



SUPPLY AND CONTROL OF ELECTRODYNAMIC TRAPS



$$Z_{x_{k-s}} = \sum_{(k=0.. \infty)} x_{k-s} \cdot z^{-k} = \sum_{(k=s.. \infty)} x_k \cdot z^{-k+s} = z^s \cdot \sum_{(k=s.. \infty)} x_k \cdot z^{-k}$$

$$Z_{x_{k-s}} = z^{-s} \cdot \left[\sum_{(k=-s.. -1)} x_k \cdot z^{-k} + Z_{x_k} \right] \cdot \frac{2 \cdot \xi_1 \cdot 2 \cdot z}{\omega_1 \cdot T \cdot z + 1} + \left(\frac{1 \cdot 2 \cdot z - 1}{\omega_1 \cdot T \cdot z + 1} \right)^2$$

$$Z_{x_{k+s}} = \sum_{(k=0.. \infty)} x_{k+s} \cdot z^{-k} = \sum_{(k=s.. \infty)} x_k \cdot z^{-k+s} = z^s \cdot \left[\sum_{(k=s.. \infty)} x_k \cdot z^{-k} \right]$$

$$Z_{x_{k+s}} = z^s \cdot \left[Z_{x_k} - \sum_{(k=0.. s-1)} x_k \cdot z^{-k} \right] \cdot \frac{2 \cdot \xi_1 \cdot 2 \cdot z}{\omega_1 \cdot T \cdot z + 1} + \frac{2 \cdot \xi_1 \cdot 2 \cdot z}{\omega_1 \cdot T \cdot z + 1} \cdot (z-1) \cdot (z+1) + \left(\frac{1 \cdot 2 \cdot z - 1}{\omega_1 \cdot T \cdot z + 1} \right)^2$$

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$$H(z) = \frac{z^2 \cdot (1 + 2 \cdot \xi_1 \cdot \varepsilon_1 + \varepsilon_1^2) + 2 \cdot z \cdot (1 - \varepsilon_1)}{z^2 \cdot (1 + 2 \cdot \xi_2 \cdot \varepsilon_2 + \varepsilon_2^2) + 2 \cdot z \cdot (1 - \varepsilon_2)}$$

ELECTRODYNAMIC TRAPS

We design and manufacture hardware for ion traps, mass spectrometers and electron and ion optics. The spectrum of our instruments extends from simple RF generators for ion traps to ultra-precision amplifiers for accurate mass measurements in microparticle traps. We also offer preamplifiers and counters for sensitive ion detection or signal filters for cooling of trapped particles.

Typical Applications:

- Ion traps
- Traps for micro- and nano-particles
- DITs
- Ion funnels
- Quadrupole mass filters
- Ion guides
- Mass-selected ion deposition
- Electrospray ion sources

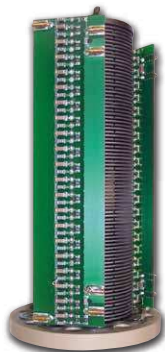
VACUUM HARDWARE

- Electrode systems for ion traps, guides, and funnels
- Rod systems for quadrupole mass analyzers
- Electron and ion optics for focussing and extracting
- Electronic accessories: filters for RF and DC supply

RC Filters:

We develop and produce customer-specific printed circuit boards with RC filters for supplying of ion funnels and other multipoles:

RC filters for	Multipoles	Ion funnels
Bypassing DC potentials	✓	✓
Coupling RF voltages	✓	✓
Acceleration fields	-	✓

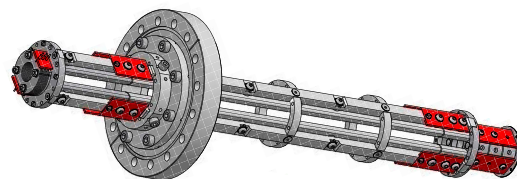


SERVICES AND CONSULTING

We provide consulting services in the following fields:

- Electrode systems for ion traps and ion guides
- Electron and ion optics
- Vacuum systems, gas inlet systems

Upon request, customer-specific solutions can be developed and our standard devices can be modified



DIGITAL SUPPLY OF MULTIPOLES (DITs)

The power analog switches are designed to supply DITs. Depending on the particular application, the maximum operating voltage and frequency can be selected by the customer. Due to the high isolation voltages, even traps operating at large bias potentials can be driven. The tristate option allows for field-free phases enabling undisturbed injection or extraction of charged particles.

Product No.	HV-AMX-3F	HV-AMX-3E
Switching frequency	< 1.4 MHz	< 4 MHz
Propagation delay	120 ns	65 ns
Jitter	< 10 ns	< 1 ns
Isolation voltage	5 kV	2 kV
Available options	Operating voltage: 100 - 1500 V* Tristate switch Integrated pulse generator	

* the switch achieves optimal performance at its maximum operating voltage



RADIO-FREQUENCY SUPPLY OF MULTIPOLES

The RF generators with a fixed output frequency between 0.1 and 10 MHz and an amplitude of up to 1.5-2 kV provide an easy-to-use supply of any multipole device for trapping or guiding of ions. If a variable output frequency is required, the

modular device RFG-M with an exchangeable power stage can be applied. Devices equipped with a precise amplitude measurement and control are intended for driving high-resolution quadrupole mass analyzers.

Product No.	RFG50	RFG50-CF	RFG-M	RFG-C	RFG300-DLU
Modular design	-	-	✓	✓	-
Amplitude monitoring	✓	✓	✓	-	optional
Amplitude measurement	optional	-	✓	-	X
Amplitude control	optional	-	optional	optional	✓
Symmetry adjustment	-	optional	✓	-	✓
Quartz-stabilized frequency	optional	-	-	-	✓
Frequency measurement	optional	-	-	-	✓
Frequency tuning	-	optional	optional	-	✓
External DC bias	✓	✓	✓	✓	✓
Integrated amplitude supply	-	-	✓	✓	✓
Output power	50 W	50 W	50 W	50 W	300 W
Analog remote control	-	-	✓	-	-
Digital remote control	optional	-	-	-	✓
Vacuum flange mounting	optional	DN100CF	-	-	-
19" mounting	optional	-	✓	✓	✓



AUDIO-FREQUENCY SUPPLY OF MULTIPOLES

The high-voltage amplifiers are suitable for supplying traps for micro- and nano-particles. The precise devices with ultra-low temperature coefficients and noise aim at accurate measu-

rements of the specific charge of the trapped particles. The low-frequency channels of the amplifiers can be used for (opto-)electric cooling and precise positioning of the particles.

Product No.	HV-AMP400FN-4	HV-AMP400FN-4 +400-D	HV-AMP5K-8	QPS400-3
Supplying of	linear and 3D quadrupoles			3D-Paul traps
Power bandwidth	200 kHz	200 kHz	5 kHz	200 kHz
Output voltage	±400 V	±400 V	±5 kV	±400 V
Output offset voltage	500 μV	±400 V digitally controlled	0 μV	100 μV
Output noise	8 mV _{p-p} DC - 100 kHz	18 mV _{p-p} DC - 100 kHz	50 mV _{p-p} DC - 100 kHz	3 mV _{eff} DC - 10 MHz
Amplification accuracy	0.1 %	0.2 %	1 %	0.1 %
Temperature coefficient	1 ppm/K	5 ppm/K	50 ppm/K	5 ppm/K



DIRECT-CURRENT SUPPLY OF ELECTRODES

The amplifiers HV-AMP provide a reliable way to control voltages on various electrodes. They can sink and source currents independently on the polarity of the output voltage so that ion or electron currents on the driven electrode do not influence its voltage. The devices can be controlled manually or

remotely - via an analog voltage or digitally via USB or LAN interfaces.



Product No.	HV-AMP 200N-1	HV-AMP 200-5D	HV-AMP 200-4DS	HV-AMP 400-5D	HV-AMP 400-4DS	HV-AMP 400-2U	HV-AMP 200-4	HV-AMP 200-4L	HV-PSU 300-5RCP
Channels	1	5	4	5	4	2	4	4	5
Output voltage	±200 V	±200 V	±200 V	±400 V	±400 V	+400 V, -400 V ±200 V	±200 V	±200 V	+300 V
Output current	±20 mA	±20 mA	±20 mA	±15 mA	±15 mA	±20 mA	±20 mA	±20 mA	+50 mA
Output noise	250 μV _{p-p}	2.2 mV _{p-p}	2.2 mV _{p-p}	2.0 mV _{p-p}	2.0 mV _{p-p}	3.5 mV _{p-p}	1.0 mV _{p-p}	1.5 mV _{p-p}	25 mV _{p-p}
Amplification accuracy	0.1%								
Temperature coefficient	50 ppm/K								
Remote control	±10 V analog	USB, LAN				±10 V analog			+6 V analog
Additional features	modular design	-	current sensor	-	current sensor	-	quadropole control	lens control	modular design

PULSE GENERATION

The switches NIM-AMX produce fast pulsed voltages. They can drive ion optics like entry or exit electrodes of ion traps or differential lenses to deflect ions or electrons. The switches can also drive piezoelectric and electromagnetic valves or small motors.

Product No.	NIM-AMX 250-3	NIM-AMX 500-3	NIM-AMX 1500-3
Maximum voltage	250 V	500 V	1500 V
Switching time	13 ns	13 ns	18 ns
Channels	3		
Input	TTL		
Housing	NIM 1/12		NIM 2/12



ION DETECTION

We offer various customer-specific solutions for:

- Low-noise preamplifiers for Faraday cups with sensitivity down to the fA range
- Counting modules and power supplies for photo-multipliers (PMT), micro-channel plates (MCPs), and electron multipliers (channeltrons)



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