

ALPHA[®] Photovoltaic Product Line Selector Guide



Where does the PV market turn
to lower its cost per watt?

alpha



ALPHA's Strategic Value Proposition

We are committed to enhancing your productivity, yield and cost of ownership as you focus on today's photovoltaic module assembly and cell metallization challenges. We do this by developing leading technology materials combined with our world class process knowledge and applications expertise.

ALPHA's Customer Value Propositions:

- Leading technology products
- Sales/Support in every major electronics geographic market
- Local and consistent technical support regionally and globally
- Continuity of supply ensured through multiple manufacturing sites
- Consistent product performance globally
- Manufacturing lot trace-ability
- Six Sigma projects for process optimization
- High-reliability products
- Access to application laboratories
- Accelerated technology customization for key customers
- Delivered lowest cost of ownership
- Solder scrap value recovery

When you commit to ALPHA product technology, we commit to your success.

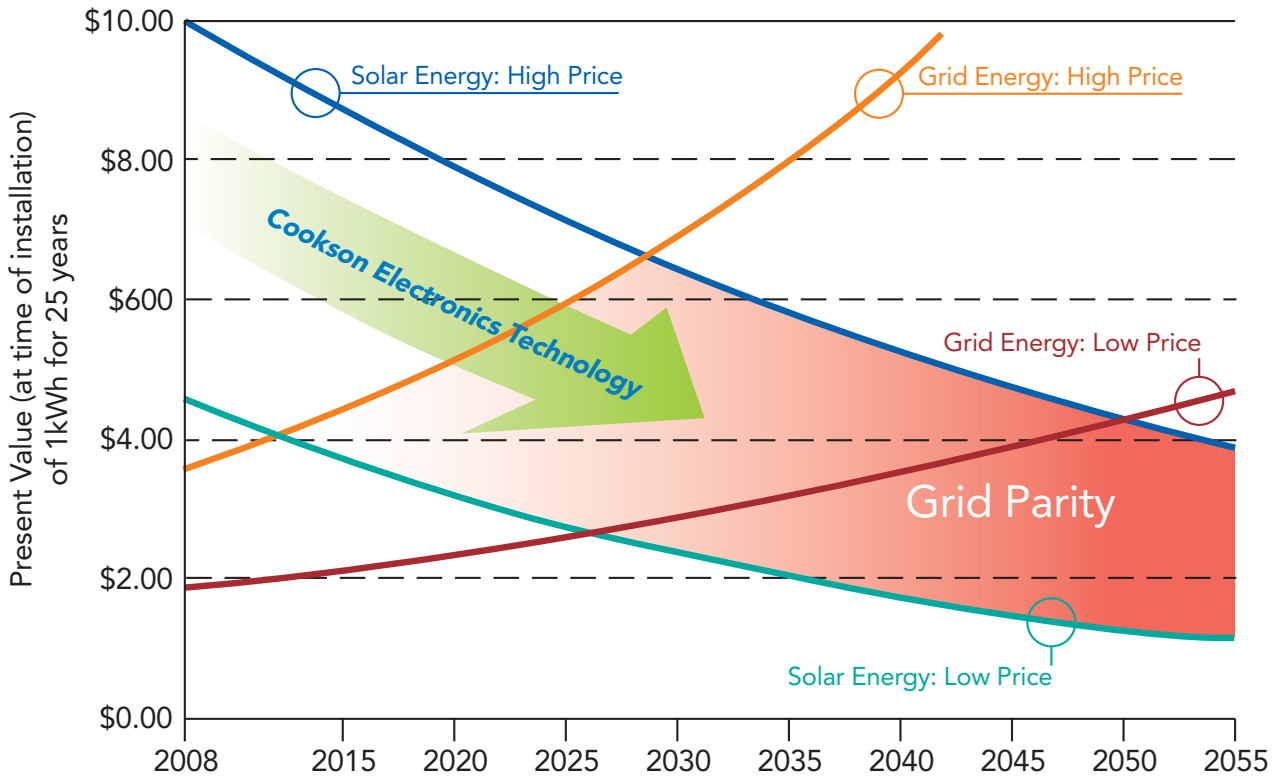
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Grid Parity

Grid Parity for Residential Photovoltaics



ALPHA's photovoltaic focus is to help customers reduce the cost per watt of electricity generated from their modules and cells, so that grid parity becomes a reality, sooner rather than later.

ALPHA® PV-READY Ribbon™

ALPHA® PV Ribbon helps speed up tabbing and stringing processes, while reducing module assembly costs.

ALPHA® PV-READY RIBBON™

Resilient Flux-Coated

The Ready Ribbon family of resilient flux-coated flat wire Photovoltaic (PV) ribbon eliminates the need to dispense flux during tabbing and stringing operations. Resilient flux is applied to standard solder-coated copper ribbon and delivered on standard spools. Ready Ribbon resilient flux is compatible with a wide variety of solder types, including SnPbAg, SnPb and low temperature SnBi. Excellent shelf life provides significant manufacturing advantages.

Features & Benefits

- Increases manufacturing up time by eliminating flux applicator maintenance
- Reduces cell scrap rate due to line restart testing associated with flux related soldering problems
- Excellent pull strength due to uniform flux deposition over the ribbon
- Compatible with standard tabber /stringer assembly soldering systems

ALPHA® PV-RIBBON

Unfluxed

ALPHA PV-Ribbon is high-quality solder-coated copper ribbon delivered on precision traverse wound spools delivered with a variety of solder alloys, including SnPbAg, SnPb and low-temperature SnBi.

Product Information

Alloys

- Sn60Pb40
- Sn63/Pb37
- Sn62/Pb36/Ag2
- SnAg3.5
- Sn42Bi58
- Other alloys by special request

Ribbon Widths

- 0.5mm
- 2.0mm
- 2.5mm
- 4.0mm
- Others by special request

Spool Sizes

4kg and 5kg



ALPHA® PV RIBBON COPPER OPTIONS

Common Name	Cu – ETP / CDA-110	Cu – DFE / CDA-101
Copper Content	99.90%	99.99%
Tensile Strength – Half Hard	38,000-46,000 psi	38,000-46,000 psi
Tensile Strength – Dead Soft Annealed	32,000-36,000 psi	32,000-36,000 psi
09mElongation – 2" Half Hard	15% minimum	15% minimum
Elongation – Dead Soft Annealed	20% minimum	20% minimum

PRIMARY SOLDER ALLOY COATINGS AVAILABLE¹

ALLOY	LIQUIDUS	ATTRIBUTES
LEAD CONTAINING		
Sn60/Pb40 Sn63/Pb37	188°C 183°C	Most common Pb-containing solder used today in PV Solar Module assembly application
Sn62/Pb36/Ag2	179°C	Common Pb-containing alloy used for the added impact of the Ag.
LEAD FREE		
Sn97/Ag3	221-230°C	Most common lead-free solder used today in PV Solar Module assembly application
Sn100	232°C	Common tinning alloy often used for bus bar applications
SACX®0807	227°C	Proprietary lead-free SnAgCu alloy designed to deliver maximum value and processability while maintaining solder joint reliability.

1. Other alloys are available to meet customer specifications and our technical staff is available to discuss your technical requirements and an appropriate alloy to meet your specifications

Packaging

- DIN 125 Reels Length 125mm, Width 125mm, Bore 16mm, Traverse 100mm: Barrel 80mm
- Reels are packed in carton boxes, which are placed in secure wooden cases for transportation.
- Camber: 6mm max, deviation in 1m of length as measured from center

ALPHA® PV-READY Exactalloy® Preforms

ALPHA® PV Solder Perform technology is based on our expertise in developing engineered solutions for challenging semiconductor and electronics assembly applications.

ALPHA® PV-READY EXACTALLOY®

Preforms

- Semiconductor die to copper / substrate interconnect expertise
 - HCPV – High Concentration Photovoltaic die attach expertise
 - Solder thickness control for high reliability
 - Proprietary high tin alloys for enhanced reliability
- Integration of ALPHA® Preforms with backside interconnects
 - Highest yield, highest reliability solution
- Extensive solder preform flux capabilities
 - Machine ready flux coated preforms
- Wide variety of preform alloys

Features & Benefits

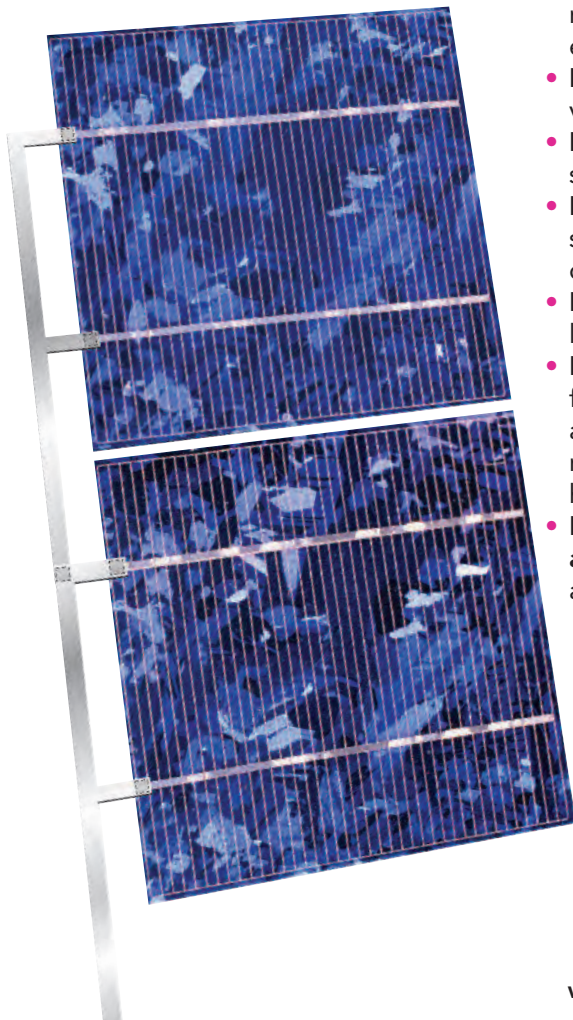
- **Low Temperature Solder Alloys** – Significant assembly stress results from the soldering process due to large material CTE mismatch. Soldering with low temperature alloys reduces this stress by minimizing the temperature excursion.
- **Improve yield** – deliver a precise volume of solder
- **Improve reliability** – controlled solder thickness
- **Improve throughput** – automated soldering with pick and place capable preforms
- **Reduce cell scrap rate** – due to lines down and restart testing
- **Reduce flux residue** – optimized flux type and amount for specific applications reduces flux residue resulting in clean cosmetics and high reliability
- **Reduce assembly thermal stress and warpage** – low temperature alloys requirements.

ALPHA® Solder Preform Alloys

- Sn60Pb40
- Sn63/Pb37
- Sn62/Pb36/Ag2
- SnAg3.5
- Sn42Bi58
- Sn42Bi57.6Ag0.4
- Numerous other alloys available – consult

Applications

- **Solar Concentrators** – Optimize the thermal conductivity of the solder interface by combining the proper material set with a low void reflow process.
- **Backside Interconnects** – The integration of ALPHA® Preforms with backside interconnects deliver repeatable solder volume, high assembly yield, and significantly improved product reliability.
- **Hand Bus Bar Soldering** – ALPHA® Preforms (with integrated flux) deliver a precisely controlled solder volume, significantly reducing variation in hand soldering results.
- **Automated Bus Bar Soldering** – Prefluxed ALPHA® Solder Preforms and provided on tape and reel packaging to enable a fully automated soldering process.



ALPHA® Liquid PV Soldering Fluxes

ALPHA® PV fluxes deliver best-in-class soldering performance and electrical reliability.

All ALPHA® fluxes have been developed using the latest Cookson Electronics' flux technology. Specific flux products were formulated to offer a safer and more environmentally friendly alternative. All ALPHA® PV-Series fluxes were developed for use with Pb-bearing and Pb-free alloys.

PV MODULE ASSEMBLY

Each flux is designed for optimal tabbing and stringing performance. These fluxes are effective on hard to solder surfaces like AgAl BUS bars and help create strong interconnects resistant to most standard pull tests. ALPHA PV fluxes will maximize throughput and yield reducing per module costs.

ALPHA® PV-32 Flux

- Low solids producing transparent, uniform residues
- Engineered for high throughput assembly whether pre-heat is used or not
- Perfect for use with the most popular soldering methods including; Hot Bar, Hot Point or Hot Air.
- ROL0

ALPHA® PV-61 Flux

- Fast drying alcohol based formulation
- Low solids for excellent cosmetics
- High soldering yields with induction type heating methods
- ORLO

ALPHA® PV-80 Flux

- Alcohol-based with medium solids
- Formulated to maintain high activity through long, high temperature, drying and soldering cycles
- Excellent for hand soldering and rework applications
- ROL0

PV-32 TECHNICAL SPECIFICATIONS

PHYSICAL PROPERTIES	TYPICAL VALUES	PARAMETERS/TEST METHOD	TYPICAL VALUES
Appearance	Clear, Pale Yellow Liquid	pH, 5% v/v aqueous solution	3.3
Solids Content, wt/wt	4.4	Recommended Thinner	ALPHA 425
Specific Gravity @ 25°C (77°C)	0.799 ± 0.003	Shelf Life	12 months
Acid Number (mg KOH/g)	22.0 ± 1.2	IPC J-STD-004 Designation	ROL0
Flash Point (T.C.C.)	15°C		

PV-61 TECHNICAL SPECIFICATIONS

PHYSICAL PROPERTIES	TYPICAL VALUES	PARAMETERS/TEST METHOD	TYPICAL VALUES
Appearance	Clear, Pale Yellow Liquid	pH, 5% v/v aqueous solution	3.3
Solids Content, wt/wt	3.8	Recommended Thinner	ALPHA 425
Specific Gravity @ 25°C (77°C)	0.794 ± 0.003	Shelf Life	12 months
Acid Number (mg KOH/g)	24.0 ± 1.2	IPC J-STD-004 Designation	ORLO
Flash Point (T.C.C.)	12°C		

PV-80 TECHNICAL SPECIFICATIONS

PHYSICAL PROPERTIES	TYPICAL VALUES	PARAMETERS/TEST METHOD	TYPICAL VALUES
Appearance	Clear, Pale Yellow Liquid	pH, 5% v/v aqueous solution	3.1
Solids Content, wt/wt	6.0	Recommended Thinner	ALPHA 425
Specific Gravity @ 25°C (77°C)	0.806	Shelf Life	12 months
Acid Number (mg KOH/g)	27.0	IPC J-STD-004 Designation	ROL0
Flash Point (T.C.C.)	17°C		

ALPHA[®] Solder Paste

Highest throughput and yield, and lowest cost of ownership for today's challenging photovoltaic cell assembly processes.

NO-CLEAN PRODUCTS (Solder Paste Requiring no Post Solder Reflow Cleaning)

ALPHA[®] PV-100

- Available in 63/37 Tin/Lead or 62/36/2 Tin/Lead/Silver alloy for the most reliable solder joint
- Clear, colorless flux residue
- High electrical reliability
- Minimum generation of random solder balls
- Available in easy to handle 30cc or 10cc syringe
- Ideal for manual or automatic dispensing

ALPHA[®] PV-200

- Available in the most popular lead free solder alloys (SAC 305, SAC 405)
- Clear, colorless post solder reflow residue
- No post reflow cleaning required
- High electrical reliability
- Available in easy to handle 30cc or 10cc syringe
- Ideal for manual or automatic dispensing
- Contains 0 halogen or halide

PV-100 TECHNICAL DATA		
CATEGORY	RESULTS	PROCEDURES/REMARKS
CHEMICAL PROPERTIES		
Corrosivity	Copper Mirror Test (L)	IPC J-STD-004 Classification: ROL-1
Halide Content	Silver Chromate Paper Test Pass)	IPC J-STD-004
PHYSICAL PROPERTIES		
Color	Clear, colorless Flux Residue	
Viscosity	85% metal load designated M04, is suitable for a wide range of dispensing applications	Malcolm Spiral Viscometer

PV-200 TECHNICAL DATA		
CATEGORY	RESULTS	PROCEDURES/REMARKS
CHEMICAL PROPERTIES		
Corrosivity	No Evidence of Copper Corrosion	IPC J-STD-004 Pass
Halide Content	Halide-free (by titration). Passes Ag Chromate Test	IPC J-STD-004
PHYSICAL PROPERTIES		
Color	Clear, colorless Flux Residue	SAC 305, 405 alloy
Viscosity	PV-200: 88.5% metal load designated M13 for printing PV-200: 83.3% metal load designated M04 for dispensing	Malcolm Spiral Viscometer, J-STD-005

PV-300 TECHNICAL DATA		
CATEGORY	RESULTS	PROCEDURES/REMARKS
CHEMICAL PROPERTIES		
Corrosivity	No Evidence of Copper Corrosion	IPC J-STD-004 and JIS-Z-3197 1986 Pass
Halide Content	Halide-free (by titration & IC)	IPC J-STD-004
PHYSICAL PROPERTIES		
Color	Clear, colorless Flux Residue	
Viscosity	84.0% metal designated M04 for Type 3 89.0% metal designated M16 for Type 4	Malcolm Spiral Viscometer, JIS Z3284 Annex 6

ALPHA[®] PV-300

- Available in the most popular lead-free solder alloys (SAC 305, SAC 405), and copper free Sn 96.5/3.5 Ag.
- Also available in low silver SACX alloys (SACX 0807 and SACX 0307)
- Clear, colorless post solder reflow residue, even after longer reflow temperature profiles
- No post reflow cleaning required
- High electrical reliability
- Available in easy to handle 30cc or 10cc syringe
- Ideal for manual or automatic dispensing



ALPHA® Silver Conductor & Conductive Adhesive

High conductivity inks and adhesives specially formulated to increase the overall conductivity of photovoltaic cells and for depositing seed layers for plating operations.

Cookson Electronics is a leader in developing formulated ink and paste materials to help PV cell manufacturers improve the overall efficiency of their cells. Whether you are working with crystalline Si cells or thin film cells, there is an ALPHA® product solution for you. Ink-jettable Ag inks allow for off-contact printing of conductors, and our high performance conductive adhesives increase the conductivity of thin film cells and can also be used for assembly operations.

ALPHA® n:1000-IJ Ink jet silver conductor

ALPHA® n:1000-IJ from Cookson Electronics was specifically developed to deliver high conductivity, low process temperatures, good adhesion and high reliability printing. n:1000-IJ is formulated using highly engineered nano-particles, manufactured by Cookson Electronics, that are consistent every time. Excellent shelf life, reproducible print characteristics, and fine line capability are designed into n:1000-IJ.

Features & Benefits

- Low process temperatures 150°C – 350°C.
- High conductivity silver lines in the range of 3 – 5 $\mu\Omega\text{cm}$.
- Consistent print characteristics.
- Long shelf life and easy start up.
- Excellent adhesion to various substrates including silicon, polymers, glass and ceramic.

PARAMETERS

TYPICAL VALUES

PARAMETERS	TYPICAL VALUES
Appearance	Dark purple to black liquid
Solids Content, wt/v	25%
Particle size, nm	10-15
Viscosity, @ 28°C Cp	10.0 ± 1
Specific Gravity g/cm ³	1.5 ± 0.1
Surface Tension @ 28°C, dynes	28 ± 2
Storage life at RT	2 months

ALPHA® n:1000-SP Screen Print silver conductor

ALPHA® n:1000-SP from Cookson Electronics was specifically developed to deliver high conductivity, low process temperatures, good adhesion and consistent high reliability printing. n:1000-SP is formulated using highly engineered nano-particles, manufactured by Cookson Electronics, that are consistent every time. Designed into n:1000-SP is excellent shelf life and reproducible print characteristics that give the user fine line capability.

Features & Benefits

- Low process temperatures 150°C – 350°C. Can be processed at up to 900°C
- High conductivity silver lines in the range of 3 – 5 $\mu\Omega\text{cm}$.
- Consistent print characteristics.
- Long shelf life and easy start up.
- Excellent adhesion to various substrates including silicon, polymers, glass and ceramic.

PARAMETERS

TYPICAL VALUES

PARAMETERS	TYPICAL VALUES
Appearance	Dark blue to black paste
Solids Content, wt/v	60%
Particle size, nm	10-15
Viscosity, @ 25°C Paxis	100 ± 5
Specific Gravity g/cm ³	1.8 ± 0.1
Storage life at RT	6 months

- Off-contact printing via ink jet
- Enhanced conductivity of transparent conductors
- Conductive adhesives designed for low temperature processing

SE3001 Silver Filled Epoxy

This material is an electrically conductive, die attach adhesive that has been formulated for microdot dispensing. The material is hardened by thermal processing in IR, convection, conduction or vapor phase equipment. Our combination of low cure times and superior thermal aging sets SE3001 apart from competitive products for PV applications.

Dispensing

Dispense, place components and cure for either 15 minutes at 130°C or 3 minutes at 165°C (snap cure). Preferably use a positive displacement dispensing with a 22 gauge (16mil I/D) needle. When material remains attached to the needle and substrate and is dragged as the needle moves away, this is called tailing. This material has been reformulated from our traditional silver filled epoxy to reduce this effect. Proper maintenance and consistency of gap height, shoot size and up height is also important to ensure no tailing. The minimum reproducible dot is 1.5 times the inner diameter of the dispensing needle (i.e., a 6mil inner diameter (I/D) will reproduce a consistent 9mil dot, which is approximately 225 microns). The smallest standard needle is 28 gauge with a 7 mil I/D (although smaller needles can be made to order).

PHYSICAL PROPERTIES

Bonding Range (°C)	130 – 170
Viscosity HBT 5x cp-51 spindle, 1rpm @ 25°C (Kcps) HBT 5x cp-51 spindle, 10rpm @ 25°C (Kcps)	150 – 220 23 – 49
Thixotropic Index (1/10)	5.5 ± 1.0
Glass Transition Temperature, Tg (°C)	90
Pot Life (hours)	8 – 12 16 (sealed)
Shelf Life @ -40°C (months)	6
Filler (Ag, % by weight)	77 ± 2

ELECTRICAL/THERMAL PROPERTIES

Volume Resistivity (ohm•cm)	<1.0 x 10 ⁻⁴
Junction Resistivity (mohm)	<5
Thermal Conductivity (W/mK)	4 – 5

MECHANICAL PROPERTIES

Die Shear (psi)	≥2300
Thermal Coefficient of Expansion (TCE) Below Tg Above Tg	5.4 x 10 ⁻⁵ TBD



ALPHA® PV Stencils

ALPHA PV Stencils are designed to accurately deposit thick film paste for highly efficient PV cell metallization.



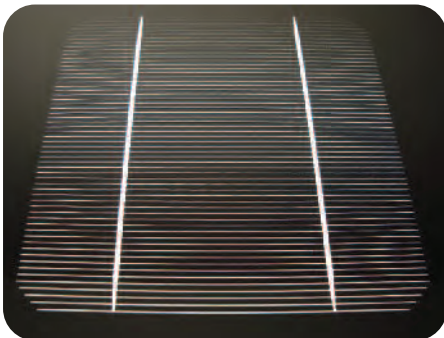
ALPHA® FORM PV Electroform Stencils Exclusively distributed by Targray Solar

ALPHA® FORM PV Electroformed Stencils are designed and manufactured to deposit thick film paste for PV cell front side metallization. Both single and double layer stencils (developmental) are available and manufactured using 100% solid nickel plating (electroforming process). The end result is a high precision durable stencil of any custom thickness with the possibility to print a full H-pattern or a variant on a silicon cell.

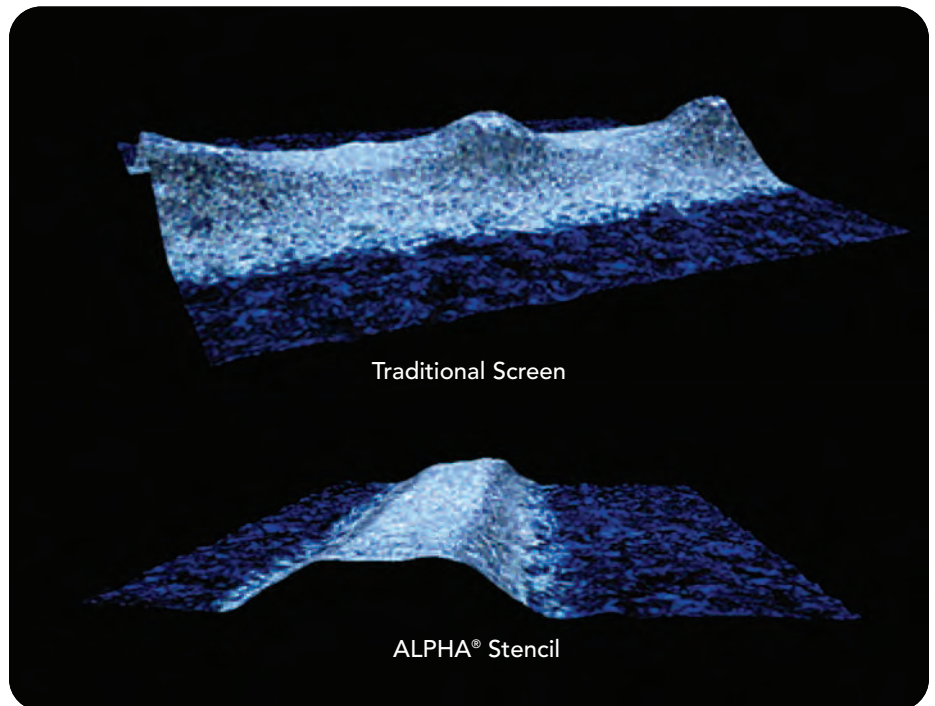
Features & Benefits

- **High Repeatability:** ALPHA® FORM PV Stencils are made using exacting manufacturing standards in order to deliver consistent performance by eliminating the two sources of variation:
 - Design Inconsistencies
 - Manufacturing Inconsistencies

- **High Precision:** Produced from the modified CAD/CAM data in a climate controlled clean room using state of the art processing tools at 10,000 DPI resolution, resulting in an Aperture Size Accuracy of ± 5 micron with superior processing capability ($CpK \geq 1.33$).
- **Ultimate Durability:** Hard Nickel stencils (> 500 VH) can provide long lifetimes.
- **Print Performance:** ALPHA® FORM PV Electroforming technology is targeted to achieve ultra fine printing results. The improved release properties from this stencil can provide the ability to print finer lines with higher aspect ratio. Improvements in cell characteristics can be reached through less shadowing and better electrical performance.



Exclusive ALPHA® PV Stencil, patent pending



Traditional Screen

ALPHA® Stencil

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