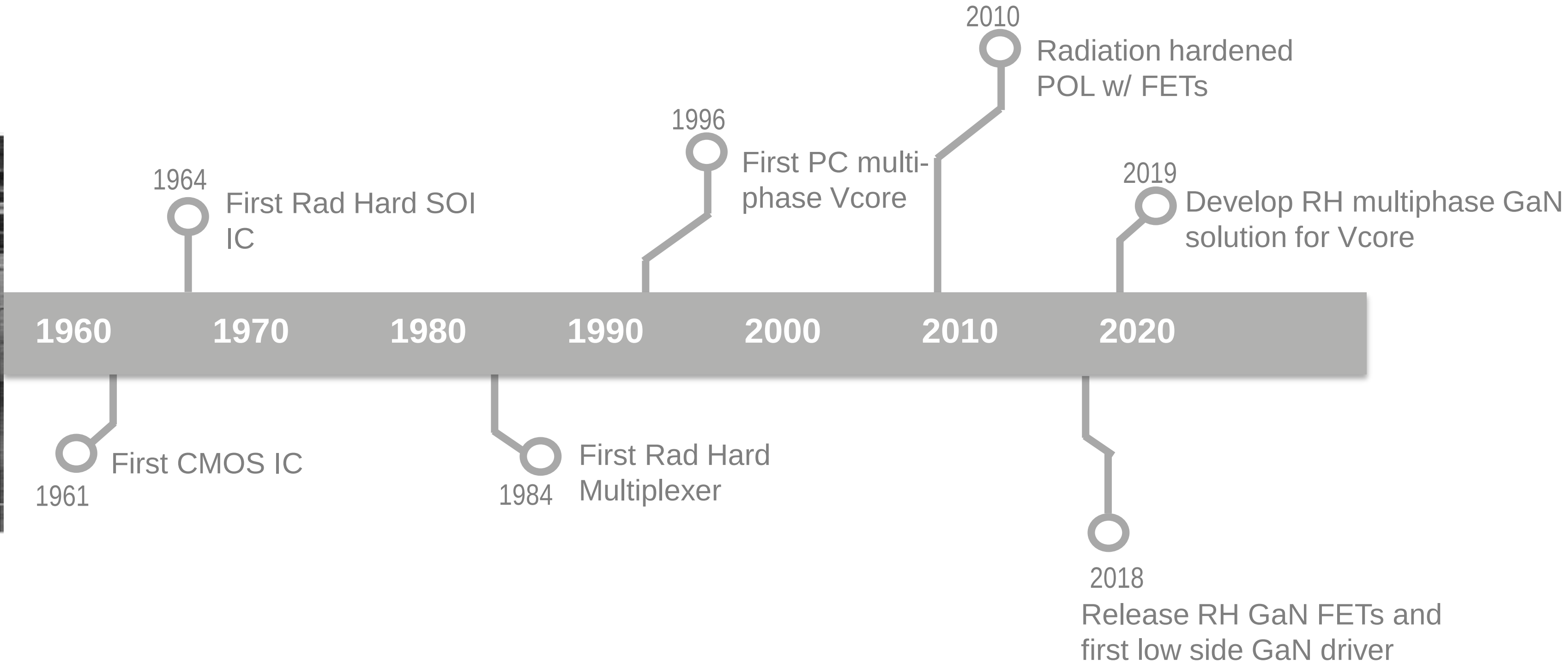
INTERSIL HIGH RELIABILITY
SPACE COMPONENT UPDATE

MAR 2019
ESCCON CONFERENCE,
ESTEC/ESA, NOORDWIJK, NL
RENESAS ELECTRONICS CORPORATION

HERITAGE OF INNOVATION FOR HIGH RELIABILITY

- **Legacy of ground-breaking innovation in the most challenging applications**



1961 First CMOS IC

1964 First Rad Hard SOI IC

1984 First Rad Hard Multiplexer

1996 First PC multi-phase Vcore

2010 Radiation hardened POL w/ FETs

2018 Release RH GaN FETs and first low side GaN driver

2019 Develop RH multiphase GaN solution for Vcore

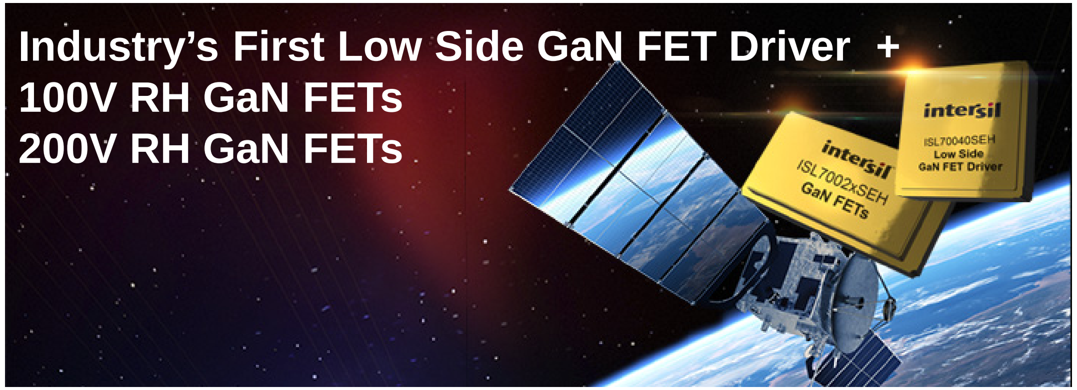
POWERING SPACE

Payload and Bus Satellite Systems, Launch Vehicles

- Support for extreme temperatures and no-down time environments
- Unrivaled flight history
- Proven Rad-Hard process technology
- In-house ELDRS radiation testing

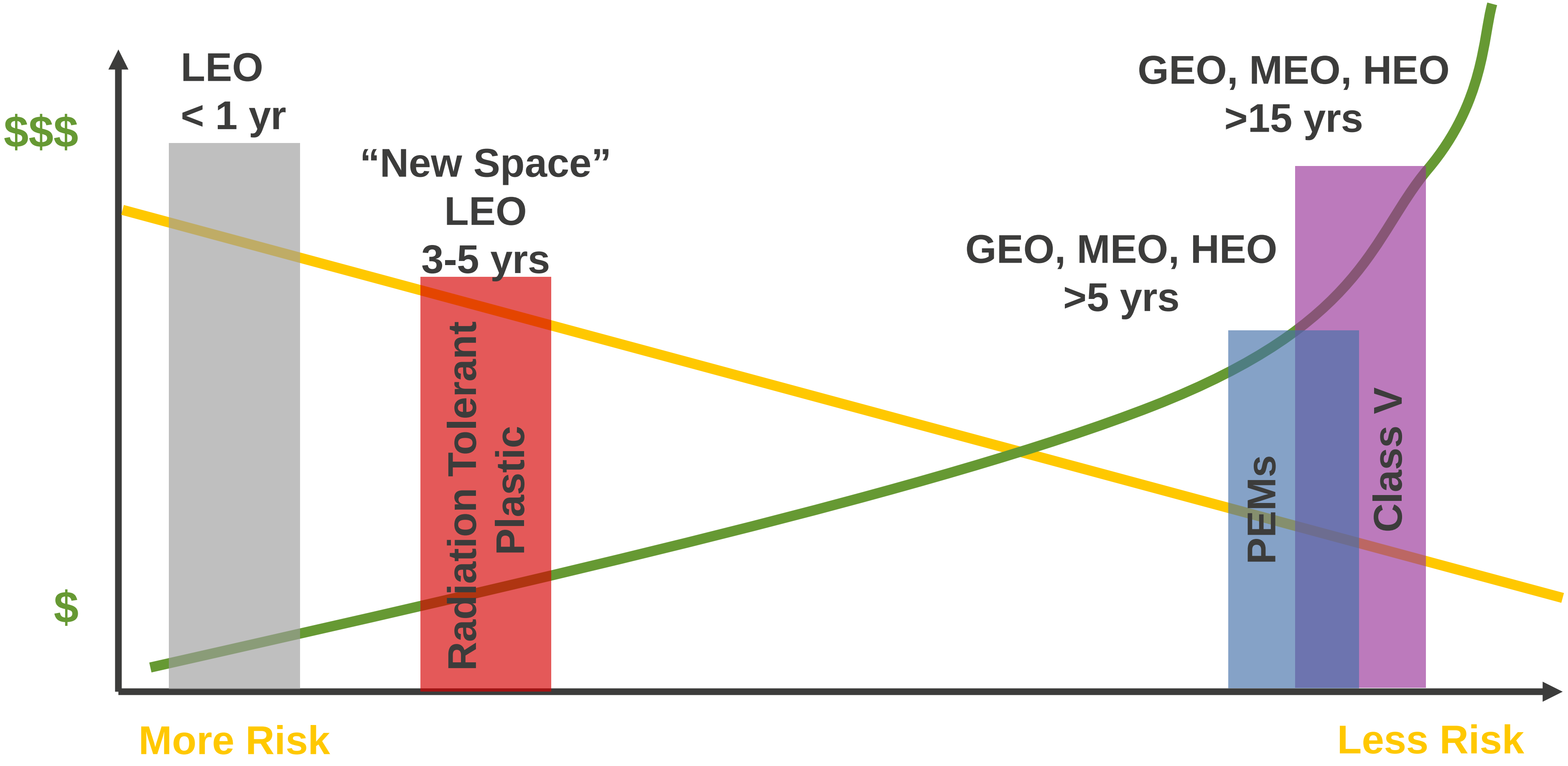
Technology Leaders in Power Management and Precision Analog

- Power: Integrated FET POLs, LDOs, GaN FETs, GaN FET Drivers, PWM Controllers
- Analog: Op Amps, In- Amps, VREFs, Temp Sensors
- Digital: Gates, buffers, decoders, inverters


Industry’s First Low Side GaN FET Driver +
100V RH GaN FETs
200V RH GaN FETs


Industry’s First Radiation-Hardened Quad Power Supply Sequencer

SUPPORTING THE BROAD SPECTRUM OF SPACE



INTERSIL SPACE PLASTIC PRODUCTS

A few years back, Renesas started developing space grade products in plastic packaging

- The first round of parts used Rad Hard die and industrial grade plastic packaging techniques
- Newer products, including roadmap parts use a mix of Rad Hard and commercially developed products
- Renesas calls this the Radiation Tolerant (RT) Plastic flow

Renesas is currently developing 1 product on a newer flow

- This flow is use the PEMs flow outlined by Aerospace Standard AS6294/1*
- The concept is to create essentially a plastic “Class V” type flow

*AS6294/1 calls for lot assurance testing for SEE – Renesas does not intend to do this testing, all other testing in the standard will be performed as specified

MISSION PROFILE FOR RT PLASTIC

Expected Life Cycle ≤ 5 years

- **Satellites will be replaced with system upgrades**

Low Earth Orbit (LEO)

- **TID target = 30krad(Si)**
- **SEE target = LET 43MeV·cm^2/mg**
  - Ensure destructive SEE to eliminate early termination of satellite life cycle
  - Non-destructive SEE can be typically handled with redundancy, EDAC, filtering, etc.

Cost Sensitive (Cost can be ~10%-20% of Class V in high volume)

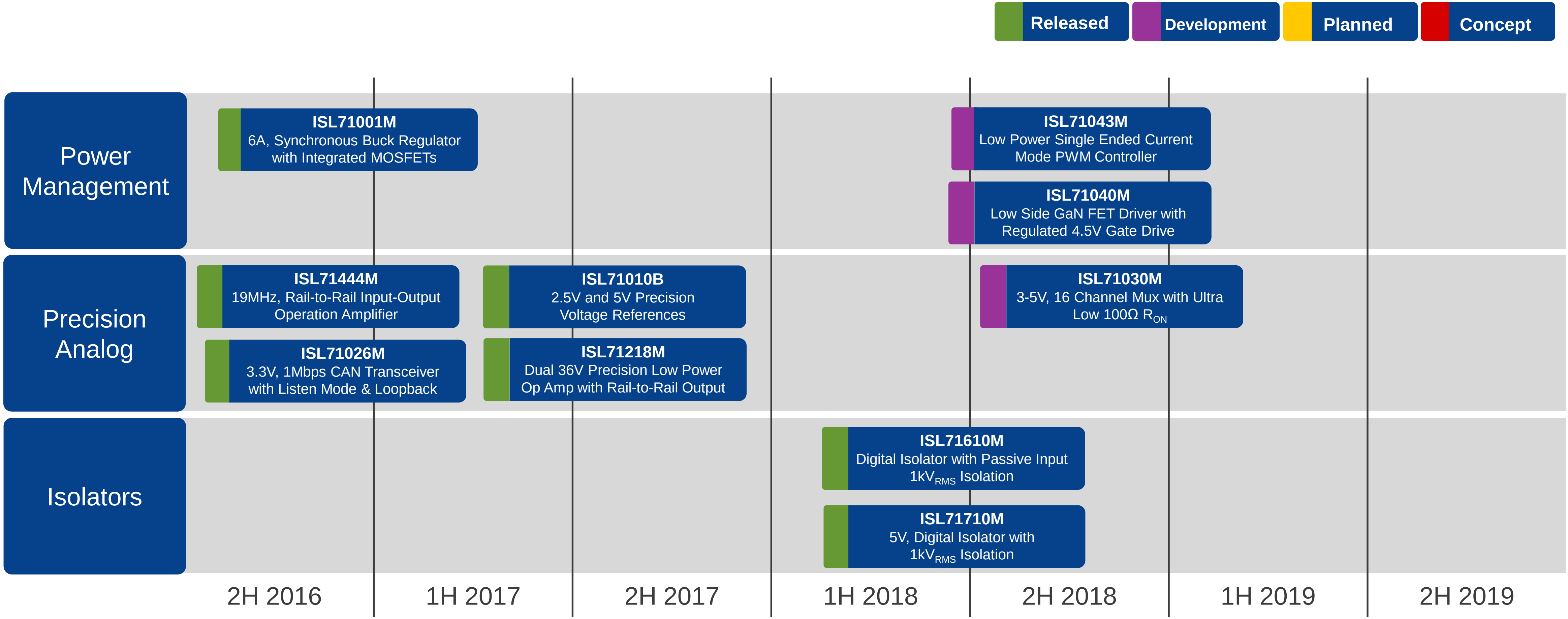
- **Cost reduction areas**
  - Plastic package vs. hermetic
  - No ongoing RLAT; radiation characterized one time up front
  - No ongoing in-line quality monitors, i.e. burn in
  - Single temperature production testing (25C)

RADIATION TOLERANT PRODUCT QUALIFICATION

- One time characterization to 30krad(Si) at a dose rate of ≤10mrad/sec.
- SEE characterization for destructive and transient events at 43MeV·cm^2/mg
  - Summary of SEE & TID testing included in the datasheet
- 2 lot temperature characterization to -55C and +125C

Test	Test Conditions	Lots	Samples/Lot
External Visual, Serialization	JSED22-B101	3	77
Preconditioning	JEDEC J-STD-020/JESD22 – A113	3	77
TCT	JESD22-A014, -65C to +150C for 500 cycles	3	77
UTHB	JESD22 A101 +85C, 85%, 100 hrs	3	77
THB	JESD A101 +85C, 85% RH 400 hrs	3	77
HTSL	JESD22 A103 +150C, 1000 hrs	3	77
HTOL	JESD22 A108, +125C, 2000 hrs	3	77
MSL	JEDEC J-STD-033C	3	77
WBS	AEC-Q100-001 Wire Bond Shear	3	77
WBP	MIL-STD-883 Method 2011, Wire Bond Pull	3	77
Outgas	ASTM E595, 1.5 NASA Plastic Outgas	1	15
ESD - HBM/MM/CDM	AEC-Q100-002, AEC-Q100-003, AEC-Q100-011	1	3
LU	Latch Up JESD 78E	1	6

RADIATION TOLERANT PRODUCTS ROADMAP



🟩 Released 🟪 Development 🟨 Planned 🟥 Concept

Power Management

🟩 **ISL71001M**
6A, Synchronous Buck Regulator with Integrated MOSFETs

🟪 **ISL71043M**
Low Power Single Ended Current Mode PWM Controller

🟪 **ISL71040M**
Low Side GaN FET Driver with Regulated 4.5V Gate Drive

Precision Analog

🟩 **ISL71444M**
19MHz, Rail-to-Rail Input-Output Operation Amplifier

🟩 **ISL71026M**
3.3V, 1Mbps CAN Transceiver with Listen Mode & Loopback

🟩 **ISL71010B**
2.5V and 5V Precision Voltage References

🟩 **ISL71218M**
Dual 36V Precision Low Power Op Amp with Rail-to-Rail Output

🟪 **ISL71030M**
3-5V, 16 Channel Mux with Ultra Low 100Ω R_{ON}

Isolators

🟩 **ISL71610M**
Digital Isolator with Passive Input $1kV_{RMS}$ Isolation

🟩 **ISL71710M**
5V, Digital Isolator with $1kV_{RMS}$ Isolation

OTHER POSITIVE ATTRIBUTES

- In the majority of the cases the die robustness is still there
  - In regards to functioning in a space environment
- Heat transfer capability is equal or better than the traditional hermetic package
- Mass and physical size are much less than the hermetic counter part
- Mechanically more rugged than many hermetic packages
  - Especially under shock & vibration
- The only difference is the handling, storage and preconditioning for board assembly
  - Nothing new compared to commercial applications
  - MSL sensitivity is not an issue once in space
- Outgassing of molding compound tested to ASTM E 595 specification
- With the Renesas acquisition we have a broad portfolio of digital products to leverage for this new space market
- All these devices are EAR99 and have limited export restrictions!

RADIATION HARDENED PEMS FLOW

NEW PEMS FLOW AT RENESAS

Our customers have provided feedback that hermeticity is not necessarily a requirement but radiation hardness and reliability are.

Mission Profile

- Expected Life Cycle > 10 years
  - Satellites will be more traditional, with new weight and size requirements
- Medium/Geosynchronous/High Elliptical Orbits (MEO/GEO/HEO)
- Traditional radiation hardness still required
  - TID Target = 75-100krad(Si)
  - SEE Target = LET of 86MeV·cm2/mg
- Not as cost sensitive
  - Cost reductions are nice, but not a primary driver
  - Size is a primary driver
  - Ongoing RLAT
  - In-line quality monitors
  - Tri-temp testing

PEMS PLASTIC QUALIFICATION TESTS

Test	Test Conditions	Lots	Samples/Lot
External Visual, Serialization	JSED22-B101	3	77
Preconditioning	JEDEC J-STD-020/JESD22 – A113	3	77
TCT	JESD22-A014, -65C to +150C for 500 cycles	3	77
UHAST	JESD22 A101 +130C, 85%, 96 hrs	3	77
HAST	JESD A101 +130C, 85% RH 96 hrs	3	77
HTSL	JESD22 A103 +150C, 1000 hrs	3	77
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CDM	AEC-Q100-011	1	3
LU	Latch Up JESD 78E	1	6

* Units for these tests will be the same devices and testing will be done in the order these are listed

PEMS PLASTIC PRODUCTION FLOW

Screen	Test Method	Condition
External Visual, and Serialization	MIL-STD-1580	
Radiography	MIL-STD-1580	
Temperature Cycling	MIL-STD-883, Method 1010	Temperature cycles, 20 cycles minimum
Initial electrical measurements	Per device specification	-55C, +25C, +125C
Engineering review		
Static Burn-In test at +125C	MIL-STD-883, Method 1015	Condition A or B
Post static BI electrical measurements	Per device specification	+25C
Dynamic Burn-In test at +125C	MIL-STD-883, Method 1015	Condition D
Final parametric and functional test	Per device specification	-55C, +25C, +125C
Calculate percent defective	Maximum acceptable PDA	<5%
Radiography	MIL-STD-1580	
Acoustic Microscopy Inspection	J-STD-020, J-STD-035	
External visual packing	MIL-STD-1580	

PEMS PLASTIC LOT ASSURANCE TESTING FLOW

Test	Sub Test	Test Method and Conditions	Quantity
Radiation Analysis		TID Only	TBD
External Visual Inspection		MIL-STD-1580 for PEMs	
Preconditioning	Moisture Soak	JESD22-A113	32
	SMT Devices Reflow Simulation	JSED22-A113, peak reflow temp +235C	
Acoustic Microscopy	All parts	J-STD-020	
Electrical Measurements	Per device spec	-55C, +25C, +125C	
Life Testing Subgroup 1	HTOL 125C	MIL-STD-883, Method 1005 2000 hrs	16
	Electrical Measurement	Hot/cold/room, per device spec	
Temperature Cycling	Temperature Cycling	MIL-STD-883 -55C to +125C, 500 cycles	
	Electrical Measurement	-55C, +25C, +125C, per device spec	
	Acoustic Microscopy		
	Failure Analysis		
HAST	Biased HAST	JSED22-A110 +130C, 85% RH 96 hrs	16
	Electrical Measurement	-55C, +25C, +125C, per device spec	

ISL73033SEHM | LOW SIDE DRIVER & 100V GAN FET

Key Specifications & Features

- V_{DS} = 100V & I_{DS} = 30A
- Very low R_{DSON}: 5mΩ (typ)
- Ultra low total gate charge: 14nC (typ)
- Integrated LS GaN FET Driver
  - 4.5V Regulated Gate Drive Voltage
  - High 3A/2.8A sink/source capability

Radiation Tolerance

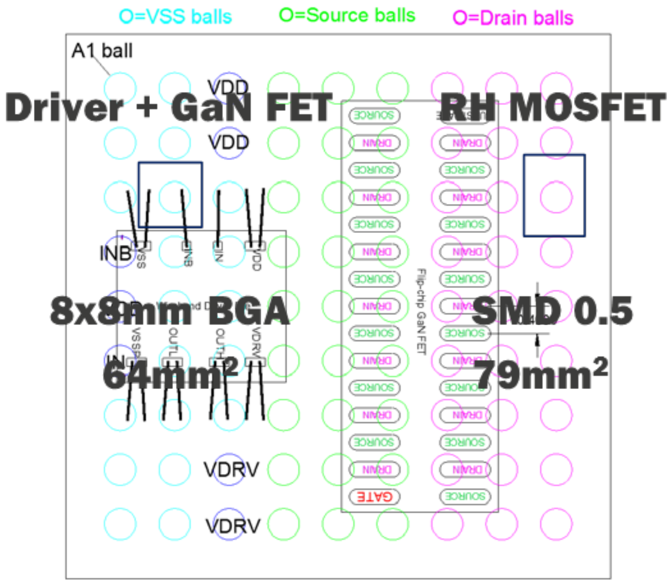
- 75krad(Si) LDR
- SEB LET = 86MeV·cm^2/mg w/ V_{DS} = 100V

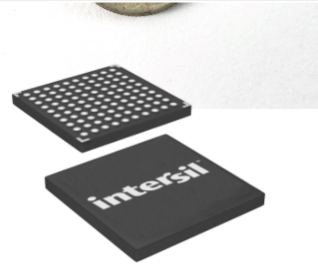
Benefits

- Simplify gate drive design with integrated driver
- Improve efficiency by reducing conduction and switching losses
- Decrease output filter size by increasing switching frequency
- Qual’ed following Aerospace Standard AS6294/1

Preliminary Package Concept

8x8mm BGA w/ 0.8mm pitch





Samples in April 2019

BIG IDEAS FOR SPACE

Renesas.com