

## UltraVolt High Voltage

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Senior Product Line Manager



## Why UltraVolt High Voltage DC/DC?

25 product lines, highly configurable, thousand of variations

## Broad Product Range

- DC to High-Voltage DC Conversion: 62 to 60kV
- Power Levels: Fractional to 250 Watts
- PCB, Chassis Mount, Lab Configurations

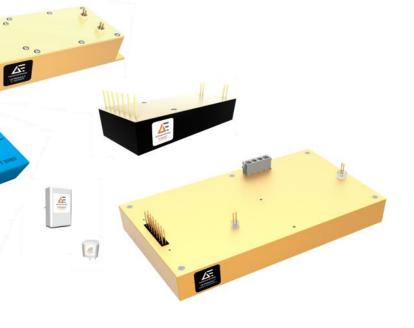
## Off-the-Shelf Configurability

- Thousands of Variants
- Custom and Derivatives Available

## Quick Delivery

- Standard Products: Typically 3 weeks ARO
- Custom Derivatives: Slightly Longer
- We deliver ON-TIME! 96% of the time







## Typical UltraVolt High Voltage Customer

## Highly Regulated

- Safety agency approvals
- High switching costs/Copy Exact



# High Performance

- High reliability content
- High ticket value

## Long Product Life Cycles

- Typically 5 7 years
- 10 years in the case of some medical and aviation customers

# Small and Medium Volumes

• Typically 5 pieces to 100 pieces







## WHO BUYS ULTRAVOLT PRODUCT?

Companies where . . .

High Voltage power is <u>not</u> a Core Competence

There's a need to bring a reliable product to market – Fast!

High Voltage power is <u>not</u> a major driver of BOM Cost (Will pay for convenience, less price sensitivity)

High Voltage performance is a Product Differentiator





**High Voltage Products** 



## **ULTAVOLT PRODUCT TYPES**

#### THREE DEFINITIONS YOU NEED TO KNOW

#### Standard Products

- Existing product lines
- Thousands of variations (catalog type products)
- Standard price book
- Fastest Delivery: 3 weeks (Typically)
- MOQ = 1 Unit (3 Units for Micro-size Products)
- Try to sell these first!

#### Derivative Products

- Variant of Standard Product with Customer-tailored features
- Examples: Different cables, connectors, extended testing, voltage, current limits
- MOQ = 26 Units
- Delivery time depends on Modifications (Could be 3-5 weeks, but No Promises)
- Configuration needs to be approved by Product Management, Engineering, Ops

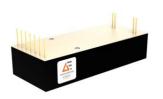
#### Custom Products

- Unique performance, footprints not available on Standard or Derivative Products
- Reserved for Strategic customers in Strategic Markets Must be approved by UltraVolt Product Management
- Delivery time is TBD



## **UltraVolt Platform Designs**

Precision, high reliability high voltage DC/DC converters from 0.5W to 250W





- Regulated Unipolar DC/DC converters provide up to 40kV.
- Available in 4W, 15W, 20W, and 30W
- UL/cUL, CE mark, and RoHS compliant



#### High Voltage Amplifiers

- High voltage amplifiers.
- Available in both unipolar and bipolar models.
- It can both source and sink current
- UL/cUL, CE mark, and RoHS compliant



#### High Power/Higher Voltage

- Regulated unipolar and dual polarity DC-to-DC converters designed up to 60kV
- Available in 60W, 125W or 250W
- Analog Control (I5/I10 interface available)
- UL/cUL, CE mark, and RoHS compliant



#### Micro-size and Compact

- · Regulated DC-to-DC converters in ultracompact packages up to 6kV
- Available from 0.1W to 6W
- UL/cUL, CE mark, and RoHS compliant

#### **Markets**

- Medical Equipment tools Medical Equipment Imaging, Surgical Lasers Clinical T&M + Laboratory : Clinical Chemistry, Analyzers, Mass Spec, SEM Semiconductor Handlers, Testers, Microscopes (Inspection/Imaging)
- Industrial (T&M, Inspection, Communications)
- Aerospace Heads-up display, Thumper



## **UltraVolt Standard Products**

### Thousands of configurations: most available in 3 to 4 weeks

#### Single-Output Unipolar (Standard Size)













#### Single-Output Unipolar (Micro-size and Compact)





US Series











Single-Output Unipolar (Precision)

Multi-Output High Voltage Modules

**High Voltage Amplifiers** 

LE Series







Isolated Low Voltage Power/Control

Low Voltage Filament

**Options and Accessories** 

FL Series











Accessories and Connectors





## **Voltage and Power (Standard Size)**

- AA Series (22% smaller than A Series)
  - 62V to 6kV
  - Up to 30W
- A Series
  - 62V to 40kV
  - 4W to 30W



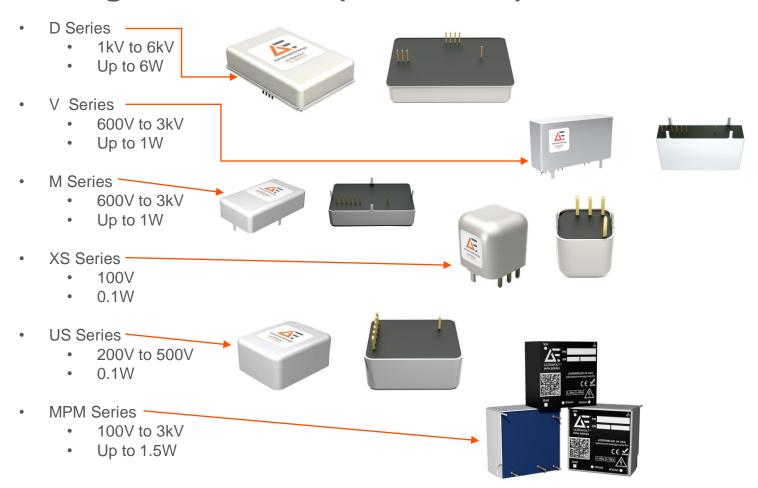
- 125V to 6kV
- 20W or 30W
- High Power C Series
  - 125V to 60kV
  - Up to 250W
- Dual Polarity Series
  - 125V to 6kV
  - 125W or 250W
- HVA Series -
  - 1kV to 20kV
  - Unipolar or Bipolar
  - Up to 2W







## **Voltage and Power (Micro-Size)**





## **Voltage and Power (All Products)**

- AA Series and A Series62V to 6kVUp to 30W
- 10 to 40 A Series
  - 10kV to 40kV
  - Up to 30W
- C Series
  - 125V to 6kV
  - 20W or 30W
- High Power C Series
  - 125V to 60kV
  - Up to 250W
- Dual Polarity
  - 125V to 6kV
  - 125W or 250W
- HVA Series
  - 1kV to 20kV
  - Unipolar or Bipolar
  - Up to 2W
- LE Series
  - 1kV to 30kV
  - Up to 30W



- D Series
  - 1kV to 6kV
  - Up to 6W
- V Series
  - 600kV to 3kV
  - Up to1W
- M Series
  - 600V to 3kV
  - Up to 1W
- XS Series
  - 100V
  - 0.1W
- US Series
  - 200V to 500V
  - 0.1W
- MPM Series
  - 100v to 3kV
  - Up to 1.5W
- FL Series (Floating)
- EFL Series (Floating)
- FIL Series (Filament power needs)



## **Application Quick Select Chart**

Product Series:	AA Series	A Series	C Series	CST Series	HPC Series	DPC Series	D Series	E Series	EFL Series	FIL Series	FL Series	FLHV Series	HVA Series	LE Series	M Series	MPM Series	US Series	V Series
Application		VI	U2	U2	U2	U2	U2	VI	U2	U2	U2	Ų2	02	U2	V2	U2	02	02
Gereral High Voltage	_	•	•		•	•	•	•					•	•	•	•	•	•
Bias Supplies		•					•			•					•	•	•	•
Capacitor Charging			•	ory	•	•												
Detectors (PMTs/APDs)				Contact Factory			•	•					•	•	•	•	•	•
Electrophesis	•	•		tact									•		•			•
Electrostatic Chuck	•	•		Con								•	•					
Electroproation	•	•	•	ace -	•													
Filiament Supplies				orm.						•								
Lasers			•	Pefe	•		•						•		•		•	•
Mass Spectrometry	•	•		ized				•					•	•				
Piezoelectronics			•	Customized Peformace	•	•												
Pulsed Power			•	Ö	•													
Portable Devices	•														•	•	•	•
Voltage Isolation									•		•	•						



## **Product Quick Select Chart**

Double 40 ada a	M	No. Co. to Alfaborat	Building	0	Ripple	TemperatureCoeThclent			
ProductSeries Micro-Size to Co	Max OutputPower   Max OutputPower   Max Output   Max Ou	MaxOutputVollage1 e DC Modules (PCB Mou	Description nt)	Control	(Peak toPeak)	(ppm/°C)			
XS	0.1W	0.1kV	Single Output (Unipolar) Bias Supply	Analog	<0.05%	<50			
US	0.1W	0.5kV	Single Output (Unipolar) Bias Supply	Analog	<0.01%	<50			
М	1W	3kV	Single Output (Unipolar) Bias Supply	Analog	<0.01%	<100 (std)			
v	1W	3kV	Single Output (Unipolar) Bias Supply	Analog	<0.01%	<100 (std)			
MPM	1.5W	3kV	Single Output (Unipolar, Isolated or Non-Isolated) Bias Supply	Proportional	<0.50% (std), <0.05%(opt)	<300			
D	6W	6kV	Single Output (Unipolar) Bias Supply	Analog	<0.02%	<100			
AA	30W	6kV	Single Output (Unipolar) Bias Supply	Analog	<0.05%	<50 (std), <25 (opt)			
Standard-Size DC to High Voltage DC Modules (PCB or Chassis-Mount)									
HVA	2W	20 kV ±20 kV(Bipolar)	Precision Single Output (Unipolar or BiPolar Reversing) Amplifier	Analog	0.05% (std) ,<0.0025% (opt)	<50 (std), <25 (opt)			
FLHV	15W	±6 kV (Dual Output)	Dual Output (Unipolar, Floating or Isolated) Bias Supply	Analog	<0.05%	<50 (std), <25 (opt)			
A	30W	40 kV	Single Output (Unipolar) Bias Supply	Analog	<0.05% (std), <0.005 (opt)	<50 (std), <25 (opt)			
AUX	30W	6 kV (Dual Output) 35 kV (Triple Output)	Dual or Triple Output (Unipolar) Bias Supply with Adjustable/Fixed Range	Potentiometer	See Data Sheet	See Data Sheet			
С	30W	6kV	Single Output (Unipolar) Cap Charging Supply	Analog	See Data sheet	<50 (std)			
High-PowerC	250W	60 kV (SingleOutput) ±6 kV (Dual Output)	Single or Dual Output (Unipolar) High-Power Cap Charging Supply	Analog	See Data sheet	<50 (std)			
LE	30W	30kV	Precision Single Output (Unipolar) Bias Supply	Analog	<0.0025%	<25 (std), <10 (opt)			
E	30W	15kV	Precision Single Output (Unipolar) Bias Supply	Analog	<0.0025%	<25 (std), <10 (opt)			
Rack-Mount AC	to High-Voltage DC Powe	erSupplies							
HVRack	1kW	40kV	Custom-Configurable 3U (Unipolar) Supply with up to 4 Outputs	Potentiometer Analog	Configurat ion Depende nt	Configurati on Dependen t			
Standard-elze D	C to DC Low-Voltage Mo	dules (PCB or Chassis-M	ount)						
FIL	15W	5V	Precision Single Output (Unipolar) Filament Supply	Analog	N/A	<15			
FL.	36W	5.6V, 12, 24, -15 V	Quad Output Fixed Range (Unipolar) Power Supply with Signal Isolators	Fixed	See Data Sheet	See Data Sheet			
EFL	36 W	12, 24, ±15, ±15 V	Quad Output Fixed Range (Unipolar) Power Supply with Signal Isolators	Fixed	See Data Sheet	See Data Sheet			

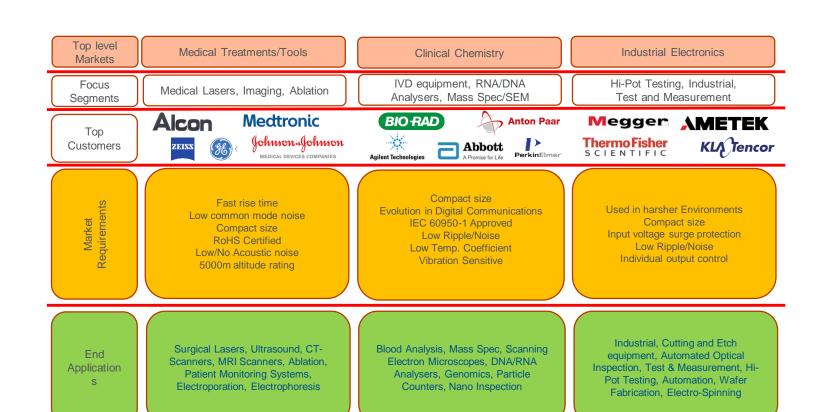


## **Key Markets Segments for Cross Selling**

Market Segment	Application	What is Powered
Medical Imaging	MRI, CT, Ultrasound, X-ray	LV: Motors, Control Electronics, Distributed DC HV: Detectors
Medical Lasers	Surgical Lasers, Aesthetic Lasers	LV: RF, Cooling pumps, TEC elements, Control Electronics HV: Charging Caps, Pockle cells
Medical Treatments	Surgical Robotics, RF Surgery, Ablation, Dialysis, Electroporation	LV: Motors, Cooling elements, Motors , Control Electronics HV: Charging Caps, Pockle cells
Clinical Test & Measurement	IVD, Blood Analysers, RNA/DNA Analyzers, Clinical Chemistry, Flow Cytometry, Electrophoresis, Particle Counters	LV: Control Electronics, Cooling elements Motors HV: Fluid separation
SEM	Life Science, Material Science, Forensics, Cellular analysis	LV: Control Electronics, Cooling elements, Motors HV: Detectors
Mass Spec	Q-LC/MS, QQQ-LC/MS, Ion-Trap, Q-TOF LC/MS, FT-MS, GC/MS, IMS, Maldi-TOF, ICP-MS	LV: Control Electronics, Cooling elements, Motors HV: Detectors
Industrial Lasers	Laser Cutting, Etching, Marking	LV: Cooling elements, Motors, Control Electronics HV: Charging Caps
Industrial Test & Measurement, Manufacturing	AOI, Burn in equipment, Vision systems, Electronic Loads, ATE, Curing equipment, Positioning equipment, Robotics, Hi Pot Testers,	LV: Motors, Control Electronics HV: Test Voltages
Specialized Communications & Computing	VXI/VPX Backplanes/Enclosures, Radar, Sonar, Telemetry, RF amplifiers	LV: Motors, Control Electronics HV: High Voltage amplifiers



## **Market and Applications**





# High Voltage Markets – Where Do We Play?

- Medical Treatments/Tools
- Clinical Diagnostics
- Analytical Instruments
- Industrial
- Semi





## **Medical Treatments/Tools**

## **Application**

- ✓ MRI/NMR
- ✓ X-Ray/CT
- ✓ Electroporation
- ✓ Cytometry
- ✓ Ultrasound
- ✓ Pulsed Power
- ✓ Surgical Lasers



## **Medical Treatments**



































Cosmetic Medical Lasers, Clinical Medical Lasers, Diagnostic Equipment, Ultrasound, CT-Scanners, MRI Scanners, Ablation, Electroporation, Cancer Treatment Equipment, Patient Monitoring Systems, Skin Treatment, Dialysis Equipment





## Clinical Diagnostics / Analytical Instruments / Industrial

## **Application**

- ✓ Analytical devices✓ X-ray
- √ Hi-Pot Testing 
  ✓ Particles
- ✓ Motor/Wire Testing
- ✓ Antennas
- ✓ Automotive
- ✓ Cap Charging
- ✓ Spectrometers
- ✓ Ultrasound

- ✓ Energy
- √ Radiation
- ✓ Laser
- ✓ PMT
- ✓ Energy



## Clinical Diagnostics / Analytical Instruments



PerkinElmer<sup>®</sup>



























**Anton Paar** 



Blood Analysis, Mass Spec, Scanning Electron Microscopes, DNA/RNA Analysers, Genomics, Particle Counters, Liquid/Gas Chromatography, Electrophoresis, Cytometry, SEM





## **Application**

- ✓ E-Beam
- ✓ E-Chuck
- ✓ Implant











E-Chuck, E-Beam, Optical Inspection, Industrial Printing, Machine Tools, Test & Measurement, Industrial cutting Equipment, Automation, Laser Etching, Wafer Fabrication,





High Voltage Case Studies





Industry: Biological research - Analytical Instrumentation

Title: High Voltage Power Supply Required for microfluidic cutting-edge mass cytometry imaging

system

Company: Biological research equipment company

#### Challenge

Provide HV power supplies (2x -250V/30W, 1x -500V/30W, -1x 1kV/30W & 1x +1kV/30W) to power detectors in a microfluidics system. Power supplies must be extremely reliable as systems can be expected to operate 24/7/365 in some laboratories.

#### **Solution**

- A Series: (2) 1/4A24-N30-H, (1) 1/2A24-N30-H, (1) 1A24-N30-H and (1) 1A24-P30-H.
- The power supplies were deemed an excellent choice for this application due in large part to these attributes:
- Our willingness to engage with the customer initially despite initial low-volume orders (competition was demanding much greater volume to start)
- Lead-time of just 2-3 weeks (as opposed to 8 weeks standard lead-time by the competitor)
- · Favourable pricing
- Historically high reliability in continuous-use applications

#### Results

- Enabled the customer to procure a smaller size sample order which reduced their initial risk as their system needs were evolving during the development phase.
- Low lead-time equated to more rapid development and deployment of beta systems than would have been possible if they utilized the competitor's supplies.
- · Product met customer's sensitive price point
- UltraVolt's high reliability in the customer's application gave them the confidence they sought to quickly rampup to full production and gain market share in a crowded biological research equipment field.



#### **Additional Benefits?**

- Short Lead time
- Exceptional Applications Support
- Flexible engineering adjustments to meet need
- Reputation for quality and reliability
- Leader in modular power supplies



Industry: Cardiovascular (Electroporation)

Title: High Voltage Power Supply Required for Surgical Ablation System Generator

Company: World Leading Medical MFG Equipment

#### Challenge

Provide (2) HV power supplies (2KV@ 250 W&, 500V@60W) to power Surgical Ablation System Generator. Power supplies must be extremely reliable as systems can face powerful vibration

#### Solution

- High power C Series: (1) 2C24-P250-I5 & (1) 1/2C24-P60-I5. Both supplies comes equipped with DB 15 Straight connector
- · For very solid connection
- The power supplies were deemed an excellent choice for this application due in large part to these attributes:
- · Power supplies were very reliable "literally indestructible" per customer. They tested to extreme conditions
- Our willingness to modify/ add on features to meet customer requirements
- Willing to build small gty (multiple times) for customer different testing stages
- · Very short Lead-time :approx. 3-4 wks.

#### Results

- Enabled the customer to Penetrate new Technology with reduced risk as their system needs were evolving during the development phase.
- Low lead-time equated to more rapid development and deployment of beta systems
- Product met customer's tough specs
- Ultravolt high reliability in the customer's application gave them the confidence they sought



#### **Additional Benefits?**

- Short Lead time
- Exceptional Applications Support
- Flexible engineering adjustments to meet need
- · Reputation for quality and reliability



Industry: Medical

Title: High Voltage Power Supply Required for medical drug delivery at the cellular level

Company: Medical Equipment

#### Challenge

Customers application needed a rugged and reliable power supply for their electroporation instrument. They were using two High Power C series units in their application during testing and having difficultly fitting the units into their system. They also were looking for ways to reduce costs.

#### Solution

Dual Polarity C Series (DP C Series): 1/2C24-NP250-1 This unit contains two High-Power C Series power supplies in a single package. One 1/2C24-N125 and one 1/2C24-P125 are housed in a low-profile aluminum casing. The customer decided that the power supply was an excellent choice for this application due in large part to these attributes:

- Short lead-time
- Favourable pricing
- · Historically high reliability in continuous-use applications
- Reduced footprint
- Willing to build small qty (multiple times) for customer different testing stages

#### Results

- Customer was able to reduce costs as the DP C Series was cheaper then purchasing two separate High-Power C Series units.(2 power supplies build into a single housing)
- Customer was happy with a single package the was able to fit into their system easily.
- Low lead-time equated to more rapid development and deployment of beta systems.
- Ultravolt high reliability in the customer's application gave them the confidence they sought.



#### **Additional Benefits?**

- Short Lead time
- Exceptional Applications Support
- Flexible engineering adjustments to meet need
- Reputation for quality and reliability
- Reduced Costs





**High Voltage Applications** 





## **Ultravolt Key Application**

- Electrostatic Separation / Sorting /Transport
- Opto-Electronics: Detecting/Manipulating Light
- Hi-Pot Testing (Wires, Cables, Magnetics)
- Capacitor Charging
- Electrostatic Clamping (E-Chucks)
- Test and Measure tools and equipment
- SEM
- Mass Spec
- Laser
- Imaging
- Gas detection





## **ELECTROSTATIC SEPARATION**

#### Industrial, Medical, Instrumentation, Consumer MARKET

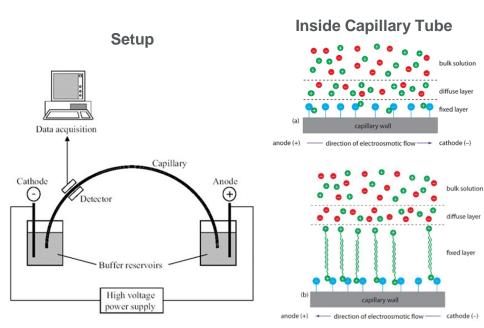
- HV detects, separates, purifies, modifies, transports particles, fluids and cells
- Can be used together with or independently of Mass Spectrometers
- Technologies where it's used
  - Gel Electrophoresis
  - Capillary Zone Electrophoresis (CZE)
  - Mass Spectrometers + Electrospray + CZE
  - Electro-Precipitation
  - Particle Measurement / Sizing
  - Electro-spinning
  - Electroporation
- Applications:
  - Sorting cells/analyzing by type (DNA/RNA, paternity tests, etc.)
  - Drug tests, Antibody characterization
  - Removing particles/contaminants from gases/fluids (Scrubbers)
  - Counting particles
  - 3D Printing of unique fabrics for filtration, medical application
  - Modifying cells to carry drug treatments into the body



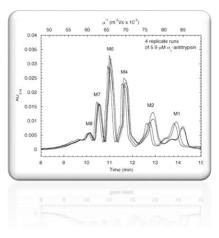
## CAPILLARY ELECTROPHORESIS (CZE)

#### Characterizes DNA, ANTIBODIES, DRUG Concentrations

- HV induces an Electro-osmotic Flow inside a Capillary Tube (Silica)
- Higher Charge/Mass ratio molecules move first followed by lesser ratios
- Detector (PMT/APD/Other) measures light intensity of fluid as it passes
- Poor stability and switching Noise decreases resolution and sample throughput



# Results (Time-Based Profile)

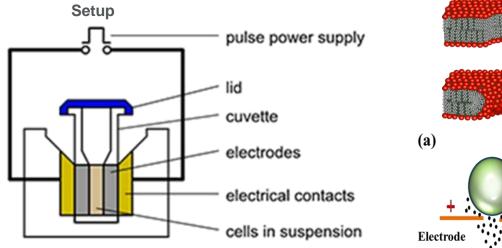


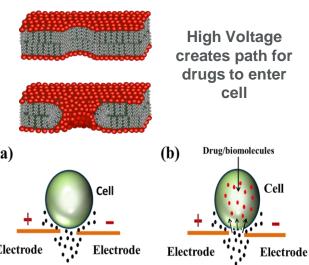


## **Electroporation**

#### also known as Electro-PERMEABILITIZATION

- Pulsed High Voltage increases the ability of cells to absorb treatments
  - Bacteria, Fungi, Yeast, Plants, Mammalian Cells
- Pores of cells are opened in a solution bath, materials forced inside
- Modified materials put into the body for treatment other purposes
- Applications: Analytical Instruments, Cardiology



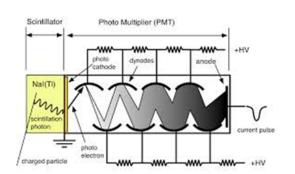


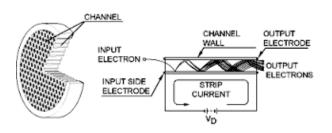


## **Detectors**

#### **Amplifying Faint ELECTRICAL and Light signals**

- High voltage needed to power detectors that sense Fluorescence, Low Light
- PMT (Photomultiplier Tube): PET, Optical Tools, CZE, Cytometry, Radiation Detectors
- APD (Avalanche Photodiodes): Used in PET/MRI, Automobiles
- MCP (Micro Channel Plates), used in X-Ray Image Intensifiers, A-Se Panels



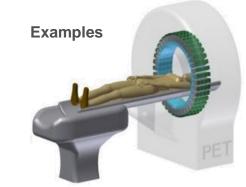




PMT (1 to 3kV)



APD (1 to 4kV)









## ASK a few QUESTIONS to get Started . . .

- What <u>Input and Output Voltages</u>?
  - Input: UltraVolt modules operate on DC input voltage (+5, +12 or+ 24 VDC, mostly)
  - Output: Ultravolt module can produce High Voltages up to 60kV
  - Polarity: Positive, Negative, or Positive & Negative (Dual Polarity)?
- How much High Voltage <u>Power</u> is needed?
  - Ohm's Law: Power (Watts) = Current (Amps) x Voltage (Volts)
- How many different High Voltage Outputs are needed?
  - UltraVolt products are mostly <u>Single Output</u> (with a few exceptions)
- What type of <u>Mounting Method</u> is preferred? Chassis or PCB?
- Polarity: Negative, Positive or Positive & Negative output voltages?
  - Positive Unipolar Output => 0 to 10kV DC, Negative Unipolar Output => 0 to -10kV DC
  - Bipolar Output => -10kV to +10kV DC
- How do they want to <u>Control</u> it?
  - UltraVolt products only have analog interfaces (with different capabilities)
- How much <u>Ripple</u>? (Ripple is the noise on the High Voltage output line)
- What are your low voltage requirements



## **UltraVolt Competition**

- Spellman (Long Island, NY)
  - Competes broadly with UltraVolt: Clones UltraVolt Modules (Umx-Series= A, AA, and C Series)
  - \$300M+ revenue: Medical (45%), Analytical (20%), Industrial (20%), X-Ray (15%)
  - Highly-focused on those who have progressed to volume/custom needs (CT Imaging)
- XP-Power/EMCO (Sunnyvale, CA)
  - DC-DC Converters A, AA, D, MPM Series
  - Rumor that delivery time is more problematic
- Matsusada Precision (Japan)
  - Broad-based competition with micro AEI UltraVolt Modules
  - Competes directly with AEI UltraVolt and HiTek
- Harris/Applied Kilovolts (Sussex, UK)
  - Broad-based competition with AEI UltraVolt Modules
- Wisman (China)
  - Competes broadly across all products
- HVM Technology (Austin, Texas)
  - Specializes in micro-size (M/V/D/US Series-like) for night vision goggles, PMT, Piezos
  - Up to 10kV, 3 Watts
  - Available through Digi-Key
- Other
  - PICO Electronics (NY), Dean Technologies (Texas), Hamamatsu (M/V/D like modules for PMT/APD)



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