
LEO ICs specification overview

Introduction

Rad-hard ICs in a plastic package are an optimized solution for LEO constellation mission profiles. Taking full advantage of its over 40-year Space heritage and its automotive AEC-Q100 qualified production lines, STMicroelectronics is introducing a new series of rad-hard components in plastic packages to support the growing Low Earth Orbit satellites market. Compliant with ST's LEO generic specification for ICs, these space-ready and automotive-based products offer a specific trade-off among footprint size savings, cost of ownership and quality assurance together with radiation hardness and large quantity capacity.

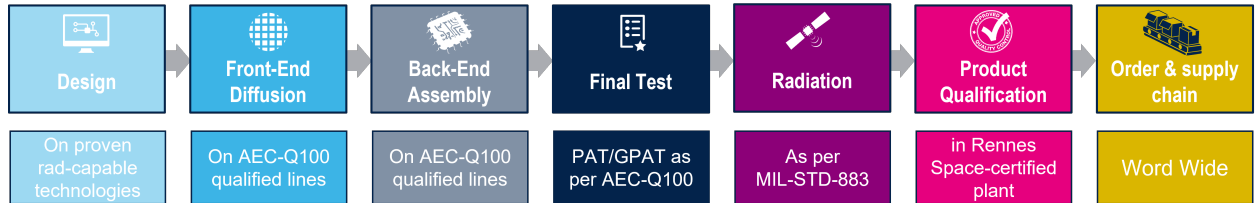
Benefits:

- Low cost of ownership
- Radiation proven in TID and SEE
- AEC-Q100 based
- Dedicated qualification level
- Screening and traceability
- Large quantity capacity
- Lightweight
- Whisker-free finishing (NiPdAu)
- Single plant source per line

1 LEO ICs flow and supply chain

LEO ICs' flow and supply chain are compliant with "ST LEO generic specification", with ST SOP267 (Finished Good Maturity Management) and with ST procedure 8161393 (General Specification for Product development).

Figure 1. LEO IC's flow



Key benefits:

- ST proprietary flow from design to delivery
- Optimised flow for small to medium quantities
- Only radiation and taping are subcontracted, managed by ST Rennes space-certified plant
- Product qualification performed by ST Rennes space-certified plant

2 LEO ICs product versions

Table 1. Product versions

Version	Specification	Order code
Dummy samples	<ul style="list-style-type: none"> - Worst case final packaging for mounting qualification - Over-marking : DUM 	Examples: - TSSOP20-DUM1 - PSO20-DUM1 - PSO36-DUM1
Development samples (see TN1418 on st.com)	<ul style="list-style-type: none"> - Final die and final package - Guaranteed at 25°C only - Not provided with any radiation hardness guarantee - Not submitted to any package testing (thermal cycles, etc.) - Not guaranteed for reliability - Delivered without Certificate of Conformance (CoC) - Marking with prefix "D" (ex: DLEOAD128) 	Examples: - LEOAD128PT-D - LEOLVDSRDPT-D - LEO3910PDT-D (see datasheets)
Flight Models (FM)	<ul style="list-style-type: none"> - Qualified as per "ST LEO Generic Specification" - Delivered with Certificate of Conformance (CoC) - Max. date code : 5 year - Marking : Part number (ex: LEOAD128) - Packing : Tape & Reel 	Examples: - LEOAD128PT - LEOLVDSRDPT - LEO3910PDT (see datasheets on st.com)

Figure 2. Examples of dummy samples

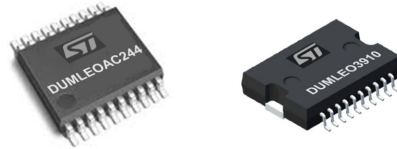


Figure 3. Examples of development samples

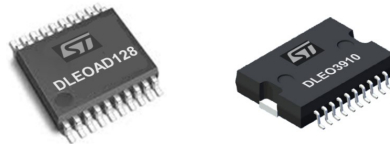
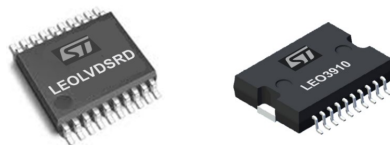


Figure 4. Examples of flight models



3 Quality assurance level overview

Table 2. Quality assurance level overview

Range			Commercial	Automotive	LEO	Rad-hard
Specification				AEC-Q100	« ST LEO »	QMLV / ESCC
Plants	Front-end	100% IDM (Integrated Device Manufacturer), AEC-Q100 qualified lines		√	√	
	Back-end					
Assembly	Process control on each lot	Outgassing			√	
		Die shear test (die glue, leadframe adhesion, ...)	√	√	√	√
		Wire pull test	√	√	√	√
		Ball shear test	√	√	√	√
		X-ray		√	√	√
		CSAM (for delamination)		√	√	
	QA gate	Optical inspection after sawing (die integrity), before molding (die placement, wire loop height), package integrity (PAO, lead burrs, corrosion)	√	√	√	√
Temp. cycling	On all delivered units at -65/+150°C		√	√	√	
Test	Production test	Tested at 3 temperatures		optional	-40/+25/+125	-55/+25/+125
		EWS	optional	PAT/GPAT	PAT/GPAT	√
Radiation	TID	At wafer lot acceptance test			50	50/100/300
	TNID	At wafer lot acceptance test			3.10 ¹¹	
	SEL	On qualification lot			Up to 62	Up to 125
	SET/SEU/SEFI	On qualification lot			optional	√
QA	Serialization / data log by unit					√
	Single assy T&F plant	Guaranteed by product line		√	√	√
Storage	Data storage	10 years			√	√
	Packaged units	5 years			√	√

4 Simplified LEO ICs qualification flow

Table 3. LEO ICs' qualification flow

Item	Description	Reference
Design and validation	Samples assembled in TSSOP20/PSO20/PSO36	ST documentation: DMS 8161393, SOP267
	Characterization on bench	
Engineering and qualification	Outgassing (RML < 1%, CVCM < 0.1%)	As per ASTM E 595
	HTOL	JESD22-A108
	HTSL	JESD22-A103
	EWS	ST documentation: DMS 8161393, SOP267
	UHASt	
	THB	
	Temperature cycling	
	Solderability	
	LU	ST documentation: DMS 8161393, SOP267
	ESD HBM	
	ESD CDM	
	128h life test (max. Vcc, max. Temp. 125°C)	
	SEE	
	TID	MIL-STD-883 TM 1019
	TNID	MIL-STD-883 TM 1017
Production	Final test	ST documentation: DMS 8161393, SOP267
	2000h operating life test (max. Vcc, max. Temp. 125°C)	
	Datasheet published on st.com	

5 Simplified LEO ICs manufacturing & control

Table 4. Simplified LEO ICs' manufacturing & control

	Item	Description	Reference
Package materials and control	Die attach	Glue or solder preform	As per AEC-Q100
	Molding	Epoxy resin	As per AEC-Q100
	Bonding	Gold wires	As per AEC-Q100
	Lead-finish	Solderability and wettability test (NiPdAu lead-frame)	As per ASTM E 595
	Outgassing	RML < 1%, CVCM < 0.1%	As per ASTM E 595
	Die shear test	As per AEC-Q100	MIL-STD-883 Method 2019
	Wire pull test	As per AEC-Q100	MIL-STD-883 Method 2011
	Ball shear test	As per AEC-Q100	AEC-Q100 / AEC-Q003
	X-Ray	Visual check	ST documentation: DM0087783
	CSAM	(for delamination)	J-SDT-020D
Radiation	TID (Total Ionizing Dose)	50 krad (Si) on each new lot. High dose rate for pure CMOS ICs, High+Low dose rate for BICMOS ICs.	MIL-STD-883 TM 1019
	TNID (Total Non-Ionizing Dose)	3.10 ¹¹ protons / cm ²	MIL-STD-883 TM 1017
	SEL @ 125°C	43 MeV.cm ² /mg minimum guaranteed,	ST LEO generic specification
	SET/SEU	tested up to 62 MeV.cm ² /mg.	
	SEFI	On product range accordingly (ADC/DAC etc...)	
Wafer lot acceptance	WLAT (Wafer Lot Acceptance Test)	EWS + TID + 1000h Life-test.	ST LEO generic specification
QA	Wafer fab	Yes	SOP243 (traceability procedure)
	Reel filling	Max. 2 lots per reel, as per ST rules	
	Single assy test & finishing plant	Yes (per line)	
Storage	Data storage	10-year	
	Packaged	5-year	
PCN/PTN	Change and termination process	Space-like	ST LEO generic specification

6 Available documentation for LEO ICs

- Datasheet (on st.com)
- CoC (on delivery of products)
- Summary qualification report (on-demand)
- ST LEO generic specification (on-demand)
- PCN/PTN (in case of change and termination of products)

6.1 Certificate of conformance (CoC) content

- Customer name
- ST order confirmation number
- ST part number
- Marking information
- Shipped quantity
- Date code
- Wafer lot identification number
- Diffusion plant
- Wafer lot acceptance test (WLAT) reference
- Radiation verification test (RVT) reference
- Product datasheet reference
- Reference of the "ST LEO generic specification"
- Assy site & test site identification

6.2 Summary qualification report content

- General information
- Radiation (*)
 - SEE
- Test results
 - Lot information
- Test group A
 - Accelerated environment stress tests
- Test group B
 - Accelerated lifetime simulation tests
- Test group E
 - Electrical verification
 - Traceability
 - Wafer fab
 - Assembly
 - Accelerated lifetime simulation tests
 - Accelerated environment stress tests

(*) Performance is guaranteed at post TID (see datasheet).

Drifts in TID are not provided, however the data can be shown through audit.

7 Glossary

Table 5. Acronyms list

Acronyms	Description
AEC	Automotive Electronics Council
Au Ni Pd	Gold Nickel Palladium
BE	Back-end
CDM	Electrostatic Discharge – Charged Device Model
CoC	Certificate of Conformity
CSAM	Confocal Scanning Acoustic Microscopy
CVCM	Collected volatile condensable material
ESD	Electrostatic discharge
GPAT	Geographical Part Average Testing
HAST	Biased HAST (Highly Accelerated Stress Test)
HBM	Electrostatic Discharge - Human Body Model
HTOL	High Temperature Operating Life
HTSL	High Temperature Storage Life
FE	Front-end
IC	Integrated circuit
LU	Latch-up
MSL	Moisture Sensitivity Level
PAT	Part Average Testing
PC	Preconditioning
RML	Recovered mass loss
SAM	Scanning Acoustic Microscopy
SEL	Single event latch-up
SET	Single event transient
SEU/SEFI	Single event upset / functional interrupt
TC	Thermal Cycle
THB	Temperature Humidity Bias
TSSOP	Thin shrink small outline package
UHAST	Unbiased HAST (Highly Accelerated Stress Test)
WBP	Wire Bond Pull
WBS	Wire Bond Shear
WLAT	Wafer lot acceptance test
XRAY	X-ray inspection

Revision history

Table 6. Document revision history

Date	Version	Changes
31-Jan-2023	1	Initial release.
11-Oct-2023	2	Updated TNID radiation description in Table 4.
11-Jul-2024	3	Updated Package materials and control in Table 4.

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