Semicoa Product Overview

John Park
President
+1(714)242-3040
jpark@semicoa.com

Tony Kazmakites
Director of Strategic Accounts
+1(914)474-4224
tkazmakites@semicoa.com

Brian P. Triggs Sr.
Director-Rad Hard Program
+1(714)242-3029
btriggs@Semicoa.com

TRANSISTOR HIGHLIGHTS

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- **Rad Hard Products**
  - **Broadest QPL offering (41 transistor part numbers)**
  - **JANTXV and JANS levels**
  - **Our RHA is designed around space program requirements which greatly exceeds MIL-PRF-19500 limits**
  - **Rad Hard By Design (RHBD)**
  - **All products are classified as EAR99 for export!**
- **Fab - Assembly - Test US based for JANS**
- **Overall production capacity has more than doubled**
- **Over 1,100 part numbers on the QPL**
  - **928 packaged parts**
  - **191 die part numbers (HC & KC)**

TRANSISTOR HIGHLIGHTS

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Semicoa's Rad Hard Bipolar Transistor Product Offering

JANS Part Number & Packages	Polarity	Rad Level
2N2218, A, AL	NPN	100 Krad(Si)
2N2219, A, AL	NPN	100 Krad(Si)
2N2221A, AL, AUA, AUB, AUBC	NPN	300 Krad(Si)
2N2222A, AL, AUA, AUB, AUBC	NPN	300 Krad(Si)
2N2369A, AUB, AUBC	NPN	300 Krad(Si)
2N2484, UB, UBC	NPN	300 Krad(Si)
2N2857, UB	NPN	300 Krad(Si)
2N2904A, AL	PNP	300 Krad(Si)
2N2905A, AL	PNP	300 Krad(Si)
2N2906A, AL, AUA, AUB, AUBC	PNP	300 Krad(Si)
2N2907A, AL, AUA, AUB, AUBC	PNP	300 Krad(Si)
2N2919, L, U	NPN	100 Krad(Si)
2N2920, L, U	NPN	100 Krad(Si)
2N2946A	PNP	100 Krad(Si)
2N3019, S	NPN	300 Krad(Si)
2N3057A	NPN	300 Krad(Si)
2N3501, L, UB	NPN	300 Krad(Si)
2N3635, L, UB	PNP	300 Krad(Si)
2N3637, L, UB	PNP	300 Krad(Si)
2N3700, UB	NPN	300 Krad(Si)
2N3735, L	NPN	300 Krad(Si)

JANS Part Number & Packages	Polarity	Rad Level
2N3737, UB	NPN	300 Krad(Si)
2N3810, L, U	PNP	100 Krad(Si)
2N3811, L, U	PNP	100 Krad(Si)
2N3866, A, UB, AUB	NPN	300 Krad(Si)
2N4029	PNP	300 Krad(Si)
2N4033, UB	PNP	300 Krad(Si)
2N4261, UB, UBC	PNP	300 Krad(Si)
2N4449	NPN	300 Krad(Si)
2N4957, UB	PNP	300 Krad(Si)
2N5151, L	PNP	300 Krad(Si)
2N5152, L	NPN	300 Krad(Si)
2N5153, L	PNP	300 Krad(Si)
2N5154, L	NPN	300 Krad(Si)
2N5794UC, AUC	NPN	300 Krad(Si)
2N6193	PNP	300 Krad(Si)
2N6987	PNP	300 Krad(Si)
2N6988	PNP	300 Krad(Si)
2N6989	NPN	100 Krad(Si)
2N6990	NPN	100 Krad(Si)
2N918, UB	NPN	300 Krad(Si)

All devices available in JANTXV and JANS plus Radiation Hardness

Semicoa has the Broadest Rad Hard Product Offering on MIL-PRF-19500!

MISSION-RISK-COST TRADESPACE

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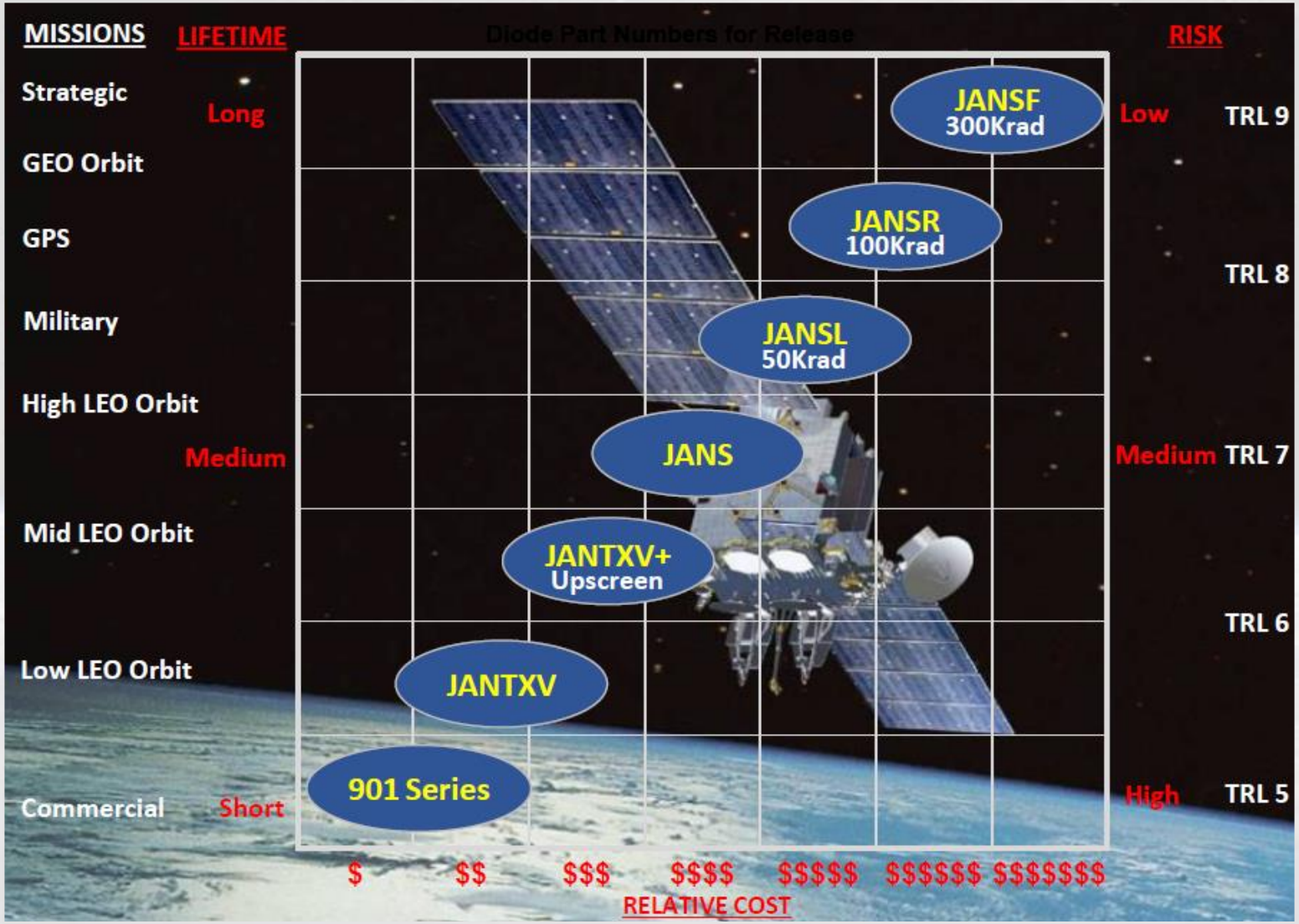

TRANSISTOR HIGHLIGHTS

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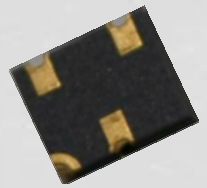
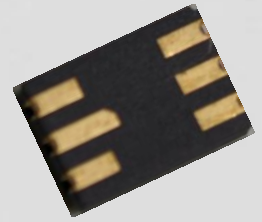
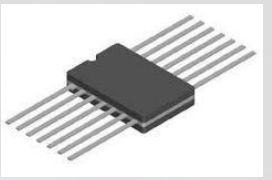
- Through Hole, Surface Mount, and Bare Die Options
- Solutions for Legacy components
- Custom Design Products
- Radiation Qualification
- Industry Benchmark Radiation Hardness Assured (RHA) Program

SEMICOA'S RHA PROGRAM

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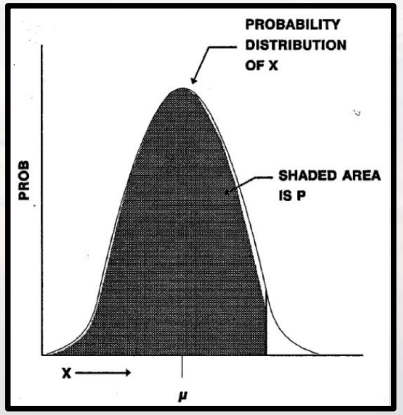
TABLE E-VIII. Group D inspection (RHA inspections)				
Test	MIL-STD-750		JANS	JANTXV
	Method	Condition	Quantity (Accept Number)	Quantity (Accept Number)
Subgroup 2				
Steady-state total dose irradiation	1019	+25°C		
Conformance inspection			4(0) 2(0) 1(0)	11(0)
End-point electrical parameters		As specified in accordance with specification sheet		

Test 11 samples per wafer for all RHA Product!

Acceptance based on 0.99/90% statistics for endpoints and deltas

Group D endpoints plus

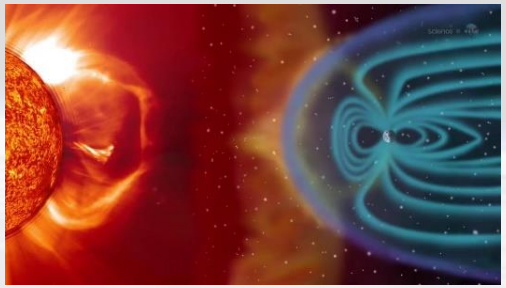
$$\Delta P = P_{PostRad} - P_{PreRad}$$



RHBD TRANSISTORS

- **Radiation Hardened By Design (RHBD)**
  - Standard Technology modified to improve radiation performance
- **Optimized for Total Dose Hardness including LDR**
  - Minimize amount of trapped charge and reduce the impact of that charge on the junction performance
  - Radiation performance 10X better than standard technology
  - No impact on Displacement Damage performance
- **RHBD Product Features**
  - Common Die layout as Standard Technology
  - Qualified to the same slash sheet as Standard Technology
  - No enhancement for Low Dose Rate @10 mrad/s

Space qualified, Space heritage, Trusted Everywhere for Mission Success



LDR QUALIFIED TRANSISTORS

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- **JANTXV + RHA, JANS + RHA**
- **Tested to Low Dose Rate (LDR)**
  - **Every wafer/lot qualified**
  - **10/30/50/100 Krad, higher if needed**
  - **10 or 100 mrad(Si)**
  - **11 biased & 11 unbiased**
  - **Room & High Temperature Anneal**
  - **Group D parameters and conditions**
  - **Customer options can be added**
- **Marked with MIL-PRF-19500 or SCD part number**
- **Available for the entire product line**

EUROPA CLIPPER PARTS

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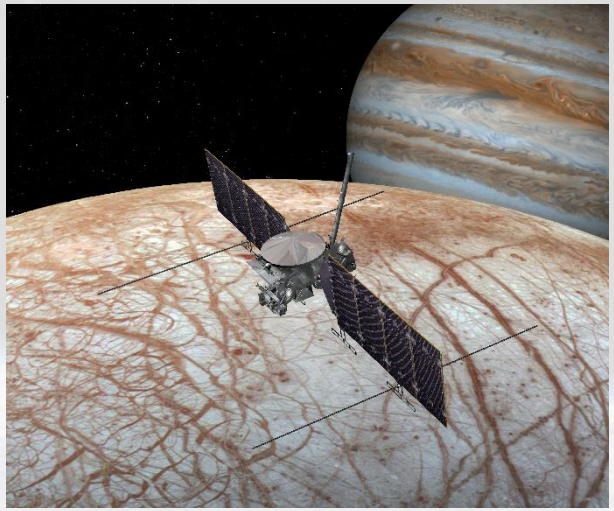
- Nasa Mission to Europa a moon of Jupiter
- Significant radiation challenge
- Semicoa RHBD utilized for bipolar transistors based on radiation performance (HDR and LDR)
  - 2N2222AUB, 2N2369AUB, 2N2484AUB, 2N2907AUB, 2N3501UB, 2N3637UB, 2N4261UB
- Tested to the Mission Requirements
  - HDR tested to 300 Krad (JANSF)
  - LDR tested to 100 Krad at 10 mrad/s and then 45 mrad/s up to 300 Krad
  - Dose end points: 10, 30, 50, 100, 150, 200, 225, 250, 275, 300 Krad
  - Annealing after radiation for 168 hours at room temperature
  - 11 samples biased at 80% VCEO and 11 samples with no bias
  - Parameters and Conditions are MIL-PRF-19500 Slash Sheet and ESCC Detail Specifications (where application for Rad Hard parts)
- Parts marked as MIL-PRF-19500 JANSF with LDR C of C
- Semicoa holds qualified wafers for all program contractors



LARGE CONSTELLATION SPACE

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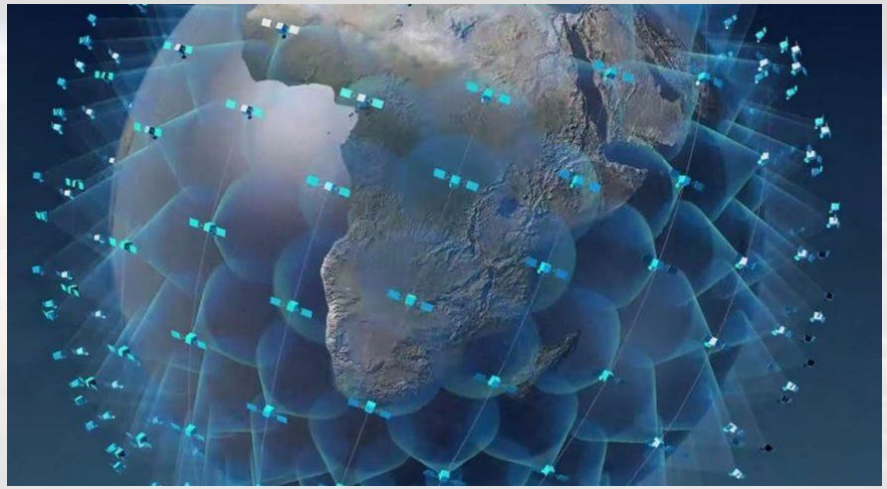
901 Series

- Low Cost option targeted for High Volume Large Constellation/Commercial Space applications
- Surface mount package and through hole packages available
- Wafer fabrication flow identical to JANS wafers using same JANS wafer fab
- Wafers selected based on sample evaluation which includes DC, AC electrical characterization, HTRB, Burn-In, High Temperature Life, and Steady State Operational Life tests
- Assembled in QML Certified Production facility in Hermetic Packaging
- Packaged devices tested for DC parameters with high and low temperature screening
- Laser marked (no serialization)
- Product family certified as radiation tolerant to 30 krad low dose rate total dose based upon years of historical data



LARGE CONSTELLATION SPACE

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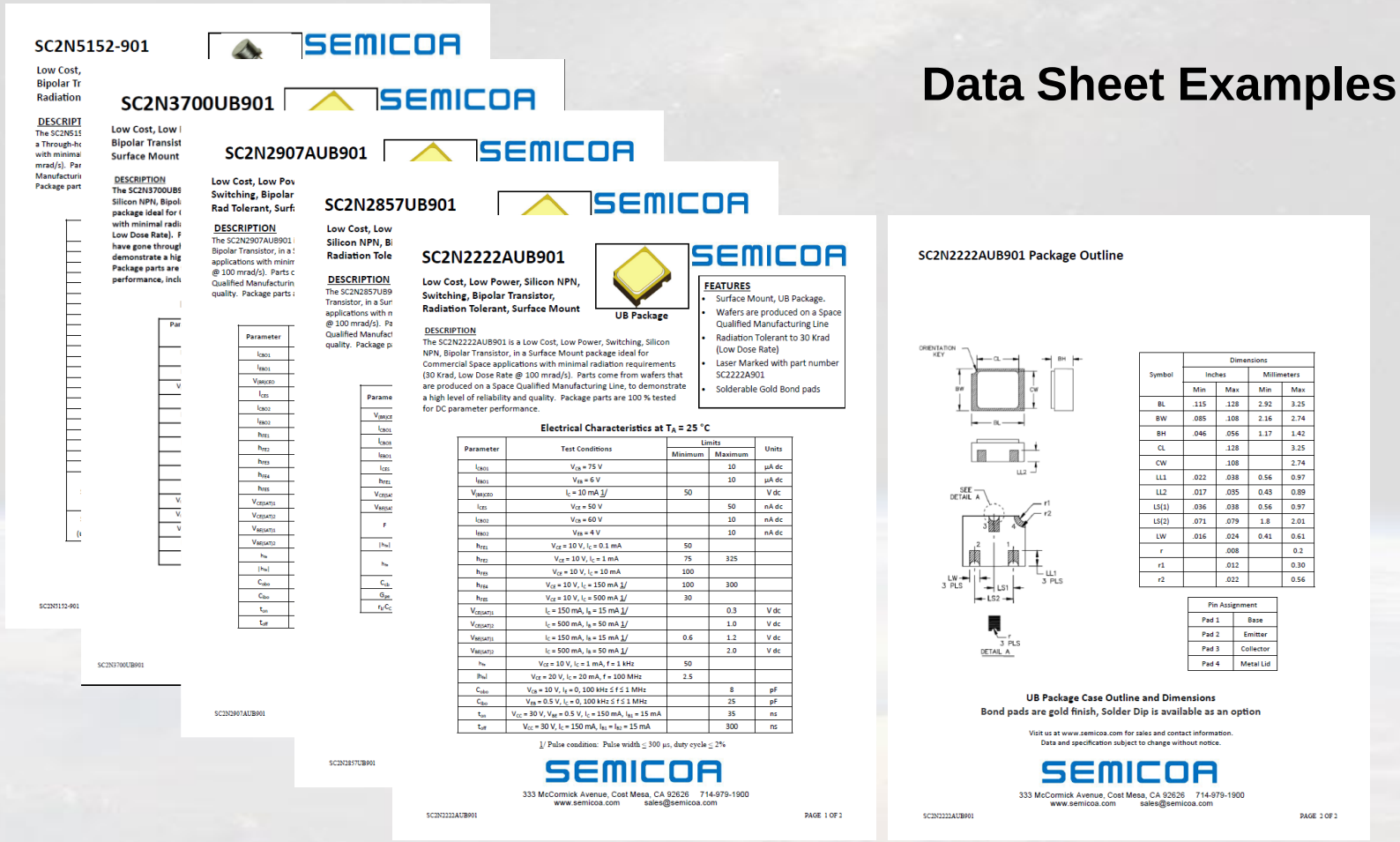
Data Sheet Examples



901 Series Space Product Flow

WAFER QUALIFICATION

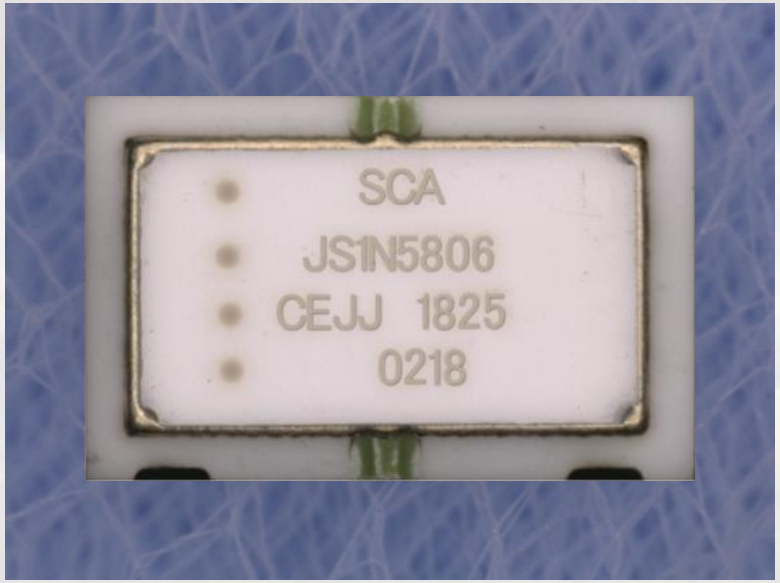
WAFER QUALIFICATION PROCESS FLOW
Wafer Production
Class Probe
Pull samples from each Wafer
Die Visual Inspection
Die Attach
Wire Bond
Internal Visual
Capping
Laser Mark
DC Electrical Test
AC Electrical Test
High Temperature Reverse Bias
DC Electrical Test
Burn-In
DC Electrical Test
High Temperature Life
DC Electrical Test
Steady State Operation Life
DC Electrical Test
Engineering Review and Approval

ASSEMBLY AND TEST FLOW
Wafer Selection
Wafer Saw
Die Visual Inspection
Die Attach
Wire Bond
Internal Visual Inspection
Pre-Moisture Bake
Thermal Vacuum Bake
Lid Seal
Visual Inspection
Stabilization Bake
Laser Mark
DC Electrical Test (100%)
Sample AC Electrical Test (45/0 or 90/1)
Sample Burn In (45/0 or 90/1)
Sample High & Low Temperature Test (45/0 or 90/1)
Sample DC Electrical Test (45/0 or 90/1)
Engineering Review
Packing for Shipment

DEVICE QUALIFICATION

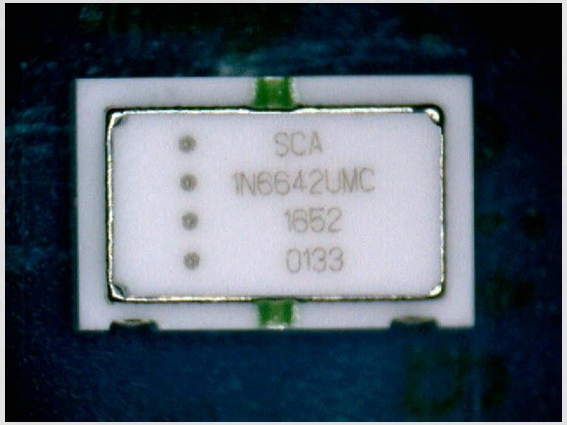
SEMICOA INNOVATION - GLASSLESS DIODE PACKAGE

- **Semicoa revolutionizes Diode packages for Space !!!**
- **Semicoa ceramic UMC package is now JANS QPL available for the /477 family of ultrafast rectifiers: 1N5802/1N5804/1N5806**
- **HC and KC die QPL available: 1N5614, 1N5615, 1N5802, 1N5804, 1N5806**
- **Product samples available for customer qualifications**



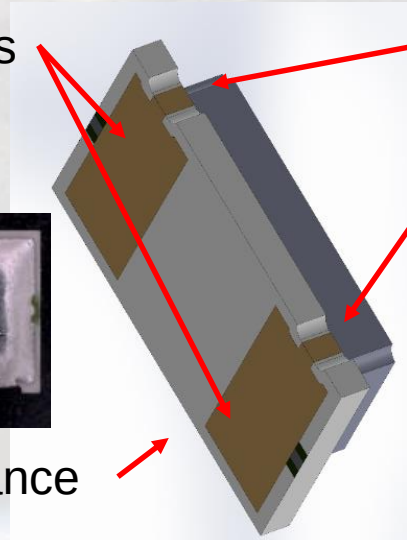
UMC PACKAGE KEY FEATURES

Semicoa research resulted in a design driven by the customer



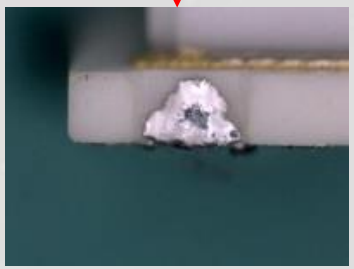
Gold pads

Solderable



Castellations

Verification of good solder flow

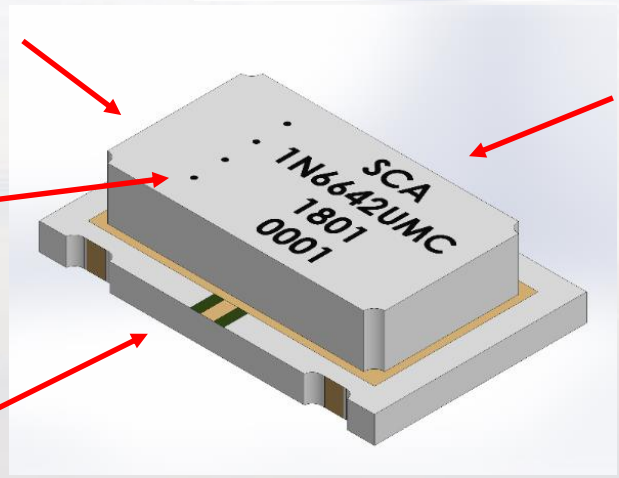


Low Thermal Resistance

Ceramic lid, no floating metal

Cathode marking

Reduced Hydrogen RGA



Laser mark:
Part number
Date code
Serial number

DIODE PRODUCT ROAD MAP

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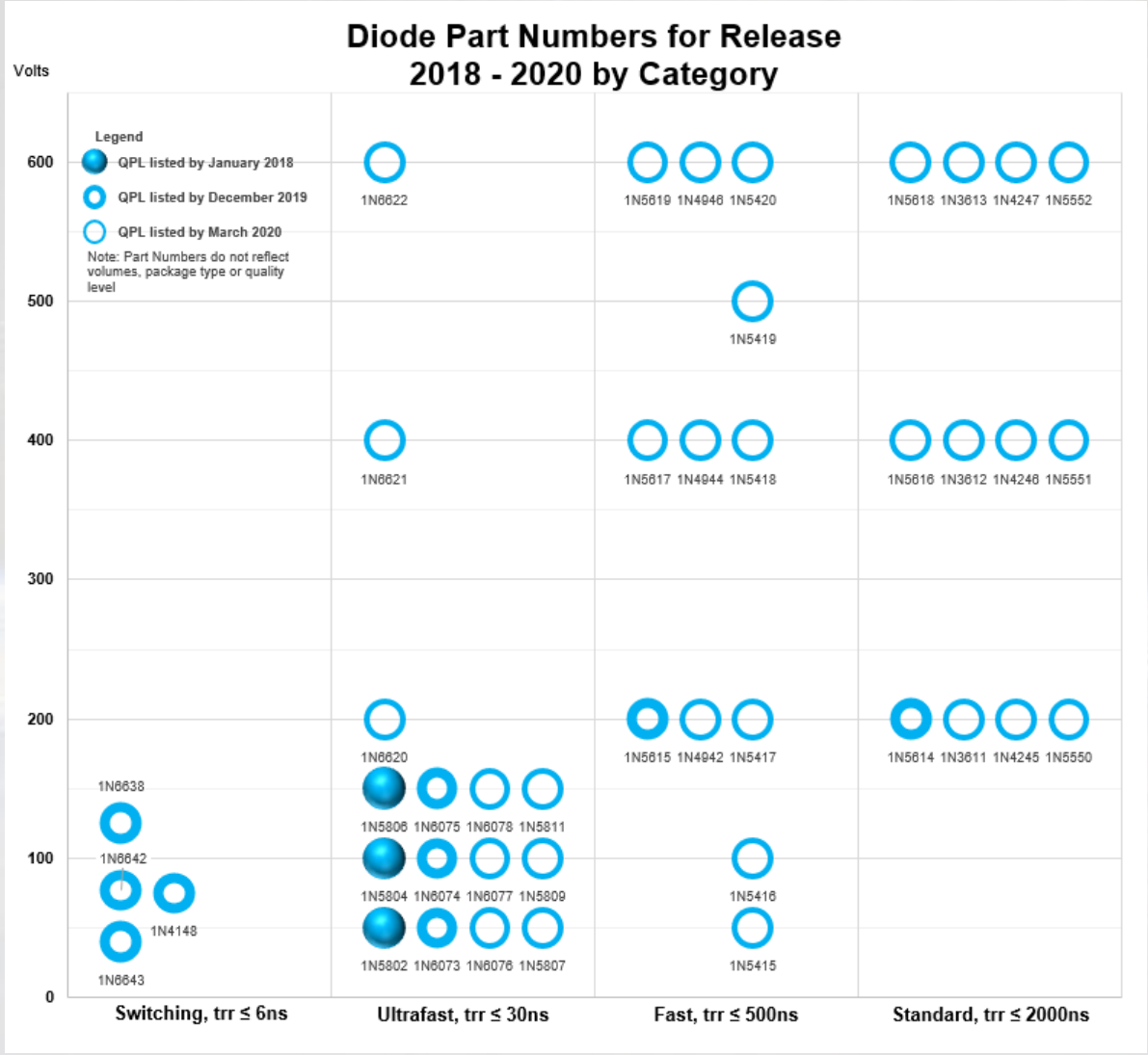
ALL JANS QUALIFIED



DRIVEN BY PROGRAM DEMAND

FAQ's & SHIPPING OPTIONS

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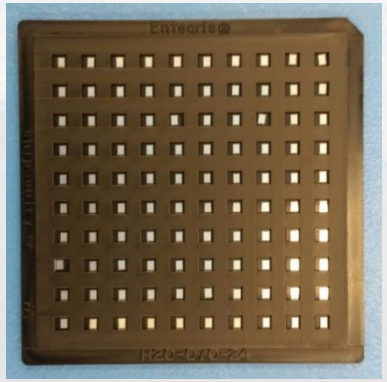
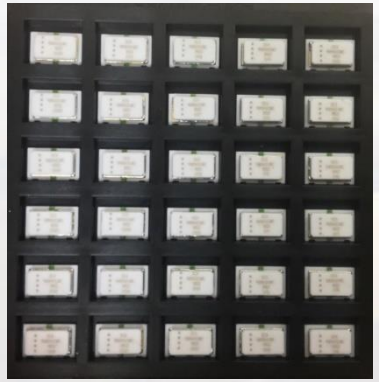
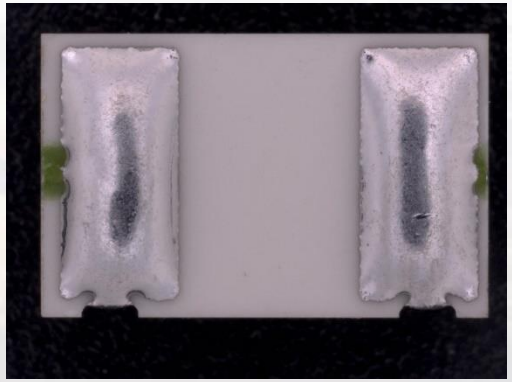
- Semicoa proven construction methods used to assemble these packages
- Laser marked with serial number- NO EXTRA CHARGE!
- Fine and Gross Leak, Red Dye, RGA - NO PROBLEM!!!
- Semicoa is giving you more choices by adding the UMC package to existing DLA Slash Sheets
- HC & KC Die form available in waffle pack
- Tape and Reel option for packaged devices
- Solder Dip option complying to Semicoa most stringent standards



Die in waffle pack



Packages in waffle pack



Solder dipped option

THANK YOU!!!

333 McCormick Avenue
Costa Mesa, CA 92626

Tony Kazmakites
Director of Strategic Accounts
+1(914)474-4224
tkazmakites@semicoa.com

Protec GmbH
High-Rel Electronic Components
Rosenheimer Landstraße 117
D-85521 Ottobrunn-Riemerling

Phone:+49 (0)89 660292-3
Fax:+49 (0)89 660292-50
eMail: sales@protec-semi.com

COMPARISON OF PRODUCT FLOWS

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SMALLSAT "901" Series
LASER MARK NO SERIAL NUMBER (100%)
DC ELECTRICAL TEST OF LOT (100%)
AC TEST (N=45/0, 90/1)
BURN IN (48 HRS, TJ=135°C) (N=45/0, 90/1)
HI/LOW TEMPERATURE TEST (N=45/0, 90/1)
DC ELECTRICAL (N=45/0, 90/1)
ENGINEERING REVIEW
SHIP

901 Wafers are the same as JANS qualified products!

MIL-PRF-19500 JANTXV	
LASER MARK NO SERIAL NUMBER (100%)	SNAP & BREAK
EXTERNAL V & M LASER DEFECTS ONLY (N=22, C=0)	GROSS LEAK (100%)
X-RAY LASER DEFECTS ONLY (N=22, C=0)	FINE LEAK (100%)
GROSS LEAK (N=22, C=0)	RED DYE (100%)
FINE LEAK (N=22, C=0)	FINAL ELECTRICAL (N=116, C=0, GO/NO GO) (IF C>0, 100%)
RED DYE (N=22, C=0)	GROUP A1 (N=116, C=0)
FIRST ELECTRICAL (N=200, PDA<3%, READ & RECORD) (100%, GO/NO GO, PDA>3%)	GROUP A2-DC (N=116, C=0, READ & RECORD)
TEMPERATURE CYCLE (100%, -55°C, +175°C, 20 CYCLES)	GROUP A3-TEMP (N=116, C=0, READ & RECORD)
HTRB (100%, 48 HRS, +150°C)	DC ELECTRICAL, END POINTS (N=116, C=0, GO/NO GO)
PRE-BURN IN ELECTRICAL TEST (100%, READ & RECORD)	GROUP A4-AC (N=116, C=0, READ & RECORD)
PDA (ACCPT<10%)	DC ELECTRICAL, END POINTS (N=116, C=0, GO/NO GO)
BURN-IN (100%, 160 HRS, TJ=135°C)	RGA
POST-BURN-IN ELECTRICAL TEST (100%, READ & RECORD)	GROUP B
DELTA ANALYSIS	GROUP C
PDA (ACCPT<10%)	GROUP D-RADIATION (A/R) JANTXV ONLY
3-SIGMA ANALYSIS	GROUP E (QUAL/REQUAL)
	FINAL INSPECTION
	SHIP

MIL-PRF-19500 JANS	
FIRST ELECTRICAL (100%, GO/NO GO)	SOLDERABILITY TEST (N=15, C=0)
LASER MARK W/SERIAL NUMBER (100%)	GROSS LEAK (100%)
TEMPERATURE CYCLE (100%, -55°C, +175°C, 20 CYCLES)	FINE LEAK (100%)
PRE-HTRB ELECTRICAL TEST (100%, READ & RECORD)	RED DYE (100%)
HTRB (100%, 48 HRS, +150°C)	X-RAY (100%)
POST-HTRB ELECTRICAL TEST (100%, READ & RECORD)	ANNEAL 24 HOURS, 200°C
DELTA ANALYSIS	DC ELECTRICAL (100%, C=0, READ & RECORD)
PDA (ACCPT<5%)	EXTERNAL VISUAL & MECHANICAL (100%)
BURN-IN (100%, 240 HRS, TJ=135°C)	GROUP A1 (N=15, C=0)
POST-BURN-IN ELECTRICAL TEST (100%, READ & RECORD)	GROUP A2-DC (N=116, C=0, READ & RECORD)
DELTA ANALYSIS	GROUP A3-TEMP (N=116, C=0, READ & RECORD)
PDA (ACCPT<5%)	DC ELECTRICAL, END POINTS (N=116, C=0, READ & RECORD)
3-SIGMA ANALYSIS	GROUP A4-AC (N=116, C=0, READ & RECORD)
TEMPERATURE TEST (100%, READ & RECORD)	END POINTS/DC ELECTRICAL (N=116, C=0, READ & RECORD)
END POINTS/DC ELECTRICAL (100%, GO/NO GO)	RGA
SNAP & BREAK	GROUP B
CONSTANT ACCELERATION (100%, Y1, 20KG's)	GROUP C
PIND (100%)	GROUP D-RADIATION (A/R)
	GROUP E (QUAL/REQUAL)
	FINAL INSPECTION
	SHIP