Discrete Semiconductor and Microelectronics Product Lines

MEWS27
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Jeffrey L. Walker
Regional Business Manager – Asia / Middle East

Your Power Solutions Provider
Sensitron Facility Expansion & New Corporate Headquarters

Hauppauge, NY
- 3809 Sq. m (41,000 ft²)
- Microelectronics Division (2014)
- Corporate headquarters
- Administration (Sales, Purchasing, Accounting)
- Microelectronics design, manufacturing & test

Deer Park, NY
- 2787 Sq. m (30,000 ft²)
- Discrete Semiconductor Division (1969)
- Discrete semiconductor design, manufacturing & test
- Wafer Fabrication

Your Power Solutions Provider
Quality and Certifications

- Registered to AS 9100, Revision C
- Registered to ISO9001:2008
- MIL-PRF-38534, Class H Qualified – Class K (2015 timeframe)
- MIL-PRF-19500 Certification for JAN, JANTX, & JANTXV Products
  - Products in process for QPL submission
- Mil-PRF-19500 Certification for JANS Products
  - Supplier of EEE parts to key customers / CPPA’s – example TESAT
  - SS discrete space level diodes for commercial space applications IAW Sensitron specification, 7700-4091
    - Process equivalent to “JANS” flow from wafer fab through testing
- Manufacturing capability of hermetic and non-hermetic cavity/hybrid space level product IAW Sensitron specification, 7700-4097
  - Process equivalent to “JANS” flow
- Manufacturing capability of Class ‘S’ and ‘K’ products to Customer Source Control Drawings
**Microelectronics**
- MIL-PRF-38534 Class H Qualified Hybrid Microelectronics Class K (2015 timeframe)
- SMT Board Level Products
- Motor Controllers and Power Drive Stages
- Solid State Power Controllers
- Transient Voltage Surge Protectors
- Integrated Assemblies
- Rectifier Assemblies
- Customer Driven - USA and Europe – NEW TO ASIA

**Discrete Semiconductors**
- MIL-PRF-19500 JANS Certified
- Axial Lead, MELF hermetic packages
- Die
- Rectifiers, Zener Diodes, Transient Voltage Suppressors, Switching Diodes, Schottky Diodes
- Customer Driven - USA and Europe – NEW TO ASIA

*Your Power Solutions Provider*
Military & Space Heritage

- Sensitron has supplied axial lead/ MELF diodes (JANS equivalents) for **10+ years** and JANS Qualified diodes beginning in 2011.
- Sensitron has shipped over **2.3 million** JANS and (JANS equivalent) diodes to **space customers**. In the same period of time Sensitron supplied 2.7 million (JAN equivalent type) and 3.4 million JANTX / JANTXV devices total **6.1 million** diodes to **military customers**.
- Sensitron is the **second largest supplier** of military & space level diodes in the world, and is the number one supplier to several of the major space/military prime contractors.
- Sensitron has the **second largest portfolio** of military & space level rectifiers, zener diodes, transient voltage suppressors and switching diodes in the world.
- Sensitron is JANS and JANTXV qualified on **19 MIL-PRF-19500 slash sheets**, **200 JANS part numbers** and **2500** with all JAN versions.
- Additional slash sheets in development – **Customer Driven**
Space Heritage

Partial List of Space Programs Using Sensitron Diodes

- ABS-2
- AEHF
- Air Force Payloads
- ANIK G1
- AMAZONAS 3
- AMOS 5
- APSTAR 7
- ARGON
- ARIANE 5
- ASIASAT
- ASTRO15
- ATLANTIC BIRD 7
- ATLAS V URCU & BRCU
- COMS MODCS
- CROSAT
- DAWN
- ECHOSTAR & DIRECTTV
- EUROSTAR 3000
- GALAXY
- GLOBALSTAR
- GPS 3
- HAAS
- HERSCHEL PLANCK
- HNS JUPITER
- HORIZONS
- INTELSAT
- IRIDIUM NEXT
- ISIS
- JWST TELESCOPE PROJECT
- LISA PATHFINDER
- MARS ORBITER &LANDER
- NIMIQ
- NPOESS
- NBNCO – 1A
- OPTUS
- ORION
- PALAPADA-D
- P858
- P982
- SATMEX
- SENTENIAL
- SINOSAT
- SMALL GEO
- SPACE SHUTTLE
- SPACE TECH 5
- SPACEBUS 4000
- STAR ONE C4
- STAR 2.7
- STAR TRACKER
- STEREO
- SWARM
- SWIFT
- TAURUS II
- TESTAR
- TERRASAR
- THOR
- TITAN
- VIASAT
- ELECTRO-L 1
Unique Process Monitors

• Using a Polariscope to monitor glass stress in all glass sleeve lots we manufacture.

• Using statistical methods (+/- 3 Sigma) to weed out atypical Vf from every JANS rectifier lot.
Your Power Solutions Provider
Experiment details:

Computer controlled AP-07 Polariscope

Samples in immersion liquid

Immersion tank
Comparison of Unannealed & Annealed Parts

Sample picture

Sample #3
Unannealed

Test area

Sample #8,
annealed

Stress map of test area (MPa)

Sample #3
Unannealed

Sample #8
annealed
• Highest quality levels one can obtain from the Department of Defense for semiconductor devices.

\[
\text{JOINT ARMY NAVY} = \text{JAN}
\]

• Stringent rules for testing are governed by MIL-PRF-19500P, Slash Sheets, and MIL-STD-750 test methods before JAN can be marked on the devices.

• The guidelines allow very little room to be creative since the key is to have a standard dependable part with known electrical parameters and quality levels for the user community.
JANS Enhancements due to MIL-PRF-19500P

- The latest revision of 19500 allows the manufacturer to weed out any Out Of Family, atypical, electrical parameters that are not within the lot norm, mandatory are \( I_r \) (leakage) and \( TTR \) (thermal impedance) now at +/- 3 Sigma limit. Process Monitoring alerts production.

- Sensitron, unlike its competition takes this process monitoring a step further with adding \( V_f \), example JANS1N6642, \( V_f \) ... \( V_f \)@100mA and eliminates any Out Of Family devices to a +/- 3 Sigma limit after power Burn-In.

- Now \( V_f \) is essentially a norm in (MIL-PRF-19500P, Amendment 2) for only rectifiers <1 watt ......but not for rectifiers > 1 Watt

- Sensitron’s rectifiers are greater than 1 watt and we continue to monitor \( V_f \) for rectifiers \( \geq \) 1 watt for our JANS PLUS PROGRAM

WE ARE STILL UNIQUE
# JANS Qualifications

<table>
<thead>
<tr>
<th>Type</th>
<th>Part Types</th>
<th>Slash Sheet</th>
<th>Packages</th>
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<tbody>
<tr>
<td>Rectifier</td>
<td>1N5614 to 1N5622</td>
<td>/427</td>
<td>Axial/US</td>
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<td></td>
<td>1N5550 to 1N5552</td>
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<td>Axial/US</td>
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<td>1N5802 to 1N5811</td>
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<td>1N6626 to 1N6631</td>
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<td>Small Signal</td>
<td>1N3595-1</td>
<td>/241</td>
<td>Axial/US</td>
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<tr>
<td></td>
<td>1N6638 and 1N6642</td>
<td>/578</td>
<td>Axial/US</td>
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<tr>
<td></td>
<td>1N6639 to 1N6641</td>
<td>/609</td>
<td>Axial/US</td>
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<tr>
<td>Transient Voltage</td>
<td>1N6108A to 1N6137A</td>
<td>/516</td>
<td>Axial/US</td>
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<td>Suppressor</td>
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<td>Zener</td>
<td>1N4099-1 to 1N4120-1</td>
<td>/435</td>
<td>Axial/UR</td>
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<td>1N6324 to 1N6351</td>
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<td>Axial/US</td>
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<td>1N4460 to 1N4496</td>
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<td>1N4958 to 1N4989</td>
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Hauppauge, Class K Timeline

June-Aug, 2013
- Employees transitioning - Administrative, Sales, Purchasing, Accounting, HR, Engineering.

Oct '13-May ‘14
- Microelectronics manufacturing transition.
- Product validation completed for product lines under ME.
- Customers notified and production begins.
- Hybrid clean room has conditional certification

June ‘14
- DLA Hybrid audit scheduled for Class H and pre-audit review for Class K

Dec ‘14
- Target for Class K facility certification

Q1/2 ‘15
- Target for providing first Class K production
Features:
- Devices are serialized
- Built and screen to space level quality
- Space quality level conformance testing is performed on each lot

<table>
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<tr>
<th>PN</th>
<th>Internal Diode</th>
<th>PIV</th>
<th>I_o</th>
<th>I_{FSM}</th>
<th>IR@V</th>
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<td>SDA1001SS</td>
<td>1N5806</td>
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<td>1.0A</td>
<td>10A</td>
<td>1uA @300</td>
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<td>SDA1002SS</td>
<td>1N6638</td>
<td>150</td>
<td>0.30A</td>
<td>2.5A</td>
<td>35uA @150</td>
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<td>SDA1003SS</td>
<td>1N6642</td>
<td>100</td>
<td>0.16A</td>
<td>2.5A</td>
<td>25uA @100</td>
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<td>1N6642</td>
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<td>0.05A</td>
<td>0.5A</td>
<td>0.05uA @20</td>
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<tr>
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<td>1N6642 (similar)</td>
<td>75</td>
<td>0.05A</td>
<td>0.5A</td>
<td>0.05uA @20</td>
<td>5</td>
</tr>
<tr>
<td>SDA1006SS</td>
<td>1N5615 (similar)</td>
<td>200</td>
<td>0.30A</td>
<td>10A</td>
<td>0.5uA @200</td>
<td>5</td>
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<tr>
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<td>1N5615</td>
<td>400</td>
<td>1.0A</td>
<td>10A</td>
<td>0.5uA @400</td>
<td>-</td>
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</table>
Space Level Diode Arrays (High Density)

Features:
- Devices are serialized
- Built and screen to space level quality
- Space quality level conformance testing is performed on each lot

Part Number: SDA1007SS
- 400V, 1A Offering the smallest package in the industry
- High density, 6.35x6.35mm
- Built and screen to space level quality
- Devices have **Two** serialized diodes in series per leg for **Redundancy**

Part Number: SDA1006SS
- 200V space level diode array
- High density
- Built and screened to space level quality
- Devices are serialized
Space Level TVS Arrays

Features:

- Uni-directional or Bi-Directional
- 500W capability for 8/20 µs repetitive pulses
- 100% electrically tested for clamp performance
- Multichannel hybrid saves board space
- Hermetic through hole package
- Ideal for high speed data lines
- Add Suffix SS for JANS level Screening

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Protection</th>
<th>Peak Pulse Power</th>
<th>Standoff Voltage</th>
<th>Capacitance</th>
<th>Vclamp at</th>
<th>Weight</th>
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<td>STB1001</td>
<td>Bidirectional</td>
<td>500 W</td>
<td>12 V</td>
<td>9 pF</td>
<td>1A, 5A</td>
<td>1 gm</td>
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<td>STB1002</td>
<td>Unidirectional</td>
<td>500 W</td>
<td>24 V</td>
<td>9 pF</td>
<td>1A, 5A</td>
<td>1 gm</td>
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<tr>
<td>STB1003</td>
<td>Unidirectional</td>
<td>500 W</td>
<td>24 V</td>
<td>25 pF</td>
<td>1A, 10A</td>
<td>3 gm</td>
</tr>
</tbody>
</table>

- Protection Level:
  - IEC 61000-4-2 ESD
  - IEC 61000-4-4 EFT
Additional Space Diode Arrays

- Devices Are Serialized
- Built And Screened To Space Level Quality
- Space Quality Level Conformance Testing Is Performed On Each Lot

<table>
<thead>
<tr>
<th>PN</th>
<th>IF</th>
<th>V_{TTRM}</th>
<th>V_{F@IF}</th>
<th>T_{TR}</th>
<th>Cj P_{F}</th>
<th>Ports Protected</th>
<th>IR1 (V_{R@40})</th>
<th>IR2 (V_{R@20})</th>
<th>Configuration</th>
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<tr>
<td>1N5768</td>
<td>0.3A</td>
<td>60V</td>
<td><a href="mailto:1V@.1A">1V@.1A</a></td>
<td>20ns</td>
<td>4</td>
<td>8</td>
<td>.1 uA</td>
<td>Common bus – cathodes only</td>
<td></td>
</tr>
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<td>1N5772</td>
<td>0.3A</td>
<td>60V</td>
<td><a href="mailto:1V@.1A">1V@.1A</a></td>
<td>20ns</td>
<td>8</td>
<td>8</td>
<td>.1 uA</td>
<td>Common buses – pos &amp; neg</td>
<td></td>
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<td>1N5774</td>
<td>0.3A</td>
<td>60V</td>
<td><a href="mailto:1V@.1A">1V@.1A</a></td>
<td>20ns</td>
<td>8</td>
<td>8</td>
<td>.1 uA</td>
<td></td>
<td></td>
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<td>1N6100</td>
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<td>75V</td>
<td><a href="mailto:1V@.1A">1V@.1A</a></td>
<td>10ns</td>
<td>4</td>
<td>7</td>
<td>.1 uA</td>
<td>25nA</td>
<td></td>
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<td>1N6101</td>
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<td>75V</td>
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<td>10ns</td>
<td>4</td>
<td>8</td>
<td>.1 uA</td>
<td>25nA Individual diodes</td>
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<td>1N6506</td>
<td>0.3A</td>
<td>60V</td>
<td><a href="mailto:1V@.3A">1V@.3A</a></td>
<td>20ns</td>
<td>4</td>
<td>8</td>
<td>.1 uA</td>
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<td></td>
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<td>1N6507</td>
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<td>60V</td>
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<td>20ns</td>
<td>8</td>
<td>8</td>
<td>.1 uA</td>
<td></td>
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<td>1N6508</td>
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<td>60V</td>
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<td>20ns</td>
<td>8</td>
<td>8</td>
<td>.1 uA</td>
<td>DIP, Common buses – pos &amp; neg</td>
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<td>1N6509</td>
<td>0.3A</td>
<td>60V</td>
<td><a href="mailto:1V@.3A">1V@.3A</a></td>
<td>20ns</td>
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<td>1N6510</td>
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<td>75V</td>
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<td>10ns</td>
<td>4</td>
<td>8</td>
<td>.1 uA</td>
<td>25nA Individual diodes, V_F matching</td>
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<tr>
<td>1N6511</td>
<td>0.3A</td>
<td>75V</td>
<td><a href="mailto:1V@.3A">1V@.3A</a></td>
<td>10ns</td>
<td>4</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Your Power Solutions Provider
Schottky Rectifier Discretes

Features:
- Available Voltages: 15 to 200V
- Ultra low leakage current for 100 & 150V
- 200°C process
- Low forward voltage drop
- Ceramic feedthroughs standard
- Fast delivery time
- Drop in replacements for industry standard product in any package

Sensitron offers full Space level traceability and serialization.

Your Power Solutions Provider

*Above is only a small selection of space level schottky. Contact factory for additional parts.
3 AMP, RAD HARD, POSITIVE ULTRA-LDO ADJUSTABLE VOLTAGE REGULATOR

- Radiation Environment
  - 100krad(Si)
  - 86MeV-cm²/mg SET/SEL/SEB
- Ultra Low Dropout
  - 65mV typical at 1.0A
  - 225mV typical at 3.0A
- Adjustable Overcurrent
- Stable with 47μF Tantalum Capacitor
12A RAD HARD SYNCHRONOUS BUCK REGULATOR

- 12A output current
- Vin 3V to 5.5V range
- Efficiency > 85%
- Current sharing with 2 devices
- Radiation environment
  - High dose 100krad(Si)
  - ELDRS 100krad(Si)
  - SEL and SEB LET_{TH} 86.4MeV/mg/cm^2
  - SEFI LET_{TH} 43MeV/mg/cm^2
  - SET LET_{TH} 86.4MeV/mg/cm^2
Octal 500 Mbps Bus LVDS Repeater

SRADI1001

Industry Equivalent to UT54LVDM328

- Octal Bus Repeater for Low Voltage Differential Signals (LVDS)
- High Speed Data Transmission for Point-to-Point or Multi-drop Interconnects
- 9 channel LVDS buffer (including Clock) with Tri-State Outputs
- 500.0 Mbps low jitter fully differential data path
- 48 Lead Flatpack

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN</th>
<th>UNIT</th>
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<tbody>
<tr>
<td>TID</td>
<td>300</td>
<td>Krad</td>
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<tr>
<td>SEL</td>
<td>60</td>
<td>MeVcm²/mg</td>
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<tr>
<td>SEE Performance (GEO Orbit)</td>
<td>1.00E-13</td>
<td>Err/Bit/day</td>
</tr>
</tbody>
</table>
Features/Benefits

• Superior thermal performance and high power density
• Flexible design configurations and various power device options
• Best performance/space ratio over competing technologies
• Sophisticated advanced simulation and modeling tools with an R&D team

SENSITRON SEMICONDUCTOR

Hermetic Custom Hybrids

Sensitron is certified to MIL-STD-38534 Class H & can process to Class K

Chip & Wire

• Flexible packaging options
• High electrical conductivity
• Power semiconductor construction capable
• Flexible bare chips and chip parts selection
• Automation friendly

Small Area Devices

• Electrically isolated package
• Flexible bare chip and die selection
• Mechanical strength
• Power semiconductor construction capable
• Automation friendly

Baseless Packaging

• Lower profile and light weight
• Lowest possible thermal resistance
• Higher temperature applications
• Lower cost
• Automation friendly

Integrated Heat Sink Packaging

• High transient power capability
• Very compact package
• Thermal resistivity
• Multiplayer structure capable
• Integrated, cross-hatched heat sink for greater efficiency

Hermetic Power Hybrid Packaging

• Electrically isolated package
• Mechanical strength
• Metal shielding
• Thermal resistivity

Your Power Solutions Provider
## Attribute Comparison by Hybrid Design

<table>
<thead>
<tr>
<th>Description</th>
<th>Baseless</th>
<th>Chip &amp; Wire</th>
<th>Int Heat Sink</th>
<th>Power Hybrid</th>
<th>Small Area Devices</th>
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<td>Multilayer structure capable</td>
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<td>Flexible bare chips selection</td>
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<td>High electrical conductivity</td>
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<td>Power semiconductor construction capable</td>
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<td>Fine line pattern</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dimensional accuracy</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Mechanical strength</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Your Power Solutions Provider
Baseless Packaging Technology

Features/Benefits:
• Lower profile and lightweight
• Lowest possible thermal resistance
• Higher temperature applications
• Removes CTE mismatch between substrate & baseplate
• Higher reliability
• Lower cost
• Automation friendly

Typical Applications
• Aircraft Power Electronics
• Severe Environment
• Weight Sensitive Applications
• Long Cycle Life

Performance Options
• Low cost (Alumina)
• High thermal conductivity (Aluminum Nitride)
• High Strength (Silicon Nitride)

Attribute Comparison by Composition:

<table>
<thead>
<tr>
<th>Thermal Performance</th>
<th>Baseless technology</th>
<th>Copper baseplate</th>
<th>AlSiC baseplate</th>
<th>Aluminum baseplate</th>
<th>IMS technology (Al)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal resistance index</td>
<td>0.4</td>
<td>1.0</td>
<td>1.1</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Max usable temperature</td>
<td>200°C</td>
<td>150°C</td>
<td>150°C</td>
<td>150°C</td>
<td>150°C</td>
</tr>
<tr>
<td>Fatigue resistance</td>
<td>superior</td>
<td>fair</td>
<td>good</td>
<td>poor</td>
<td>excellent</td>
</tr>
<tr>
<td>Flatness (per inch)</td>
<td>&lt;=0.003</td>
<td>&gt;=0.005</td>
<td>N/A**</td>
<td>&gt;= 0.005</td>
<td>&gt;= 0.005</td>
</tr>
<tr>
<td>Cost factor</td>
<td>$</td>
<td>$$$$</td>
<td>$$$</td>
<td>$$</td>
<td>$</td>
</tr>
<tr>
<td>Weight index</td>
<td>0.2</td>
<td>1.0</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Typical package height (for a comparable module)</td>
<td>0.2 inch</td>
<td>0.325 inch</td>
<td>0.37 inch</td>
<td>0.325 inch</td>
<td>0.325 inch</td>
</tr>
</tbody>
</table>

** Bottom surface of AlSiC baseplates is normally designed to have curvature.

Your Power Solutions Provider
# Baseless Packaging Technology

## Baseless Material Options & Performance Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Alumina (Al₂O₃, 96%)</th>
<th>Aluminum Nitride (AlN)</th>
<th>Silicon Nitride (Si₃N₄*)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thermal performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>color</td>
<td>white</td>
<td>gray</td>
<td>pink</td>
</tr>
<tr>
<td>density</td>
<td>3.80 g/cc</td>
<td>3.3 g/cc</td>
<td>3.2 g/cc</td>
</tr>
<tr>
<td>flexural strength</td>
<td>320 MPa</td>
<td>290 Mpa</td>
<td>650 MPa</td>
</tr>
<tr>
<td>elastic modulus</td>
<td>300 GPa</td>
<td>330 GPa</td>
<td>300 GPa</td>
</tr>
<tr>
<td>Fracture toughness</td>
<td>3.5 MPa-m⁰/²</td>
<td>3.5 MPa-m⁰/²</td>
<td>6.7 MPa-m⁰/²</td>
</tr>
<tr>
<td>CTE</td>
<td>6.4 um/m-C</td>
<td>4.7 um/m-C</td>
<td>2.5 um/m-C</td>
</tr>
<tr>
<td>thermal conductivity</td>
<td>25 W/m-K</td>
<td>180 W/m-K</td>
<td>90 W/m-K</td>
</tr>
<tr>
<td>heat capacity</td>
<td>880 J/kg-C</td>
<td>740 J/kg-C</td>
<td>700 J/kg-C</td>
</tr>
</tbody>
</table>
We are pleased to be in Japan and to offer 45 years of heritage as a leading manufacturer of High Reliability Products.

**Japan contacts**

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