

# ***Reliability Report***

**Report Title:** LTC3639 at Vanguard Automotive  
Grade 0 Qualification

**Report Number:** 20951

**Revision:** A

**Date:** 18 April 2024

## Summary

This report documents the successful completion of the reliability qualification requirements for the automotive (Grade 0) release of the LTC3639 product in a 16-MINI\_SO\_EP package. The LTC3639 is a high efficiency step-down DC/DC regulator with internal high side and synchronous power switches that draws only 12 $\mu$ A typical DC supply current while maintaining a regulated output voltage at no load. The LTC3639 can supply up to 100mA load current and features a programmable peak current limit that provides a simple method for optimizing efficiency and for reducing output ripple and component size. The LTC3639's combination of Burst Mode® operation, integrated power switches, low quiescent current, and programmable peak current limit provides high efficiency over a broad range of load currents.

**AECQ100 Qualification Test Methods and Summary**

AEC Test Group	AEC Stress Test Name	Abbreviation	AEC Test#	Reference
<b>Group A</b> ACCELERATED ENVIRONMENT STRESS TESTS	Preconditioning	PC	A1	<a href="#">Table 2</a> , and <a href="#">Table 4</a>
	Temperature Humidity Bias or Biased-HAST	THB or HAST	A2	
	Autoclave or Unbiased HAST or Temperature Humidity (without Bias)	AC, UHST, or TH	A3	
	Temperature Cycle	TC	A4	
	Power Temperature Cycling	PTC	A5	
	High Temperature Storage Life	HTSL	A6	
<b>Group B</b> ACCELERATED LIFETIME SIMULATION TESTS	High Temperature Operating Life	HTOL	B1	<a href="#">Table 2</a> , and <a href="#">Table 4</a>
	Early Life Failure Rate	ELFR	B2	
	NVM Endurance, Data Retention, and Operational Life	EDR	B3	
<b>Group C</b> PACKAGE ASSEMBLY INTEGRITY TESTS	Wire Bond Shear	WBS	C1	<ul style="list-style-type: none"> <li>• Test C2 (and C1 for Cu Wire) are shown in <a href="#">Table 4</a>.</li> <li>• Tests C3-6 are qualified and controlled with inline monitors and may be viewed on-site at Analog Devices.</li> </ul>
	Wire Bond Pull Strength	WBP	C2	
	Solderability	SD	C3	
	Physical Dimensions	PD	C4	
	Solder Ball Shear	SBS	C5	
	Lead Integrity	LI	C6	
<b>Group D</b> DIE FABRICATION RELIABILITY TESTS	Electromigration	EM	D1	Die Fabrication Reliability data may be viewed on-site at Analog Devices.
	Time Dependent Dielectric Breakdown	TDDDB	D2	
	Hot Carrier Injection	HCI	D3	
	Negative Bias Temperature Instability	BTI	D4	
	Stress Migration	SM	D5	
<b>Group E</b> ELECTRICAL VERIFICATION TESTS	Pre- and Post-Stress Electrical Test	TEST	E1	<a href="#">Table 5</a> and <a href="#">Table 6</a>
	Electrostatic Discharge Human Body Model	HBM	E2	
	Electrostatic Discharge Charged Device Model	CDM	E3	
	Latch-Up	LU	E4	<ul style="list-style-type: none"> <li>• For Tests E5, E6 and E7, ADI New Product Yield Analysis Testing Guidelines meet AEC Q100 requirements.</li> <li>• Results for Tests E7-E11 are available as applicable on a case by case basis.</li> <li>• Test E12 results may be viewed on-site at Analog Devices</li> </ul>
	Electrical Distributions	ED	E5	
	Fault Grading	FG	E6	
	Characterization	CHAR	E7	
	Electromagnetic Compatibility	EMC	E9	
	Short Circuit Characterization	SC	E10	
	Soft Error Rate	SER	E11	
	Lead (Pb) Free	LF	E12	
	<b>Group F</b> DEFECT SCREENING TESTS	Process Average Test	PAT	F1
Statistical Bin/Yield Analysis		SBA	F2	
<b>Group G</b> CAVITY PACKAGE INTEGRITY TESTS	Mechanical Shock	MS	G1	< Applicable only for Cavity-Packages >
	Variable Frequency Vibration	VFV	G2	
	Constant Acceleration	CA	G3	
	Gross/Fine Leak	GFL	G4	
	Package Drop	DROP	G5	
	Lid Torque	LT	G6	
	Die Shear	DS	G7	
	Internal Water Vapor	IWV	G8	

## Die/Fab Product Characteristics

**Table 1: Die/Fab Product Characteristics- 0.6um DMOS**

Product Characteristics	Product to be qualified
Generic/Root Part #	LTC3639
Die Id	VP8399/A
Die Size (mm)	1.7 x 2.7
Wafer Fabrication Site	E_VANG0108
Wafer Fabrication Process	0.6um DMOS
Die Substrate	Si
Metallization / # Layers	AlCu(0.5%)/3
Polyimide	No

**Die/Fab Test Results**
**Table 2: Die/Fab Test Results - 0.6um DMOS at Vanguard-Taiwan**

Test Name	AEC #	Spec	Conditions	Generic/Root Part #	Lot #	Fail/SS	eTest Temp
Early Life Failure Rate (ELFR)	B2	AEC Q100-008	Ta=150C, P48	LTC3639	Q20951.1.ELA-MMPVANGUARD	0/380	RH
					Q20951.1.ELB-MMPVANGUARD	0/380	RH
					Q20951.1.ELC-MMPVANGUARD	0/50	RH
					Q20951.2.ELA-MMPVANGUARD	0/285	RH
					Q20951.2.ELB-MMPVANGUARD	0/285	RH
					Q20951.2.ELC-MMPVANGUARD	0/239	RH
					Q20951.3.ELA-MMPVANGUARD	0/285	RH
					Q20951.3.ELB-MMPVANGUARD	0/285	RH
					Q20951.3.ELC-MMPVANGUARD	0/240	RH
High Temperature Operating Life (HTOL)	B1	JESD22-A108	Ta=150C, 1,000 Hours	LTC3639	Q20951.1.HO-MMPVANGUARD	0/77	RCH
					Q20951.2.HO-MMPVANGUARD	0/77	RCH
					Q20951.3.HO-MMPVANGUARD	0/77	RCH
High Temperature Storage Life (HTSL)	A6	JESD22-A103	150°C, 2,000 Hours	LTC3639	Q20951.1.HS-MMPVANGUARD	0/45	RH
Highly Accelerated Temperature and Humidity Stress Test (HAST) <sup>1</sup>	A2	JESD22-A110	130C 85%RH 33.3 psia, Biased, 96 Hours	LTC3639	Q20951.1.HA-MPVANGUARD	0/77	RH
					Q20951.2.HA-MPVANGUARD	0/77	RH
					Q20951.3.HA-MPVANGUARD	0/77	RH

<sup>1</sup> These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

## Package/Assembly Product Characteristics

**Table 3: Package/Assembly Product Characteristics - 16-MINI\_SO\_EP at UTAC (UT3)**

<b>Product Characteristics</b>	<b>Product to be qualified</b>
Generic/Root Part #	LTC3639
Package	16-MINI_SO_EP
Body Size (mm)	4.039 x 3.00 x 0.86
Assembly Location	UTAC (UT3)
MSL/Peak Reflow Temperature(°C)	3 / 260
Mold Compound	Hitachi CEL 8240HF10L
Die Attach	Ablestik 8290 conductive
Leadframe Material	Copper
Lead Finish	Matte Sn
Wire Bond Material/Diameter (mils)	GPG-2 2N Gold / 1.00

**Package/Assembly Test Results**
**Table 4: Package/Assembly Test Results - MINI\_SO\_EP at UTAC (UT3)**

Test Name	AEC #	Spec	Conditions	Generic/Root Part #	Lot #	Fail/SS	eTest Temp
High Temperature Storage Life (HTSL)	A6	JESD22-A103	150°C, 2,000 Hours	LTC3639	Q20951.1.HS-MMPVANGUARD	0/45	RH
Highly Accelerated Temperature and Humidity Stress Test (HAST) <sup>1</sup>	A2	JESD22-A110	130C 85%RH 33.3 psia, Biased, 96 Hours	LTC3639	Q20951.1.HA-MPVANGUARD	0/77	RH
					Q20951.2.HA-MPVANGUARD	0/77	RH
					Q20951.3.HA-MPVANGUARD	0/77	RH
Solder Heat Resistance (SHR)	A1	J-STD-020	MSL-1	LTC3639	Q20951.1.SH-MPVANGUARD	0/30	R
Temperature Cycling (TC) <sup>1</sup>	A4	JESD22-A104	-65°C/+150°C, 2,000 Cycles	LTC3639	Q20951.1.TC-MMPVANGUARD	0/77	H
					Q20951.2.TC-MMPVANGUARD	0/77	H
					Q20951.3.TC-MMPVANGUARD	0/77	H
Unbiased HAST (UHST) <sup>1</sup>	A3	JESD22-A118	130C 85%RH 33.3 psia, 96 Hours	LTC3639	Q20951.1.Uh-MMPVANGUARD	0/77	R
					Q20951.2.Uh-MMPVANGUARD	0/77	R
					Q20951.3.Uh-MMPVANGUARD	0/77	R
Wire Bond Pull	C2	MIL-STD-883, M2011	Post TCT, Single Duration	LTC3639	Q20951.1.TCw-MMPVANGUARD	0/10	NA
Wire Bond Shear	C1	AEC Q100-001	N/A, Single Duration	LTC3639	Q20951.1.TCbs-MMPVANGUARD	0/10	NA

<sup>1</sup>These samples were subjected to preconditioning at MSL 3 with 3x reflow peak temp of 260°C prior to the start of the stress test.

## ESD and Latch-Up Test Results

**Table 5: ESD Test Result**

ESD Model	Generic/Root Part #	Package	ESD Test Spec	RC Network	Highest Pass Level	Class	eTest Temp
FICDM	LTC3639	16-MINI_SO_EP	AEC Q100-011	1Ω, Cpkg	±1250V	C3	RH
HBM	LTC3639	16-MINI_SO_EP	AEC-Q100-002	1.5kΩ, 100pF	±2000V	2	RH

**Table 6: Latch Up Test Result**

LU Test Spec	Generic/Root Part #	Passing Current	Passing Over-Voltage	Temperature (T <sub>A</sub> )	Class	eTest Temp
JESD78	LTC3639	+100mA, -100mA	+150V	150°C	II	RH

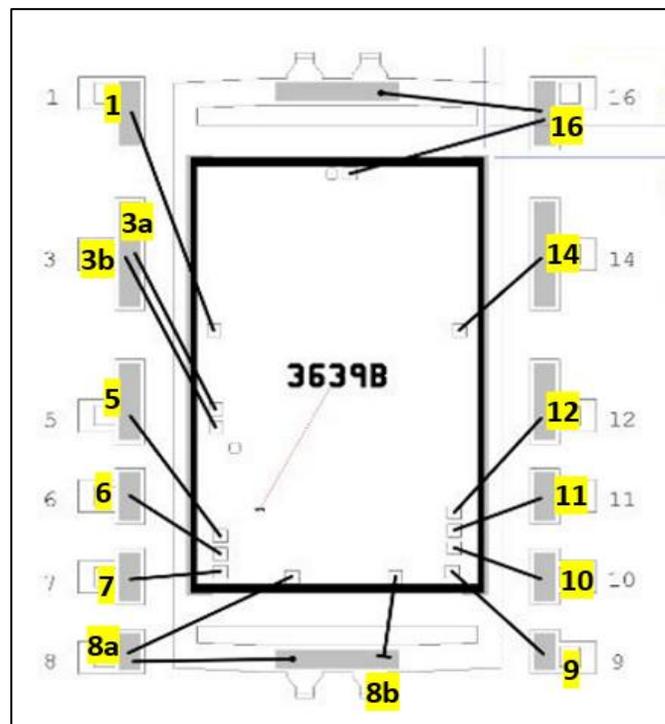
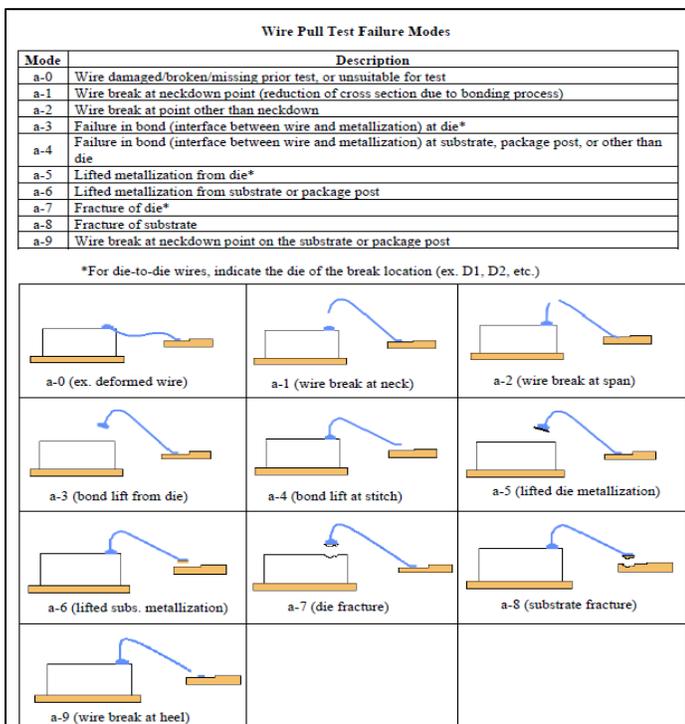
## Approvals

Reliability Engineer: Ryan Quintin

## Appendix

### Post TCT Wire Bond Pull Test Results

Q20951.1.TCw_MMPVANGUARD										
Unit	1		2		3		4		5	
Ball	Pull	Mode								
1	8.16	a-1	8.06	a-1	8.61	a-1	8.53	a-1	7.85	a-1
3a	7.45	a-1	8.21	a-1	8.76	a-1	8.76	a-1	8.04	a-1
3b	7.62	a-1	8.52	a-1	8.62	a-1	8.50	a-1	8.50	a-1
5	7.57	a-1	8.62	a-1	8.89	a-1	9.02	a-1	8.81	a-1
6	9.72	a-1	9.51	a-1	9.41	a-1	10.07	a-1	9.89	a-1
7	10.34	a-1	10.10	a-1	9.93	a-1	10.44	a-1	10.07	a-1
8a	9.00	a-1	8.85	a-1	8.99	a-1	9.15	a-1	9.15	a-1
8b	10.03	a-1	10.06	a-1	9.92	a-1	10.21	a-1	9.78	a-1
9	10.47	a-1	10.44	a-1	10.36	a-1	10.44	a-1	10.65	a-1
10	10.97	a-1	10.87	a-1	11.41	a-1	11.21	a-1	10.98	a-1
11	11.21	a-1	10.99	a-1	11.25	a-1	10.86	a-1	11.20	a-1
12	9.72	a-1	9.90	a-1	9.30	a-1	9.60	a-1	9.75	a-1
14	10.13	a-1	9.93	a-1	9.77	a-1	9.96	a-1	10.16	a-1
16	9.09	a-1	9.20	a-1	8.23	a-1	8.90	a-1	9.32	a-1
MIN	7.45		8.06		8.23		8.50		7.85	
MAX	11.21		10.99		11.41		11.21		11.20	
AVE	9.39		9.52		9.53		9.69		9.58	
STDEV	1.27		0.96		0.97		0.89		1.03	



**Post TCT Wire Bond Shear Test Results**

Q20951.1.TCBS_MMPVANGUARD										
Unit	1		2		3		4		5	
Ball	Shear	Mode								
1	40.86	A	34.90	A	36.36	B	44.65	A	37.90	A
3a	45.01	B	45.85	A	39.53	A	51.29	A	41.31	A
3b	41.70	A	41.45	A	33.56	A	46.15	A	33.40	A
5	46.17	A	40.19	A	42.34	A	34.56	A	39.62	A
6	41.93	A	42.78	A	39.45	A	50.74	B	35.89	A
7	46.74	A	45.38	A	42.89	A	49.77	A	36.91	B
8a	50.91	A	44.19	A	39.93	A	43.47	B	47.14	A
8b	39.62	A	38.66	A	36.60	A	38.76	A	38.17	A
9	42.68	B	37.87	B	38.00	A	45.06	A	38.95	A
10	40.80	A	41.73	B	39.78	A	43.82	A	36.94	A
11	31.39	A	42.57	A	38.43	A	31.63	A	36.13	A
12	34.10	A	42.63	A	36.17	A	41.49	A	40.20	A
14	42.08	A	38.79	A	37.15	A	46.91	A	34.47	A
16	36.27	A	36.52	A	36.69	A	45.04	A	35.97	A
MIN	31.39		34.90		33.56		31.63		33.40	
MAX	50.91		45.85		42.89		51.29		47.14	
AVE	41.45		40.96		38.35		43.81		38.07	
STDEV	5.12		3.28		2.52		5.71		3.41	

