

Specification of Hercules[®] PMX 500 / PMX 1000

Model-based Plasma Metrology System (SEERS) for Process Development

PLASMA PARAMETERS:

Core parameters:

- **Electron collision rate** as effective collision rate for momentum transfer including stochastic heating
 - Measurement range (approximate):
 $v_e = 10^7 - 5 \cdot 10^9 \text{ s}^{-1}$
- **Electron density:**
 - The electron density is calculated by a complete model with sheath thickness. RF-peak voltage or DC bias measurement point at the matchbox or chamber is necessary.
 - Without peak or DC bias voltage or if there are two power couplings as capacitive and inductive, the model uses a given (predetermined) sheath thickness. Systematic, reproducible deviations are possible, the repeatability is not concerned.
 - Measurement range (approximate):
 $n_e = 10^9 - 10^{11} \text{ cm}^{-3}$

Other parameters:

- Plasma bulk resistance
- Sheath width
- RF peak voltage (RF peak voltage measurement point at the matchbox necessary)
- First harmonic of RF current

PRE-CONDITIONS:

Chamber:

- Cylindrical chamber geometry
- Sensor flange located above process wafer and not covered by other chamber parts
- Well-grounded chamber wall and liner
- For full performance: RF peak voltage in case of ESC and/or dielectric coating (anodization or Y_2O_3) on chamber surface, otherwise also DC bias

Excitation:

- Capacitive or at least unshielded inductive RF power coupling
- Excitation frequency:
 - PMX 500 series: 13.56 MHz up to 35 MHz
 - PMX 1000 series: 13.56 MHz up to 70 MHz

Pressure Range:

- Pressure range depends on gas, reactor geometry, and RF power.
- Approximate upper limits:
 - 35 Pa (260 mTorr) typical
 - 50 Pa (380 mTorr) for electropositive gases

TECHNICAL DATA:

Bandwidth:

500 MHz (PMX 500) / 1000 MHz (PMX 1000)

Sampling rate:

1 GS/s (PMX 500) / 2 GS/s (PMX 1000)

Number of channels:

1 channel

Temporal resolution:

100 ms – 1000 ms (10 S/s – 1 S/s)

Weight:

6.3 kg

Dimensions:

H: 210 mm, D: 250 mm, W: 280 mm

HARDWARE:

- Ripac Vario Modul, 19" rack compatible
- AC/DC Converter CPA250 Series, maxpowerPRO
 - Technical data: AC / DC Converter CPCI 250 W
 - Input voltage range: 90 - 264 V AC
 - Frequency: 50 - 60 Hz
 - Main fuse: 2 x T2L/ 250 V, IEC 60127-2/III
- Controller unit: F14 – 3U Compact PCI® / Express Pentium® M SBC with F600 Side Card for SATA/Legacy I/O
 - 02F014-00 (R): Celeron M 373, 1 GHz, 512MB DDR2 DRAM, 1Gigabit/1 Fast Ethernet, 0 ... + 60 °C,
 - Front Connections: VGA, two USB 2.0 (Series A),
 - 2 x 10/100/1000 Base-T Ethernet (RJ45)
 - 02F600-003 (R), 3U CPCI extension, internal USB 2.0 connector with dongle
 - Hard disk: MHY02120BH, 120 GB Sata, 5400 rpm
- Digitizer card (Manufacturer: Acqiris):
DC 135, Hercules® PMX 500, DC 140, Hercules® PMX 1000

SOFTWARE:

Operating system:
Basic system:

- Windows® XP Professional, US version 2002
- Hercules® PMX as SEERS implementation
- Hercules Master - GUI (Graphical User Interface) for configuration of Hercules® and data visualization

Interfaces:

- Modbus/TCP SEMI E54.9
- LAM Plug and Play (optional)
- TOOLweb® ToolSide Protocol (optional)
- SECS/HSMS SEMI E37 (optional)

ENVIRONMENTAL SPECIFICATIONS HARDWARE:

COMPACT PCI CONVERTER:

Operating temperature	$U_{i,nom}$, $I_{o,nom}$, cooling by forced air flow with 400 LFM derating from 50 to 70 °C of 2,5 % per °C	0 ... 50 °C
Storage temperature	Non operating	- 40 ... 85 °C
Relative humidity	Non condensing	10 ... 95 %
Shock	IEC/EN 60068-2-27, 11 ms	max. 20 g
Random vibration	IEC/EN 60068-2-64, 10 ... 2000 / 200 ... 2000	6 g _{rms}
MTBF	MIL-HDBK-217F Notice 2, G _B , 40 °C	279000 h

CONTROLLER UNIT and SIDE CARD:

Operating temperature	Airflow: min 10 m ³ /h	0 ... 60 °C
Storage temperature	Non operating	- 40 ... 85 °C
Relative humidity	Non condensing	max. 95 %
Shock	IEC/EN 60068-2-27, 11 ms	max. 15 g
Vibration (sinusoidal)	IEC/EN 60068-2-6, 10 ... 150 Hz	2 g
Altitude		- 300 m ... 3000 m
Bump	IEC/EN 60068-2-29, 16 ms	max. 10 g

HARD DISK:

Operating temperature	5 ... 55 °C (ambient)	5 ... 60 °C
Storage temperature	Non operating	- 40 ... 65 °C
Relative humidity	Operating (non condensing) Non operating (non condensing) Maximum wet bulb	8 ... 90 % RH (non condensing) 5 ... 95 % RH (non condensing) 29 °C (operating), 40 °C (non operating)
Shock	Operating Non operating	3185 m/s ² (325 g) (duration 2 ms) 8820 m/s ² (900 g) (duration 1 ms)
Vibration	Operating Non operating	9.8 m/s ² (1.0 g) (5 ... 500 Hz) 49 m/s ² (5.0 g) (5 ... 500 Hz)
Altitude	Operating Non operating	- 300 m ... 3000 m - 300 m ... 12000 m
Power requirements		5 V ± 5 %

DIGITIZER CARD:

Operating temperature	Airflow: min 108 m ³ /h	0 ... 40 °C
Storage temperature	Non operating	- 40 ... 65 °C
Relative humidity	Non condensing	5 ... 95 %
Shock	Half-sine pulse	30 g
Vibration	Random	5 ... 500 Hz

SAFETY and EMC

<i>Compact PCI Converter:</i>	Norms / Standards	
Approvals	EN 60950 (TÜV), UL 1950, cUL 1950	
Protection degree		IP 20
Electric strength test voltage	Class I, I/case (basic insulation)	1.5 kV AC
Electric strength test voltage	Class I, I/O (reinforced insulation)	3 kV AC
Electric strength test voltage	Class I, O/case (functional insulation)	0.5 kV AC
Electrostatic discharge	IEC/EN 61000-4-2, level 3 (contact/air)	4/8 kV, criterion B
Electromagnetic field	IEC/EN 61000-4-3, level 3	10 V/m, criterion A
Electric fast transients/burst	IEC/EN 61000-4-4, level 3 (direct/capacitive)	1/2 kV, criterion B
Surge	IEC/EN 61000-4-5, level 3 (L/L, L/C)	1/2 kV criterion B
Conducted disturbances	IEC/EN 61000-4-6, level 2	3 V, criterion A
Electromagnetic Emission	CISPR 22/EN 55022, conducted / radiated	Class A / A

<i>Controller Unit and Side Card:</i>	Norms / Standards	
General board standards	CompactPCI® Core Specification PICMG 2.0 R3.0 CompactPCI® Express Specification EXP.0 R1.0	
Flammability rating	UL 94V-0	
Electromagnetic Emission	EN 55022 (radio disturbance) EN 61000-4-2 (ESD) EN 61000-4-4 (burst)	
Environment	IEC/EN 60068-2-1 IEC/EN 60068-2-2 IEC/EN 60068-2-30	

Digitizer Card:	
Low Voltage Safety (Council Directive 73/23/EEC)	EN 61010-1: 1993 A2: 1995
Electromagnetic Compatibility (Council Directive 89/336/EEC)	EN 61326-1: 1997 A1: 1998
Electromagnetic Emission	EN 55011: 1998, EN 61326-1: 1997 Class A
Industrial Environment	EN 61000-4-2 1995 (ESD) EN 61000-4-3 1996 (Electromagnetic fields) EN 61000-4-4 1995 (Burst) EN 61000-4-5 1995 (Surge) EN 61000-4-6 1996 (Conducted disturbances) EN 61000-4-8 1993 (Magnetic fields) EN 61000-4-11 1994 (Voltage dips and short interruptions)

Hercules®:	Norms / Standards
Product safety guideline	SEMI S2-93A
Safety requirements for electrical equipment	EN 61010 - 1 / IEC 61010 - 1
Electro-magnetic Compatibility	Emission: Class B EN 61326 -1 : 1997 A1: 1998, A2: 2001 A3: 2003, EN 55011, EN 55022, EN 61000-3-2: 2000, EN 61000-3-3: 1995 A1: 2001, Immunity: Class B EN 61326 -1 : 1997 A1: 1998, A2: 2001, A3: 2003, EN 61000-4-11, IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4, IEC 61000-4-5, IEC 61000-4-6
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