

## PINNACLE® PLUS+ PULSED- DC POWER SUPPLIES

Proven benefits for reactive-sputtering applications

- Reduce the cost and complexity of oxide and nitride processes
- Virtually eliminate arcing

# PINNACLE® PLUS+ PULSED-DC POWER SUPPLIES

The Advanced Energy® (AE) Pinnacle® Plus+ power supply provides all of the advantages of a pulsed-DC solution for your reactive processes—in a one-box package that delivers additional benefits in the form of ease of use, cost savings, and superior flexibility. Combining standard DC technology and process-proven pulsed-DC technology patented by AE in the 1990s, the Pinnacle Plus+ power supply provides higher deposition rates, more repeatable performance, and exceptional film quality compared to complicated and expensive AC-power solutions.

## Benefits

- Higher deposition and yield rates
- Superior film uniformity and quality
- Reduced substrate damage caused by arcing
- Lower cost
- Easy system integration
- Excellent process flexibility and latitude
- Repeatable performance
- Stable operation high on the transition curve
- Higher throughput
- Convenient monitoring and control
- Unmatched system flexibility

## Features

- One compact package
- Adjustable frequency range of 5 to 350 kHz
- Variable duty cycle up to 45%
- Wide voltage range—single-tap wide impedance range
- High-power operation
- Low substrate heating
- Superior arc control
- Dual-output for multi-chamber production

The Pinnacle Plus+ product line consists of single-output 5 kW and 10 kW models, as well as a dual-output 5 kW model.

### The Pulsed-DC Advantage

Pulsed DC is the latest technology for reactive-sputtering applications requiring extremely uniform, high-quality films, combined with efficient production and lower upfront costs. The Pinnacle Plus+ pulsed-DC power supply's technology offers an array of benefits, including:

#### Higher Deposition and Yield Rates

Compared to AC-power solutions, pulsed-DC methods deliver a much larger percentage of power to the actual sputtering process. This means that valuable process time is used more efficiently—resulting in higher deposition rates and thus significantly higher yield, run after run.

Adding additional power and synchronizing your process has never been easier.

#### Superior Film Quality

All units are compatible with a wide variety of gases (including 100% O<sub>2</sub>), allowing materials to be processed in a reactive-gas environment.

#### Reduced Substrate Damage

The Pinnacle Plus+ supply periodically reverses electrode voltage, clearing the buildup of charges by attracting the opposite charge during the reverse pulse. In many cases, arcs are completely eliminated. In the event that arcs do occur, the Pinnacle Plus+ supply responds swiftly, extinguishing micro-arcs in less than 5 μs and hard arcs in less than 200 μs. These capabilities prevent substrate damage in the form of "meteors" on the film surface.

### The Pinnacle® Plus+ Advantage

The Pinnacle Plus+ design integrates the DC power supply and pulsing components into one compact package that offers unmatched ease of use in addition to wide flexibility. This advanced design offers clear advantages for your pulsing process, including:

#### Lower Cost

This one-package design means that there are fewer units to buy. More compact than traditional two-module systems, the Pinnacle Plus+ unit also consumes less valuable space.

For multi-chamber production, the 5 kW dual-output model eliminates the need for two separate power supplies. With individually controllable dual-output pulsed-DC power capabilities, a single Pinnacle Plus+ unit is all you need.

#### Easy System Integration

As a one-box solution, the Pinnacle Plus+ supply eliminates the need for complicated and time-consuming interconnects between two separate modules. Installation is quick, easy, and straightforward.

#### Excellent Process Flexibility and Latitude

Wide operating parameters give you maximum control and flexibility. The Pinnacle Plus+ power supply's adjustable frequency range of 5 to 350 kHz, adjustable duty cycle to 45%, and up to 6:1 output impedance range make it ideal for extending the performance of existing processes as well as for expanding the possibilities for developing new, previously unachievable DC processes.

### Repeatable Performance

Pulsed-DC technology offers a remarkably stable solution for reactive processes. On top of this, the Pinnacle Plus+ power supply delivers extremely tight regulation, with output repeatability of  $\pm 0.1\%$ .

#### Stable Operation High on the Transition Curve

Reactive-sputtering closed-loop control optimizes deposition rates by ensuring stable operation high on the transition curve. Repeatable operation and superior arc management make the Pinnacle Plus power supply a key component of a closed-loop control scheme.

#### Higher Throughput

Sophisticated master/slave and synchronous pulsing (synch pulse or CEX) capabilities allow you to combine and synchronize units to achieve higher power levels and thus increase throughput. Synch pulse synchronizes the pulsing pattern of multiple units to deliver maximum power to the process. Using these capabilities, up to six units can be combined to achieve up to 60 kW per master/slave combination. In addition, up to six units or master/slave stacks can be synchronized using the synch-pulse capability.

#### Convenient Monitoring and Control

For maximum ease and convenience, the Pinnacle Plus+ power supply offers an array of display/control options:

- Active front panel or remote panel
- Passive display
- Numerous I/O protocols

The active front panel offers a full feature set, including programmable energy output in joules, output limit controls, ramp/run recipes, and user-friendly arc-control features.

Interface options include a selection of isolated or non-isolated interface cards, the addition of a second interface card, and/or an active control panel (on-board or remote). Analog selections are available in 15 V and 24 V configurations. Digital selections include AE Bus (RS-232, RS-422, and RS-485), Profibus, DeviceNet®, and others.

#### Unmatched System Flexibility

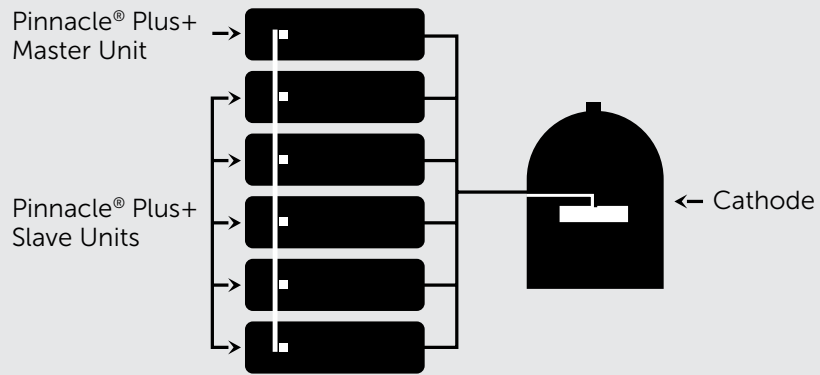
Any unit is easily designated as either master or slave with the flick of a switch, making Pinnacle Plus+ units of the same configuration completely interchangeable. Similarly, any Pinnacle Plus+ synch-pulse unit is user-configurable to operate as either a transmitter or a receiver. With this flexibility, ordering multiple units for your complex system and stocking spares is simplified to one part number. Adding additional power or synchronizing your process has never been easier.

## Applications

### Master/Slave Capability

For applications requiring higher-power operation:

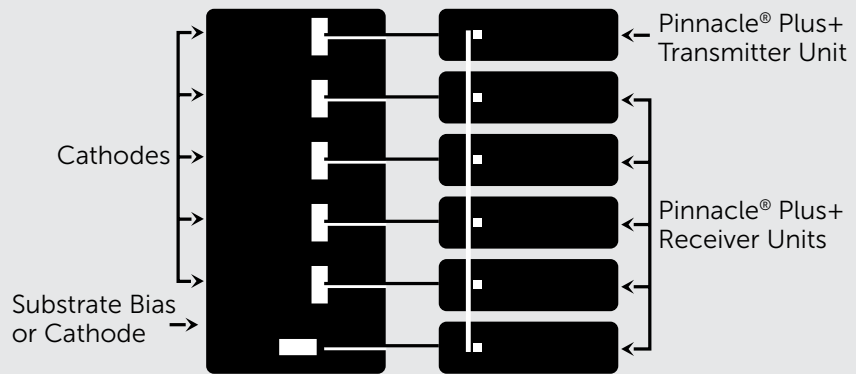
- Master sets all operating parameters.
- Synchronized units deliver up to 60 kW.
- Master/slave designation is user configurable.
- One part number covers all units in this configuration.



### Synchronous Pulsing

For applications in which multiple cathodes share a plasma:

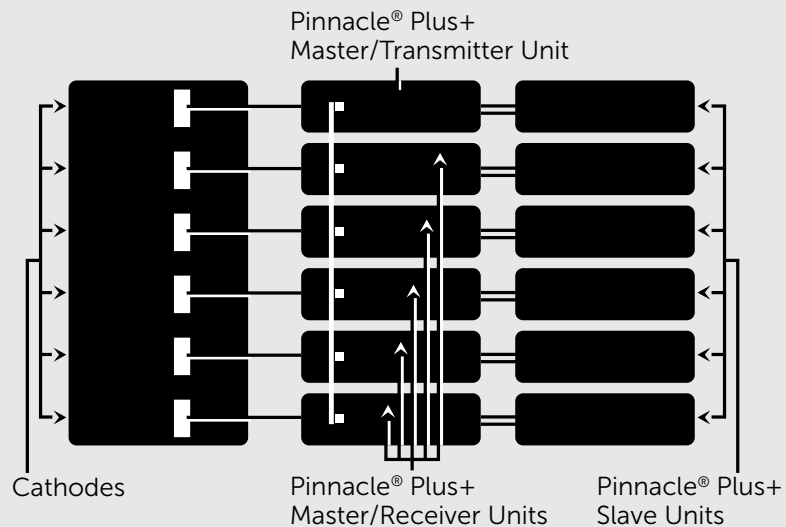
- Transmitter sets pulse frequency,  $T_{rev}$ , and arc management of all units—all other settings are independent, including set point and regulation mode.
- Transmitter/receiver designation is user configurable.
- One part number covers all units in this configuration.

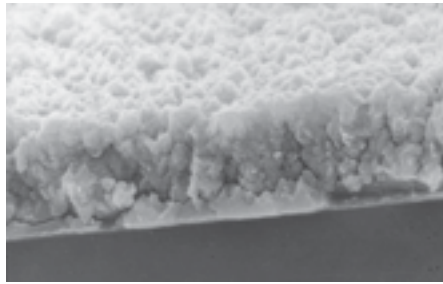
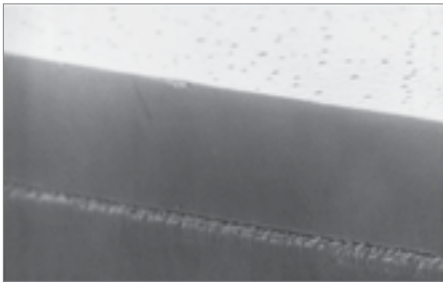


### Synchronous Pulsing of Master/Slave Units

For higher power applications, multiple cathodes share a plasma:

- Transmitter sets pulse frequency,  $T_{rev}$ , and arc management of all master units and their slave units—all other settings are independent, including set point and regulation mode.
- Synchronized units deliver up to 60 kW—per master.
- One part number covers all units in this configuration.





Al<sub>2</sub>O<sub>3</sub> sputtered with the aid of an AE® pulsed-DC product (left)

Al<sub>2</sub>O<sub>3</sub> sputtered without the aid of a pulsed-DC product (right)

(Photo source: Centre for Advanced Materials and Surface Engineering, University of Salford, U.K.)

### Electrical Specifications

	5 kW, Single Output	5 kW, Dual Output	10 kW, Single Output
<b>Output Power</b>			
Maximum	5 kW	5 kW, independently controlled outputs	10 kW
Voltage Range	325 to 650 VDC; optional 325 to 800 VDC output (wide Z)		
Maximum Current	15.4 ADC	15.4 ADC per output	30.8 ADC
Input Power Connector	Five-terminal, DIN compression terminal block; maximum wire size: #6 AWG		
Output Connector	Two-terminal, multi-contact, pluggable connector with strain relief or UHF connector		
Frequency	5 to 350 kHz, variable		
Reverse Time	0.4 to 5 μs, variable; optional 0.4 to 10 μs range		
Duty Cycle	Up to 45% reverse time, variable		
Reverse Voltage	10% of operating voltage (just prior to reversal)		
Ignition Capability	1500 VDC max, 1350 VDC typical		
Regulation Modes	Power, voltage, or current		
Repeatability	From run to run at constant set point: 0.1% from 10 to 100% of rated power		
<b>Input Power</b>			
AC Line Voltage	200/208 or 400 or 480 VAC		
Current	200/208 VAC: 17 A nominal per Φ	200/208 VAC: 35 A nominal per Φ	
	400 VAC: 8.5 A nominal per Φ	400 VAC: 17 A nominal per Φ	
	480 VAC: 7.5 A nominal per Φ	480 VAC: 15 A nominal per Φ	
Regulatory Compliance	CE, NRTL on certain models		
Ground Reference	Negative, positive, or floating output up to 1500 VDC with respect to ground or terminal to terminal		

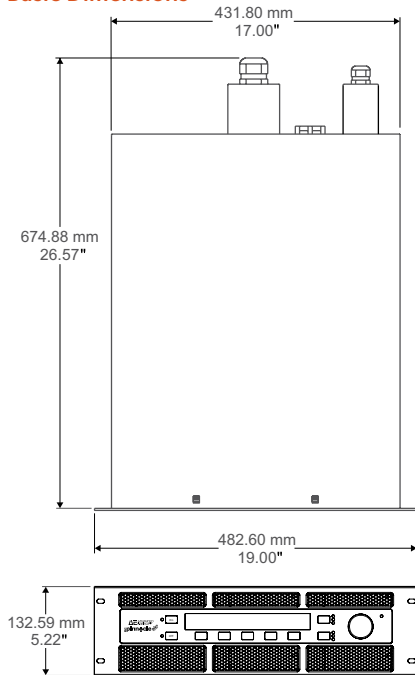
### I/O Control Specifications

	5 kW, Single Output	5 kW, Dual Output	10 kW, Single Output
Analog Interface Options	<ul style="list-style-type: none"> <li>• 37-pin isolated (to 500 VRMS), 0 to 10 VDC analog, 0/24 VDC digital</li> <li>• 37-pin, 0 to 10 VDC or 0 to 5 VDC isolated analog, 0/15 VDC digital</li> <li>• 37-pin, 0 to 10 VDC or 0 to 5 VDC non-isolated analog, 0/15 VDC digital</li> </ul>		
Serial Communication Options	RS-232, RS-422, RS-485 (selectable baud rates up to 57.6 k): AE Bus protocol; ASCII protocol (MDX and emulation)		
	Profibus (selectable baud rates of 1.5 MB or 12 MB); AE Bus protocol		
	DeviceNet® option available		
Accessory	Remote, active monitor/control panel		

## Physical Specifications

	5 kW, Single Output	5 kW, Dual Output	10 kW, Single Output
Size (Including Connectors)	133 mm (H) x 483 mm (W) x 675 mm (D) 5.22" (H) x 19" (W) x 26.57" (D)		
Weight	21.4 kg (47 lb)	30 kg (66 lb)	
Maximum Recommended Output Cable Length	10 m (32.8') RG393 or equivalent		
Cooling Medium	Air		
Input Power Connector	Five-terminal, DIN compression terminal block; maximum wire size: #6 AWG		
Output Connector	Two-terminal, multi-contact, pluggable connector with strain relief or UHF connector		

## Basic Dimensions



A POWERFUL ADVANTAGE™

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ENG-PNCLPLUS-210-05 0M 1.12