Texas Instruments Enabling New Space

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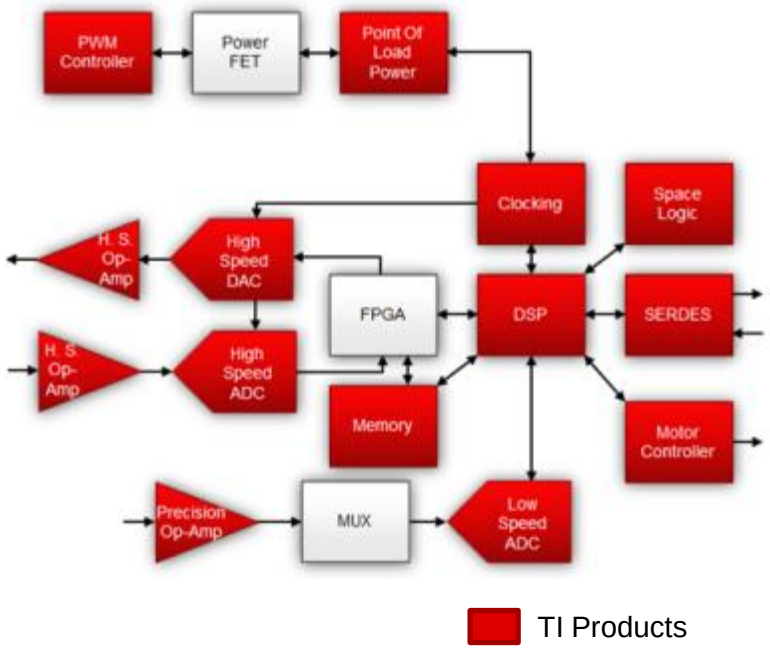
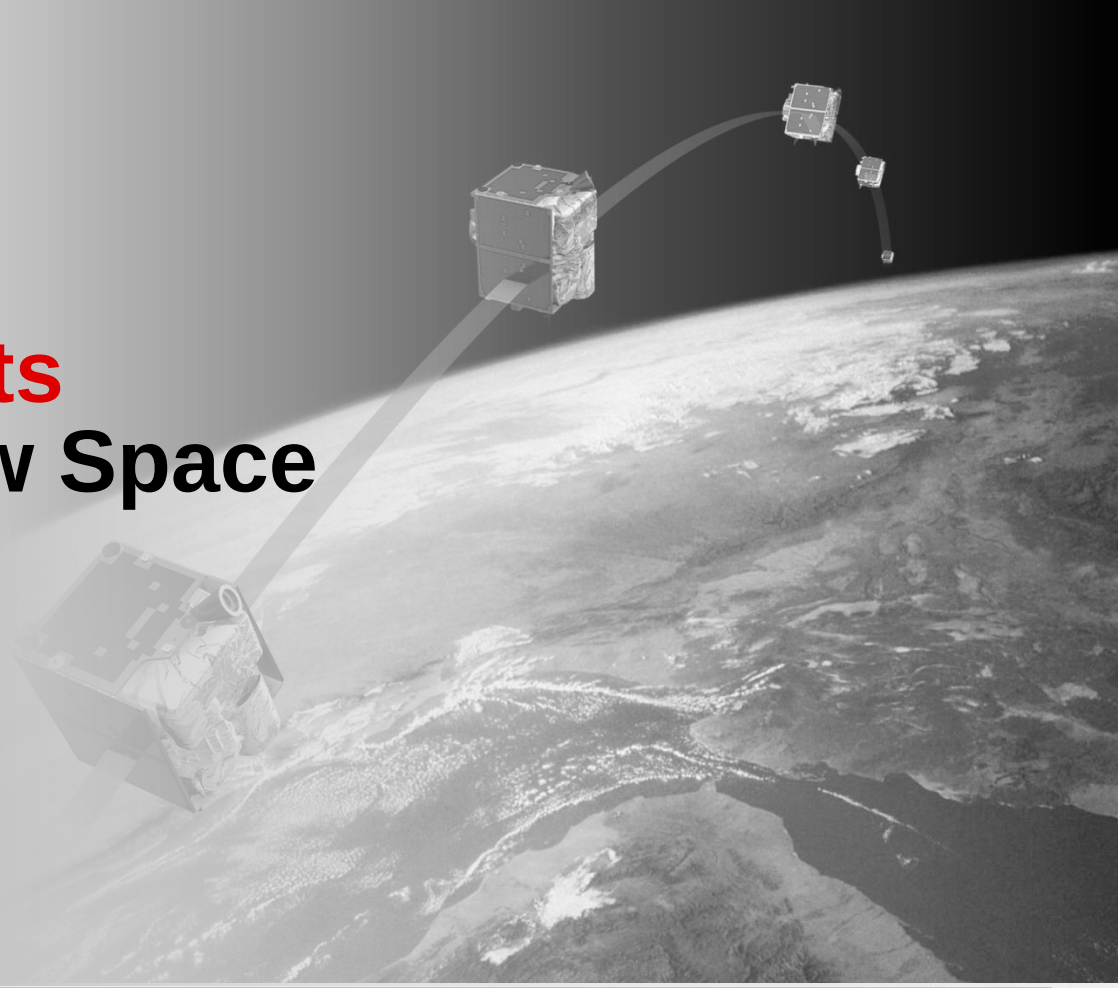
TI's Dedication to Space Market

- TI IC's are aboard **every space shuttle ever launched** and most payloads up to this day.
- **Longevity**
  - 60 years experience in the Space Market
- **Supporting long product life cycles**
  - Selling parts designed > 30 years ago
  - No obsolescence for convenience
- **Global company**
  - 8 QMLV-certified wafer fabs and growing
  - Dozens of Design Centers around the Globe
- **TI investing to grow Space business**



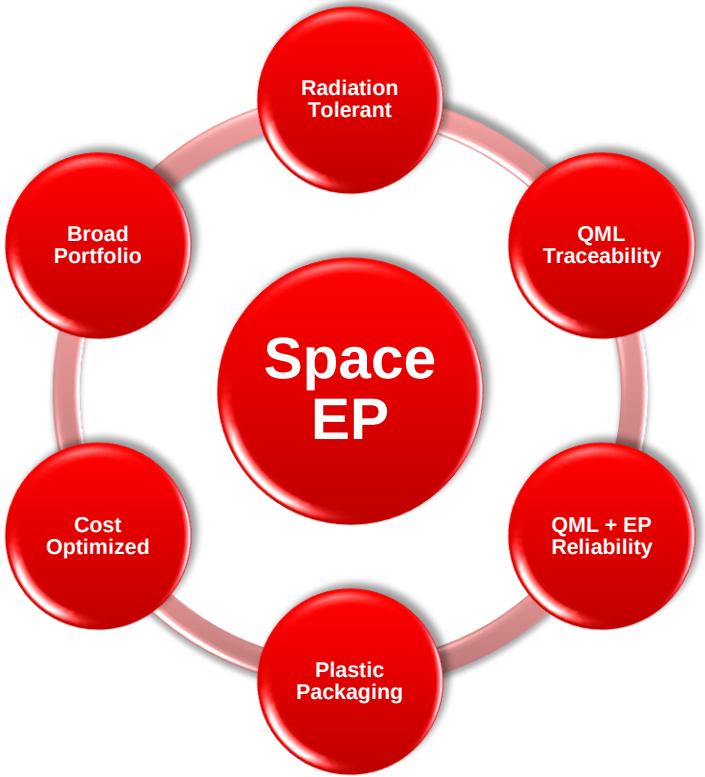
Texas Instruments
Space EP for New Space



What is Space EP?

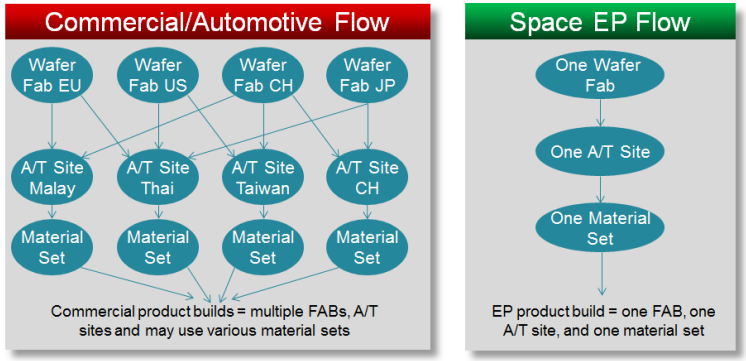
- Cost effective, high performance radiation **tolerant** solution for **shorter** duration **high volume** small satellites

- **Space EP = Traceability + Reliability + Radiation**
  - QMLV like flow
    - Wafer lot accept
    - Traceability
  - Radiation
    - RHA Qualification: **20k rad**
    - SEL Characterization : **43MeV**
  - Extra tests for qualification, production and lot acceptance
  - Enhanced Products Reliability
    - Robust material set (lead frame, mold compound, bond wire, etc..)
    - Enhanced qualification (HAST, extended temperature, meets MIL-PRF 38535 Class N)



TI's Space EP Advantages

Space EP Baseline Controlled Flow



Variability of TID

COTS devices

- Tested for electrical performance
- No test for radiation → Even though TID might be good on devices from same wafer, it can drastically change on another wafer
- Once devices shipped from Semiconductor supplier, not possible to distinguish from one wafer to other

Radiation Lot Acceptance Testing (RLAT) for Space EP Devices

Lot-to-Lot variation impact on HDR TID

Example device	HDR TID (krad)	Status
Lot #1	100	Pass
Lot #2	30	Pass
Lot #3	10	Fail

Wafer-to-Wafer impact on LDR TID

Example device	LDR TID (krad)	Status
Wafer #2	80	Pass
Wafer #3	50	Pass
Wafer #15	30	Fail

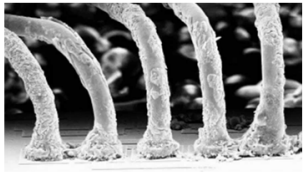
Cu Bond Wire Concerns

Most of COTS products now use Copper

Risk with Copper wire

- Bond integrity (Cu bonding to aluminum)[1]
- Corrosion due to mold compound interaction[2]
- Higher failure rate due to bondwire neck breaks during temperature cycling (The coefficient of thermal expansion [CTE] of Cu is higher than Au)[3]

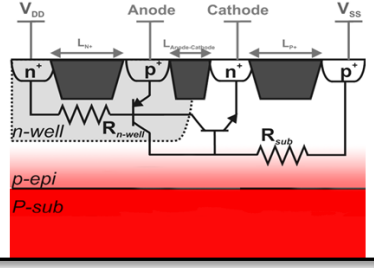
Space EP devices use gold bond wire



Sources:
[1] Luke England and Tom Jiang. "Reliability of Cu Wire Bonding to Al Metallization". Electronic Components and Technology Conference. 2007.
[2] Hui Teng, et al. "Effect of Moisture and Temperature on Al-Cu Interfacial Strength". International Conference on Electronic Packaging Technology & High Density Packaging, 2008.
[3] Bart Vandevelde and Geert Willems. "Early fatigue failures in Cooper wire bonds inside packages with low CTE Green Mold Compounds". 4th ESTC Conference. 2012, Amsterdam, The Netherlands.

Key Sources of Variability for SEL

- EPI thickness
- EPI doping
- Substrate doping



Example device: Exhibits SEL based on 0.5um variation

EPI (um)	Temp	LET	SEL
Commer.	25	60	Yes
9.5	25	85	No
9.5	125	85	No
10	25	85	Yes
10	125	60	Yes

EPI parameters controlled tightly for Space EP flow

TI's Range of Solutions

Quality / Reliability / Cost

	Commercial	Q100	EP	QMLQ	SEP	QMLV	
						QMLV	QMLV-RHA
Packaging	Plastic	Plastic	Plastic	Ceramic	Plastic	Ceramic	Ceramic
Single Controlled Baseline	No	No	Yes	Yes	Yes	Yes	Yes
Bond Wires	Au/Cu	Au/Cu	Au	Al	Au	Al	Al
Is Pure Sn used?	Yes	Yes	No	No	No	No	No
Production Burnin	No	No	No	No	No	Yes	Yes
Typical Temperature Range	-40°C - 85°C	-40°C - 125°C	-55°C - 125°C (majority)	-55°C - 125°C	-55°C - 125°C (majority)	-55°C - 125°C	-55°C - 125°C
Radiation (SEL/SEE)	No	No	No	No	Yes	Yes	Yes
Radiation (TID) Lot Acceptance (RLAT)	No	No	No	No	Yes	No	Yes
Lot Level Temp Cycle	No	No	No	Group D	Lot Level	Group D	Group D
Lot Level HAST	No	No	No	N/A	Yes	N/A	N/A
Life Test Per Wafer Lot	No	No	No	No	No	Yes	Yes

Upcoming Space EP Devices

- Power
- Precision ADC
- Op Amp
- Comparator
- Interface
- Current Sensor
- µController
- Many More!

Development on-going for different product types. Contact TI for more details.


Thank You!
CCR 1235C
PS50604-RFHK
THA