS* is normally searched for a peak. The search range will possibly be enlarged by ±¼ u.

If possible use *amplif-MODE AUTO* for *ADJUST*, it will be easier to obtain a result.

Peak criteria:



Four criteria must be met for a peak to be detected:

a) $I_{max} > 2\ I_{min}$

b) $I_{end} < 0.5\ I_{max}$

c) $I_{max} > I_{tresh}$

d) $\Delta m_{50\%} \geq ⅛$ u *) at ½ I_{max}

*) ¼ u with *mass-MODE:PEAK*

Time:

$t_{Adjust} \approx 0.5...1.25$ *DWELL*

Start:

Stop measuring cycle: *run/halt:halt*

Choose *mass-MODE:SAMPLE*

Choose *cycle-FUNCT:ADJUST*

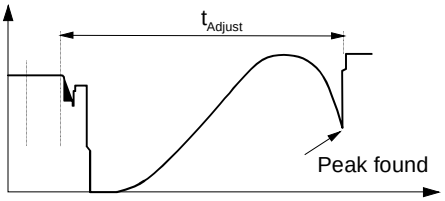
Choose *cycle-MODE:MONO* or *MULTI*

Choose *cycle-ADJ-TYP:COARSE*

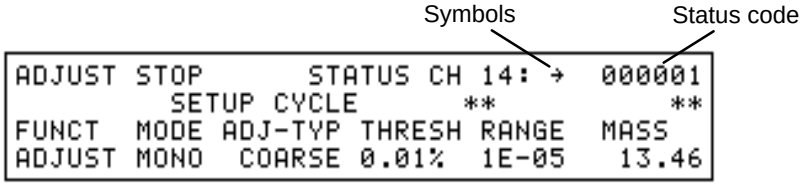
Start *ADJUST* measurement: *run/halt:run*

Procedure: Signal **mon**

With successful Adjust the mass number *MASS* of the measured channel is updated with the new value. If unsuccessful it remains unchanged.



Status message: After expiration a status message is displayed:



The 3 main parameters *THRESH, RANGE, MASS* can be entered here directly. You do no have to switch back to the *channels* group.

Symbols:

OK The adjust was successful

→ Increase *MASS* slightly

← Decrease *MASS* slightly

↑ Increase Intensity or lower *THRESH*

↓ Decrease Intensity

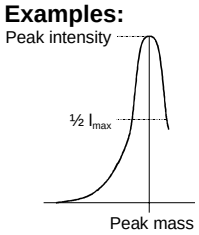
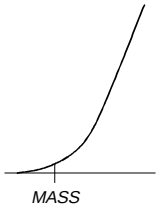
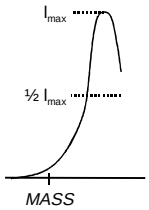
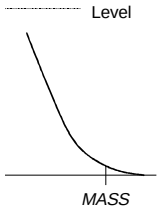
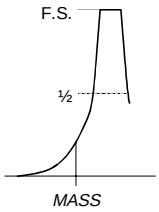
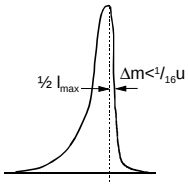
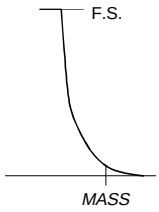
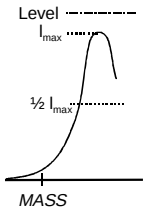
I Peak too narrow (e.g. parasitic pulse or poor peak shape). Repeat ADJUST. If unsuccessful: investigate peak shape.

Status code:

	Peak width	Intensity		Mass number *MASS*		
	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Bit=1:	too narrow	<*THRESH*	too high	too low *)	too high	too low
Symbol:	**I**	↑	↓	→	←	→

*) and intensity not dropped back to ½

Examples:

 000000 : OK	 000001 : → increase *MASS*	 000100 : → increase *MASS*	 010010 : ↑ ← decrease *MASS*
 001000 : ↓ increase *RANGE* *)	 100000 : **I** Peak too narrow, repeat, investigate shape	 001010 : ↓ ← increase *RANGE* *) decrease *MASS*	 010100 : ↑ → *RANGE* *) or decrease *THRESH* and increase *MASS*

*) or preferably use *amplif-MODE:AUTO*

Adjust FINE

A peak maximum within the range of ± ⅛ u around the mass number *MASS* is searched. Also in this case *amplif-MODE:AUTO* is recommended.

Peak criteria:

a) $I_{max} > I_1 + 1{,}5\%$

b) $I_2 < I_{max} - 1{,}5\%$

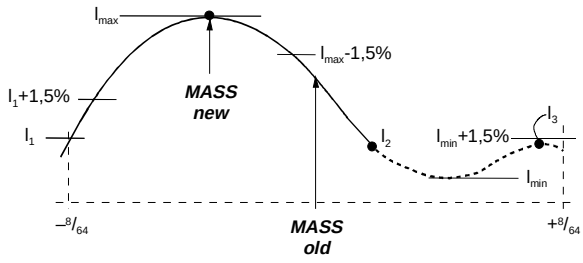
c) I_{max} >THRESH

d) No overdriving

e) $I_3 < I_{min} + 1{,}5\%$

time:

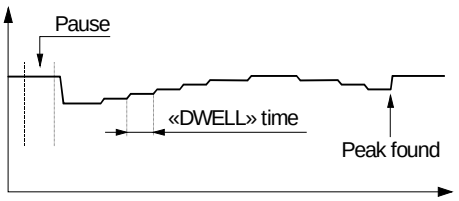
$t_{Adjust} \approx 16$ *DWELL*



Start: If you are not sure that a peak is located within the searched range, first perform an ADJUST COARSE.Start as described under COARSE, however with *cycle-ADJ-TYP:FINE*

Procedure: Signal ***mon***

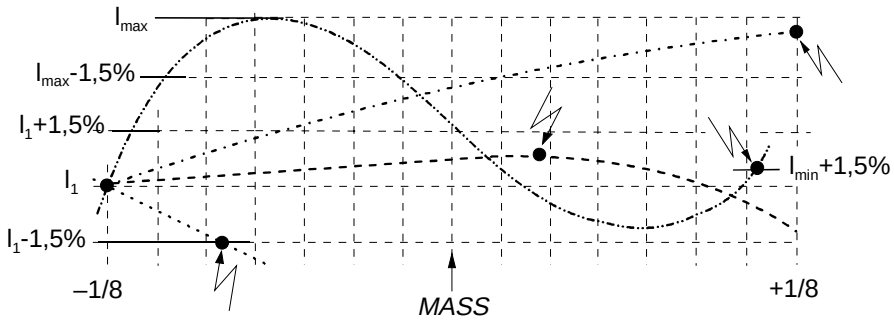
If Adjust was successful the *MASS* of the measured channel us updated with the new value, if it was unsuccessful it remains unchanged



Status message: As in ADJUST-COARSE, however, without information on mass number and peak width.
Bits 1, 2 and 5 are always zero.

	---	Intensity		Mass number *MASS*		
	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Bit=1: Symbol:	---	<*THRESH* ↑	too high ↓	---	---	no Peak → ←

Examples of unsuccessful fine searches:



6.13 Analog outputs

On the QC 422 there are some signal connections (see pin assignment, p. 11).

Nowadays measurement data are generally acquired with computers. For investigating possible measuring problems (noise, transient response, etc.) and for special cases the analog signals can be very useful.

Connectors

elm Analog filtered electrometer signal. It can be readily evaluated only in *amp-MODE:FIX* (Fixrange). With *Autorange* it becomes difficult to follow. **elm** is highly suitable for assessing the quality of the raw measured values. The calibration factor *CALIB* has no influence on **elm**.

mon Monitor sequentially supplies the measurement signals of all measurement channels after they have been processed by the signal processor. It also serves as the analog output of the ion counter and can be used in linear or logarithmic format.

AO The AO/IC 421 option can output up to twelve analog measured values in linear or logarithmic format.

You can assign one or several measurement channels (*output-AO-CH*) to each of the twelve AO channels. If several measured values are assigned to the same AO channel they will be output sequentially.

Via the computer interface also data from the PC software can be output on the AO 421.

sync Indicates the start of the measurement and is suitable for triggering an oscilloscope.

scan Proportional to the momentary mass number
0...10.24 V for QMH 400/410; 0...10.00 V for QME 125

The behavior of the above signals in the various operating modes is described beginning on page 42.

Output formats

The measured values at **mon** and **AO** have the following formats:

LIN Linear

LOG 3D Logarithmic across 3 decades

LOG 8D Logarithmic across 8 decades

LOG Logarithmic across 3 or 10 decades

The possible choices (operating mode dependent) can be found in the following tables, the scaling from the corresponding formulas and diagrams.

The formulas and graphics apply to positive measurement signals.

In the negative range the characteristics are mirror imaged at the zero according to the formulas a) ... e) and n) ... q)

Note: $\log = \log_{10}$ $Uo = U_{output}$ at **mon** or **AO**

Mass units: U: [V] I: [A] Counting rate: [cps] counts per second, s^{-1}

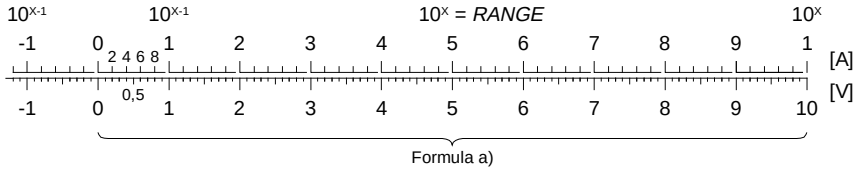
Electrometer operation

detect-TYPE:FARAD, SEM

mass-MODE	*output-AO-MODE, MONITOR*	*amplif-MODE*	Output format: Decades	Output format: V/Decade	Formulas
SCAN-N *SCAN-F*	*LIN*	*FIX,AUTO* *AUTO-D*	1	10	a)
STAIR *PEAK-L*	*LOG 3D*	*FIX,AUTO* [1] *AUTO-D* [1]	3	3.333	b), c), d)
PEAK-F *ADJ-COARSE* [3]	*LOG 8D*	*AUTO* [2] *AUTO-D* [2]	8	1.25	e)
SAMPLE *ADJ-FINE* [3]	*LIN*	*FIX,AUTO* *AUTO-D*	1	10	a)
	LOG 3D	*FIX*	3	3.333	b), c), d)
	LOG 8D	*AUTO* *AUTO-D*	8	1.25	e)

[1] only for SCAN-*SPEED* 10...50 ms/u, with *STAIR* 2... 5 ms/u
[2] only for SCAN-*SPEED* ≥ 100ms/u, with *STAIR* ≥ 10 ms/u
3) only at ***mon*** connector

LIN a) for Uo: 0...10 V: $I = 0.1 \times RANGE \times Uo$

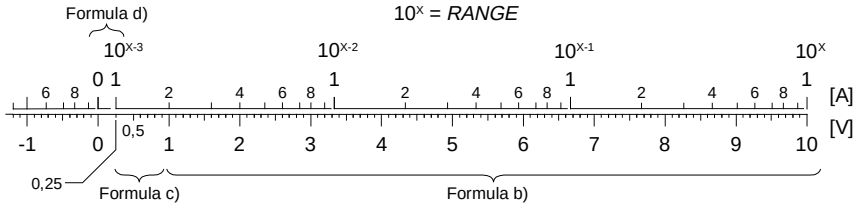


LOG 3D b) for Uo: 1V...10V $I = 10^{-3} \times RANGE \times 10^{0.3\ Uo}$

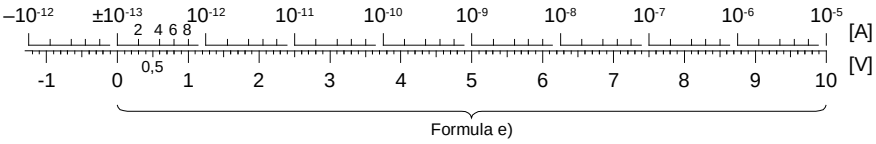
c) 0.25V...1V $I = 1.333 \times 10^{-3} \times RANGE \times (Uo+0.5)$

d) 0V... 0.25V $I = 4 \times 10^{-3} \times RANGE \times Uo$

Applicable with *amplif-MODE:AUTO: RANGE = O-RNG.*



LOG 8D e) for Uo: 0...10 V: $I = 10^{(0.8\ Uo - 13)}$

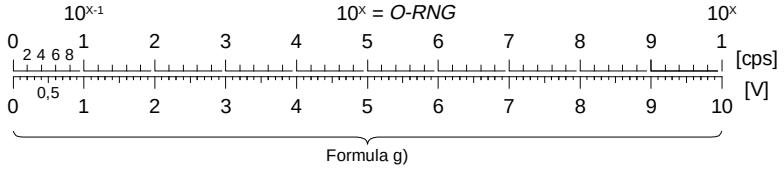


Ion counting operation

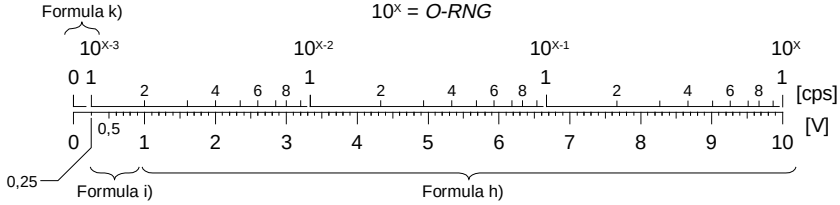
detect-TYPE:ION-CNT

mass-MODE	*output-AO-MODE, MONITOR*	*output-LOG-DEC*	Output format: Decades	Output format: V/Decade	Formulas
SCAN, STAIR	*LIN*	---	1	10	g)
SAMPLE	*LOG*	*3 DEC*	3	3.333	h), i), k)
PEAK ADJUST [3]		*10 DEC (>20 ms/u)*	10	1	l), m)

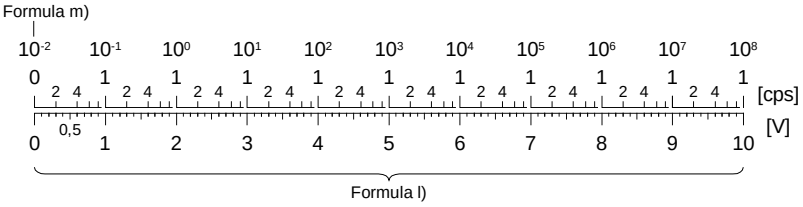
LIN g) for Uo: 0...10 V: Rate = 0.1 × *O-RNG* × Uo



LOG 3 DEC h) for Uo: 1V...10V Rate = 10^{-3} × *O-RNG* × $10^{0.3\ Uo}$
i) 0.25V...1V Rate =1.333 × 10^{-3} × *O-RNG* × (Uo+0.5)
k) 0V... 0.25V Rate = 4 ×10^{-3} × *O-RNG* × Uo



LOG 10 DEC l) for Uo: 0V...10V Rate = $10^{(Uo - 2)}$

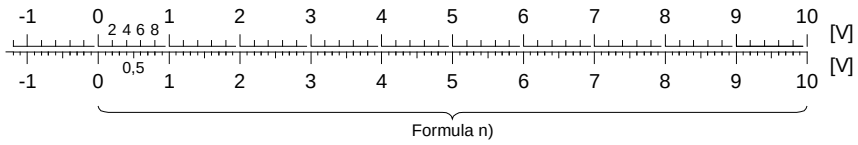


Extern input

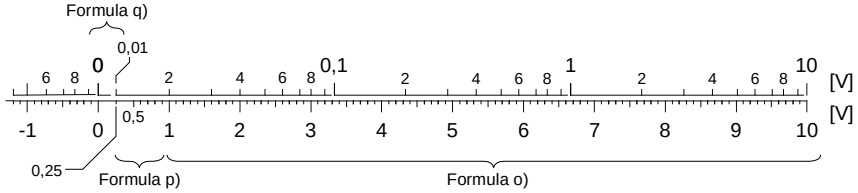
detect-TYPE:EXTERN

mass-MODE	*output-AO-MODE, MONITOR*	Output format Decades	Output format V/Decade	Formulas
SCAN, STAIR	*LIN*	1	10	n)
SAMPLE, PEAK	*LOG 3D*	3	3.333	o), p), q)

LIN n) for Uo: 0V...10V U_{Extern} = (1 / *GAIN*) × Uo



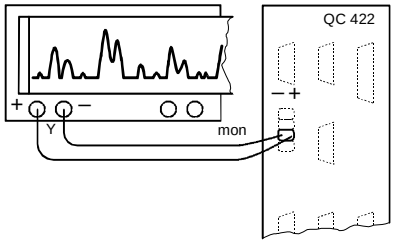
LOG 3D o) for Uo: 1V...10V U_{Extern} = (0.01 / *GAIN*) × $10^{0.3\ Uo}$
p) 0.25V...1V U_{Extern} = (0.01333 / *GAIN*) × (Uo + 0.5)
q) 0V... 0.25V U_{Extern} = (0.04 / *GAIN*) × Uo



Recording

For recording analog measured values (spectra or versus time) the following possibilities exist:

y/t Recorder



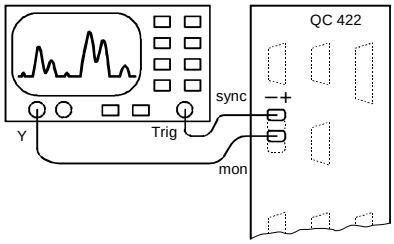
Paper feed should match SPEED, e.g. 1 mm/s for 1 s/u.

Sensitivity: 10 V for full scale deflection

Mirror imaged spectra can be inverted with *amplif-CALIB: -1*.

Instead of **mon** you can also use one or several **AO** outputs, see p. 11.

y/t - Oscilloscope



The same applies as for the y/t recorder.

Additional tips:

Choose a *WIDTH* that is somewhat larger (e.g. 14) than the range to be represented (e.g. 10 u) and optimize for minimum flicker!

sync triggers the oscilloscope with each start of the selected channel. Trigger manually to the positive slope, for *PAUSE* to the negative slope.

Digital storage scopes are advantageous

x/y Recording

The **scan** output supplies the mass number signal (0...10.24 V for the full mass range). x/y recording is only suitable for special cases.

6.14 Switching functions

With the TRIP switching functions measured values can be monitored in *mass-MODE:SAMPLE* or with *detect-TYPE:PI,PE,AI*.

With *halt* the state of the switching functions is OFF.

Each measuring channel has two switching functions: TRIP A and TRIP B.

These can be assigned to the output bits of the DO 420A modules as desired and also be interrogated via the computer interface.

If several switching functions are assigned to the same DO bit they are logically combined with an AND function. There is no warning if the DO bits are already assigned.

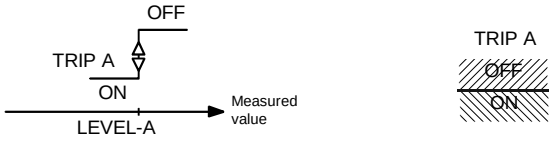
The DO 420A can also be controlled from the computer interface. Simultaneous assignment of switching functions is not advisable.

Vacuum relay

Choose *trip-TYPE : ABS*

Enter trip-LEVEL-A

ABS-TRIP A switches ON when threshold A is exceeded



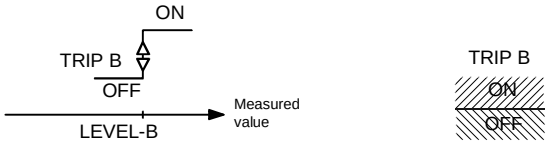
With *trip-DO-A:xx* assign a DO bit if DO 420A exists

Overpressure relay

Choose *trip-TYPE : ABS*

Enter *trip-LEVEL-B*

ABS-TRIP B switches ON when threshold B is exceeded



With *trip-DO-B:xy* assign a DO bit if DO 420A exists.

Window comparator

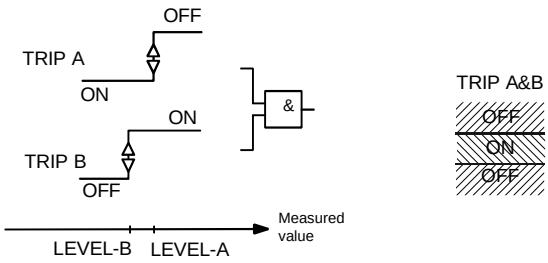
The window comparator is only possible in conjunction with the DO 420A module

Choose *trip-TYPE : ABS*

With *trip-LEVEL-A* enter the upper threshold

With *trip-LEVEL-B* enter the lower threshold

With *trip-DO-A:xx, trip-DO-B:xx* assign A and B to the same DO bit.



Hysteresis function

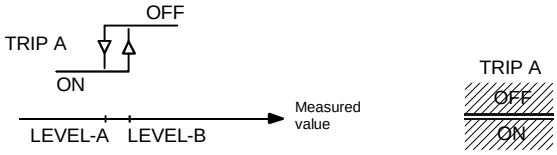
The hysteresis prevents fluttering with unsteady signals. The minimum hysteresis is 10%

Choose *trip-TYPE : HYST*

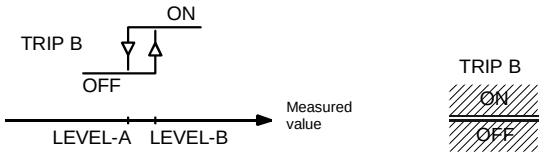
With *trip-LEVEL-A* enter the lower threshold

With *trip-LEVEL-B* enter the upper threshold

TRIP A switches ON when the signal drops below LEVEL-A and switches OFF when it exceeds LEVEL-B



TRIP B works inversely to A



With *trip-DO-A : xx, trip-DO-B : xy* assign the DO bits if DO 420A exists

Window and hysteresis

This requires two measurement channels and one DO 420A.

With *select:x* choose the first measurement channel x

Choose *trip-TYPE : HYST*

With *trip-LEVEL-A* enter the lower threshold

With *trip-LEVEL-B* enter the upper threshold

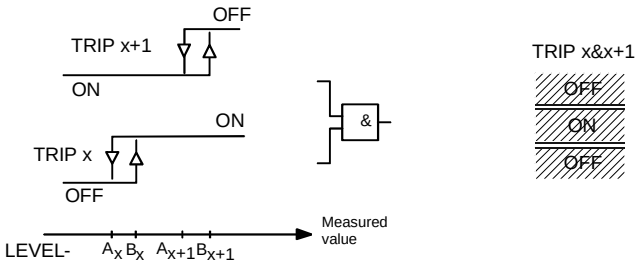
With *trip-DO-A* assign a DO bit

With *aux-COPY TO CH:x+*1 copy channel x to channel x+1

With *select:x+1* choose the measuring channel x+1

With *trip-LEVEL-A* enter the lower threshold

With *trip-LEVEL-B* enter the upper threshold



Many other combinations are feasible.

7 Troubleshooting

7.1 General

Skilled personnel

Work on an **open unit** (as specifically instructed in some parts of this Chapter) may only be performed by **skilled personnel.**

Corresponding warnings are not given separately on each occasion!

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

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

7.2 Warnings

Warnings related to operator action are displayed for approx. 10 sec.

No	Warning	Meaning, comments
1	** OP ERROR **	Operator error, illegal entry
2	** ↑ ONLY ↓ **	Parameter change with ⏫ ⏶ ⏷ ⏬
3	** > MAX **	Input value too large
4	** < MIN **	Input value too small
5	** SYNTAX ! **	Incorrect format
6	** REMOTE **	Unit set to computer operation
7	** CH SKIP **	Selected channel is in *aux-STATE:SKIP*
8	** EXTERN ! **	Control by external signal
9	** HARDWARE **	Necessary hardware does not exist
10	** ENTER ONLY **	Confirmation only possible with ↵
	** SIMULATION **	Simulation mode activated

No	Warning	Meaning, comments
17	** NO HV **	No HV 420 or HV 421 exists
18	** NO IS **	No IS 420 exists
19	** CANNOT DEG **	*DEGAS* not possible with *FILAM:1+2*
20	** NO AUTO **	*FILAM:1+2* not selectable with *DEGAS*
21	** ONLY F1 **	Only one filament available
22	** BUFFER **	Buffer management not OK

Other operator information is displayed in suitable locations.

7.3 Error messages

For many error types **ERROR !!** is displayed. To obtain detailed information press the *error* key.

NEXT displays the next error messages if more than one exists.

CLEAR deletes all messages (unresolved errors reappear immediately)

RETURN jumps to the preceding display information

Note

Find out whether or not error messages are reproducible.

For this purpose switch all involved components OFF and ON again.

Restart the computer and the software.

For sporadic errors or errors that are difficult to reproduce see p. 54

The following tables help you to take appropriate action in response to reproducible error messages or faults.

This information and methods apply to the most probable cases, however, exceptions are feasible.

7.3.1 ERROR table

No	Description	Possible cause / Test methods	Correction
2	Communication CS to QC	CS 422, its cable or QC 422 defective	Replace
3 4 7	CS 422 stack overflow CS 422 idle error, op. syst. overloaded CS 422 watchdog error	CS 422 defective	Replace
14 15 16	CS 422 Display RAM CS 422 EPROM checksum incorr. CS 422 RAM	run testprogram: *config-TEST-CS422:EPROM-T* or *RAM-T*	Replace CS 422 if not ok
17 18 19	QMS controller stack overflow Reset error QMS controller watchdog error	QC 422 defective	Replace
20	QMS controller EPROM checksum	run testprogram: *config-TEST-QMS:EPROM-T*	Replace QC 422 if not ok
21 22 23	QMS controller NOVRAM QMS controller dual port RAM QMS controller buffer RAM	run testprogram: *config-TEST-QMS:RAM-T*	Replace QC 422 if not ok
24 25	DSP-EPROM checksum DSP dual port RAM	run testprogram: *config-TEST-DSP:EPROM-T* or *RAM-T*	Replace QC 422 if not ok
26 27 28 29	Monitor-DAC error Resolution-DAC error AO-DAC error ADC error	Only for factory use with special instruments	
33	QMS controller idle error (Op. sys.)	QC 422 defective	Replace QC 422
34	SEM error	SEM high voltage overloaded or defective Cabling/jumper error Faulty insulation Arcing SEM should have 18 MΩ CD should have > 100 MΩ Measure 1V per 1kV at test socket Measure actual high voltage	 See p. 18 and 19 Check by detaching cable Switch off unit for 2 min. Ohm meter Insulation tester DVM High voltage probe
35	CD error	CD Voltage HV 421 overloaded or defective	See Error 34
36	Ion source error	V1...V9 overloaded or defective Switch off the unit, detach IS cable: if error disappears if error persists	 Check insulation of Cable /QMA F1, F2 (on IS 420) or IS 420 defective
37 38	Filament 1 defective Filament 2 defective	Test filament 1 or 2 (≈ 1 Ω) and cable	QMA 400 [5], IS 420 pin assignment See p. 12
39	Emission error (Emission ≠ set point)	Pressure too high Filament burnt out (QMA 125), Filament transport protection not removed Switch *emiss:OFF -...ON,* if unsuccessful Adjust PROTECTION Cable interrupted or insulation fault Wiring in QMA interrupted or Insulation fault Wrong settings	$p < 10^{-4}$ mbar Check with ohm meter, replace, if defective; see QMA 125 [6] Remove [5], [6] See 6.2 or QME 125 [4] Measure QMA 400 [5] QMA 125 [6] Test report and [5], [6]
40	CAN error	QC 422 defective (CAN for CS 422)	Replace QC 422
41	Parameter lost	QC 422 NOVRAM defective	Replace QC 422
42	Communication from QC to CS	CS 422, its cable or QC 422 defective	Replace
43	Communication QMS-controller / DSP	Quadrupole controller QC 422 defective	Replace QC 422
44	Communication LAN	LAN communication not o.k.	Check connection, settings, parameters, see p. 20, [7] etc.
45	Communication RS-232-C	RS-232 communication not o.k.	Check connection, settings, parameters
46	RF error	QMH 4x0 in heat-up phase Error message from QMH 4x0	Heat-up time approx. 10 min. QMH 4x0 [3]

7.4 Measurement signal problems

Problem	Possible cause / Test methods	Correction
No measurement signal with EP 422 or CP 400	Try simulation	Replace QC 422 if not ok
	Cabling not o.k.	Check, see p. 18 u. 19
	Wrong detector selection	Set *detect-TYPE* correctly
	No emission	Switch on *filam*
	Emission too low	Adjust: see test report
	No SEM high voltage	Switch on *sem:*, see also error 34. QME 125 fuse F1 [4]
	SEM high voltage too low	Increase: *detect-SEM* channel dependent *sem hv-SEM-VOLTAGE* channel independent See also Error 34 for HV 420
	No high voltage with HV 421	See Error 34
	Field axis voltage too low	See test report *v1..v6-F-AXIS (possibly V4)* QME125 [4]
	Wrong ion source parameters	See test report, QMA400 [5], QMA125 [6]
	Resolution too high: try integral spectrum with *mass-RESOL:OFF*.	If integral spectrum exists adjust resolution. QMH 4x0 [3], QME 125 [4]
No measured value with EP 422	EP in wrong connector of QMH	Check, see p. 18
	SCAN-N with 10 ms/u, *range* 10^{-9} A Disconnect EP 422 from QMA, touch input with screwdriver	50 (60) Hz signal should appear Check signal with an oscilloscope, if not o.k. replace EP 422
No measured value with CP 400	Threshold too high	Decrease *amplif-CP-LEV* see p.39
Electrometer signal negative	EP1 and EP2 cable mixed up	Check, see p. 18
	POLARITY switch on QME 125 set to "–"	Set POLARITY to "+"
Electrometer offset strongly mass dependent	Loose ground connection (EP input or below QMA connector plate)	Tighten / correct
	Open shielding below QMA connector plate	QMA 400 [5], QMA 125 [6]
Electrometer signal: - not zero between peaks - negative / small peaks missing	Offset not aligned	Perform offset correction, see p. 39
Offset in *range* 10^{-12} very high	Temperature of the EP 422 too high	Decrease
	Bad insulation collector to flange (good: >>1 GΩ)	Correct insulation fault → QMA 400 [5], QMA 125 [6]
	Moisture in electrometer or on analyzer connector	Dry with warm air (no over 60 °C) See p.55
Electrometer signal sensitive to vibrations	Knurled nut loose on EP input Shield below connector plate of QMA not correctly installed	Tighten Correct shielding QMA 400 [5], QMA 125 [6]
High noise signals with EP 422	Analyze signal (*amplif-MODE:FIX, SCAN-N*, high *SPEED*) with PC or **elm** signal with oscilloscope	Remedy noise or choose slower *SPEED, DWELL* and/or increase *amplif-FILTER*
High counting rate with CP 400 also besides peaks	Corona or arcing in CP 400 or in HV 420 in HV 421 in high voltage cables in QMA or SEM	Open CP 400 and dry with war air (<50°C), Remove dust. Replace HV 421 Replace cable QMA 400 [5], QMA 125 [6]
High counting rate with CP 400 also without high voltage	Poor ground connection, shielding open, coupling of parasitic signals, e.g. with isolated system set-up.	Correct Establish shielding or decouple
Measurement signal: -Limited to values <10 V -Jumps to 10.24 V	With *SEM* and *FIX-range* 10^{-11} and 10^{-12} A	EP 422 overdriven Use Autorange or *RANGE* 10^{-10} and higher SEM voltage

Problem	Possible cause / Test methods	Correction
Unsatisfactory peak shape, poor sensitivity	Small emission (0.1 mA) cannot be set on QME 125	Replace the insulators in the ion source, see QMA 125 [6]

Problem	Possible cause / Test methods	Correction
	Ion source insulation in analyzer bad (good: >100 MΩ)	Replace the insulators in the ion source, see QMA 400 [5], QMA 125 [6]
Unsatisfactory peak shape, poor sensitivity	Ion source or rod system in analyzer contaminated or defective	Clean QMA 400 [5], QMA 125 [6]
	SEM voltage too low	See Error 34
	SEM contaminated or defective	Replace SEM, QMA 400 [5], QMA 125 [6]
Peaks become wider/narrower with increasing mass number	Incorrect setting of *resolution coarse*	Adjust QMH 4x0 [3], QME 125 [4]

7.5 General problems

Problem	Possible cause / Test methods	Correction
Fans not running, no indication on CS 422 or *power*-LED	Line voltage missing or too low	Check line voltage
	Power cable defective	Replace power cable
	Short circuit in external unit such as QMH 4x0 or QME 125	Switch off / unplug ext. equipment / switch on again. If unsuccessful replace the defective unit.
	Short circuit on bus or in wiring Defective power supply	Trace Replace power supply (manufacturer's warranty becomes void if the power supply is opened)
Fans running, display on CS 422 is blank	Contrast strongly out of adjustment	Adjust contrast with ⌨
	CS 422 or its cable defective	Replace
	QC 422 not correctly installed or defective	See p.23 or replace
CS 422 keys dead	Control via interface	Manual control: *config-CTRL-MODE:CS 422*
QMH 4x0 connector does not fit into QC 422	QMH cable with old locking device	Use adapter, see p.56
Sporadic error messages	EMC problems	Correct the ground connection, see p. 16 Detach QMG cable from noise sources Identify noise source and eliminate noise Use LAN (fiber optics)
	Line voltage dips	Check supply voltage quality
No ArcNet communication	Check status LEDs of the OPA 200, check FO connection	OPA 200 [7]
	FO connectors contaminated	Clean, e.g. with alcohol
	HUB has no power	Check
	Stray light	Mount caps on all unused FO connectors!
	Wrong settings	Check jumper settings on all LAN units QC 422, OH 421. See p. 20 and [7], [8]
	Wrong node addresses	Correct
	QC 422 defective	Replace QC 422
	Defective LAN port device	Reduce system to minimum and then rebuild it in steps

7.6 Service interventions

If you are unable to remedy a fault or if you are not allowed to do so due to the lack of skilled personnel, please contact the responsible service location.

If you need advice or if you want to return the equipment for repair, please supply a comprehensive description of the error together with:

- Description of fault, e.g. hard copies, recorder charts and text
- Application conditions and operating modes under which the error occurs
- In case of sporadic errors all observations that could help to reproduce the error
- Type, series, software and firmware numbers of all components involved.

Products that have been exposed to vacuum conditions must always be accompanied by a completed contamination declaration VDMA No. 2121.

8 Maintenance

The QMS 422 and QMI 422 have lateral ventilation inlets. Their filters are to be cleaned before the air circulation becomes obstructed. The cleaning interval depends on the local dust evolution. Dry dust can easily be removed with the aid of a vacuum cleaner.

Skilled personnel

If necessary remove the filters and wash them in a mild soap solution. Dry them well before you reinstall them!

Defective filters should be replaced, see p. 56.

The installed fans should be checked semi-annually. Replace them if they are not running smoothly or are overly noisy.

Dusty circuit boards can be cleaned with compressed air (max. 2 bar). Make sure that no components get damaged or bent.

Moisture (condensation) in the EP 422 can lead to unstable behavior (offset fluctuations). Open the EP 422 and dry it with a hair dryer (max. 60 °C).

Refer to the maintenance instructions in all the user's guides of the components that form part of the system. See list of literature on p. 58.

9 Decommissioning

Please contact your Balzers service location on instructions of how to dispose of your system.

10 Spare parts and accessories

		Ordering number
QMS 422	Basic unit without QC 422	BG 444 580-T
CS 422	Operator console	BG 444 650-T
	1 Filter mat for QMS 422	B 5099 154 FD
	1 Ventilator for QMS 422	B 5099 130 CD
	1 Blanking plate, 4 subunits (20 mm wide)	BG 544 775-T
	Power supply for QMS 422 and QMI 422 (90...265 V)	B 5181 214 QY
QMI 422	Control unit with QC 422	BG D27 280
	1 Air filter mat for QMI 422	B 5099 154 FB
EP 422	Electrometer	BG 444 570-T
	Input cable TNC/TNC, 200°C, l = 0.5 m	B 4564 401 EB
	Input cable TNC/TNC, 70°C, l = 6 m, low-noise	B 4564 401 E2
	TNC short circuit plug (fits QMA)	B 4728 138 BC
QC 422	Quadruple controller without options	BG 444 590 -T
AO 421	Analog output (incl. connector)	BG 442 328-T
IC 421	Ion counter and analog output	BG 442 320-T
	Ion counter preamplifier CP 400	BG 442 210-T
	Cable CP 400-QC 422: 3m	BG 448 134-T
	Cable CP 400-QC 422: 10m	BG 448 199-T
Ion source supply IS 420		BG 512 900-T
	Ion source cable 3 m	BG 548 082-T
	Ion source cable 10 m	BG 548 083-T
	Fuses F1, F2 2.5 A slow	B 4666 444
HV 420	SEM high voltage supply	BG 546 040-T
	Fuse F1 0.2 AT	B 4666 422
HV 421	SEM high voltage supply	BG 442 250-T
	HV cable 3m	BG 541 978-T
	HV cable 10m	BG 541 979-T
AI 421	Analog input (incl. connector)	BG 442 240 -T
DI 420	Digital input	BG 512 830 -T
	1 Connector housing	BG 531 194-T
	1 Multipoint connector, solder version	B 4717 306 DL
DO 420A	Digital output	BG 512 842 -T
	Connector, see DI 420	
PI 420	Pirani module	BG 512 715 -T
PE 420	Cold cathode module	BG 512 726 -T
OH 421	Optical hub	BG 442 465-T
OPA 200	Optical PC Arcnet interface	B 5278 503 KT
OHA 200	Optical hub 5-port	BG 442 510-T
OHA 200	Optical hub 10-port	BG 442 520-T
	Fiber-optic conductor PCF 10m	B 5159 615 2H
	Fiber-optic conductor PCF 20m	B 5159 615 2K
	Fiber-optic conductor PCF 50m	B 5159 615 2Q
	Fiber-optic conductor APF 1 m	B 5159 615 2C
	Fiber-optic conductor APF 3 m	B 5159 615 2D
	Other lengths on request	
Adapter for QMH 400 / QME125 with sliding lock		B 4720 786 CD

Appendix

A: Default parameter values

For activating the default parameters see Parameter *INIT*.

Channels

Parameter	Function	Default value	Parameter	Function	Default value
AI-CH	*detect*	0	*MODE*	*amplif*	FIX
AO-CH	*output*	1	*MODE*	*mass*	SCAN-N
AO-MODE	*output*	LIN	*MONITOR*	*output*	LIN
AVERAGE	*mass*	1	*O-RNG*	*output*	E-1
CALIB	*amplif*	1.000 E0	*P-CAL*	*amplif*	1.0
COPY TO XX	*aux*	0	*PE-CTRL*	*detect*	OFF
CP-LEV	*amplif*	0.00 V	*PI-CH*	*detect*	1
DO-A	*trip*	OFF	*RANGE*	*amplif*	E-5
DO-B	*trip*	OFF	*RANGE-L*	*amplif*	E-5
DWELL	*mass*	1 s/u	*RESOL*	*mass*	25
FILTER	*amplif*	AUTO	*SEM*	*detect*	SEM-HV
FIRST	*mass*	14.00	*SPEED*	*mass*	1 s/u
GAIN	*amplif*	×1	*STATE*	*aux*	ENABLE
LEVEL-A	*trip*	1.00 E-6	*THRESH*	*mass*	0.3 %F.S.
LEVEL-B	*trip*	1.00 E-5	*TYPE*	*detect*	SEM
LOG-DEC	*output*	3 DEC	*TYPE*	*trip*	ABS
MASS	*mass*	14.00	*WIDTH*	*mass*	+16

General

Parameter	Function	Default value	Parameter	Function	Default value
BAUD	*config*	2400 Bit/s	*MODE*	*config*	CS 422
DETECT	*config*	SEM	*NODE*	*config*	176
IS-TYP	*config*	CB	*OPTION*	*config*	NO
MASS-R	*config*	512	*QMA*	*config*	400
			SEM+FIL	*config*	INTERN

Ion source

400

Parameter	Function	Axial	CB	Grid	SPM	Spec+/-
E-PROT	*emiss*	4.40 A	4.40 A	4.40 A	3.50 A	0.00 A
EMISS	*emiss*	1.00 mA	1.00 mA	1.00 mA	0.50 mA	OFF
V1	*v1...v6*	90 V	90 V	90 V	40 V	0 V
V2	*v1...v6*	70.0 V	70.0 V	70.0 V	40.0 V	0 V
V3	*v1...v6*	+20.0 V	+20.0 V	0.0 V	0,0 V	0 V
V4	*v1...v6*	15 V	15 V	15 V	3 V	0 V
V5	*v1...v6*	0 V	250 V	0 V	0 V	0 V
V6	*v1...v6*	300 V	300 V	300 V	110 V	0 V
V7	*v7...*	0 V	0 V	0 V	0 V	0 V
V8	*v7...*	0 V	0 V	0 V	0 V	0 V
V9	*v7...*	30 V	0 V	0 V	30 V	0 V

Operation

Parameter	Function	Default value	Parameter	Function	Default value
ADJ-TYP	*cycle*	COARSE	*FIL1*	*ion src*	SET 0
BEGIN	*cycle*	0	*FIL2*	*ion src*	SET 0
COPY TO SET	*ion src*	SET 0	*FUNCT*	*cycle*	CYCLE
CYCLES	*cycle*	REPEAT	*MODE*	*cycle*	MONO
D-EMIS	*ion src*	10.0 mA	*MODE*	*ion src*	NORMAL
D-PROT	*ion src*	4.00 A	*SEM-VOLTAGE*	*sem hv*	1500 V
D-TIME	*ion src*	10 min	*TRIG*	*cycle*	INTERN
END	*cycle*	63	*TYPE*	*ion src*	CB
FILAM	*ion src*	1			

B: Literature

[1] Technological information
Partial pressure measurement in vacuum technology
BG 800 169 PE

[2] Communication protocol Quadrupole Controller QC 422
BG 800 452 BE

[3] Operating instructions RF Generator QMH 400 / 410
BG 800 409 BE

[4] Operating instructions Quadrupole electronics QME 125
BG 800 325 BE

[5] Operating instructions QMA 400 / 410 / 430 Analyzer
BK 800 127 BE

[6] Operating instructions Analyzer QMA 125
BK 800 153 BE

[7] User's guide Network Controller Board OPA 200
SH-ARC BAL

[8] Operating manual Optical Hub OHA 200
BG 803 054 BE

[9] Operating instructions Pirani module PI 420
BG 800 182 BE

[10] Operating instructions Penning Module PE 420
BG 800 183 BE

Ordering source
Balzers Instruments, FL 9496 Balzers, Principality of Liechtenstein

C: Index

Note:
Information on the parameters can be found in the alphabetical list beginning on page 28

Original: German BG 800 451 BD (9801)

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