



Verify end-of-life reliability & performance of hybrid DC-DC converters for space PMAD

Space Power Workshop 2022

Representing IR HiRel



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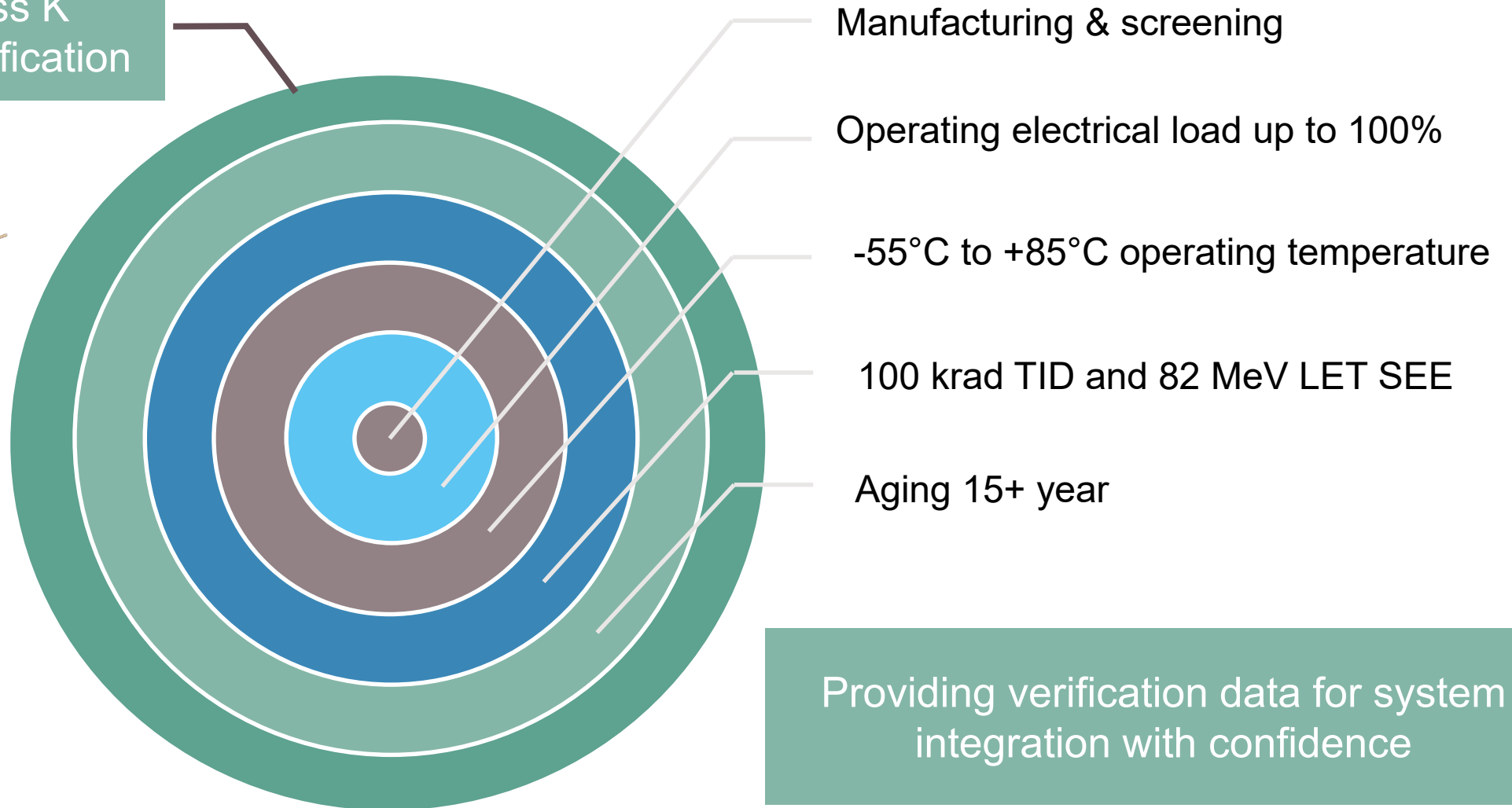
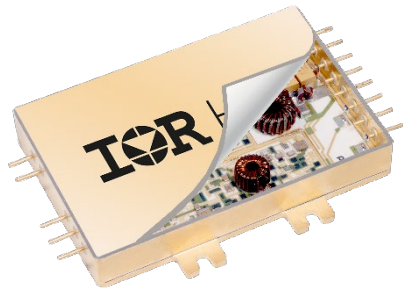
Infineon & IR HiRel: trusted supplier for space applications

- › Solution provider for memories, RF and power electronics for tough applications
- › Long history of providing power management electronics to the space community
- › Reputation of providing the highest quality and reliable products depends upon radiation-hardened designs and manufacturing process controls
- › Users of our products can count on an excellent level of service from technical pre-sales engineering, through post-sales quality support

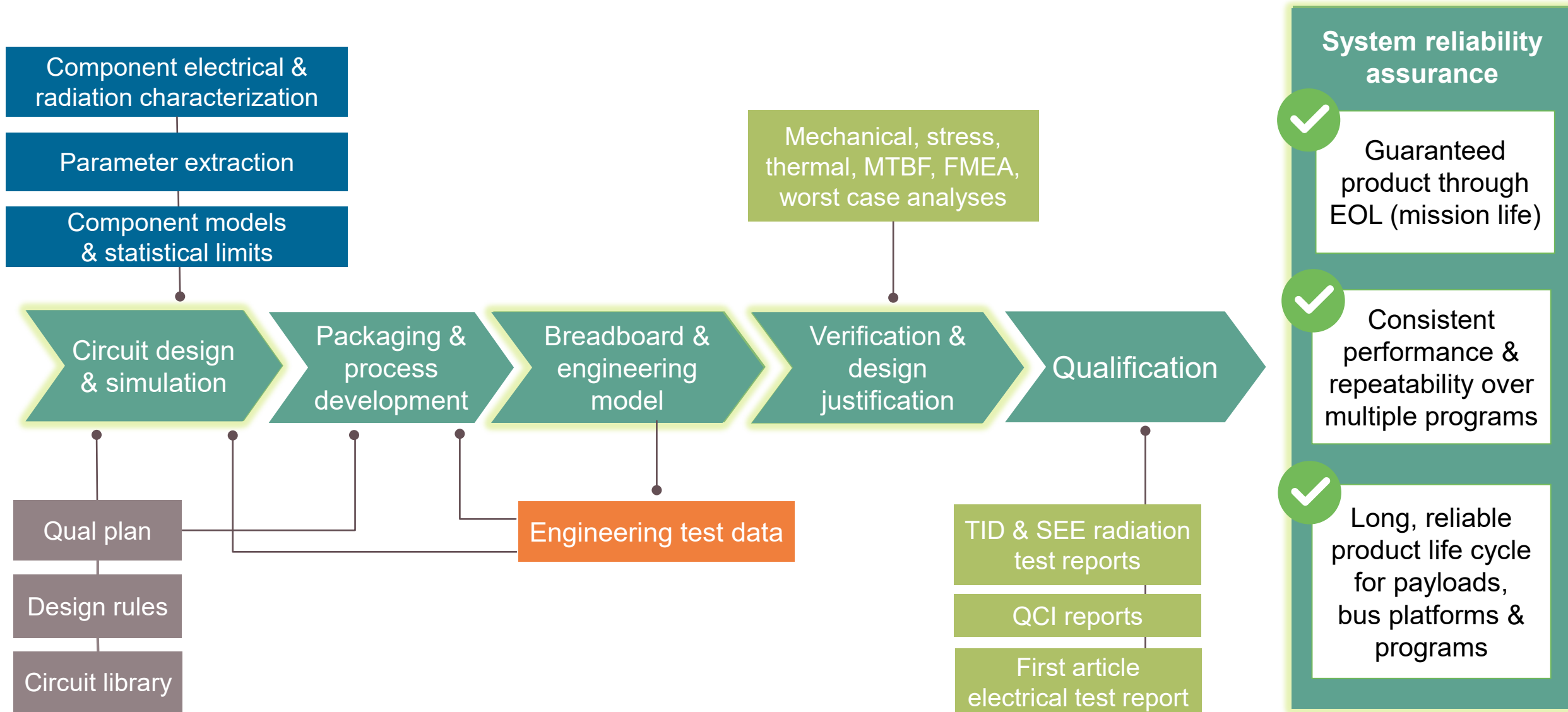


The challenge: predicting mission EOL performance and reliability

IR HiRel Class K
EOL SMD Specification



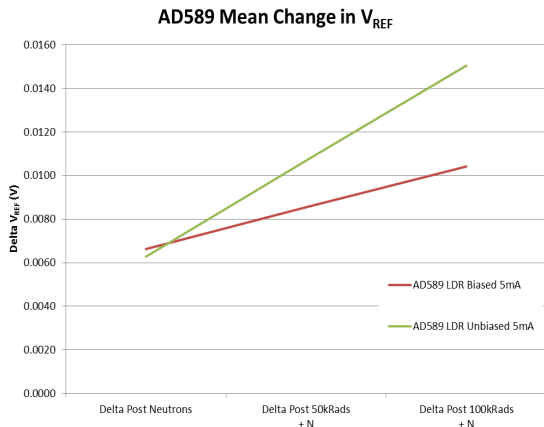
Assure system reliability with design process to verify and validate from component through product level



Component characterization and modeling are critical to predict design performance



Test data collection over bias, temperature, life and radiation

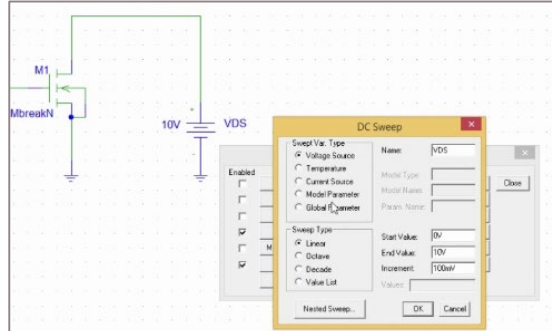


Statistical analysis and part SCD limits

Unbiased @ 1.5mA Post LDR TID + 1E12 Neutrons	50kRads		100kRads		SCD Limits	
	-Δ	+Δ	-Δ	+Δ	-Δ	+Δ
Mean Δ (mV)	--	5.72	--	8.77	--	--
P99/C90 Δ Limits (mV) ⁵	0	7.41	0	11.39	-0.11	12.22
P99/C90 Aging Limits (mV) ⁴	-0.49	3.38	-0.49	3.38	-0.49	3.38
P99/C90 Temp Limits (mV) ³	-5.15	0.97	-5.15	0.97	-4.94	3.71
Total @ P99/C90 (mV) ²	-5.64	11.76	-5.64	15.74	-5.54	19.31
Total @ P99/C90 (%) ^{1,2}	-0.457	0.952	-0.457	1.275	-0.449	1.564

SCD for procurement and production element evaluation

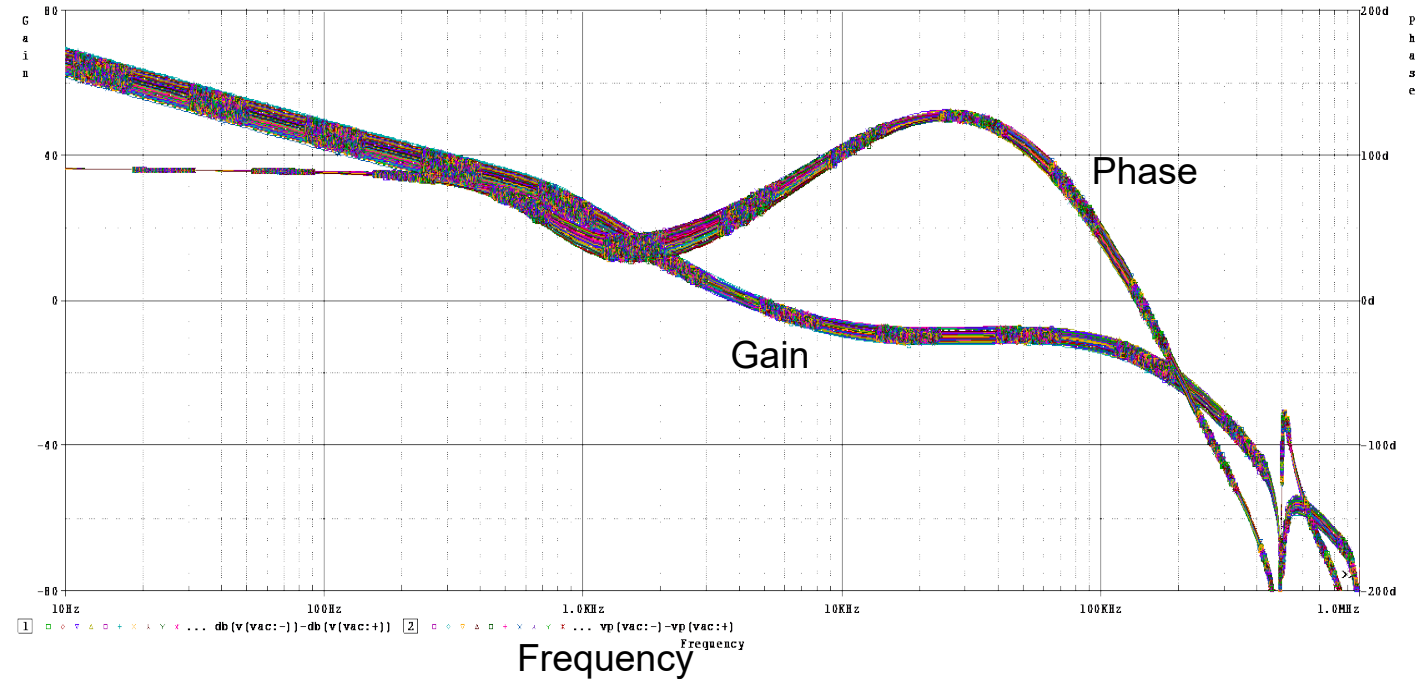
		<small>P15M HiRel 2520 Junction Avenue San Jose, CA 95134 (408) 424-5000</small>	
SOURCE CONTROL DRAWING	PREPARED BY E. Lee	TITLE HT Transistor Assembly, 2N2222 on 22 x 22 Moly Tab	
	PURCH Michael Berg	DRAWING NO. SCD 204X-0024	
	APPROVED BY Rich Perry	REVISION LETTER A	
	DATE OF APPROVAL 10/22/15	SIZE A	EDGE CODE 52467



Data shown here are for illustration only and may not be representative of a real component for confidentiality reasons

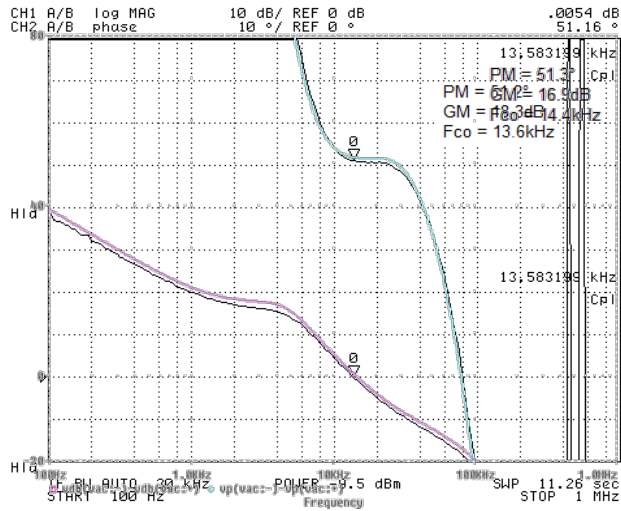
PSPICE circuit simulations predict performance and support analyses

- › Customize piece part models based on part SCD
- › Checks circuit design integrity
- › Predicts circuit behavior over operating conditions, temperature, radiation and lifetime
 - Trustworthy assumptions for parameter drift
 - Accuracy of models
- › Validates model beginning of life with actual test data

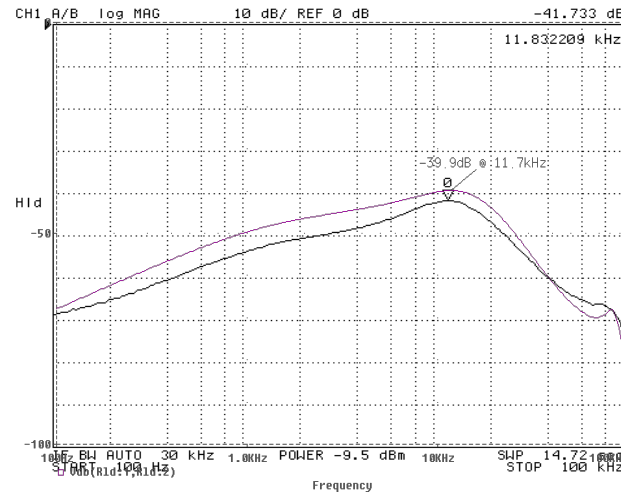


Model verification with hardware measurement provides confidence in analyses results

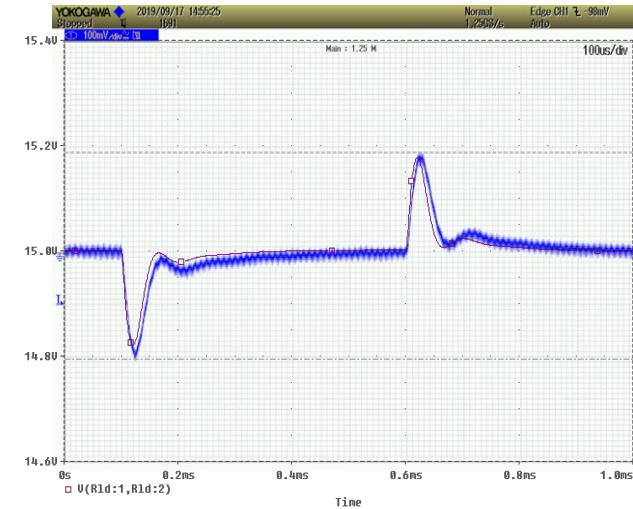
Loop Response



Line Rejection (PSRR)

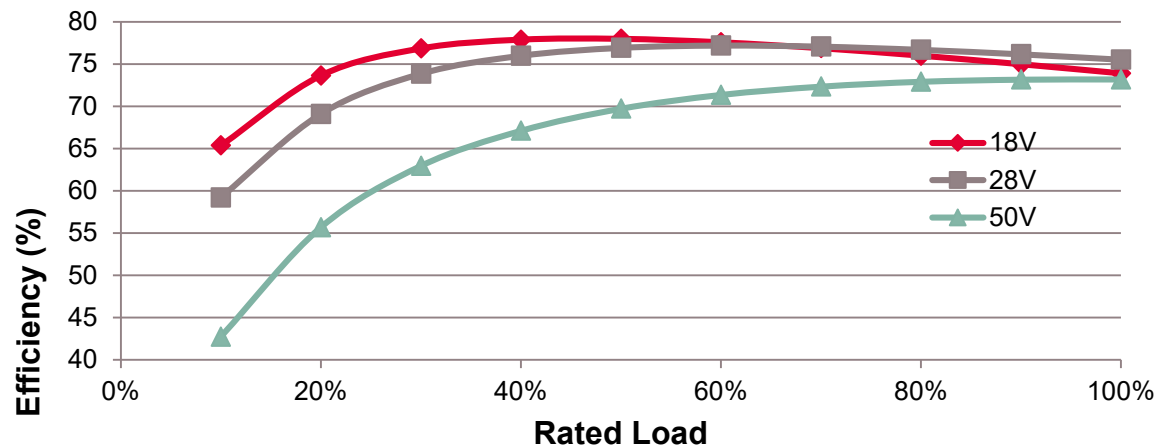


Step Load Response



Simulated vs. Measured Results

M3GB2803R3S Efficiency, 85°C



Detailed characterization



Reduces risk



Faster system level verification

Higher assurance: **product-level radiation testing** used to confirm worst case analysis (WCA) based on element-level radiation test data

SEE	IOR HiRel An Infineon Technologies Company			PMM HiRel 2520 Junction Avenue San Jose, CA 95134 (408) 434-5000		
	RADIATION TEST REPORT	PREPARED BY H. Wu	M3GB2805S SEE Test Report			
		CHECKED H. Wu				
		APPROVED BY L. Alexander				
		DATE OF APPROVAL 7/16/18	DRAWING NO. RAD-174175SEE	REVISION LETTER A		
	SIZE A	CAGE CODE 52467	SHEET 1 OF 36			

TID	IOR HiRel An Infineon Technologies Company			PMM HiRel 2520 Junction Avenue San Jose, CA 95134 (408) 434-5000		
	RADIATION TEST REPORT	PREPARED BY T. Dao	RADIATION TEST REPORT M3GB2805S DC-DC CONVERTERS			
		CHECK BY H. Wu				
		APPROVED BY L. Alexander				
		DATE OF APPROVAL 7/17/18	DRAWING NO. RAD-174175TID	REVISION LETTER A		
	SIZE A	CAGE CODE 52467	SHEET 1 OF 43			

LDR	IOR HiRel An Infineon Technologies Company			PMM HiRel 2520 Junction Avenue San Jose, CA 95134 (408) 434-5000		
	RADIATION TEST REPORT	PREPARED BY S. Steinman	M3GB2805S, DC-DC Converter LDR Radiation Test Report			
		CHECK BY P. Lee				
		APPROVED BY L. Alexander				
		DATE OF APPROVAL 08/18/17	DRAWING NO. RAD-174175LDR	REVISION LETTER C		
	SIZE A	CAGE CODE 52467	SHEET 1 OF 11			

Documented radiation performance

- › Detailed radiation test reports available
- › SEE, TID HDR (LDR when applicable)
- › Test procedure, facility and set up
- › Full electrical results with waveforms
- › Lot or model specific testing available
- › Radiation results included in WCA for EOL prediction for RHA parts
- › DLA RHA available on select models

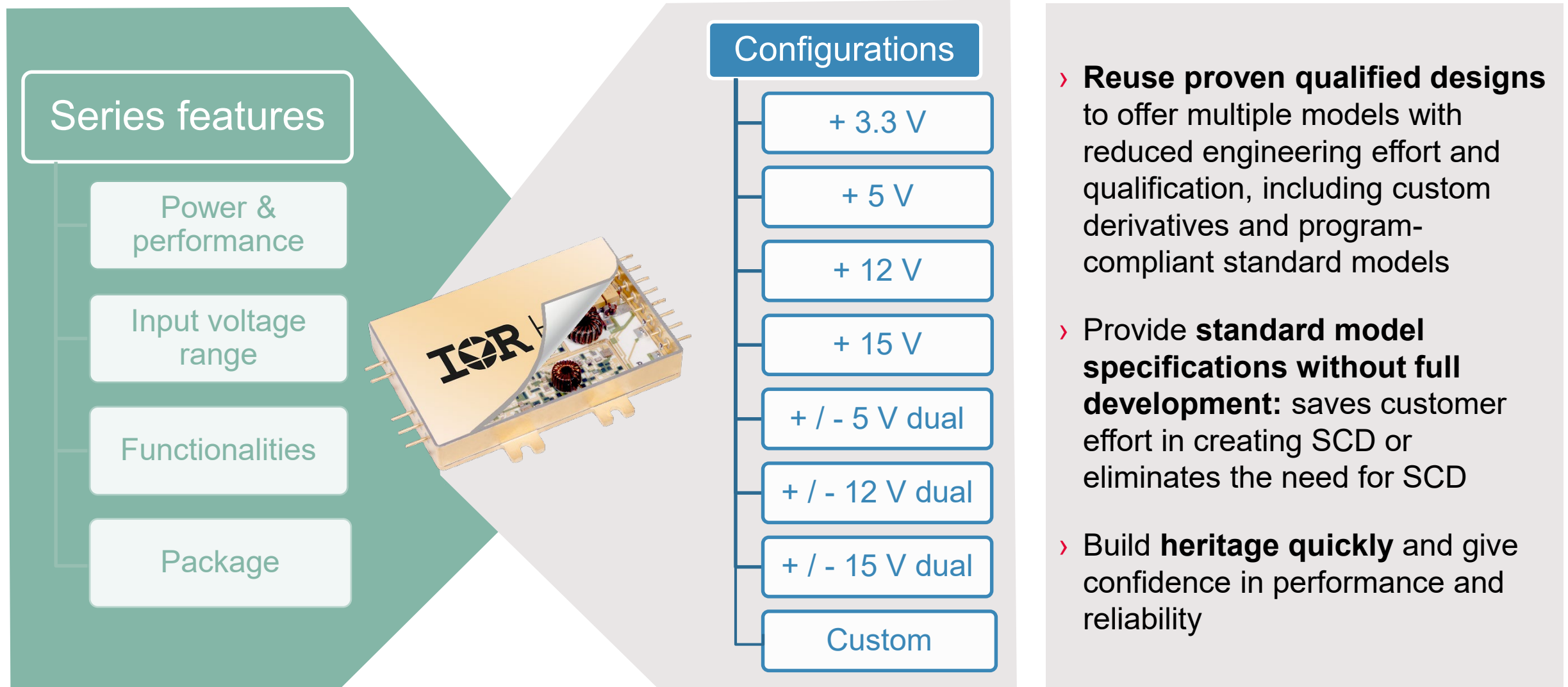


82 MeV
SEE

100krad
TID min


4.0 GENERAL INFORMATION
5.0 TEST SAMPLES
6.0 HEAVY IONS (SEE) TEST
6.1 TEST OBJECTIVES
6.2 TEST FACILITIES
6.3 HEAVY IONS TEST PROCEDURE
7.0 EXECUTIVE SUMMARY OF M3GB2805S RADIATION TEST RESULTS ..
7.1 HEAVY IONS TEST RESULTS
APPENDIX A: SEE OCSILLOSCOPE WAVEFORMS

Design methodology easily enables derivatives for high confidence use across payloads and bus platforms




Class K rad hard hermetic hybrid DC-DC converters

100 krad, 82 MeV from 5 W to 120 W




LS series (30 W)
Integrated 461 filter
Output voltage as low as 1.5 V



S series (10 W)
Compact
External
MIL-STD-461 filter

New



ARA series (5 W)
Compact, light, SMT
28 V (ARA) & 100 Vin (ARE)
External
MIL-STD-461 filter



LSO series (30 W)
Integrated 461 filter
Available with telemetry & overvoltage protection (LSO)
Output voltage as low as 1.5 V

LSO series 30 W		M3GB series 40 W	
		LS series 30 W	GH 50 W
	S series 10 W		GHP 120 W
ARA series 5 W			
1.1" x 1.45"	1.7" x 1.3"	2.3" x 1.5"	3.5" x 2.5"
13 g	50 g	80 g	110 g
Outline includes pins & flanges			

Each series has multiple standard models with standard outputs, single & dual

- M3GB series (40 W)**
Best-selling isolated converter
Single, dual & triple output
Integrated 461 filter
28 V, 70 V, 120 Vin
- GH series (50 W)**
Output voltage as low as 1 V
First hybrid space converter with *synchronous rectification*
Best-in-class efficiency
Bus converter for DPA
- GHP series (120 W)**
Highest power density 40 W/in³
28 V, 120 Vin

Mature product line that can be used as is with no additional de-rating in most applications
Backed by rigorous supporting data to prove reliability

IR HiRel broad hybrid DC-DC offering supports complex power architecture with multiple loads at various voltages and power levels

Board/section	HiRel part	Power	Output voltage
CIE – Camera Interface Electronics	LSO2803R3S	25W	3.3V
	GHP2815S	120W	15S
Power Conditioning and Distribution	GH2803R3S	50W	3.3V
CTCE – CGI Thermal Control Electronics	ARA2815S	5W	15V
	ARA2805S	5W	5V
	LSO2803R3S	25W	3.3V
	AF28461	10W	EMI filter
	LS2815D	30W	±15V dual
PAME-CPDU Precision Alignment Mechanism Electronics	ARA2805S	5W	5V
Communication and Power Distribution Unit	M3GB2812S	40W	12V

IR HiRel, single source supplier for complex power architecture

Nancy Grace Roman Space Telescope
Nine different types of IR HiRel converters
>100 converters in the system

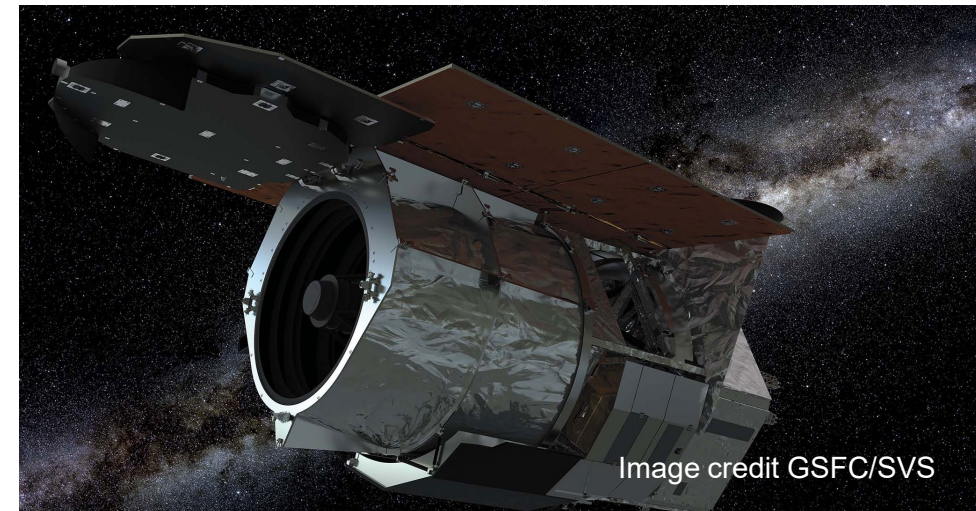
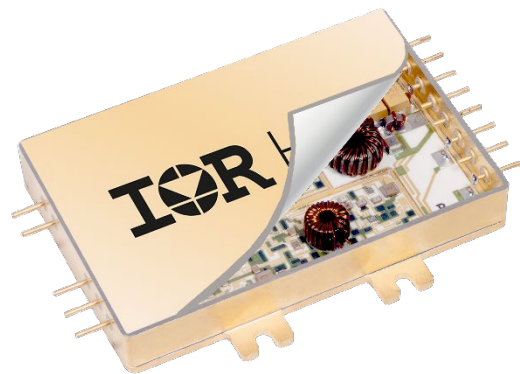


Image credit GSFC/SVS

Design in rad hard isolated hybrid DC-DC converters with confidence



› Rigorous gated development process verifies and validates performance



› Designed based on library of characterized and modeled components including IR rad hard MOSFETs



› Extensive test data collection and simulation model verification gives confidence in analysis results



› Platform design methodology leverages proven designs and processes and builds heritage quickly



› Verified and documented performance meets the need of many programs with reduced internal engineering effort and program risk

Questions?



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