

OPERATING INSTRUCTIONS

EP 112
EP 511

Electrometer preamplifiers

Contents:	Page
1. INTRODUCTION	1
2. FEATURES	1
3. SPECIFICATION	1
4. DESCRIPTION	2
5. INSTALLATION	2
5.1 Installation	2
5.2 Connections	2
5.3 Grounding	2
6. OPERATION	3
6.1 Control units	3
6.2 Zero point adjustment	3
6.3 Input voltage	3
6.4 Input impulses	3
7. MAINTENANCE	4
7.1 Troubleshooting table	4
7.2 Function checks	5
8. DETAILED DESCRIPTION	5
9. SPARE PARTS	5
10. ACCESSOIRES	5
APPENDIX A: Schematics and lay-out plan	
B: Spare parts list	

1. INTRODUCTION

The EP 112 electrometer preamplifier is a highly sensitive current/voltage converter that features a short rise time. When used together with an appropriate control unit, it can measure very low currents. Its main application is the detection of ion currents in mass spectrometers with and without SEM secondary electron multipliers.

The EP 511 is identical to the EP 112 with the exception of the control signal cable.

2. FEATURES

- Remote controlled measurement range switchover
- Measurement ranges 10^{-5} , 10^{-7} , 10^{-9} , 10^{-11} A
- Low drift and noise
- Short rise times
- Short recovery time after overdriving
- Low input resistance
- Compact unit
- Low interference installation close to the signal source
- BNC input connector

3. SPECIFICATION

General		
Designation	EP 112	EP 511
Order Nr.	BG 528 755 -U	BG 521 300 -U
Schematics Nr.	BG 541 015 -AS	BG 521 970 -BS
Control signal cable	shielded	not shielded
Length	0.85 m	3 m
Connector	CANNON D 9-P	CANNON D 25-P
Conductors	4 x 2 x 0.15 mm ²	twisted in pairs
Dimensions	112 x 60 x 32 mm	
Permissible ambient temperature		
In operation	0... 50 °C	
In storage	-40... 70 °C	
Weight	450 g	

Mass range [A]	10 ⁻⁵	10 ⁻⁷	10 ⁻⁹	10 ⁻¹¹
Sensitivity [A/V]	10 ⁻⁶	10 ⁻⁸	10 ⁻¹¹	10 ⁻⁸
Tolerance at 25 °C [%]	±1	±1	±2	±2
Rise time 10... 90% [ms]	0.04	0.1	1.5	60
Zero point drift 0... 50 °C [mV]	±5	±5	±10	±100

Recovery time < Rise time after a 100x overdriving

Supply
+16 V DC < 25 mA, ±0.2 V, Ripple < 10 mV
-16 V DC < 10 mA, ±0.2 V, Ripple < 10 mV

Input
Connector BNC
Input resistance 100 kOhms
Permissible overvoltage 250 V

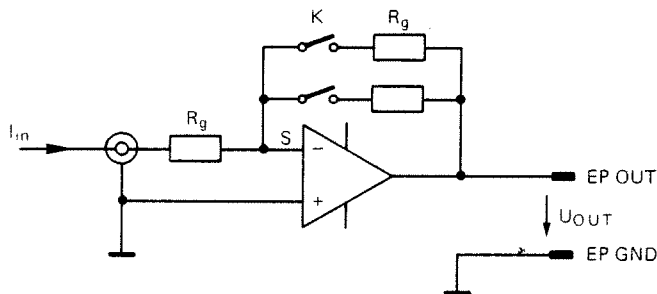
Output
EP OUT to EP GND at connector J2
Full deflection ±10 V
Load 2 mA maximum
Output impedance 47 Ohms

Zero point
Adjustment range ± 15 mV typical

Control signal
Range control
- EXP 5/7/9 L
- Active low 0... +3 V
- Internal pull-up 5 kOhm to +16 V

4. DESCRIPTION

Principle diagram for EP 112



The measurement range is selected by the Reed relay K, which turns on the corresponding feedback resistor R_g. It produces a proportional voltage drop in R_g.

The OPAMP keeps summation point S on 0 V potential.

Thus:

$$U_{out} = -I_{in} R_g$$

5. INSTALLATION

5.1 Installation

Mount the EP 112 on the vibration dampers located on the holder bracket or holder ring supplied with your mass spectrometer analyzer.

When mounting be sure that it is possible to make the connection to the signal source with the short (11 cm, approx.) coaxial cable.

For fast measurements in sensitive ranges it is important to avoid vibrations and shocks during operation.

The preamplifier must be protected from high temperatures, drafts, moisture and strong magnetic fields which can all cause instabilities in the more sensitive ranges.

5.2 Connections

Connect the EP 112 control signal cable to the EP connector of your measurement unit and secure the connector.

Make the connection between the BNC input socket and the Faraday or SEM collector of the mass spectrometer. The short, low-noise cable usually gives the best results.

If you are going to bake-out the analyzer during operation, use the longer, heat-resistant input cable. Note, however, that the noise and vibration sensitivity of this cable is poorer than that of the shorter cable.

Pay special attention that the entire inside conductor is well shielded!

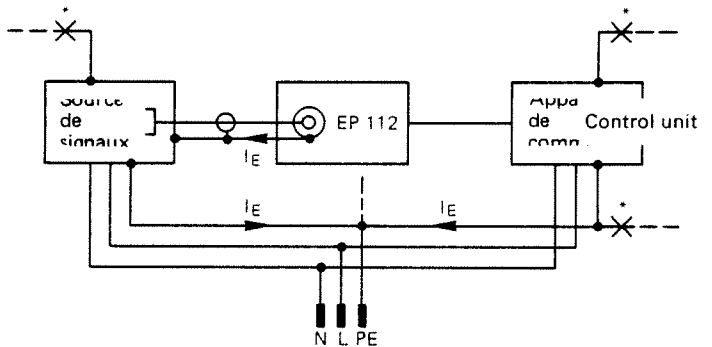
5.3 Grounding

The input connector and thus also the EP 112 housing are grounded to the signal source when the input cable is connected.

No outside currents may be allowed to flow along the input cable shielding. These would cause interference.

For this reason, the control unit must always be grounded to the same point as the signal source. For mass spectrometer applications, this point is the protective ground for the pumping system.

Pay strict attention that no I_E ground currents flow in the two grounding lines concerned.



PE: protective ground

L: Live

N: Neutral

* Do not connect any "foreign" grounding lines to the common ground!

6. OPERATION

6.1 Control unit

The EP 112 is usually used with control units which allow additional measurement ranges through post amplification. These control units also have adjustable filters to separate signals and noise. Logarithmic or quasi-logarithmic post amplification allows large dynamic ranges without the necessity of changing the measurement range of the EP 112.

6.2 Zero point adjustment

Adjust the zero point of the electrometer controller (post amplification) in your control unit before adjusting the zero point in the EP 112.

- Disconnect the BNC connector and shield it (such as with Al foil), do not short circuit
- Set the control unit filter to approx. 1 sec.
- Select measurement range 10^{-5} and post amplification x10 or x100
- Adjust the zero point on the trimmer potentiometer (bore close to the control signal cable)
- Check the zero point in the more sensitive ranges and carry out fine adjustment if necessary

Vibrations could make the adjustment difficult in the most sensitive range. Set the trimmer potentiometer and then withdraw the screwdriver to observe the zero point.

6.3 Input voltage

In an ideal current/voltage converter the summation point and thus the input always remains on 0 V. Because of the R_S protective resistor (100 kOhm) it is only possible to approximate this ideal situation.

For larger measurement signals (10^{-5} A) the following holds:

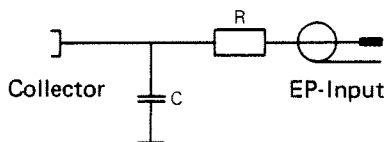
$$U_{\text{INPUT}} = I \cdot R_S = 10^{-5} \text{ A} \cdot 10^5 \text{ Ohm} = 1 \text{ V}$$

In the more sensitive ranges correspondingly lower and thus mostly negligible input voltages occur.

6.4 Input impulses

An SEM supplies an output current impulse for each incoming particle. These current impulses are usually converted to correct mean values in electron amplifiers.

If there are not very many in-coming particles and the SEM gain is set very high, each individual impulse from the preamplifier can be overdriven, and a correct mean value conversion is not possible. This results in non-linearity.



In such cases, choose a less sensitive measurement range and a high post amplification.

In extreme cases an integration capacitor is useful. However, it must not be connected directly to the summation point, and it must be decoupled with a resistor. R should be approximately the same as the measurement resistance when turned on. Make sure that the shielding is good!

7. MAINTENANCE

WARNINGS

The EP 112 preamplifier contains sensitive semiconductor elements which react to static charges.

Touching them can cause damage. Please follow the preventative measures outlined.

Touching the measurement resistors and insulators with uncovered fingers can cause permanent instabilities.

The EP 112 electrometer preamplifier needs no maintenance. However, when the humidity is high, zero point deviations can occur. In this latter case the EP 112 pc board must not be cleaned with solvents. It may only be dried with hot air (max. 70 °C).

7.1 Troubleshooting

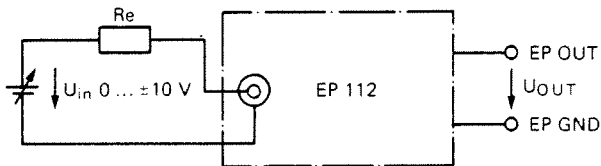
Symptom	Possible cause	Localizing	Rectification
No electrometer signal, no reaction when the unit is on the most sensitive range and the input cable is jiggled	Control signal cable incorrectly connected	Visual check	Connect correctly
	Operational error at the control unit	Visual check	Make correct setting
	Defective control unit	Measure the control signals and supply at J2	Repair or replace
	EP 112 defective	Measure output signal at J2	ditto
No electrometer signal, but there is a reaction when the unit is on the most sensitive range and the input cable is jiggled	No signal at the input	Check signal source (mass spectrometer)	Correct source of malfunction
Electrometer signal is negative i.e. is "standing on its head"	Polarity not adapted to the type of measurement	Visual check	Adjust according to the control unit operating instructions
Electrometer signal is not 0 when the signal source is turned off	Zero point not adjusted	Shield input	Adjust the control unit and the EP 112
	High interference at the ELECTROMETER 0...10 V output	Investigate the interference with an oscilloscope	Protect the analyzer and the electrometer from vibrations Select a longer filter constant
	Insulation fault in the QMA	Shield the input, the zero point can now be adjusted	Upgrade the ion collector insulation
	Moisture in the EP 112 or in the signal source	Zero point is ok in the less sensitive ranges, but unstable	Carefully dry the EP 112 and the QMA flange with hot air
Electrometer zero point dependent on the mass scan	RF shielding under the connector plate of the analyzer is open	Visual check after the protective cylinder has been removed (Turn off mains power because of high voltage)	Correctly install shielding
	Poor or open grounding contact	Visual check	Tighten screws

7.2 Function checks

The correct functioning of the EP 112 can be checked in a simple manner:

- Jiggle the input cable in the 10^{-11} mass range. This must have an effect on the output signal (jump of several volts at a short filter constant).

All the other measurement ranges can be tested with the following auxiliary circuit.



I Range	10^{-5}	10^{-7}	10^{-9}	10^{-11}
R_e	900 kOhms	100 kOhms	10 GOhms	1 TOhm

On Thus:

$$U_{out} = -U_{in}$$

Test resistor R and the line to the BNC connector must be shielded for the more sensitive range.

8. DETAILED DESCRIPTION

Refer to circuit diagrams BG 541 015 -AS/BG 521 970 -BS

Voltage is supplied to the EP 112/EP 511 via cable J2.

Feedback resistor R4 is on continually supplied by voltage divider R28/R29 for the most sensitive measurement ranges. Depending on the type of operation, an additional resistor with a K1...K3 Reed relay must be connected in parallel. The range is thus made less sensitive by 2 decades i.e. by a factor of 100.

The input is protected by diodes D1 and D2. An additional diode circuit from the output to the input gives good protection from overdrive. The amplifier zero point can be adjusted on trimmer potentiometer R12 from outside the unit.

The measurement ranges are selected via control lines EXP5L... EXP9L and transistors H4...H6, which trip relays K1...K3.

The output is conducted to the control unit for post amplification.

Mass range EP 511	Control signals		
	EXP5	EXP7	EXP9
10^{-5}	L	H	H
10^{-7}	H	L	H
10^{-9}	H	H	L
10^{-11}	H	H	H

9. SPARE PARTS

Order spare parts according to the enclosed spare parts list. When ordering be sure to state the model name and the serial number as given on the nameplate.

Ordering example:

10 pc damping element 3800.1, 6 x 7 x M3, Order Nr. B 3695 700 99, as per spare parts list BG 900 239 E, Item 7.

10. ACCESSORIES

Input cable

low noise 1 = 12 cm BNC/MHV BG 519 090 -U
1 = 11 cm BNC/SHV BG 541 972 -T

bakeable 1 = 50 cm BNC/MHV BG 519 075 -U
200 °C BNC/SHV BG 548 153 -T

Control cable
extension

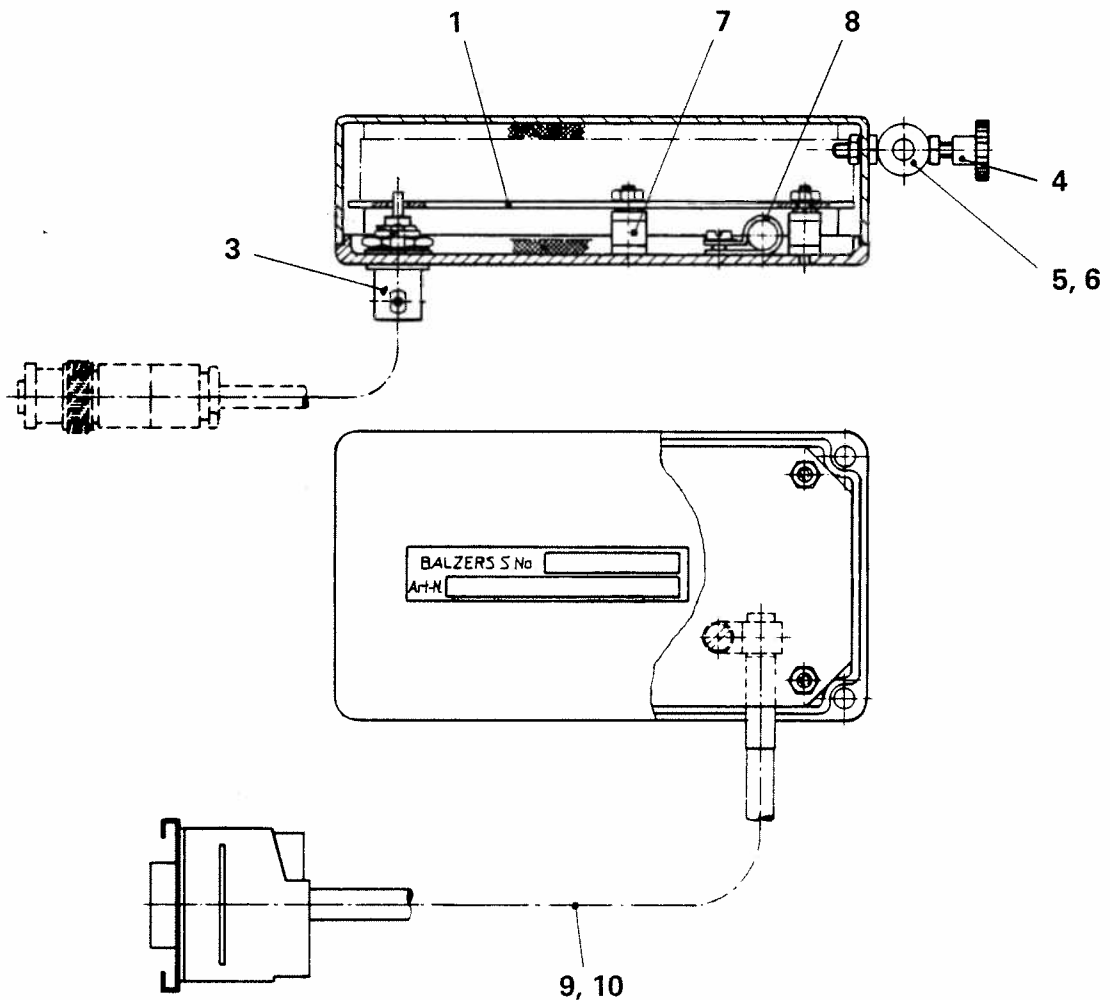
for EP 511 1 = 7 m BG 521 802 -U

Caution:

The electrical diagrams in the appendix of these operating instructions are only for general information purposes and are not binding.

For troubleshooting, etc. refer to the diagrams supplied with the unit itself. These represent the exact status of the unit and must therefore be carefully filed.

	Description Teil	Item Pos.	Order No. Bestell-Nr.	S	Reference Bemerkungen
1	PC board / Elektrometerprint	1	BG 521 301 -U		
		2			
1	Socket / Chassisbuchse, 4-842 147	3	B 4728 351 BB	J1	
2	Milled nut / Rändelmutter, INOX, M3	4	N 3477 114 X		
2	Damper / Dämpfer	5	B 3695 700 81		to / zu EP 112
2	Damper / Dämpfer	6	B 3695 700 89		to / zu EP 511
5	Damper / Dämpfer, 3800.1, 6 x 7 x M3	7	B 3695 700 99		
1	Cable saddle / Kabelbride	8	B 4631 512 LD		
1	Control cable / Steuerkabel	9	BG 541 505 -T		to / zu EP 112
1	Control cable / Steuerkabel	10	BG 521 306 -T		to / zu EP 511

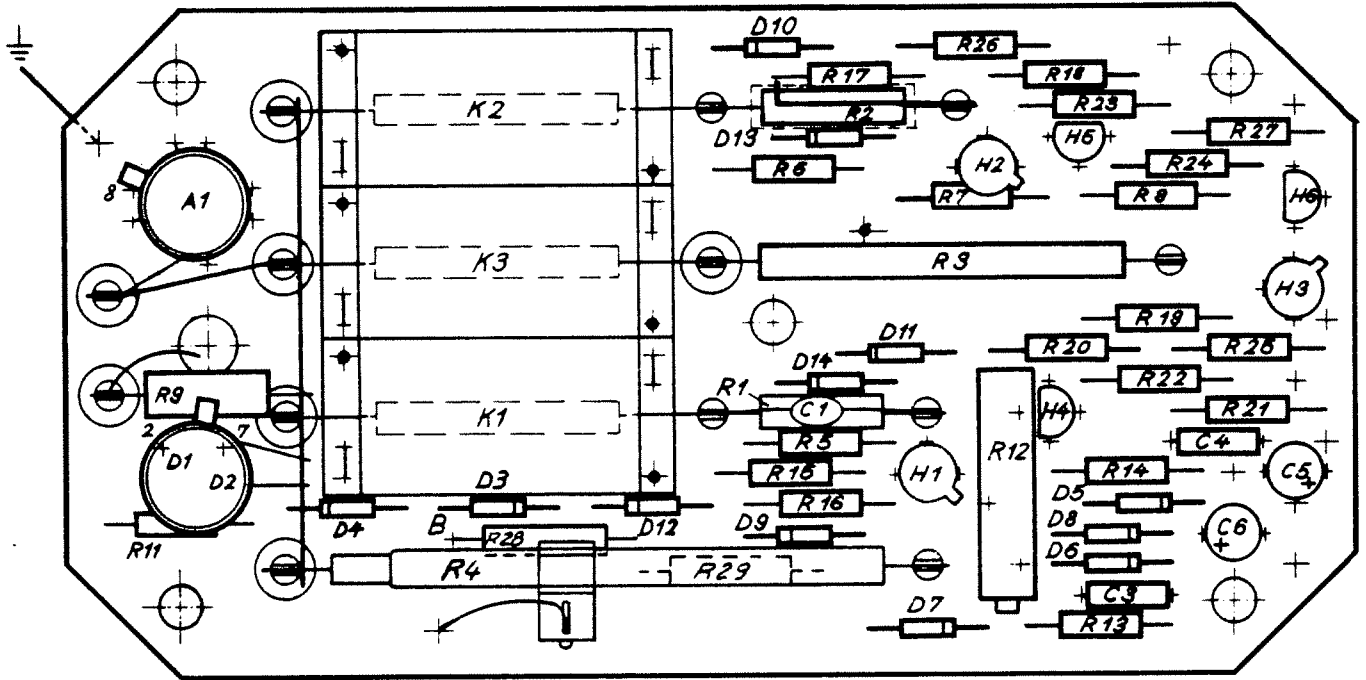


Spare Parts for / Ersatzteile zu

Electrometer / Elektrometer EP 112 BG 528 755 -U
 EP 511

BALZERS

BG 800 239 E



Electrometer pc board / Elektrometerprint

BG 521 301 BU

* C1 may be selected from 3.3 ... 15 pF

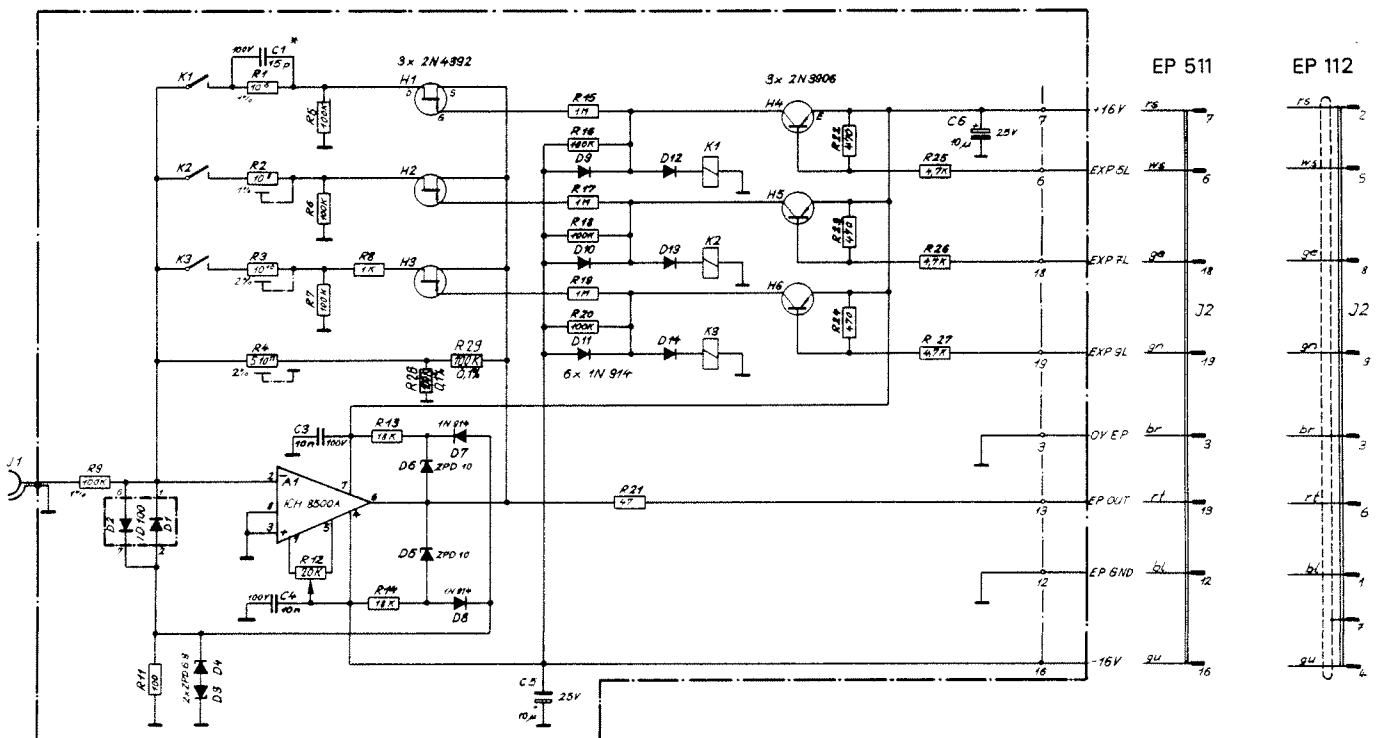


Diagram / Schema

EP 112

BG 541 015 AS

EP 511

BG 521 970 BS

