



We power space

Rad hard MOSFETs screening & quality conformance inspection

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IOR HiRel
An Infineon Technologies Company

High reliability for extreme environments

Our customers' applications demand high-reliability devices that perform to specification in the harshest environments for 15 years and longer. Mission and product assurance are key priorities. To ensure top performance and operability, our products undergo rigorous screening and quality conformance inspections (QCI).

Infinion and IR HiRel perform 100% screening of all components in accordance with specified quality levels. Additional testing eliminates nonconforming parts, increasing confidence in the reliability of long-lasting, high performance specification compliance.

Our high-reliability power semiconductors also undergo various levels of periodic quality conformance testing. Both the US and European communities have developed specifications detailing quality conformance testing sequence.

- › US DLA specifications, MIL-PRF-19500 and MIL-STD-750, govern the quality conformance testing sequence performed on discrete MOSFET semiconductors manufactured to JANS or JANTXV levels.
- › In Europe, ESA's ESCC 5000 is the standard for discrete semiconductors, hermetically sealed and die.

We offer rad hard power MOSFETs and diodes with the following screening and QCI levels based on DLA MIL-PRF-19500:

- › DLA approved Qualified Product List (QPL) with S-level screenings to MIL-PRF-19500, sold under military part number starting with JAN branded prefix under DLA approved slash sheet. JANS is the most rigorous level of screening and acceptance requirements available to assure the performance, quality and reliability of discrete semiconductors intended for space flight applications.
- › IR HiRel's Qualified IR List (QIRL) with S-level equivalent screenings to MIL-PRF-19500, manufactured and tested on the same production line with the same flow as MIL-PRF-19500 DLA approved line. QIRL part numbers have SCS suffixes.
- › Source Control Drawing (SCD)
- › Commercial off the shelf (COTS) with no QCI

For customers needing ESA ESCC-5000 qualified components, we offer the following quality levels:

- › "P" for professional level used in Engineering Modules (EM)
- › "ES" for ESA space level, ESA satellites Flight Modules (FM)

Greater assurance with PCB board-level qualification

IR HiRel's rad hard power semiconductors already undergo rigorous qualification and reliability testing at the chip or package level to qualify as QPL products. But in reality, these parts are mounted to boards for use in subsystems, such as motor controllers, intermediate bus converters, DC-DC converters and more.

That's why with our newest package designs, we proactively developed board-level qualification tests to offer even greater levels of assurance to our customers. Originating as internal customer acceptance tests for use in IR HiRel's own DC-DC converters, these board-level protocols include:

- › **Random vibration** based on ECSS-Q-ST-70-38C, with increased test constraints
- › **Mechanical shock** based on ECSS-Q-ST-70-38C, with modified test conditions
- › **Thermal cycling** per ECSS-Q-ST-70-38C (-55°C to 100°C) with added constraints

- › **Post-test inspection** for fine and gross leak, and cross-sectioning of solder joints per ECSS-Q-ST-70-38C

Our board-level qualification tests simulate the harsh demands power electronics endure in space flight. Some of the standards are already part of IR HiRel's usual package-level qualification for MOSFETs. With the board testing, we changed certain parameters, based on our space power electronics experience and customer requirements, to more accurately mirror launch conditions.

Satellite manufacturers globally rely on IR HiRel's DC-DC converters. While industry standards for PCB-level qualification of high-reliability power semiconductors currently don't exist, our protocols either comply with or exceed the test conditions chosen as guidelines. We firmly believe that providing this next level of test data gives customers even more confidence using our high-reliability products.

Process flow

		JANS (or SCS)	JANTXV (or SCV)	COTS	ESCC 5000
Product screening flow steps	Specification				
Wafer lot acceptance	MIL-STD-750	✓	✓	✓	✓
Assembly					
Internal visual inspection	MIL-STD-750 TM 2069 / ESCC 5000 F3	✓	✓	✓	✓
Inspection lot accumulation	See note 3	✓	✓	✓	
Screening					
High temperature stabilization bake					✓
Temperature cycling	MIL-STD-750 TM 1051 / ESCC 5000 F3	✓	✓		✓
Constant acceleration	MIL-STD-750 TM 2006 / ESCC 5000 F3	✓			
Particle Impact Noise Detection (PIND)	MIL-STD-750 TM 2052 / ESCC 5000 F3	See note 2			✓
Case marking		✓	✓	✓	
Serialization (3.10.9) and case marking		✓			✓
Radiography	MIL-STD-750 TM 2076 / ESCC 5000 F3	✓			✓
Thermal impedance	MIL-STD-750 TM 3161 / ESCC 5000 F3	✓	✓	✓	✓
EAS single pulse avalanche energy	MIL-STD-750 TM 3470 / ESCC 5000 F3	✓	✓		
SOA (Safe Operating Area)	MIL-STD-750 TM 3774 / ESCC 5000 F3	✓	✓		✓
Electrical / gate stress test	See note 1	✓	✓		✓
Burn-in					
Initial electrical test	See note 1	✓	✓	✓	✓
High Temperature Gate Bias (HTGB)	MIL-STD-750 TM 1042 / ESCC 5000 F3	✓	✓		✓
Interim electrical, delta and PDA (E.5.2)	See note 1	✓	✓		✓
High Temperature Reverse Bias (HTRB)	MIL-STD-750 TM 1042 / ESCC 5000 F3	✓	✓		✓
Final electrical test, delta and PDA (E.5.2)	See note 1	✓	✓		✓
Outlier identification (interim and final)		✓	✓		✓
Final electrical test (hot)	See note 1	✓			✓
Final electrical test (cold)	See note 1	✓			✓
Outlier identification (hot and cold tests)		✓			
QCI sample selection and tests		✓	✓		✓
Finishing					
Solder dip		✓	✓	✓	
Lead form (option)					
Hermetic seal (fine leak detection)	MIL-STD-750 TM 1071 / ESCC 5000 F3	✓	✓	✓	✓
Bubble test (gross leak detection)		✓	✓	✓	✓
Case isolation (isolated devices)	MIL-STD-750 TM 1081 / ESCC 5000 F3	✓	✓		
Group A2 electrical test	See note 1	✓			✓
Outlier identification (A2)	See note 1	✓			✓
QC final visual examination	MIL-STD-750 TM 2071 / ESCC 5000 F3	✓	✓	✓	✓
Packaging, labelling and C of C		✓	✓	✓	✓
Configuration audit		✓	✓	✓	✓

Note 1: Electrical test with read and record, test method 3403 (VTH), 3407 (BVDSS), 3411 (IGSS), 3413 (IDSS), 3421 ($R_{DS(on)}$), and 4011 (VSD) apply.

Note 2: 100% PIND. If parts are built with die coat, screen is omitted and tested as part of QCI.

Note 3: JANS inspection lot requirements: Small lot is 1,000 parts or fewer, die must originate from a single wafer lot, and built (sealed) within 31 calendar days.

ESCC 5000
JANS

JANTXV

SCS

SCV

European standard for discrete semiconductors, hermetically sealed and die screened in accordance with DLA MIL-PRF-19500 standard for discrete components. This is the highest level of testing including the standard tests, the JANTXV tests, plus particle impact noise detection, serialization, failure analysis, and traceability to a wafer lot. Screened in accordance with DLA MIL-PRF-19500 standard for discrete components. This includes the standard tests, plus the TX power and condition tests, and a visual inspection. IR HiRel QIRL equivalent to JANS screening
IR HiRel QIRL equivalent to JANTXV screening

QCI sample selection & tests

		JANS (or SCS)	JANTXV (or SCV)	COTS	ESCC 5000
Quality Conformance Inspection	Specification reference				
Group A - electrical verification	MIL-STD-750 / ESCC 5000 F4	✓	✓		
Group B - long-term performance verification (JANS)	MIL-STD-750 / ESCC 5000 F4	✓			✓
Group B - long-term performance verification (JANTX, JANTXV)	MIL-STD-750 / ESCC 5000 F4		✓		
Group C - packaging, annual (12 month), each package type	MIL-STD-750 / ESCC 5000 F4	✓	✓		✓
Group E - product qualification	MIL-STD-750 / ESCC 5000 F4	✓	✓		

Robust radiation testing

Over the life of a multi-year spacecraft mission, cumulative total ionizing dose (TID) levels in the range of 100krad can be common. While TID levels >20Mrad are possible in highly active magnetospheres, such as found around Jupiter, Saturn, Uranus, and Neptune, spacecraft shielding can reduce such TID levels by a factor of 800 to 25krad. IR HiRel's rad hard power semiconductors are tested for TID levels of 100krad to 1Mrad. Even at the minimum 100krad TID rating, the devices show high-performance and can easily operate for at least three years in LEO with minimal shielding.

IR HiRel's rad hard power semiconductors are also tested for single event effects (SEE) with high-energy radiation bombardment from Kr, Xe, and Au ions, typically making the devices immune for LET levels of 37 MeV/mg/cm² to 90 MeV/mg/cm². While the possibility of particles/ions with LET \geq 28 MeV/mg/cm² for GEO is two per year, our device qualifications exceed the LET levels required for short- and long-term space missions in LEO, MEO, GEO and deep space.

Confidence of QPLs

IR HiRel continues to make holistic investments in silicon for space and other demanding applications. With silicon's proven heritage, performance, robustness, and well-established screening and reliability standards, our high-reliability power semiconductors are backed by the confidence of QPLs and all that entails. Why risk your mission with anything else?

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