

Microsemi Leadership in Discrete Products for Space Applications

Microsemi Space Forum Russia – November 2013

Ronan Dillon
Director of Technology, HiRel Products Group

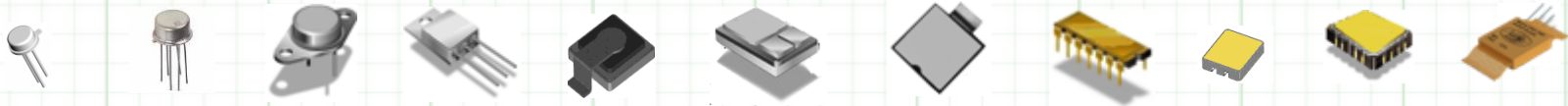


The Industry's Widest Range Of Hi-Rel Components & Circuits

Avionics / Military / Space/ Extreme Env. Products



- **SIGNAL / ZENER DIODES**
- **SCRs / THYRISTORS**
- **DIE & CHIP**
- **SCHOTTKY DIODES**
- **TRANSISTORS**
- **HERMETIC PACKAGES**
- **IGBTs**
- **TVS / TSPD ARRAYS**
- **JAN, JANTX, JANTXV, JANS**
- **MILMOSFETs**
- **HIREL NON-HERMETIC/PLASTICS**
- **RAD HARD MOSFET & BJT**
- **RECTIFIERS**
- **MODULES**
- **CUSTOM**



Hybrids & Power Solutions

- **POINT-OF-LOAD SWITCHERS (POL)**
- **LINEAR REGULATORS (ULDO)**
- **SOLID STATE RELAYS { 2014 }**
- **CUSTOM**



**SiC* Diodes
&
GaN* FET**

* Limited sample quantity

HiRel Group (HRG) Products – Value Proposition

- Over **50 years of heritage** servicing defence and space markets with Hi-Rel components.
- **First company** to have parts **qualified to space level** (JANS qualification) by the US defence procurement team (DLA, formerly DSCC) and still a dominant player with 62% QPL listing.
- Widest product portfolio
 - Leadership role in QML/QPL : **59%** of total listing
- Proven abilities in unique packaging, custom designs and hybrid power solutions.
- Comprehensive HiRel Up-Screened Plastic/Non-hermetic Product Portfolio
- We **seldom obsolete** Hi-Rel Components.
- **Highest Quality Standards** - AS9100 / ISO9001, MIL-PRF-38534, MIL-PRF-19500, LEAN
- Continue to lead through technological innovation
 - Offer system solutions by leveraging breadth of technology and core strength.
 - Adopting new technologies and developing innovative products to meet our customers' needs today's and tomorrow



HiRel Group (HRG) Facility locations

LAWRENCE, MA (HQ):

- Facility Square Footage
 - 160,000 square feet
- 4 floors – 40,000 sq ft per floor



HRG HQ , Fab, Assembly, new technologies, ITAR products

ENNIS, IRELAND:

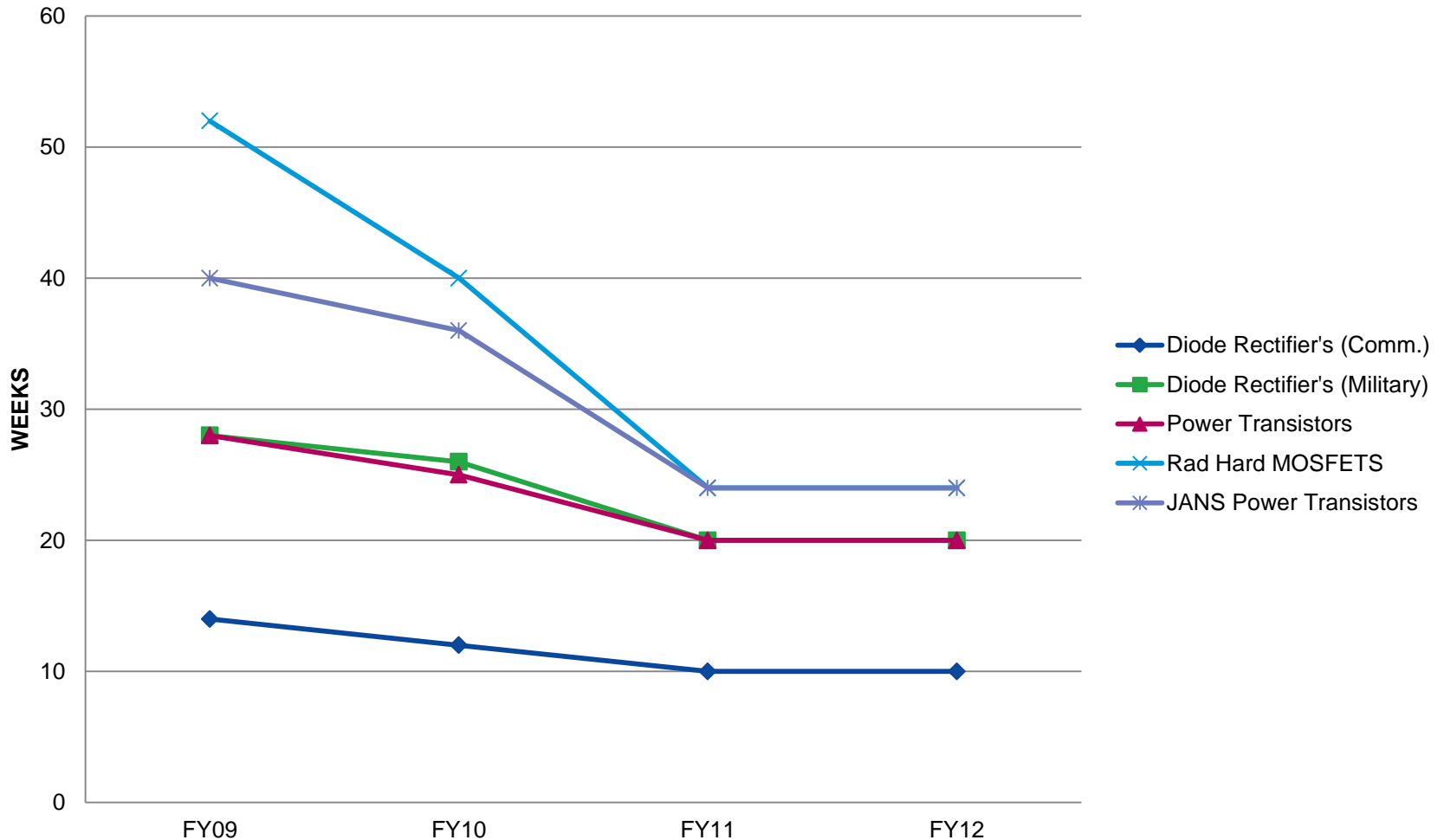
- Facility Square Footage
 - 100,000 square feet
- 2 floors



Test , Verification, screening,
Shipping

Lead Time Reduction

LEAD TIME REDUCTION



HRG - New Technology Roadmap

HIGH TEMPERATURE HERMETIC PRODUCTS

> 200⁰C & <= 300⁰ C, discretes and modules

RADIATION HARD & RADIATION TOLERANT PRODUCTS

Rad-hard Si, SiC, & GaN discretes & hybrid modules

HERMETIC PRODUCTS

New products, unique packaging, leadership in QML

UPSCREENED & HI-REL NON-HERMETIC

TVS with multi-stroke protection (RTCA DO-160E), Schottkys

HiRel Group Product Lines

Hermetic Products



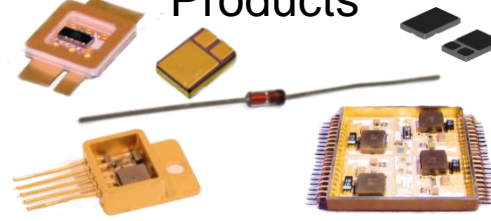
Ronan Dillon

rdillon@microsemi.com

+353 87 232 7242

(based in Ennis, Ireland)

RAD Hard and Hybrid Products



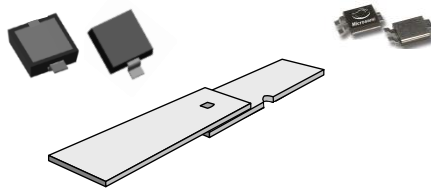
Al Ortega

Al.ortega@microsemi.com

+1 508 365 7874

(based in MA, USA)

Non-Hermetic Products



Ciara O'Regan (formerly O'Callaghan)

ciara.oregan@microsemi.com

+353 86 044 1586

(based in Ennis, Ireland)

Extreme Environment Products



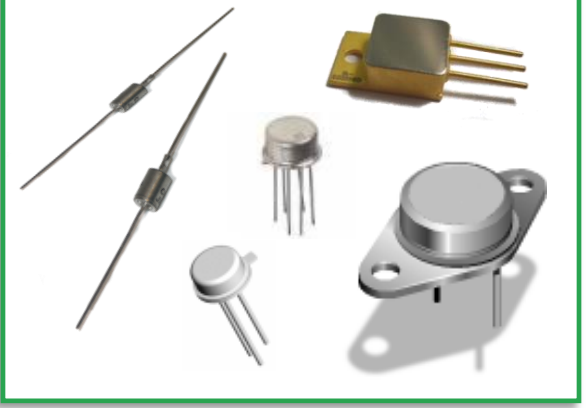
Paul Ellerman

pellerman@microsemi.com

+1 480 290 4475

(based in AZ, USA)

Hermetic Products



Hermetic Products (HDP)

Ronan Dillon

rdillon@microsemi.com

+353 87 232 7242

(based in Ennis, Ireland)

Hermetic Products (HDP)

Product Families

- Diodes
 - Rectifiers
 - High Voltage Rectifiers
 - Fast Recovery
 - Ultrafast Recovery
 - Transient Voltage Suppressors (TVS)
 - Zener
 - Schottky

- Transistors
 - MOSFETs
 - BiPOLARs

- Modules
 - Single phase and three phase bridge rectifiers

**Microsemi Leadership Role in today's
DLA, Land and Maritime's QML**

*Qualified up to JANS
levels per
MIL-PRF-19500*



DEFENSE LOGISTICS AGENCY
AMERICA'S COMBAT LOGISTICS SUPPORT AGENCY

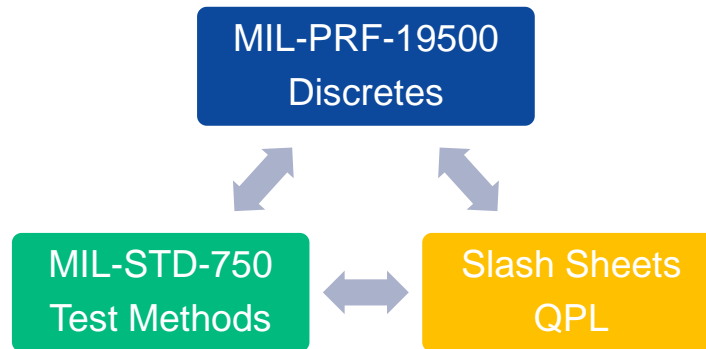
Defense Supply Center Columbus
Taking the Lead in Land and Maritime Support



■ What is DLA Land and Maritime and DSCC ?

- DLA – Defense Logistic Agency
- DSCC - Defence Supply Centre, Columbus
- DLA is formerly known as DSCC , based in Columbus Ohio
- Part of US Department of Defense (DoD)
- One of the largest suppliers of weapons systems spare parts & components.
- Consists of a number of organisations – test, procurement etc..
- Specific mission of the DLA Sourcing and Qualifications Unit (DSCC-VQ) centers around establishing and maintaining a known-good supplier base that have successfully demonstrated their products meet the specified performance, quality, and reliability levels via the DoD product Qualification program.
 - QML : Qualified Manufacturing List
 - QPL : Qualified Product List

MIL Specifications for Discrete



- **MIL-PRF-19500**: Specification establishes the general performance requirements for discrete semiconductor devices.
 - Quality levels for encapsulated devices are by the prefixes
 - JAN** - Joint Army-Navy ; **JANTX** - Joint Army-Navy with eXtra Testing
 - JANTXV** - JANTX with Visual inspection ; **JANS** - Joint Army-Navy-space
 - JANS has 8 radiation hardness assurance (RHA) levels (M, D, P, L, R, F, G and H).
 - 2 Quality levels for unencapsulated devices (die)- JANHC and JANKC.
- **MIL-STD-750** : Uniform test methods including basic environmental tests and conditions surrounding military operations, and physical and electrical tests.
- **Slash Sheets** : Specifications for individual devices. Similar to a data sheet.
 - Example Slash Sheet: MIL-PRF-19500 / **123**

<http://www.dla.mil/Pages/default.aspx>

Quality Levels

- Screening of product
 - Remove early life failures (bath tub curve)
 - Remove possible latent failure modes
 - Environmental, mechanical and electrical stress testing is used

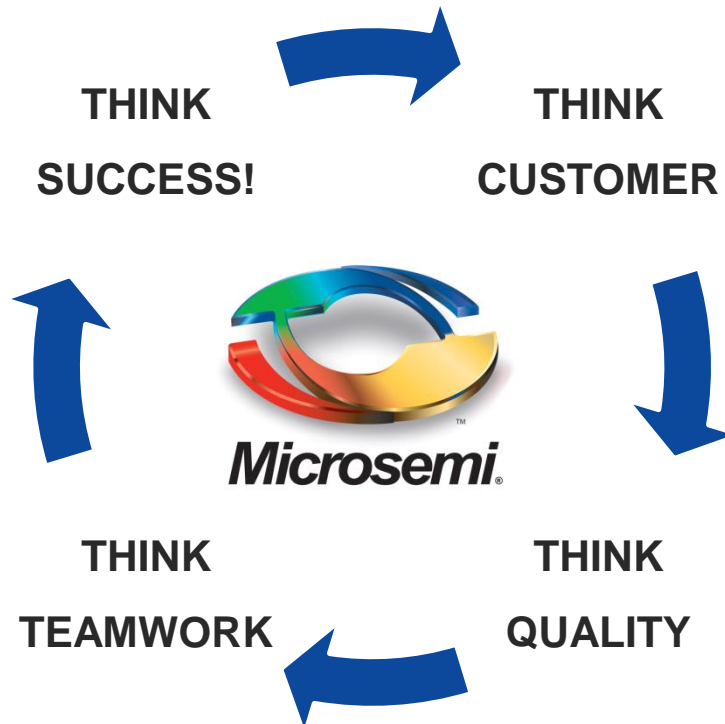
- Conformance/Lot Acceptance Testing
 - Sample testing to ensure lot 'conforms' to specification
 - Confidence that product is highly reliable

Quality Levels

Process Step		Quality Level				
Per MIL-PRF-19500, Appendix E	MIL-STD-750, TM	Commerical	JAN	JANTX	JANTXV	JANS
Wafer Fabrication			Approved Facility	Approved Facility	Approved Facility	Approved Facility
Die Visual	2073					100%
Assembly			Approved Facility	Approved Facility	Approved Facility	Approved Facility
Eng Lot Release			Sample	Sample	Sample	Sample
Stabisation Bake	1032		Optional	Optional	Optional	100%
Temp Cycle	1051		100%	100%	100%	100%
Thermal Impedance/First Test	3101/Various	100%	100%	100%	100%	100%
Internal Visual	2074				100%	100%
Tin/lead Plate						At this stage
Marking						At this stage
Dimensions						
Serialisation						100%
Read and Record	Various			100% (Bin & Cell)	100% (Bin & Cell)	100%
HTRB - 48 hours	1038A			100%	100%	100%
Read and Record	Various			100% (Bin & Cell)	100% (Bin & Cell)	100%
Burn-in	1038B			100% (96 hours)	100% (96 hours)	100% (240 hours)
Read and Record	Various			100% (Bin & Cell)	100% (Bin & Cell)	100%
Hot and Cold Test	Various					100%
Tin/lead Plate		At this stage	At this stage	At this stage	At this stage	
Marking		At this stage	At this stage	At this stage	At this stage	
Hot Solder Dip						
Scope Display	4023		100%	100%	100%	100%
Go No Go Test						100%
Radiography	2076					100%
External Visual	2071					100%
Pack		100%	100%	100%	100%	100%
FQA		100%	100%	100%	100%	100%
Conformance - Group A	Various		Sample	Sample	Sample	Sample
Conformance - Group B - JAN	Various		Sample	Sample	Sample	
Conformance - Group B - JANS	Various					Sample
Conformance - Group C	Various		Sample	Sample	Sample	Sample

Notes : This table is for reference only - some process steps are not included such as lead attach etc..

HRG Quality System



- **MIL-PRF-19500**
JAN / TX / TXV / JANS
certified manufacturer
- **MIL-PRF-38534**
JANHC / JANKC
certified manufacturer
- **AS9100 / ISO9001**
certified manufacturer

Broadest QPL portfolio

- Microsemi provides over 59 percent of QPL/QML part types than all other suppliers combined.
- 220 Slash sheets
 - Over 30% increase since 2005
- Over 8000 QPL / QML listings
- Over 1900 JANS Qualified parts
- New product development efforts remain very active
- Wide portfolio of [Sole Source products](#)



Hermetic Products

HERMETIC GLASS PACKAGES



Package	Current rating (A)	Power Rating (W)
	Rectifier	Zener
A	1	1
B	3	5
C	12-20	1500 (TVS)
D	0.5	0.5



MELF
(Surface Mount)
Size: A/B/C/D



AXIAL
(Through-hole)
Size: A/B/C/D

Hermetic Products

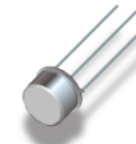
METAL CAN THRU-HOLE PACKAGES



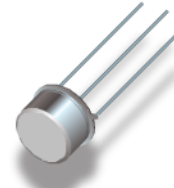
Various power and current ratings available depending on die size



TO-46



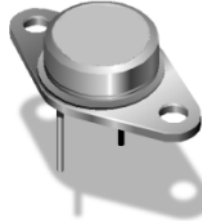
TO-18



T-39 / TO-5



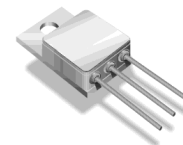
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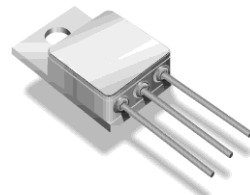
TO-3



DO-13



TO-254



TO-257 AA

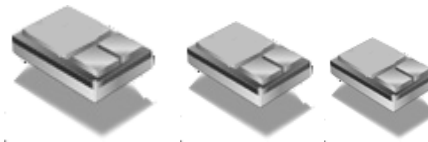


DO-4 / 5

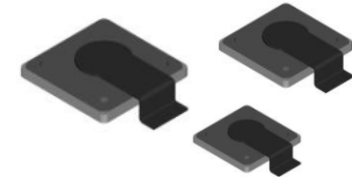
Hermetic Products

SURFACE MOUNT PACKAGES

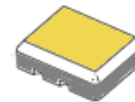
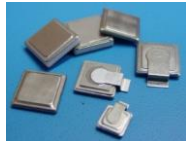
Package	Current Rating (A)
SMD-2.0	75
SMD-1.0	35
SMD-0.5	15
SMD-0.22	3
ThinKey™ 1	100
ThinKey™ 2	25
ThinKey™ 3	150
ThinKey™ 4	75
SLUGGER	50
3/4/6 PIN LLC	--
18 PIN LLC	--



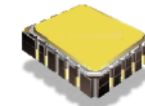
SMD 2 / 1 / 0.5 / 0.22



ThinKey™ 1 / 2 / 3 / 4



3 / 4 / 6 PIN LCC(UA / UB / U)

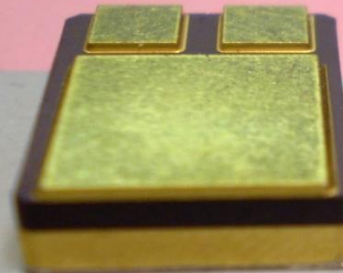


18 PIN LCC

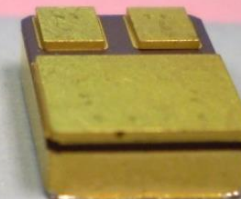


SLUGGER

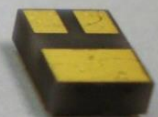
U1 Package (SMD1.0)
.625" x .450"



U3 Package (SMD.5)
.400" x .300"



U4 Package (SMD.22)
.220" x .150"



Hermetic Products

Qualified Parts List Search Engine

The QPL Database Engine

KEY to knowing and finding all
MSC Military QPL Products



- Extensive QPL Database with Specs
- Powerful Search, Sort and Filter Capability
- Hot Links to Spec Sheets, Packages, etc.
- Contacts (USA and European Sales and FAE's)
- Application Notes Links
- Links to Packages
- Designed to Benefit Everyone

Developed by Ray DiBugnara, Microsemi, Lawrence, MA USA

Hermetic Products

Qualified Parts List Search Engine

- To retrieve the zipped copy (about 6500k) click the link below and choose the “Save” option:
- [Master Plus MSC QPL Engine.zip](#)
- If your mail service happens to delete hyperlinks, copy the http line below, paste it into your browser and hit "Enter"...
- http://www.msc-l.com/fyi/qplpxv/master_plus_msc_qpl_engine.zip
- **Remember to enable Macros in Excel.** Unlike Office 2003, Office 2007 and Office 2010 force you to select the menu to re-enable macros each time you open this file. However, if you do not wish to keep enabling Macros in either Excel 2007 or Excel 2010, then place the Master Plus MSC QPL Engine into a special folder and when you open it with Excel, go to the options and set that folder as a Trusted Source. Anything and everything in that folder with macros will then open with no questions. Don't select "My Documents" or the "Desktop" as "Trusted" since that is too broad a net any you might accidentally catch a "scorpion".
- Master Plus MSC QPL Engine is Office 2007 and Office 2010 compatible although Office 2007 may occasionally (and randomly) resize some graphic objects such as a map or text in a text box. Harmless but irritating.

Hermetic Products

PUSH Products- MILMOS

➤ **MIL MOSFETS- QPL / Hermetic products include**

JAN2N, JANTX2N, JANTXV2N AND JANS2N prefixes and all SCD's sourced from them where there is no Radiation Hardness Assurance (RHA) level indicator character contained in the Part Number.

Does not include RADHARD MOSFETS

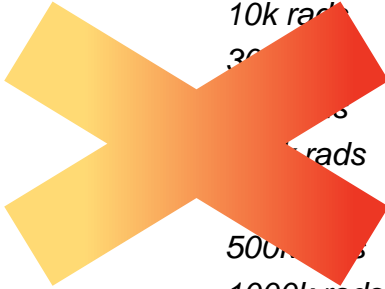
MIL MOSFETs

- JAN2Nxxxx
- JANTX2Nxxxx
- JANTXV2Nxxxx
- JANS2Nxxxx
- *All SCDs derived from the above*

Rad Hard MOSFETs

- **JANSy2Nxxxx**

RHA character (y)	Total Ionizing Dose Level
M	3k rads
D	10k rads
P	30k rads
L	100k rads
R	300k rads
F	500k rads
G	1000k rads
H	

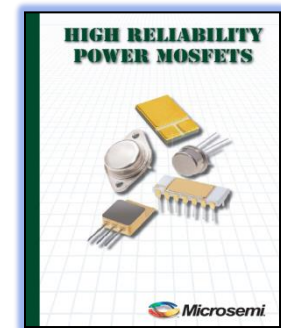


Hermetic Products

PUSH Products- MILMOS

- Our products are drop in replacement to IR.
 - No design change needed. Same technical specs /Slash sheet.
- Collateral
 - Cross reference to IR products & Product Catalog

IR cross reference	Part Number	Qual Level	IR cross reference	Part Number	Qual Level
IRF350	2N6768	JXV	IRFN250	2N7225U	JXV
IRF350	2N6768T1	JXV	IRF150	2N6764	JXV
IRF450	2N6770	JXV	IRF150	2N6764T1	JXV
IRF450	2N6770T1	JXV	IRFF110	2N6782	JXV
IRFF330	2N6800	JXV	IRFE110	2N6782U	JXV
IRFE330	2N6800U	JXV	IRFF210	2N6784	JXV
IRFF430	2N6802	JXV	IRFE210	2N6784U	JXV
IRFE430	2N6802U	JXV	IRFF120	2N6788	JXV
IRFM350	2N7227	JXV	IRFE120	2N6788U	JXV
IRFN350	2N7227U	JXV	IRFF220	2N6790	JXV
IRFM450	2N7228	JXV	IRFE220	2N6790U	JXV
IRFN450	2N7228U	JXV	IRFF130	2N6796	JXV
IRF330	2N6760	JXV	IRFE130	2N6796U	JXV
IRF430	2N6762	JXV	IRFF230	2N6798	JXVS
IRF130	2N6756	JXV	IRFE230	2N6798U	JXV
IRF230	2N6758	JXV	IRF9130	2N6804	JXV
IRF250	2N6766	JXV	IRFF9130	2N6849	JXV, HC
IRF250	2N6766T1	JXV	IRFE9130	2N6849U	JXV
IRFN9140	2N7236U	JXVS	IRFM150	2N7224	JXV
IRFG110	2N7334	JXV	IRFN150	2N7224U	JXV
IRFG9110	2N7335	JXV	IRFM9140	2N7236	JXVS



Hermetic Products



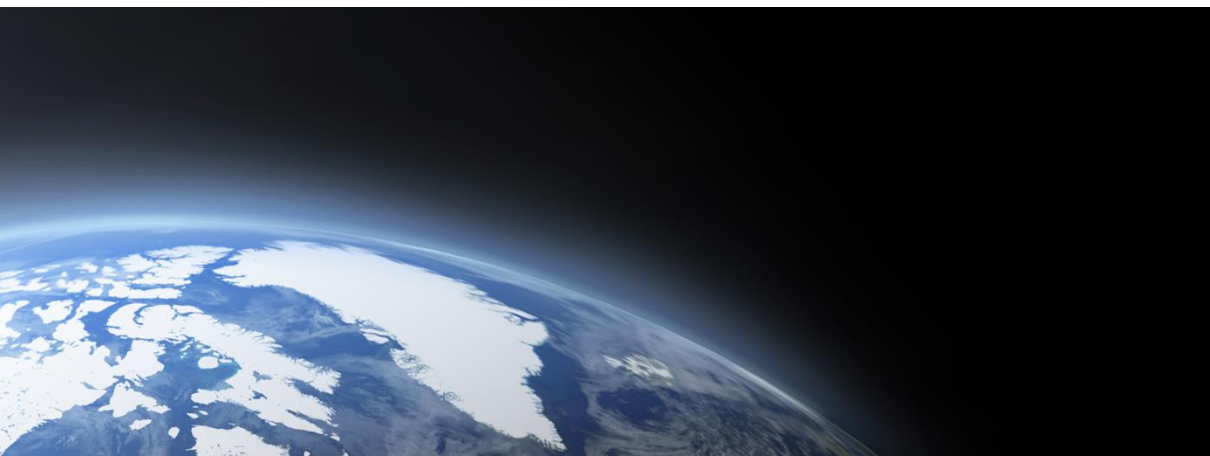
New Products in 2013

- Sharp Knee Zener
 - 1.2V to 2.4V in modified UB package
- Lo Cap TVS
 - Lo Cap TVS in glass package

Key DLA Qualification – ThinKey™ Schottkys

Update on SiC for Space Application

A Flexible Diode Package for Space Application



New Product Review

Sharp Knee Zener

Sharp Knee Zener

- A new high reliability, ultra-sharp knee diode device - targeted at low voltage regulation and transient protection applications in the defense, aerospace, industrial and medical sectors.
- The low leakage ratings also make the new diodes ideal for high-speed and -frequency electro static discharge (ESD) applications and portable applications to ensure longer battery life.
- In addition, the Zener diodes can be used for certain transient voltage protection (TVS) applications requiring low impedance and low-voltage.
- UB - Hi Rel Package
- 500mW rating

Sharp Knee Zener

■ Product Information

- Part numbers: SLZ1.0A thru SZL2.4A;
- Voltage : 1V to 2.4V
- Current : Test current of 250 microamps (uA) and maximum surge current of 25 amps (A);
- Reverse Leakage Current: less than 50 nanoamperes (nA)
- ESD and EFT protection per IEC 61000-42 and IEC 61000-4-4

Data Sheet



SZL1.0A – SZL2.4A



Low Voltage Ultra-Sharp Knee Zener Diode

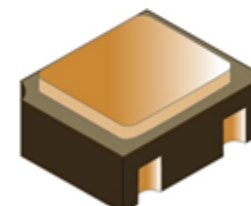
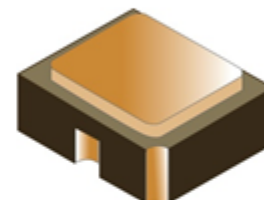
DESCRIPTION

This new multi-layer pn junction Zener design for ultra-sharp knee characteristics is used for low-voltage regulation and very low leakage currents. The new design offers significantly improved voltage regulation and lower dynamic impedance and capacitance compared to conventional Zeners. They also provide ESD protection for those threats defined per IEC 61000-4-2 or electrical fast transients per IEC 61000-4-4 as well as other transient threats. Because of their small physical size and weight, this product is ideal for use in miniaturized electronic equipment such as hand-held instruments, implantable medical devices, PDAs, computers, computer peripherals, cell phones, etc.

Important: For the latest information, visit our website <http://www.microsemi.com>.

FEATURES

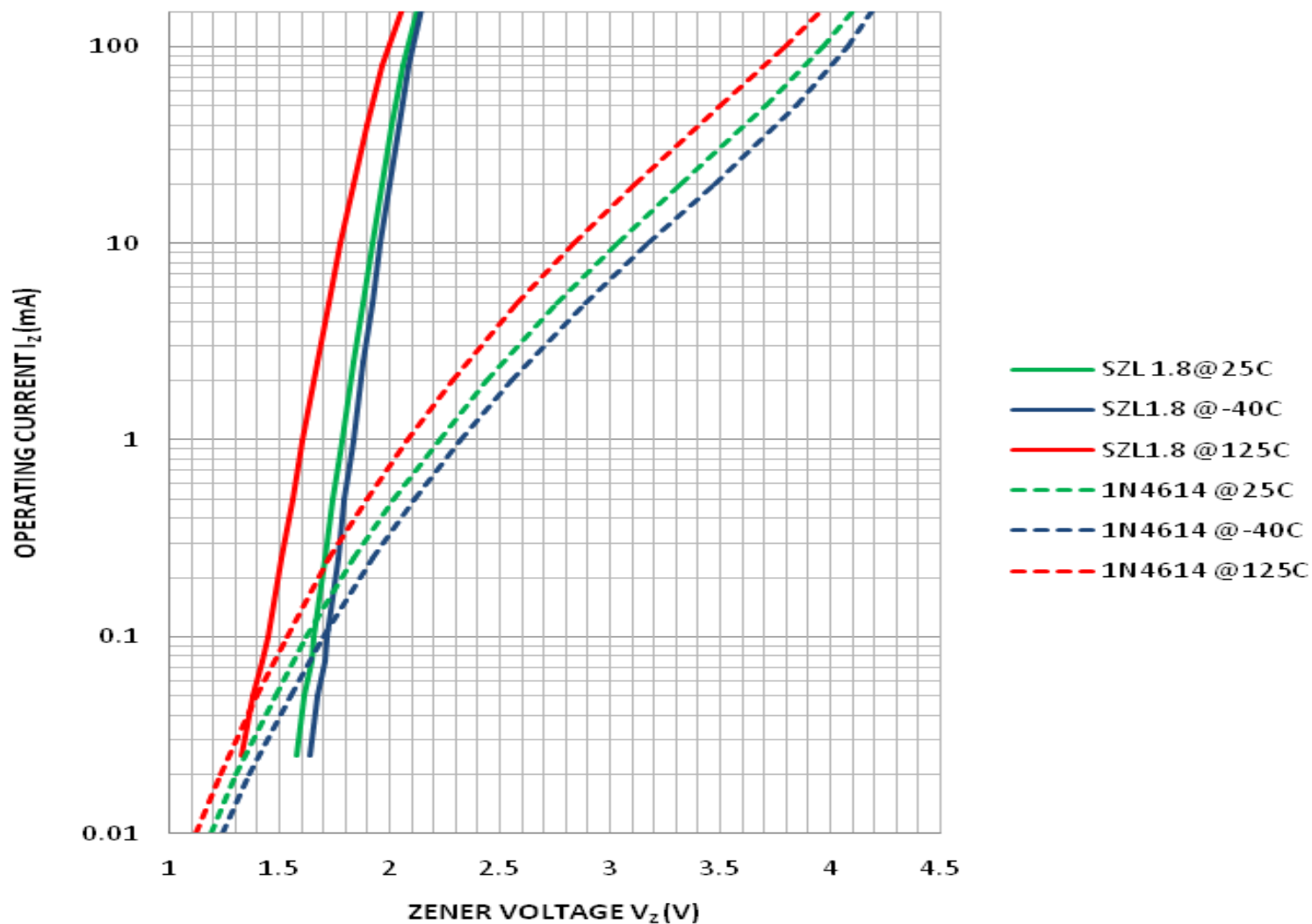
- Ultra-sharp knee, low-voltage Zener
- Excellent Voltage Regulation over two orders of magnitude Zener current change
- Lower Zener impedance
- Lower leakage current
- Lower capacitance
- Small, hermetically sealed, surface mount UB package
- High surge capability
- RoHS compliant versions are available
- ESD Nonsensitive Rating



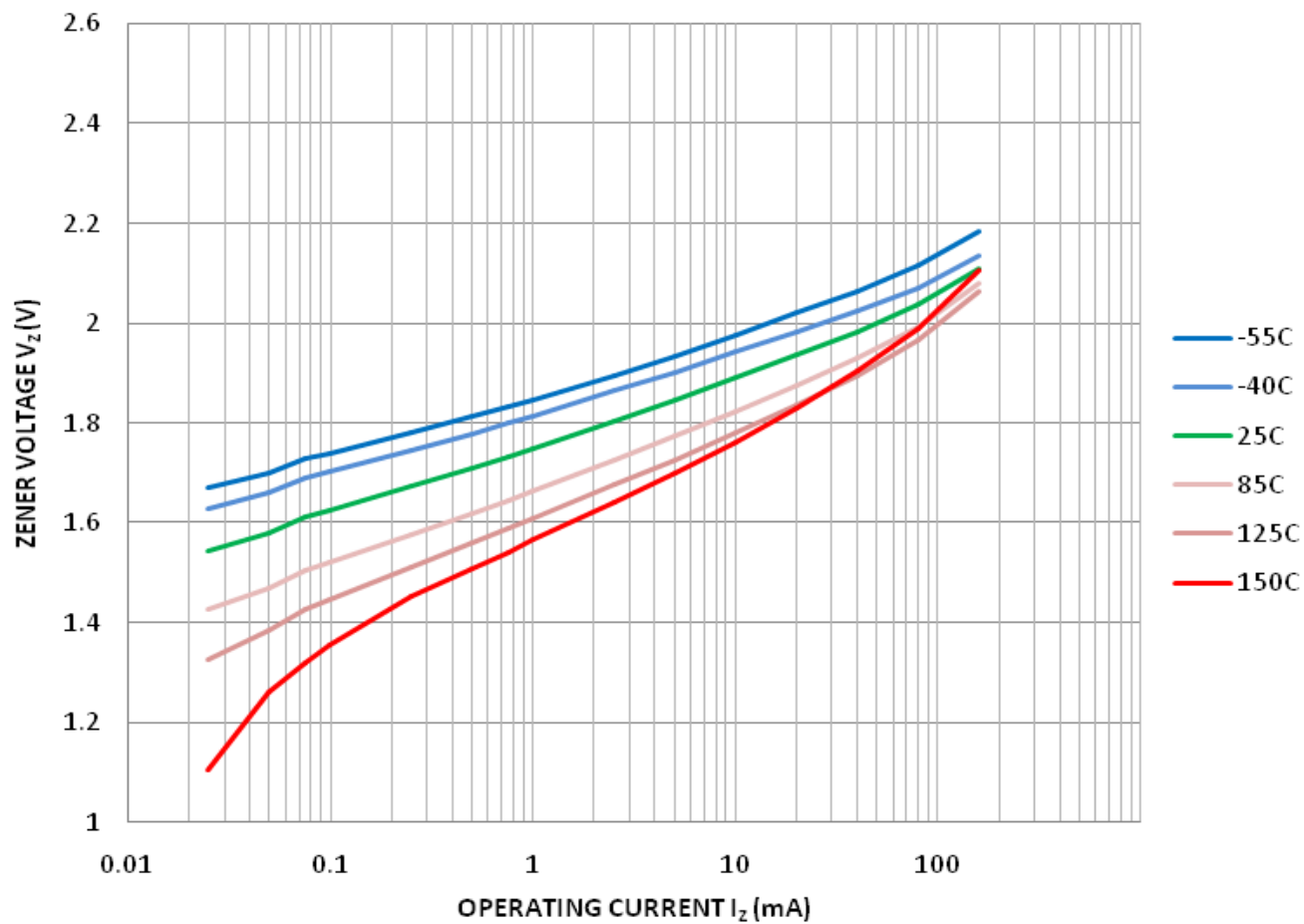
UB Package

Preliminary

Some Curves



Some Curves



ZENER VOLTAGE vs. OPERATING CURRENT vs. TEMPERATURE - SZL1.8A (typical)

Detailed Schedule

- Design - verification complete
- Development - Complete
- Qualification – Complete
- Product Release – Oct 2013





New Product Review

Lo Cap TVS


Lo Cap TVS

- Need for surge protection in high speed applications
- Lower capacitance → lower noises interference - Low capacitance - < 15pF (at 1500W) – allowing you go to higher frequencies
- Higher power - Various Power Levels – 150W, 500W and 1500W
- Hi Rel Package
- Patented Design


1N8183US thru 1N8218US



**Voidless-Hermetically-Sealed Unidirectional
Low-Capacitance Transient Voltage Suppressors**
Preliminary Draft



**"B" SQ-MELF
Package**

DESCRIPTION

This series of voidless-hermetically-sealed unidirectional low-capacitance Transient Voltage Suppressor (TVS) designs are ideal for protecting higher frequency applications in high-reliability applications where a failure cannot be tolerated. They include a unique rectifier diode in series and opposite direction from the TVS to achieve a very low capacitance of 10 pF. This product series provides a working peak "standoff" voltage selection from 5.0 to 170 volts with 500 watt ratings. They are very robust in hard-glass construction and also use an internal metallurgical bond identified as Category 1 for high reliability applications. These devices are also available in axial leaded packages for thru-hole mounting.

Important: For the latest information, visit our website <http://www.microsemi.com>.

FEATURES

- High surge current and peak pulse power provides transient voltage protection for sensitive circuits.
- Very low capacitance for high frequency or high baud rate applications.
- Triple-layer passivation.
- Internal "Category 1" metallurgical bonds.
- Voidless hermetically sealed glass package.
- Low Capacitance
- RoHS compliant versions are also available.

APPLICATIONS / BENEFITS

- High reliability transient protection.
- Extremely robust construction.
- Working peak "standoff" voltage (V_{WM}) from 5.0 to 170 volts.
- Available as 500 W peak pulse power (P_{PP}) at 10/1000 μ s.
- Lowest available capacitance for 500 W rated TVS.
- ESD and EFT protection per IEC61000-4-2 and IEC61000-4-4 respectively.
- Secondary lightning protection per select levels in IEC61000-4-5.
- Square-end-cap terminals for easy placement.
- Nonsensitive to ESD per MIL-STD-750 method 1020.
- Inherently radiation hard as described in Microsemi [MicroNote 050](#).

MAXIMUM RATINGS

Parameters/Test Conditions	Symbol	Value	Unit
Junction and Storage Temperature	T_J and T_{STG}	-55 to +175	$^{\circ}$ C
Capacitance at zero volts	C	10	pF
Thermal Resistance Junction to ambient	$R_{\theta JA}$	75	$^{\circ}$ C/W
Peak Pulse Power at 25 $^{\circ}$ C (10/1000 μ s)	P_{PP}	500	W
Impulse repetition rate (duty factor)	d.f	0.01	%
Steady State (Average) Power @ $T_A = 25^{\circ}$ C	P_{MWS}	2.0	W
Solder Temperature (10 s maximum)	T_{SP}	260	$^{\circ}$ C

Also available in:

"B" Package
(axial-leaded)
1N8183 – 1N8218

MSC – Lawrence
6 Lake Street,
Lawrence, MA 01841
1-800-446-1158
(978) 620-2600
Fax: (978) 689-0803

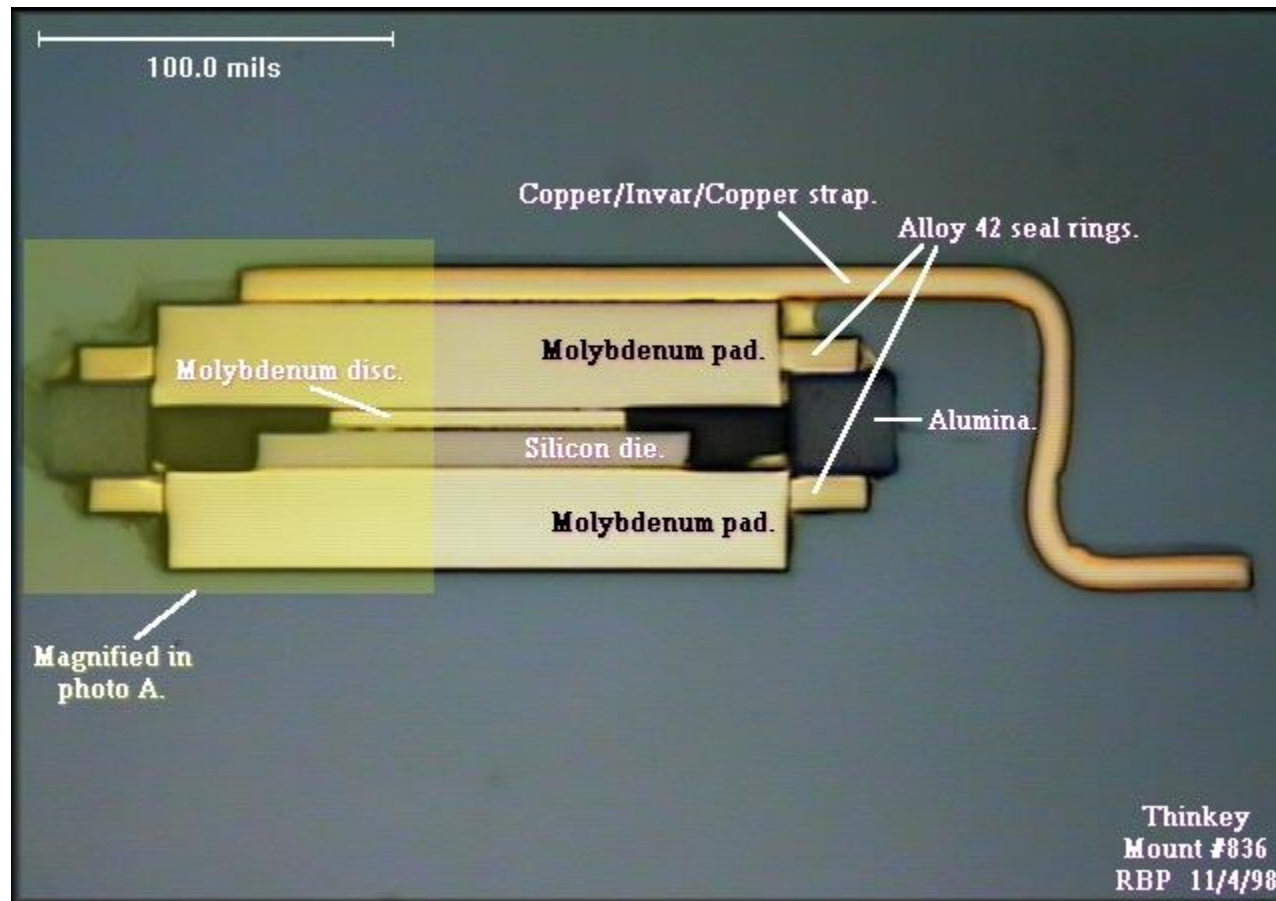
MSC – Ireland
Gort Road Business Park,
Ennis, Co. Clare, Ireland

Detailed Schedule

- Design and Prototyping – Complete
- Development – Complete
- Qualification
 - Qualification samples being built
 - Qualification testing to be complete by April 2014
- Product Release (500W) – May 2014



ThinKey™™2 With Schottky Die

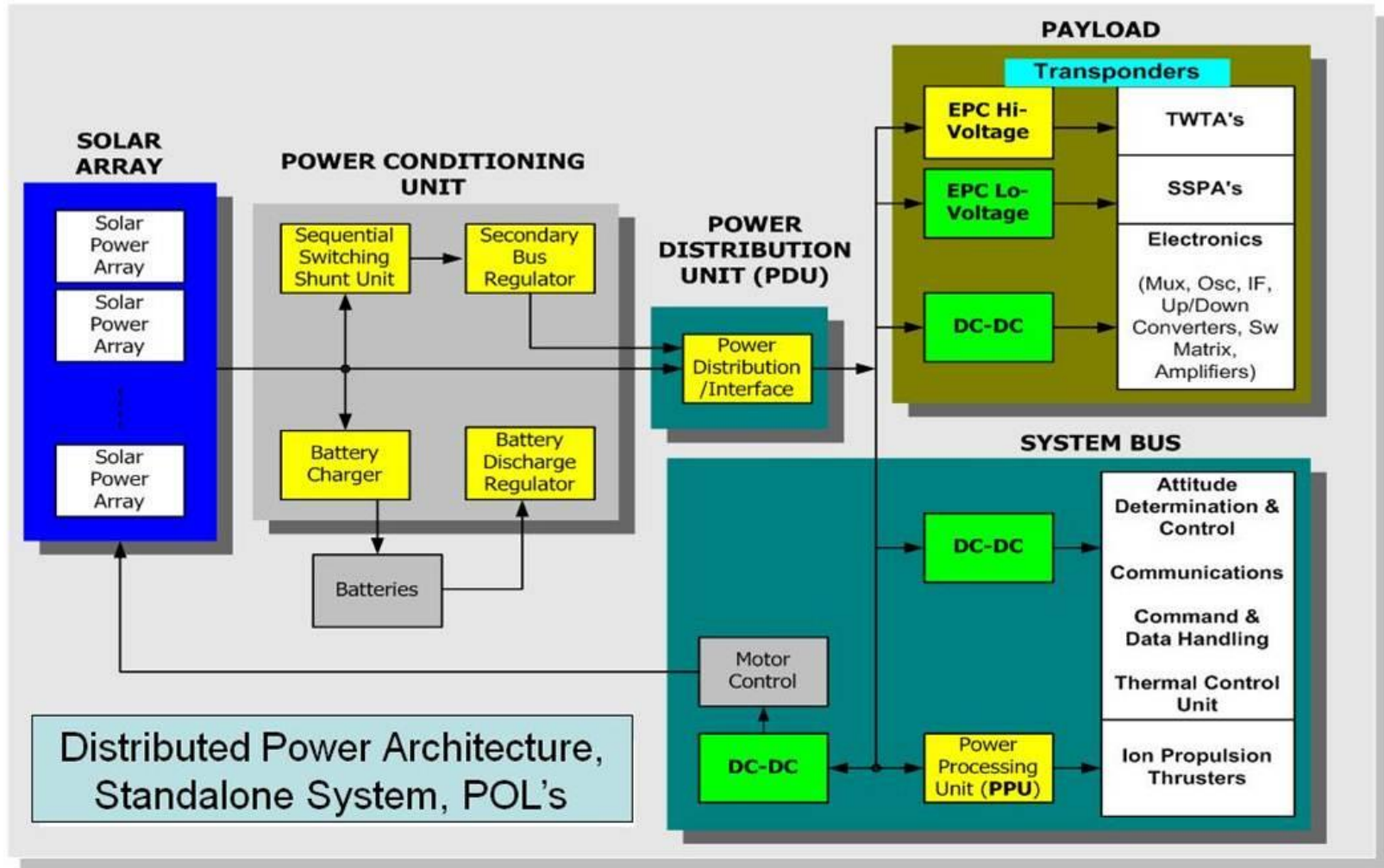


- JANTXV1N6872-6905 & 6910-6942, (MIL-PRF-19500/719-726)
(25-150A, 15-100V, Schottky)
- Double plug construction, no wire bonds
- Surface mount with top strap available on anode or cathode
- Double-side cooling
 - Parts run cooler
- High surge capability, no internal strap or wire bonds
- Low inductance, no internal strap or wire bonds
- Weight: 0.9 -1.8 grams (9 x lighter than TO-254)
- Low thermal resistance: typical 0.2-0.85°C/W
- No soft solder used in construction
 - Eliminating solder creep and re-crystallization during Int. Op. Life (power cycling) and high temp. storage
 - Prevents solder seal from mixing with mounting solders, compromising the hermetic seal
- Pre-cap inspection easily performed prior to seal (JANTXV & JANS equiv.)
- Rugged ceramic and metal construction, no glass seals
- All die (Schottky, TVS, and rectifier) made on MSC QPL line

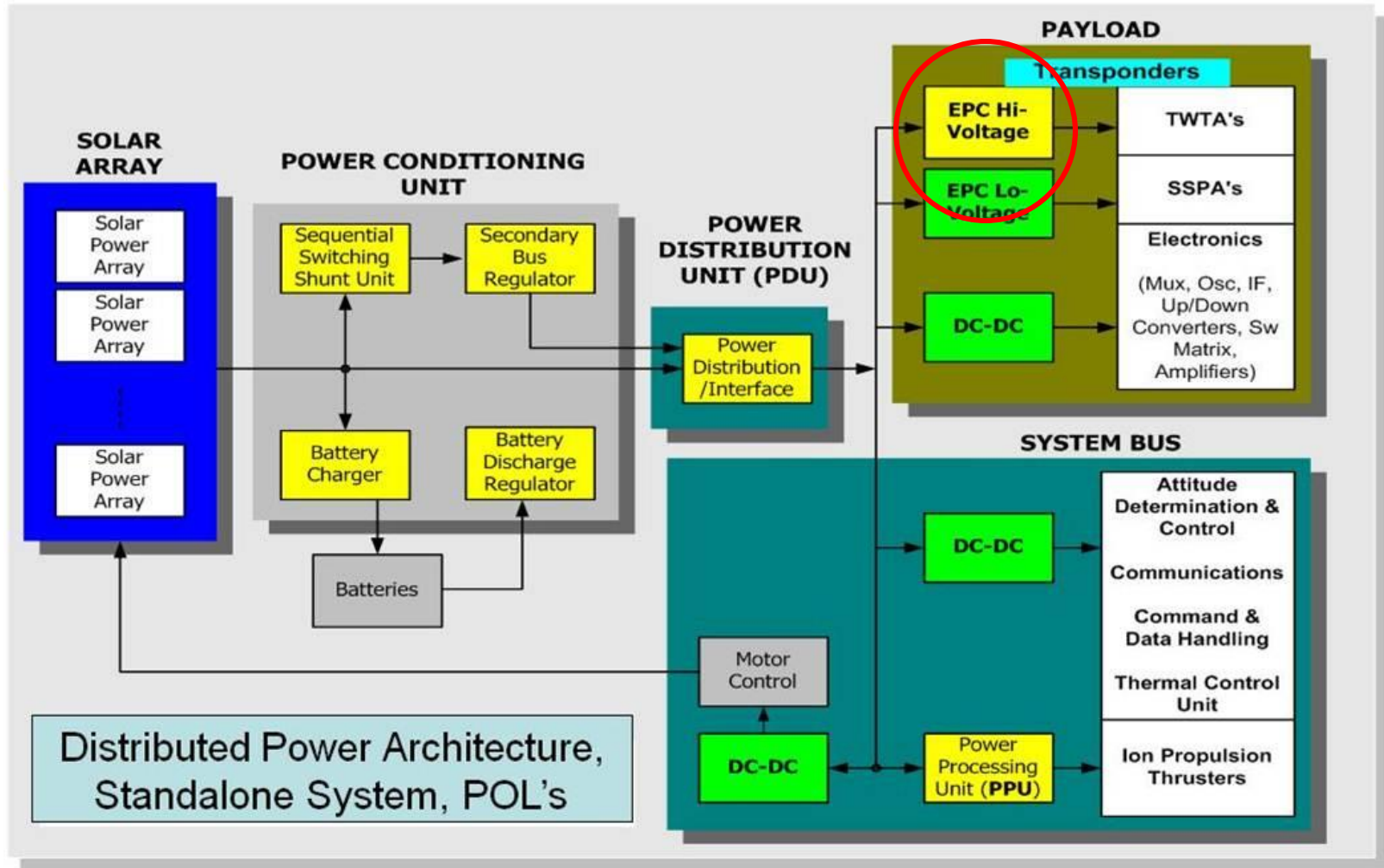
SiC Schottky Diode for Space Application

Voidless Hard Glass Diode (1.5A, 1200V)

EPC's – High Voltage Diode Requirements



EPC's – High Voltage Diode Requirements



EPC's – High Voltage Diode Requirements

- SiC diodes are used as HV rectifier diodes, they rectify the HV transformer voltages for TWT purpose
- As the TWT require a lot of intermediate voltage (up to 6), there are 8 windings on the transformer and so at least 8*4 SiC diodes
- They can also be used in bridge multipliers between Helix and Collector
- The benefit of SiC is the extremely fast switching but also lower V_f for a 1200V diode – therefore you can increase the power capability or temperature rating

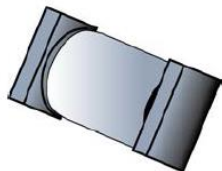
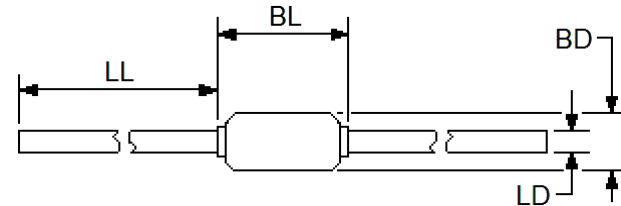
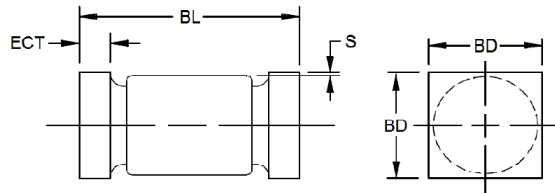
Microsemi HRG's SiC development

- Innovation for space & military applications for over 45 years in silicon semiconductor technology, versatile packaging, and high reliability dominance
- Leveraging HiRel manufacturing & test experience in the development of emerging technologies
 - **Silicon Carbide (SiC) Schottky (voidless hard glass)** – one of the world's most rugged hermetic packages in both axial and surface mount offering fast switching, high power density and extreme reliability
 - **HiTemp SiC Schottky (voidless hard glass)** – specially designed high temp SiC chips housed in hard glass offering continuous, highly reliable operation from -65°C to $+300^{\circ}\text{C}$
 - **Std Temp SiC Schottky (metal cavity devices)** – SiC built into some of the most established hermetic HiRel thru-hole packages available (TO-254/257/258/3/39) as well as newer surface mount designs (SMD-1/.5/.22)
 - **Std & HiTemp Silicon Carbide (SiC) Modules/Hybrids** – standard and custom designs for military, aviation & commercial applications ranging from -65°C to $+300^{\circ}\text{C}$ using state-of-the-art materials designed to withstand harsh & extreme environments

Hard Glass SiC B-body Glass (Prototypes)

Product Type	P/N	Current (A)	Voltage (V)	Description	Package Type	Lead Type	Max Op Temp
StdTemp SiC Voidless	MSiCSB1.5A120	1.5	1200	SiC Schottky Rectifier	B-body Glass	Axial	125°C
	MSiCSB1.5A120US	1.5	1200	SiC Schottky Rectifier	B-body Glass (US)	MELF	125°C
HiTemp SiC Voidless	MSiCSB1A120HT	1	1200	SiC Schottky Rectifier	B-body Glass	Axial	300°C
	MSiCSB1A120HTUS	1	1200	SiC Schottky Rectifier	B-body Glass (US)	MELF	300°C

PACKAGES



SiC Advantage - Extreme Reliability

- **Standard temp applications** – Marked improvement in reliability due to the higher Activation Energy associated with SiC. Even more when using high temp devices or systems at standard temperatures
- **High temp applications** – Device & system performance & reliability in extreme environments including high temp & vibration

Number of Failures (r)	Number of Devices Tested	Test Hours per Device	Test Temperature (°C)	Use Temperature (°C)	Activation Energy: Ea (eV)	Acceleration Factor (Af)	FIT* Failures In Time (per billion hours)	MTTF (years)
0	22	1000	150	55	0.7	260	160	714
0	22	1000	150	55	0.9	1,276	33	3497
0	22	1000	260	55	0.9	208,411	0.2	571,224
0	400	1000	300	175	0.7	52	44	2,603
0	125	1000	300	175	0.9	162	45	2518
0	7000	1000	300	260	0.7	3	45	2,527
0	5000	1000	300	260	0.9	4	47	2,446

NOTE:

Silicon (Si) Ea = 0.7 eV

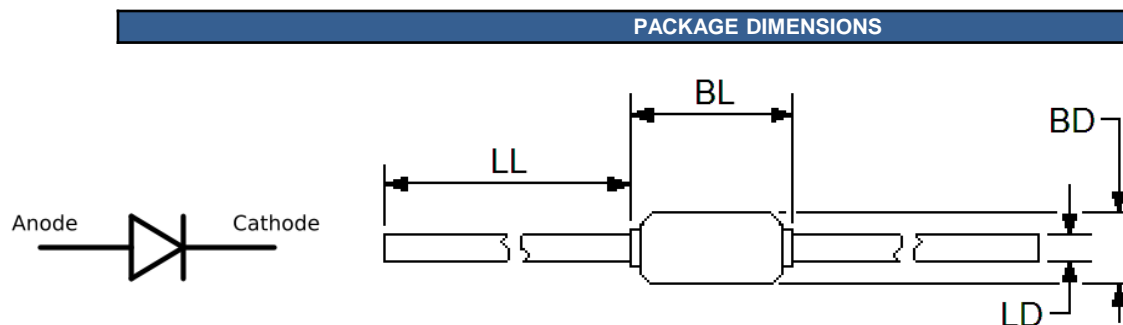
Silicon Carbide (SiC) Ea = 0.9 eV*

*SiC Ea Reference: Liangchun Yu, Simulation, Modeling and Characterization of SiC Devices, Rutgers-New Brunswick, (May 2010)

SiC Schottky Diode Description

■ General description

- Silicon Carbide (SiC) Rectifier Diode
- Rating: 1.5 A, 1200 V
- Axial Leaded Hard Glass Voidless Hermetic Package
- Internal metallurgical bonds
- SnPb plated copper leads (Standard)

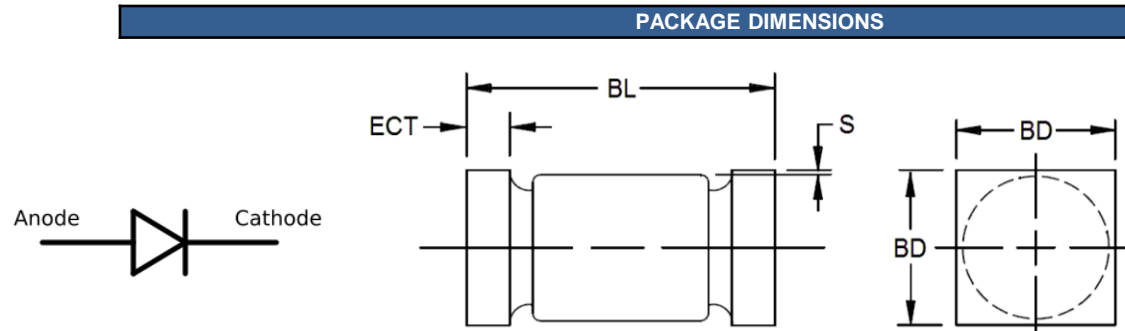


Ltr	DIMENSIONS			
	INCH		MILLIMETERS	
	Min	Max	Min	Max
BD	0.115	0.142	2.92	3.61
BL	0.13	0.3	3.3	7.62
LD	0.036	0.042	0.91	1.07
LL	0.9	1.3	22.86	33.02

SiC Schottky Diode Description

■ General description

- Silicon Carbide (SiC) Rectifier Diode
- Rating: 1.5 A, 1200 V
- Surface Mount Hard Glass Voidless Hermetic Package
- Internal metallurgical bonds
- SnPb plated copper end caps (Standard)



Ltr	DIMENSIONS				Notes
	INCH		MILLIMETERS		
	Min	Max	Min	Max	
BD	0.137	0.148	3.48	3.76	8
BL	0.200	0.225	5.08	5.72	
ECT	0.019	0.028	0.48	0.71	8
S	0.003		0.08		

Design Advantages & Benefits

- Design advantages & benefits
 - Thermally matched tungsten double plug construction
 - Proven design used on military & space diode products
 - Non-cavity (voidless) construction provides significant performance advantages in high voltage applications preventing internal dielectric breakdown
 - Extremely fast switching capability compared to ultrafast rectifiers
 - Temperature independent switching
 - Zero reverse recovery current

Datasheet Graph Samples

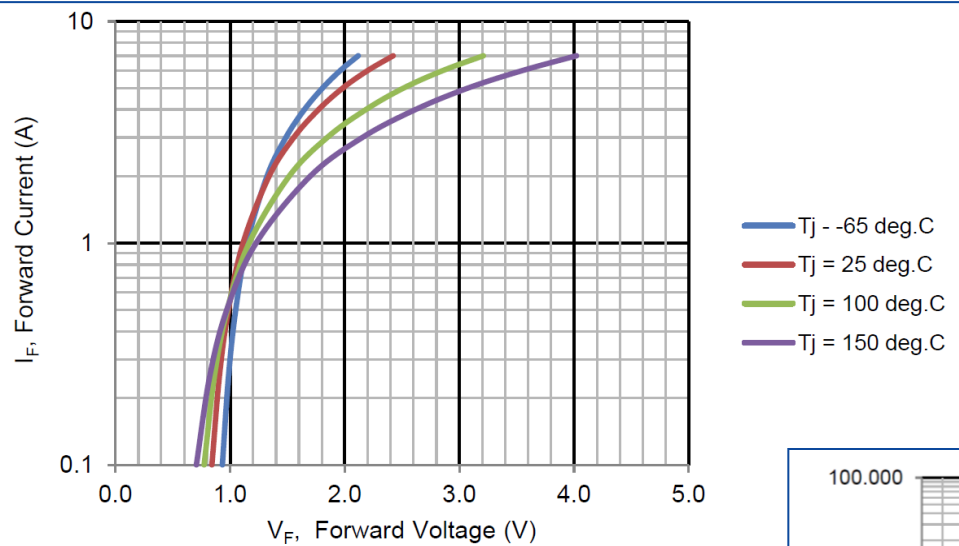


FIGURE 3
Forward Voltage vs. Forward Current

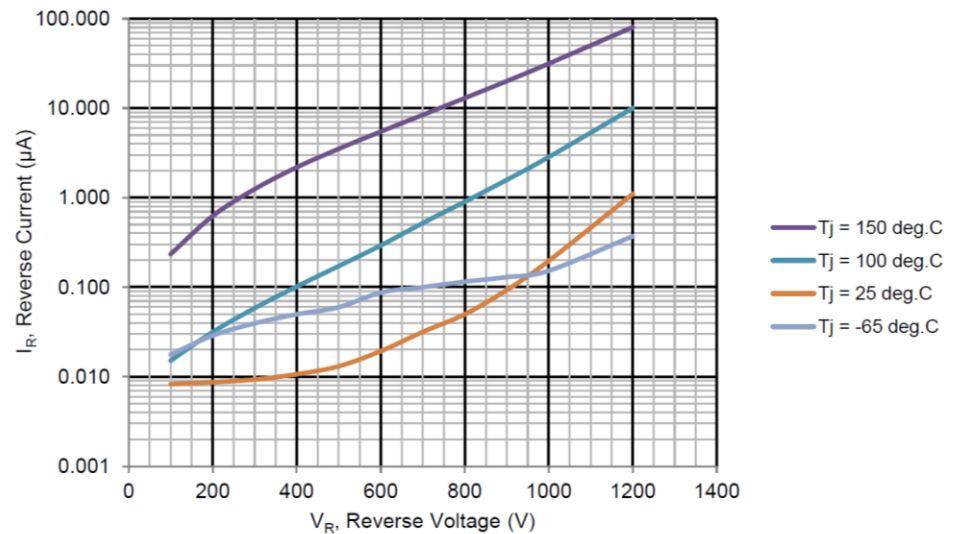


FIGURE 4
Reverse Leakage Current vs. Reverse Voltage

Low Profile Solar Diode Packages

Flat Metal Contact

- Passed extensive qualification testing for ISS (Space station)
- Ultra-thin construction (0.5 mm)
- Flexible leads
- Leads are weldable
- Sturdy ceramic-to-metal seal
- Easy to heat sink to solar panel
- Custom lead length and materials available
- Larger die size than 1N5811, lower V_f



Unique Testing Performed

- Extreme Temperature Cycling
 - 5000 cycles liquid to liquid -197 to +150°C
 - 20,000 cycles air to air -100 to +61°C

- Charged Particle Radiation

Mesa die

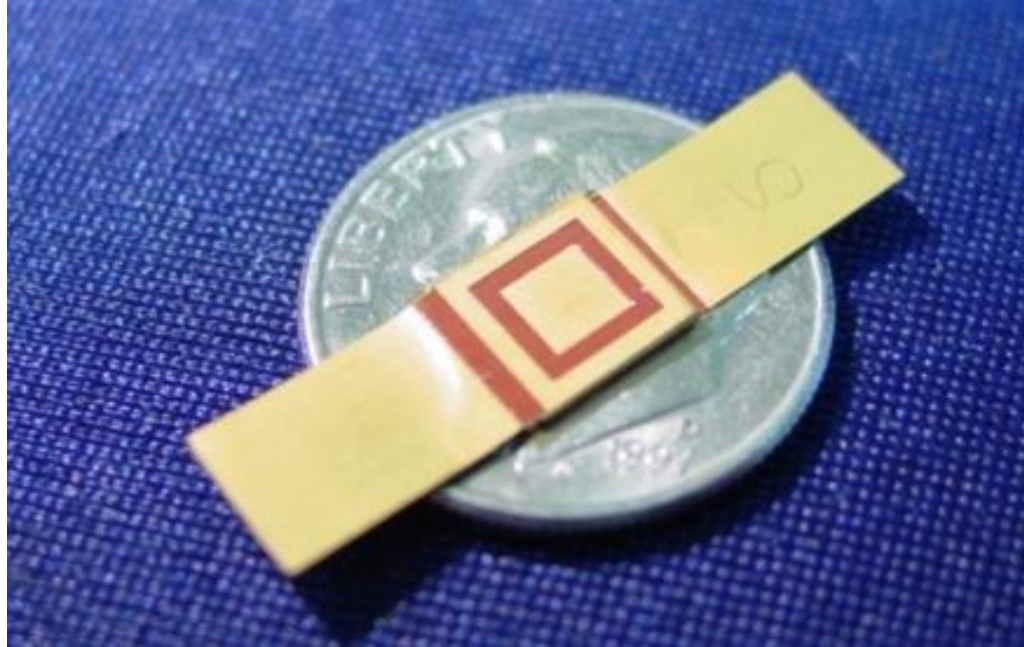
- Electron (1MeV electrons with 6×10^{14} el/cm² total fluence)
- Proton (45MeV protons with 6×10^6 protons/cm² fluence)

Planar N substrate die

- Electron (1MeV electrons with 3×10^{15} el/cm² total fluence)

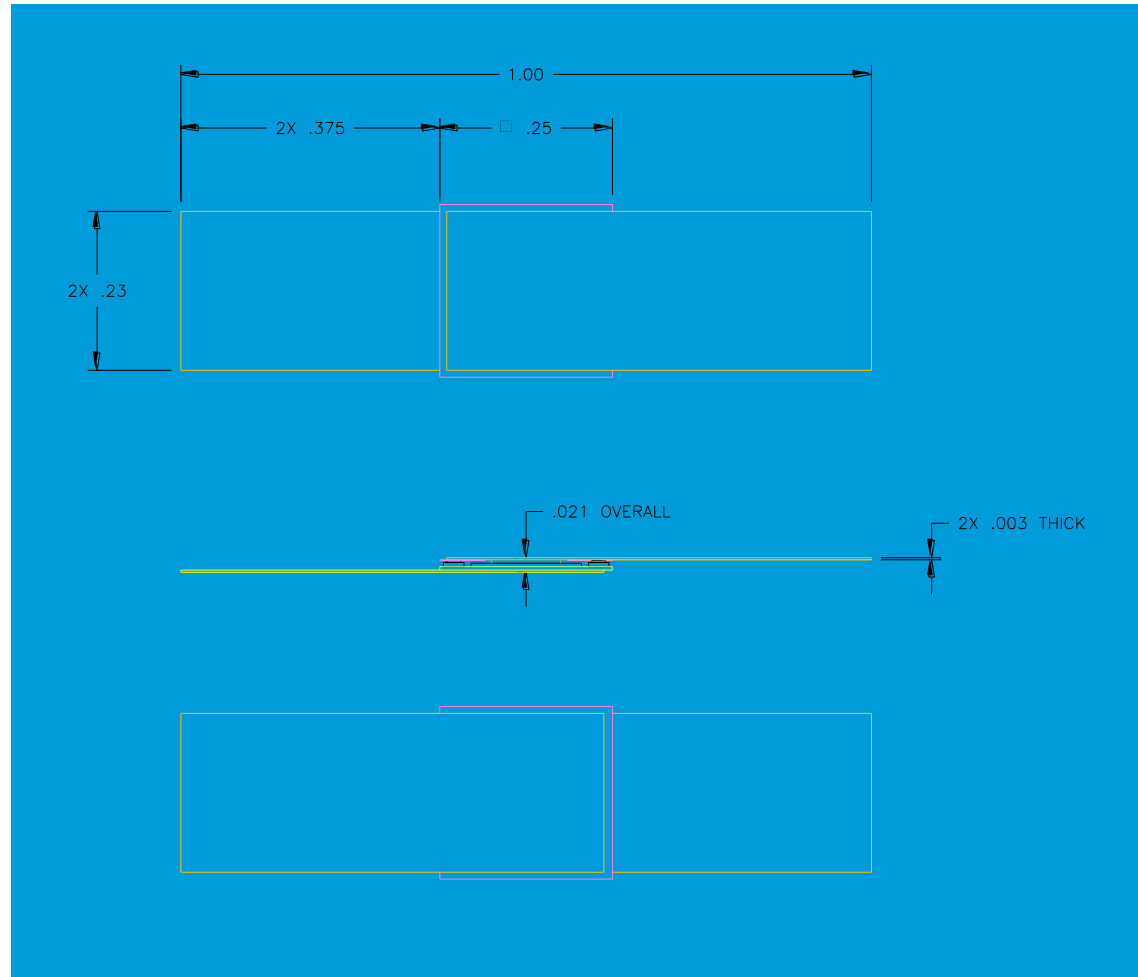
- 20,000 Power Cycles
- Weldability after Moisture Resistance Testing
- Lead pull tests at various pull angles
- Accelerated Life Testing
 - FIT rate calculated from activation energy

Flex Leads



Flex Lead Dimensions (in)

- Flex circuit leads
- extremely low profile
- Weldable
- By-pass or blocking
- Can be mounted directly to panel
- Light weight
- Can be scaled to die size
- Passes extreme temperature cycling



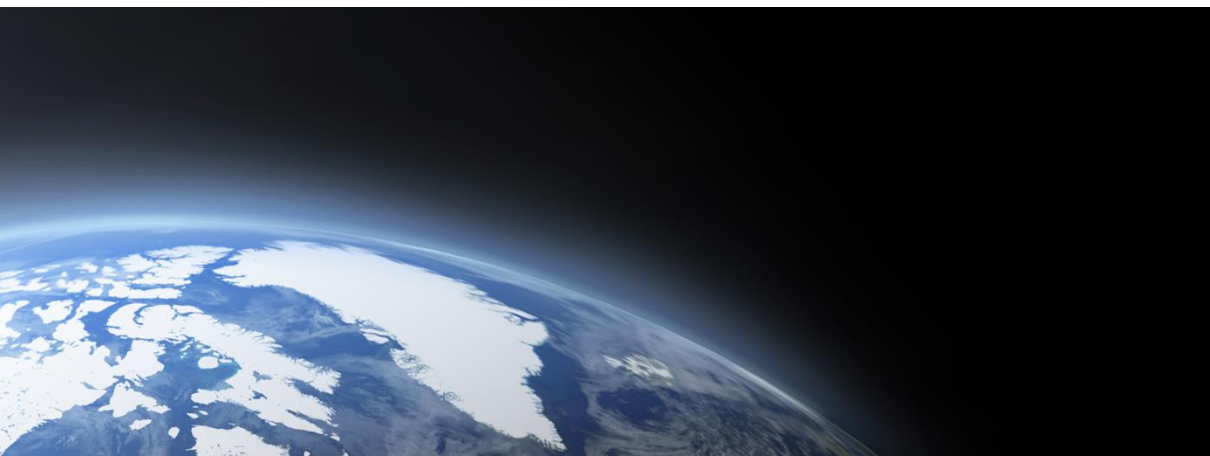
Flex Diode Testing

- Passed 250 Mrad
 - Customer supplied data
- Liquid to liquid thermal cycling (-197C to +150C) 100 cycles
 - Used for lot qualification testing
- Flying on TacSat-2
- Passed JANS equivalent screening flow
 - Including Group A, B, and C testing

Plating Versus Solder Dip

- Microsemi HRG promotes both hot solder dip and electroplated finishes
- There are no issues with Microsemi's electroplated finishes -
 - Storage – no restrictions once standard conditions used
 - Lead content – aim for > 10% Pb
 - Application – no issues
- Standard finish for majority of product is electroplated finish – preferred to allow for Microsemi's unique laser marked SMD end caps





Thank You