United Silicon Carbide, Inc.

AEC-Q101 Product Qualification Report

Discrete TO Packaged SiC Cascodes

Included Products:

TO-247-3L	TO-220-3L	TO-247-4L
UJ3C120150K3S	UJ3C065080T3S	UF3C120150K4S
UJ3C120080K3S	UF3C065040T3S	UF3C120080K4S
UJ3C120070K3S	UJ3C065030T3S	UF3C120040K4S
UJ3C120040K3S	UF3C065080T3S	UF3C065080K4S
UJ3C065080K3S	UF3C065030T3S	UF3C065040K4S
UF3C065040K3S		UF3C065030K4S
UJ3C065030K3S		
UF3C065080K3S		
UF3C065030K3S		
UF3C120080K3S		
UJ3C120040K3S		
UF3C170400K3S		
UF3C120400K3S		

Scope

This report summarizes the AEC-Q101 qualification results for the UJ3C and UF3C family of discrete SiC Cascodes in TO-220-3L, TO-247-3L and TO-247-4L plastic packages.

The environmental stress tests listed below are performed with pre-stress and post-stress electrical tests. Reviewing the electrical results for new failures and any significant shift performance satisfies the AEC-Q101 qualification standards, as well as UnitedSiC Quality requirements.

Reliability Stress Test Summary

Test Name	Test Standard	# Samples x # Lots	Failures
High Temperature Reverse Bias (HTRB)	MIL-STD-750-1 M1038 Method A (***1000 Hours***) T_J=175ºC, V=80% V_{max}	77x10 lots	0/770
High Temperature Reverse Bias (HTRB)	MIL-STD-750-1 M1038 Method A (***168Hours***) T_J=175ºC, V=80% V_{max}	77x4 lots	0/308
High Temperature Gate Bias (HTGB)	JESD22 A-108 (1000 Hours) T_J=175ºC, V=100% V_{max} (+25V), bias in on direction	77x10 lots	0/770
Highly Accelerated Stress Test (HAST)	JESD22 A-110 (96 Hours) T_A=130ºC/85%RH	77x8 lots	0/616
High Humidity, High Temperature, Reverse Bias	JESD22 A-110 (1000 Hours) T= 85°C, 85% RH, V_{GS}=0V, V_{DS}=100V	77x3 lots	0/231
Intermittent Operating Life (IOL)	MIL-STD-750 Method 1037 DT_J ≥125ºC, 3000 cycles (5 minutes on/ 5 minutes off)	77x10 lots	0/770

Temperature Cycle (TC)	JESD22 A-104 (1000 Cycles)	77x10 lots	0/770
Autoclave (PCT)	JESD22 A-102 121°C/ RH = 100%, 96 hours, 15psig	77x10 lots	0/770
Parametric Verification	Per Datasheet	100% FT x 9 lots	
Physical Dimensions	Per AEC-Q101 Rev D	30x3 packages	0/90
ESD – Charged Device Model	AEC-Q101-005 Field Induced Charged-Device Model, 3 positive and 3 negative pulses applied to All Pins	10x2 lots	0/20
ESD – Human Body Model	AEC-Q101-001 Human Body Model: R=1500 ohm, C=100 pf, 3 positive and 3 negative pulses applied to All Pins	10x2 lots	0/20
Bondline Thickness	Per Assembly Spec	10x6 lots	0/60
Die Shear	Per Assembly Spec	10x6 lots	0/60
Die Attach Voids	Per Assembly Spec	10x6 lots	0/60
Wire Pull	Per Assembly Spec	10x6 lots	0/60
Wedge Shear	Per Assembly Spec	10x6 lots	0/60
CSAM	Per Assembly Spec	60x6 lots	0/360
Lead Integrity Test	Per AEC-Q101 Rev D	30x2 lots	0/60
Solderability Test	Per AEC-Q101 Rev D	10x2 lots	0/20

ESD Testing:

UnitedSiC FETs have integrated ESD protection. The ESD protection will vary with the chip size. All products will meet a minimum rating of C3 (>1000V) for the Charged Device Model, and H2 (>2000V and <4000V) for the Human Body Model.

Reliability Evaluation:

The FIT rate data presented below is determined according to JEDEC Standard JESD 85 and is determined from the HTRB and HTGB Burn-In sample size.

FIT = 0.75697 failures per billion device hours

MTTF = 150,805.79 years

From the equations:

$$\lambda_{hours} = \frac{X^2(\alpha, \nu)}{2 \times D \times H \times A_f}$$

$$FIT = \lambda_{hours} \times 10^9$$

$$MTTF_{hours} = {}^{1}/_{\lambda_{hours}}$$

And

$$A_f = e^{\frac{E_a}{k}\left(\frac{1}{T_{use}} - \frac{1}{T_{test}}\right)}$$

Where:

X^2 = Chi-Squared probability function for a given Confidence Level (α) and Degree of Freedom ($\nu = 2r+2$, where r = the number of failures in the Test Population),

D = Number of Devices in the Test Population,

H = Test Hours per Device,

A_f = Acceleration Factor from the Arrhenius equation,

E_a = Activation Energy (eV),

T_{use} = standardized Use Temperature,

T_{test} = Temperature of Stress Test, and

k = Boltzmann's Constant.

In our calculations, we used our HTRB and HTGB Burn-In data:

D = 770 devices for HTRB (1000H), 308 devices for HTRB (168H), and 770 for HTGB,

H = 1000 hours or 168 hours for HTRB and 1000 hours for HTGB,

$1 - \alpha$ = 0.6 (60% Confidence Level)

r = 0 Failures

E_a = 0.7 eV

T_{use} = 55 °C or 328 K

T_{test} = 175 °C or 448 K