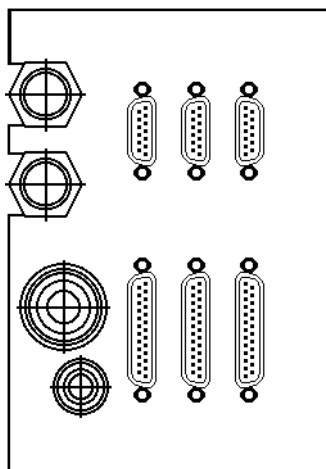


## Electronics for energy analyzer

PA 421



Safety  
Installation  
Operation  
Technical data

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## General

For an overall view of the equipment please consult the operating manual of the PPM 421 Plasma Process Monitor. For the two QMS 422 quadrupole controllers the relevant information can be found in the QMG 422 Operating manual.

However, the information in this booklet has **priority**, particularly with respect to the **more stringent safety requirements**.

The electronics for the PA 421 energy analyzer fulfills three principal functions:

- It interconnects the voltages of two IS 420 ion source supplies for the four operating modes of the energy analyzer (→ Appendix A).
- It transmits the measured values from the EP 112 or CP 400 to the appropriate quadrupole controller:
  - to the QC-M for a mass scan
  - to the QC-E for an energy scan.
- It generates the energy scan voltage of  $\pm 0...512$  VDC required for energy analysis.

## Validity


This manual applies to modules with part number  
BG442450-T

The part number can be taken from the nameplate.

The functions described as well as the illustrations and data contained in this manual are subject to change without notice.

# 1 Safety

## 1.1 Safety information

Take the necessary precautions when performing installation or maintenance work as well as troubleshooting (→  6ff, 16, 17).

## 1.2 Explanation of symbols

**DANGER:**

Information on preventing personal injury or extensive equipment damage.

**CAUTION:**

Special information on damage prevention.

**NOTE:**

Special information on cost-effective use.

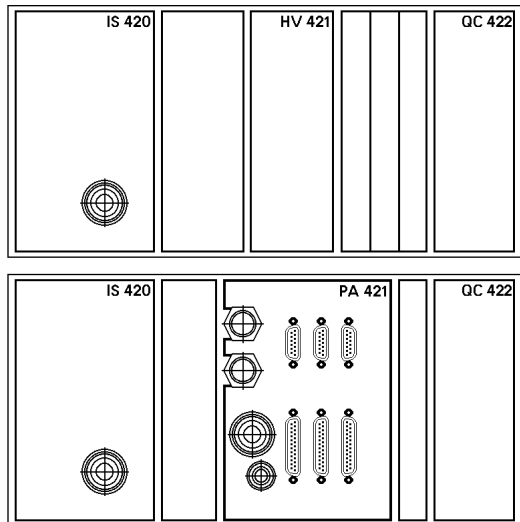
## 1.3 General stipulations

Since the individual electronic components are delicate, appropriate measures must be taken to protect them from static electricity. Store the modules in antistatic bags or containers.

Damage resulting from incorrect handling may lead to revocation of the warranty.

Pfeiffer Vacuum accepts no responsibility and the warranty becomes null and void if alterations are made to the product or if the product is used with accessories not listed in the product documentation.

## 2 System overview



The analyzer is controlled by two controllers, QMS 422-M and QMS 422-E.

Controller M (M for mass) contains a conventional mass spectrometer control for mass analysis. It controls the RF generator, the ion source, the SEM and any existing I/O modules.

Controller E (E for energy) contains a mass spectrometer control that has been redesigned for energy analysis. It controls the energy scan voltage  $V_{esc}$ . The energy is assigned to the parameters MASS and FIRST. In this case SPEED does not mean seconds per amu but seconds per Volt.

The PA 421 has no direct bus interface. It obtains the supply voltage from the QMH connector of the QC-E. Most lines of the QMH are connected directly to the QC-M. The changeover relay is switched with the SPEC-SRC control signals of the two IS 420 units as well as the MODE1 control line (Integral) of the QC-E.

## 3 Installation

**CAUTION:**

IS 420 units with serial numbers below 746 may not be used together with the PA 421.

**DANGER:**

The unit may not be installed in an environment with moist or even conductive contamination.

The PA 421 module is energized by hazardous high voltages. Do not turn it on until all installation steps have been completed and checked.

Before you perform any manipulations on the module or the connectors, turn off the line voltage of **all** power sources within the system (incl. plasma generator).

Open connectors must basically be regarded as hazardous. Under no circumstance may the mechanical lock on the connectors be removed.

### 3.1 Installing the PA 421 into the controller

The PA 421 module is to be installed into the QMS 422-E controller.

Arrangement → Appendix B


**DANGER:**

For safety reasons and in order to prevent EMC problems the rear panel of the PA 421 must be firmly fastened to the frame with all four screws.

### 3.2 Controllers and ground connection



#### **DANGER:**

The two controllers may not be fitted with CS 422 operator consoles; the front panels are to be closed with filler panels (→  17).

The two controllers are to be installed in a closed, grounded cabinet that can only be opened with a tool or key. Contact with the rear panel connectors should not be possible during operation.

Both controllers must be connected to the ground distributor in the cabinet by permanently installed, stranded ground wires with a cross-section of 4 mm<sup>2</sup> (or larger, if larger currents can flow from the plasma).

The stranded ground conductors (color: yellow/green) must be fastened to the power supply mounting plate in the QMS 422 by means of a suitable cable lug and an M4 screw with lock washer. The M4 tapped hole is located behind the rear panel section with the power inlet of the QMS 422. The stranded ground conductor can be guided through one of the ventilation louvers. Before you open the unit detach all cables, and after installation firmly tighten all 4 rear panel screws!

The cabinet must be connected to the protective ground of the overall system by means of a permanently installed ground conductor. VDE 0160 E1990 requires a conductor cross-section of at least 10 mm<sup>2</sup>, but please refer to the regulations applicable to your specific system.

The ground connection and power distribution must be implemented in such a way that no inadmissible ground currents (also RF!) can be transmitted via the ground conductors of the two QMS 422 controllers.

If a unit is disconnected from the normal AC power ground because the power plug has been pulled or accidentally come loose, contact with the equipment housing or the pins of the exposed power plug could be extremely hazardous if these special grounding measures are not implemented. A further hazard would be that the protective ground conductors in the power cables could become overloaded by high currents from the equipment.

Power cables should always be connected first and disconnected last so that the protective ground is always available as long as any other cable is connected.

### 3.3 Computer connections



**DANGER:**

For connecting the two controllers to the computer, only fiber-optic lines may be used; the electrically transmissive RS232C interface may not be used.

### 3.4 Other connections



**DANGER:**

The connections or the rear panels of the two QC 422 quadrupole controllers and on the equipment options such as AO 421, AI 421, DO 420A, DI 420 etc. must be protected against accidental contact or be equipped with the necessary insulation or protection elements.

The same applies to the cables and equipment connected to these modules.



In normal operation only the intended extra-low voltages are applied. However, in case of defects or sparkovers, hazardous voltages can occur. The insulation against contact must be rated for 1200 VDC (or higher, if higher voltages can emanate from the plasma).

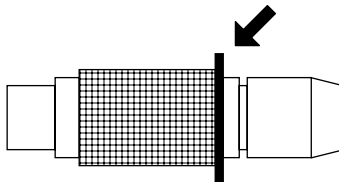
### 3.5 System cabling

→ Appendix B.



#### **DANGER:**

The round connectors of the cable to the IS 420 and QMA 4x0 are fitted with a retaining ring. They can be plugged in normally but only be detached with the aid of the supplied retaining ring pliers. Make sure that you plug the cables into the right connector. For releasing the lock place the retaining ring with the aid of the pliers over the collar, directly adjacent to the groove. After the connector has been unplugged the ring must be immediately reinserted into the groove with the aid of the pliers!



## 4 Operation



### DANGER:

Do not turn on the controllers until all installation steps have been correctly completed (→ 6ff). If service is needed → 17.

### 4.1 Configuration of the controllers

		Controller M	Controller E
<config> SYSTEM	QMA	400	400
	MASS-R	depending on QMH	512
	DETECT	SEM / H-SEM	SEM / H-SEM
	IS-TYP	SPEC +/-	SPEC +/-
	OPTION	NO or CP	NO or CP

### 4.2 Choosing the ion mode



### CAUTION:

Before you switch to energy scan voltage mode the energy scan voltage  $V_{esc}$  must be set to 0 V.

Mode	Controller M		Controller E	
	<ion src> TYPE	<emiss> EMISS	<ion src> TYPE	<emiss> EMISS
Ions +	SPEC +	OFF	SPEC +	OFF
Ions -	SPEC -	OFF	SPEC -	1 mA <sup>1)</sup>
Neutrals coarse	SPEC +	≈ 1 mA	SPEC +	OFF
Neutrals fine	SPEC +	≈ 0.1 mA	SPEC +	1 mA <sup>1)</sup>

<sup>1)</sup> or any value  $\neq 0$  (Only used for changing over the operating mode, has no influence on the emission.)

### 4.3 Choosing the scan mode

	Controller E
Mass scan	<mass> RESOL > 0 (value irrelevant)
Energy scan	<mass> RESOL = 0 or OFF

This parameter must be set to the same value for all measurement channels used!

By selecting the scan mode, the measured values of the electrometer or the CP 400 are switched to the corresponding controller (E or M).

### 4.4 Operation

Controller M controls the RF stage, filament, SEM, and CP-LEVEL in all modes.

Controller E controls the energy scan voltage  $V_{esc}$ . For synchronizing the measured values with the corresponding control variable (Mass or  $V_{esc}$ ) the measurement data acquisition of controller M is used for the mass scan whereas for the energy scan the one of controller E is used.





All parameters of the <amplif> function (e.g. Range, Filter...) are controlled by the responsible controller. (Exception: CP-LEVEL is always controlled by controller M.)

Legend to the table on the following pages:

"—" No effect on measurement

"+++" The value can be user-selected in accordance with the measurements to be performed

## Mass scan

Parameter		Controller M	Controller E
<detect>	TYPE SEM	+++ SEM-HV	— —
<mass>	MODE	+++	SAMPLE or SCAN HALT
	SPEED	+++	—
	FIRST/MASS	+++ as Masse	+++ as $V_{esc}$ in Volt
	WIDTH	+++	—
	RESOL	+++	>0 (→ 4.3)
<amplif>		+++	—
<output>		+++	—
<emiss>	EMISS	→ 4.2	→ 4.2
<V1...V6>		→  PPM 422	→  PPM 422
<V7...>		→  PPM 422	→  PPM 422
<sem HV>		+++	—
<ion src>	MODE	NORMAL	—
	TYPE	→ 4.2	—
	FILAM	+++	—
	FIL1, FIL2	Choose SET according to ion mode	Choose SET according to ion mode
<cycle>		+++	—
<sem>		SEM on/off	—
<filam>		Filament on/off	—
<run/halt>		run / halt	halt

## Energy scan


Parameter	Controller M	Controller E
<detect> TYPE SEM	— SEM-HV	+++ —
<mass> MODE	SAMPLE HALT or SCAN HALT	SCAN-N, SAMPLE or STAIR
SPEED	—	Set in s/Volt
FIRST/MASS	+++ as mass	+++ as $V_{esc}$ in Volt
WIDTH	—	+++ as $V_{esc}$ in Volt
RESOL	—	0 (→ 4.3)
<amplif> CP LEVEL all others	+++ —	— +++
<output>	—	+++
<emiss> EMISS	→ 4.2	→ 4.2
<V1...V6>	→  PPM 422	→  PPM 422
<V7...>	→  PPM 422	→  PPM 422
<sem HV>	+++	—
<ion src> MODE	NORMAL	—
TYPE	→ 4.2	—
FILAM	+++	—
FIL1, FIL2	Choose SET →  PPM 422	Choose SET →  PPM 422
<cycle>	—	+++
<sem>	SEM on/off	—
<filam>	Filament on/off	—
<run/halt>	halt	run / halt



### NOTE:

The error message **RF-ERROR** in controller E means overloading of the  $\pm 500V E_{scan}$  supply.

## 5 Technical data

Dimensions	Circuit board SC 420
Space requirement	6 slots
Supply voltage	$\pm 24$ VDC 0.6 A from QMH connector of QC-E
Fuses F1, F2	0.4 A slow (only for $\pm 500$ V section)
Cable temperature QMA 2 (4 conductors)	max. 80 °C (other cables → corresponding  )

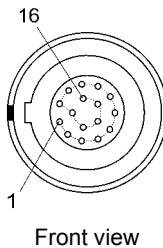
$\pm 500$  V Energy Scan voltage

Output voltage $V_{esc}$	0 ... +512 V switchable to 0 ... -512 VDC, relative to QMA-GND
Load	max. 250 nF parallel to 1.4 M $\Omega$
Ripple	50 mV <sub>pp</sub> max.
Control voltage (Scan)	0 ... 10.240 V
Zero error	100 mV max.
Zero drift	3 mV /°C max.
Gain error	0.3% F.S. max.
Gain drift	150 ppm/°C max.

### 5.1 Connector pinout

Connector QMA 1

LEMO  
16-pin, female

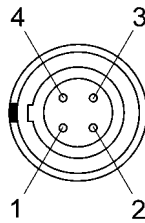


Pin assignment

Pin 1 QMA Gnd	Pin 9 Fil Com
Pin 2 Ioniz	Pin 10 Field Axis
Pin 3 Defl. I	Pin 11 Ref Gnd
Pin 4 Foc 2	Pin 12 Screen
Pin 5 Infl	Pin 13 Mirror
Pin 6 Foc 1	Pin 14 Center
Pin 7 Fil +	Pin 15 Extr
Pin 8 Fil -	Pin 16 Defl. O

Connector QMA 2

LEMO  
4-pin, female



Pin assignment

- Pin 1 Case
- Pin 2 Entry
- Pin 3 Screen
- Pin 4 not connected

## 6 Maintenance

**DANGER:**

The PA 421 module is energized by hazardous high voltages. Before you perform any manipulations on the module or the connectors, turn off the line voltage of **all** power sources within the system (incl. plasma generator).

The following parts are to be cleaned monthly (more often if the environment is dusty):

- Air filter of both controllers  
⇒ extract dust with a vacuum cleaner
- Electronics of PA 421 analyzer  
⇒ blow out with compressed air
- Ion source supply IS 420  
⇒ blow out with compressed air

**DANGER:**

When using compressed air make sure that the applicable handling and safety measures are strictly followed.

**CAUTION:**

The compressed air must meet the following specifications:

- free of moisture
- gauge pressure  $\leq 2$  bar



## 7 Troubleshooting

Faults may only be remedied by qualified personnel!

**DANGER:**

The PA 421 module is energized by hazardous high voltages. Before you perform any manipulations on the module or the connectors, turn off the line voltage of **all** power sources within the system (incl. plasma generator).

For certain service work it may be necessary to equip the two controllers with CS 422 operator consoles.

**DANGER:**

Daily check the operator consoles daily for any signs of cracks. If cracks are detected further operation of the equipment is no longer allowed (the membrane is one of several links in the insulation chain).

Replace the operator consoles with filler panels immediately after the service work has been completed.

If no energy scan voltage is available check the two fuses F1 and F2 inside the PA 421.

**DANGER:**

Only fuses of the specified type and rating may be used as replacements. The utilization of repaired fuses or short-circuiting of the fuse holder is inadmissible.

If the fuses blow repeatedly the module is defective. Return it to the nearest Pfeiffer Vacuum Service Center. Repairs by other locations are not allowed for safety reasons.

## 8 Spare parts

When ordering spare parts, always specify:

- Product type
- Serial number inscribed on nameplate

Description	Ordering number
Pliers for retaining rings	N5733103CC
Retaining ring for 16-pin connector	N3829530-X
Retaining ring for 4-pin connector	N3829440-X
Fuses 0.4 A slow $\varnothing 5 \times 20$ mm	B4666428
Cables	→ Appendix B

## Appendix

**A: Assignment of potentials V0 ... V9** From IS 420-M and IS 420-E to the analyzer, to the energy scan voltage and the reference potential

### Mode: Ions + or –

V0M	V1M	V2M	V3M	V4M	V5M	V6M	V7M	V8M	V9M
n.c.	V <sub>esc</sub>	Fil –		n.c.	ITRO	n.c.	n.c.	Foc 1	Entry
V0E	V1E	V2E	V3E	V4E	V5E	V6E	V7E	V8E	0.5V9E
V <sub>esc</sub>		Center	Foc 2	Field Axis	Case	Defl. I	Defl. O	Mirror	INFL

### Mode: Neutrals coarse

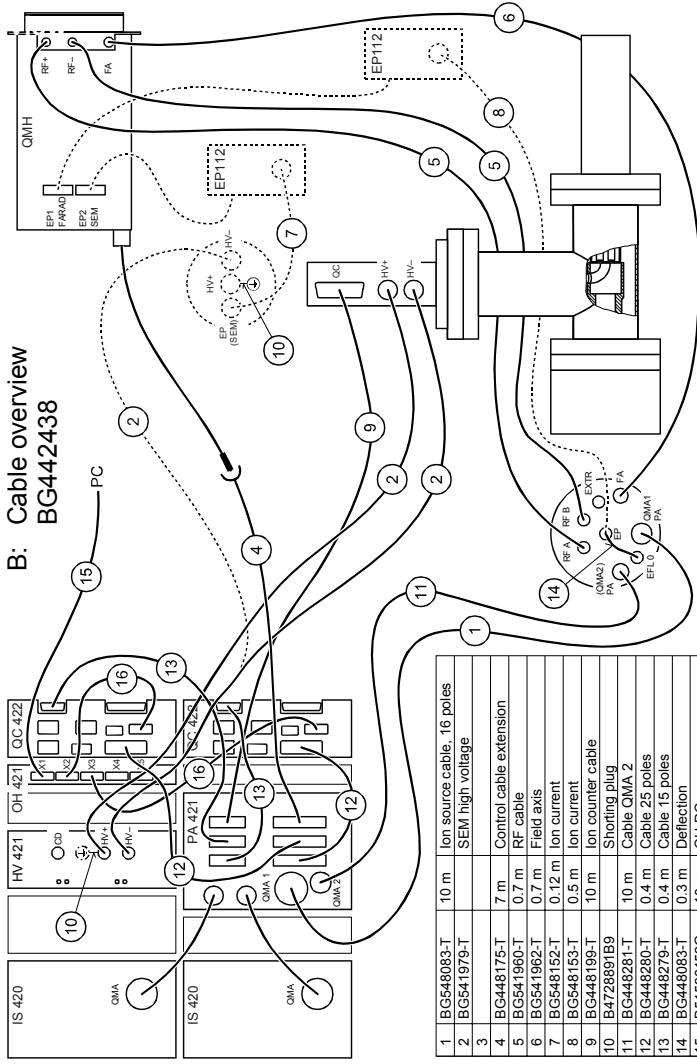
V0M	V1M	V2M	V3M	V4M	V5M	V6M	V7M	V8M	V9M
n.c.	Ioniz/Gnd	Fil –		n.c.	Extract	n.c.	n.c.	Foc 1	n.c.
V0E	V1E	V2E	V3E	V4E	V5E	V6E	V7E	V8E	0.5V9E
V <sub>esc</sub>	Entry*	Center	Foc 2	Field Axis	Case	Defl. I	Defl. O	Mirror	INFL

### Mode: Neutrals fine

V0M	V1M	V2M	0.4V3M	V4M	0.01V5M	V6M	V7M	V8M	V9M
n.c.		Fil –	Ioniz/Gnd	n.c.	Extract	n.c.	n.c.	Foc 1	n.c.
V0E	V1E	V2E	V3E	V4E	V5E	V6E	V7E	V8E	0.5V9E
V <sub>esc</sub>	Entry*	Center	Foc 2	Field Axis	Case	Defl. I	Defl. O	Mirror	INFL

### Explanations

V <sub>x</sub> M, V <sub>x</sub> E	Potential V <sub>x</sub> of IS 420-M, IS 420-E
0.4V3M	V3M is multiplied times 0.4
0.01V5M	V5M is multiplied times 0.01
0.5V9E	V9E is multiplied times 0.5
V <sub>esc</sub>	Energy scan voltage (0...±500 V)
Ioniz/Gnd	Is at reference potential Reference Ground (Ref Gnd, 0V)
ITRO	Ion transfer optics: Ionizer and Extraction connected in parallel
Entry*	Corresponds to Stop in Neutrals mode
n.c.	Not connected



B: Cable overview  
BG442438

1	BG548083-T	10 m	Ion source cable, 16 poles
2	BG541979-T		SEM high voltage
3	BG448175-T	7 m	Control cable extension
4	BG541960-T	0.7 m	RF cable
5	BG541962-T	0.7 m	Field axis
6	BG548152-T	0.12 m	Ion current
7	BG548153-T	0.5 m	Ion current
8	BG448199-T	10 m	Ion counter cable
9	BA728891B9		Shorting plug
10	BG448281-T	10 m	Cable OMA 2
11	BG448280-T	0.4 m	Cable 25 poles
12	BG448290-T	0.4 m	Cable 15 poles
13	BG448083-T	0.3 m	Deflection
14	BG448083-T	10 m	OH-PC
15	B51596152G	10 m	OH-PC
16	B51596152C	1 m	OH-OC (2 pieces)

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