



Paramount[®] 3 kW RF Power-Delivery Systems

Breakthrough RF power-delivery accuracy and control for next-generation technology nodes

Keeps pace—in real time—with the most abrupt plasma-impedance changes, enabling faster transitions, shorter process steps, and reduced process times

Benefits

Optimizes film uniformity and throughput with unprecedented power-delivery accuracy

Enables next-generation etch and deposition processes with faster process transitions

Facilitates seamless process transitions

Enhances yield

Maximizes ROI

Features

Next-generation measurement system, enabling ultra-accurate power and impedance measurement across the full output range—at 50 Ω and off 50 Ω

Near-instantaneous frequency tuning (optional)

Optional pulse and pulse synchronization with the widest pulse frequency range available

Optional HALO (high accuracy, low output) and arc-management system

Compact, half-rack package

The half-rack, 3 kW Paramount[®] <u>RF power supply</u> features an enhanced power and impedance measurement system that delivers exceptional power accuracy and control at 13.56 MHz fixed or variable frequencies into 50 Ω and non-50 Ω loads. Able to keep pace—in real time—with the most abrupt plasma-impedance changes, the Paramount RF power-delivery system enables faster transitions, shorter process steps, and reduced process times for next-generation technology nodes. Its impedance measurement rivals the accuracy of a network analyzer, while optional frequency tuning tunes virtually instantaneously (i.e. msec), faster than any other product on the market. The result is truly unprecedented accuracy, repeatability, and process control.

Typical Applications

The Paramount RF power-delivery system enables unprecedented power accuracy and control.

Market Applications:

- <u>Semiconductor</u>
- Flat panel display
- MEMS manufacturing
- <u>Solar</u>

Process Applications:

- Etch: silicon, dielectric, metal, and strip
- Deposition: PECVD, HDP-CVD, PVD, PEALD

Ideal for advanced process innovation in etch and PEALD applications, Paramount® systems are already installed on next-generation etch platforms at major OEMs worldwide.

The Paramount® RF Power-Delivery System offers a rich feature set in a compact package			
Standard Features	Optional Features		
Ultra fast, accurate power and impedance measure- ment system	Advanced HALO (high accuracy, low output) control down to 5 W	DeviceNet [®] or Profibus Communication	
Analog, digital (RS-232), and Ethernet communication	Near-instantaneous frequency tuning	Phase synchronization (CEX)	
Water solenoid contact	Enhanced pulsing	Pulse synchronization	
Compact, half-rack package	Sophisticated arc manage- ment system		

Optimizes Film Uniformity and Throughput Provides Ultra-Accurate Power Delivery

The Paramount RF power-delivery system maintains set point despite even the most rapid changes in plasma impedance. This unprecedented level of accuracy means that power is virtually always delivered at set point—dramatically reducing scrap caused by off set point power delivery. The result is better yield, especially for processes with steps shorter than 10 seconds.

As device materials, structures, and designs become more sophisticated, wafer-towafer film uniformity is increasingly critical. The incomparable tuning speed and power-delivery precision of the Paramount system create consummately repeatable processes that produce the steadfast film quality that advanced manufacturing operations require.



Impedance matching (red) versus a network analyzer (green)

Figure 1. The Paramount[®] system's power & impedance measurement technology rivals the accuracy of a network analyzer

Enables Next-Generation Etch and Deposition Processes Allows Faster Transitions

The Paramount RF power-delivery system enables faster gas and pressure transitions than ever possible with its unprecedented ability to keep pace in real time—with even the most abrupt plasma-impedance changes. No other product on the market compares to the Paramount system's near-instantaneous frequency tuning (optional). This capability enables the shorter steps and processing times that are essential to next-generation ≤ 32 nm node device manufacturing.

Speed Comparison: Near-Instantaneous Paramount® Frequency Tuning vs. Variable Matching Network Tuning

Optional Paramount frequency tuning is exponentially faster than a variable matching network tune—with or without pre-sets. It reduces tuning time from a scale of seconds to hundredths of a second (0.01 sec or less). At this speed, the Paramount RF Power-Delivery System keeps pace with plasma impedance—in real time—enabling faster process gas and pressure transitions than previously possible.

Tuning Method	Time Elapsed Between Ignition and Tune	Smith® Chart Representation of Tuning Trajectory	Scope Trace Representation of Tuning Process
Variable Matching Network—No Pre-Set	Actual scope measurement: 2.72 sec (Typical range: 2 to 3 sec)		RF on Reached Restup Rest
Variable Matching Network—with Pre-Set	Actual scope measurement: 1.05 sec (Typical range: 0.5 to 1.5 sec)		RF on Reached Reache
Paramount [®] Frequency Tuning	Actual scope measurement: ~0.01 sec ^[1] (No typical range exists; actual fre- quency tuning response is a matter of microseconds.) [1] This value <i>includes</i> plasma-impedance shift time.		RF On AND Match Reached
	Tek Stop		ForwardReverse
	2 311 5000V % [ch2 5000VO544].00m8 A II [30.40 %]	Chi z Hamma Chi z Hamma The second	mount [®] frequency tuning fast that it appears ntaneous on the longer scale above. Its tuning
	Paramount® frequency tuni on a 4.0 msec/div tim	ng: ~0.01 sec proce lescale on th	ess is only observable ne expanded, 4.0 msec/div

scale on the left.

Facilitates Seamless Process Transitions Enables Impedance Tuning During Pulsing

No matching network can tune during pulsing, especially low-frequency pulsing. Traditionally, the match network is turned off while RF is pulsed. This can lead to significant mismatch and can make it impossible to adjust process settings without turning pulsing off and re-tuning the match. When equipped with frequency tuning and pulse mode (optional features), Paramount systems enable the unprecedented capability to tune in real time during pulsing. This extends the impedance operating range of your pulsing process and eliminates the need to stop your process to adjust your matching network, which saves time, facilitates seamless transitions, and helps maintain process stability. The end result is higher process productivity, efficiency, and throughput.

When equipped with frequency tuning and pulse mode (optional features), Paramount[®] systems enable the unprecedented capability to tune in realtime during pulsing. No other product on the market offers this capability.

Enhances Yield

Shrinking geometries make nextgeneration devices especially vulnerable to particle contamination. A highly developed arc-management system (optional) enables the Paramount system to detect and significantly reduce arcing, which can lead to particulates, wafer damage, and eventually, damage to equipment. This arc-management feature expands the operating window, increases productive manufacturing time, and boosts yield.

Increases ROI Maximizes Tool Utilization

The Paramount RF power-delivery system's ultra-high power accuracy, real-time tuning during pulsing, sophisticated arc management, and other advanced capabilities work together to optimize tool utilization. Excellent wafer-to-wafer uniformity, seamless process transitions, decreased process inconsistencies, and reduced need to shut down your process to remedy arc-caused particle contamination, all increase the number of processes a tool can run without subsystem changes or chamber re-qualifications, thus optimizing tool use, uptime, and equipment ROI.

Enables Longer Tuner Life

Patent-pending Paramount frequency tuning decreases or even eliminates within-process mechanical tuning in tuner pre-set mode. This reduces matching network wear, enabling greater equipment longevity.

Optimized Power-Delivery/Match Solution

The Paramount RF Power-Delivery System and <u>Navigator[®] Digital</u> <u>Matching Network</u> create an ideal partnership for the most demanding leading-edge processes.



Figure 2. The Navigator® Digital Matching Network provides rapid, accurate, and reliable matching across a wide range of load impedances

Specifications

Electrical	Paramount [®] 3 kW RF Power-Delivery System
Output Power	
Forward power into 1.1:1 VSWR	3000 W
Forward power into 1.5:1 VSWR	3000 W
Forward power into 2:1 VSWR	2700 W
Forward power into 3:1 VSWR	2133 W
Accuracy	±1 W or 1% of set point (into 50 Ω), whichever is greater (standard)
	±1 W or 2% of set point (into 3:1 VSWR), whichever is greater
	HALO option (high accuracy, low output)
	±0.25 W or 1% of set point (into 50 Ω), whichever is greater
Frequency	13.56 MHz ±0.005% (Optional frequency tune/sweep 12.88 to 14.24 MHz)
Reflected Power Limit	Selectable 600 W max
Regulation	30 to 3000 W (Optional HALO [high accuracy, low output]: 5 to 3000 W)
Regulation Modes	Standard: Forward power, load power
	Optional: Output voltage, external feedback loop
RF Stability	2% AM max into all linear loads
Power Measurement Repeatability	±0.5% over warranty period; 2.0% unit to unit
Response Time	< 2 msec
Pulsing Option	10 Hz to 100 kHz
Phase Synchronization (CEX)	Optional
Pulse Synchronization	Optional
Input Power	
Voltage	200/208 VAC ±10%, 3 Φ , no neutral (compatible with grounded " Δ " and standard " Δ " inputs)
Current	13.7/14.5 A per Φ at nominal line for 208/200 VAC
Frequency	50/60 Hz ±3 Hz
Power Factor	0.95
Efficiency	> 60% at 3 kW into 50 Ω
Protection Features	
Mismatch	Capable of continuous operation into any impedance mismatch condition without damage; limited by reflected power limit setting
Over-Current	20 A fuses
Other	Over-temperature (air and water), VA limiting, dissipation limit, low/high AC line, reflected power limit, air flow

Physical	Paramount® 3 kW RF Power-Delivery System
Dimensions	13.3 cm x 21.6 cm x 44.5 cm (5.25" x 8.5" x 17.5")
Weight	< 16 kg (35 lb)
Form Factor	Half rack
Mounting	5 cm (2") clearance required for air flow in front and back
Connector Specifications	
Output Power	Standard: HN, female
Input Power	Standard: Harting® type Han-Q 5/0 with switch
	Optional: Harting® type Han-Q 5/0 without switch
Analog (User) Port	25-pin, D-sub, female
Serial (Host) Port	9-pin, D-sub, female
Coolant	Standard: 3/8" NPT, female

I/O Control Specifications	Paramount [®] 3 kW RF Power-Delivery System
Analog Interface Options	Standard: 25-pin, D-sub
Serial Communications Options	Standard: RS-232, Ethernet
	Optional: DeviceNet [®] , Profibus

Environmental	Paramount [®] 3 kW RF Power-Delivery System
Ambient Operating Temp	+5 to +40°C (+41 to +104°F)
Storage Temperature	-25 to +55°C (-13 to +131°F)
Relative Operating Humidity	5 to 85%, non-condensing, no formation of ice
Atmospheric Pressure	78.8 to 106 kPa (788 to 1060 mbar); Equiv. altitude: 2000 to -500 m (6562 to -1640')
Cooling Requirements	
Cooling Medium	Water and forced air
Min Water Temp (Inlet)	+5°C (+41°F)
Min Water Flow Rate	> 7.6 lpm (2 gpm)
Min Water Pressure	0.83 Bar (12 psi)

Dimensional Drawing



For more information on the Paramount RF Power-Delivery System, visit: www.advanced-energy.com/en/Paramount.html

To view AE's comprehensive power systems portfolio, visit: www.advanced-energy.com/en/Power_Systems.html

To view AE's complete product portfolio, visit: www.advanced-energy.com/en/Products.html

Specifications are subject to change without notice.



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