

RIC70847: A Radiation Hardened Buck Controller for High Performance FPGAs in Space Applications

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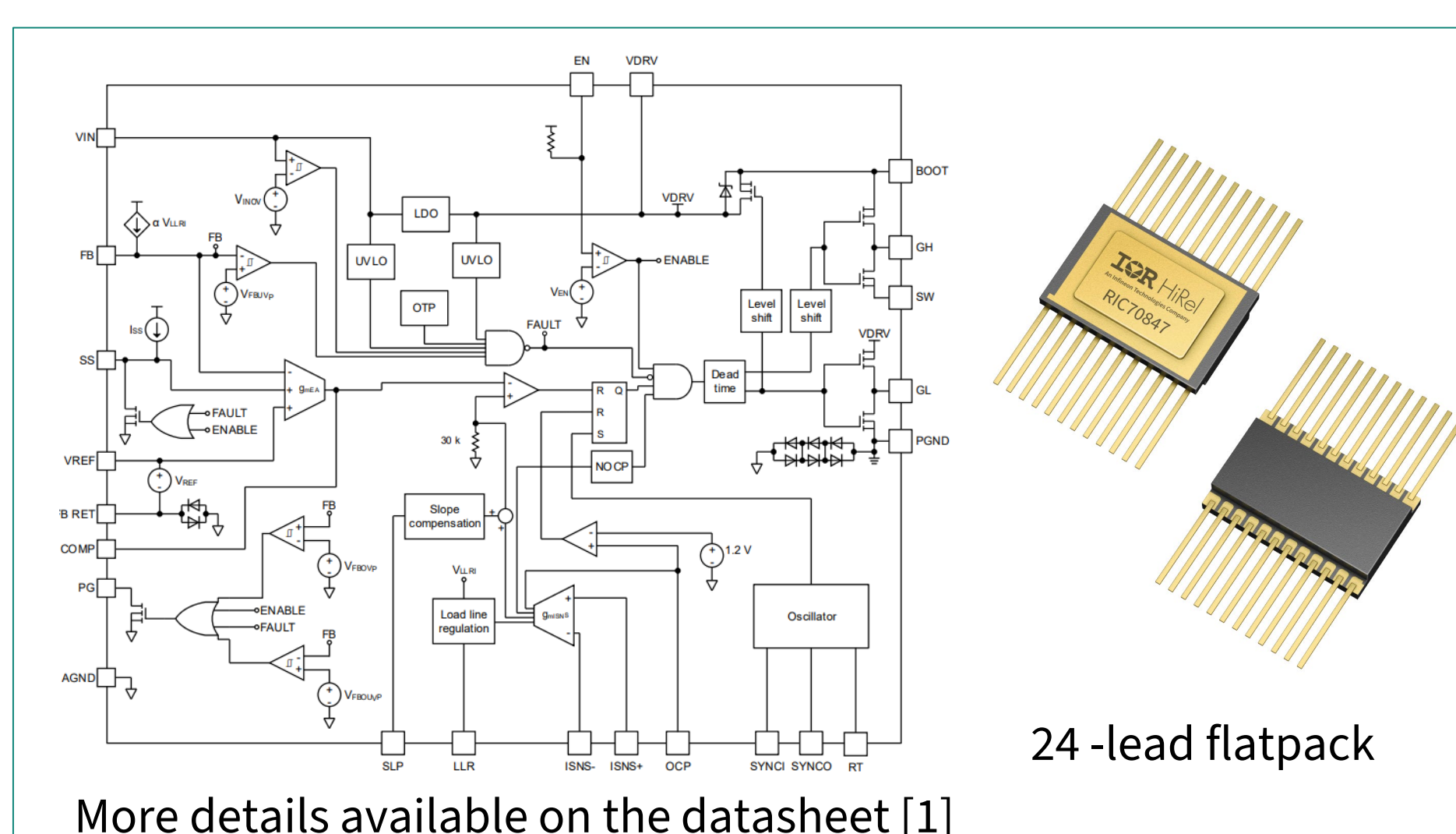
Introduction

RIC70847 is a radiation hardened by design (RHBD) synchronous buck controller with an integrated gate driver designed for harsh radiation environment and space applications. The device offers reliable performance up to 100 krad (Si) post radiation and Single Event Effects (SEE) characterized up to linear energy transfer (LET) of 81.8 MeV.cm²/mg. RIC70847 operates over the full military ambient temperature range of -55°C to 125°C and is available in hermetically sealed 24-lead flatpack or in die form.

The integrated half bridge driver has 5 V gate drive voltage and is designed to work with logic level MOSFETs, such as Infineon's radiation hardened R8 MOSFETs.

RIC70847 supports a typical wide input voltage 5 V to 12 V and output voltage of 0.6 V to 5 V. This makes it ideal for point of load (PoL) applications such as core rails for high power FPGAs and ASICs.

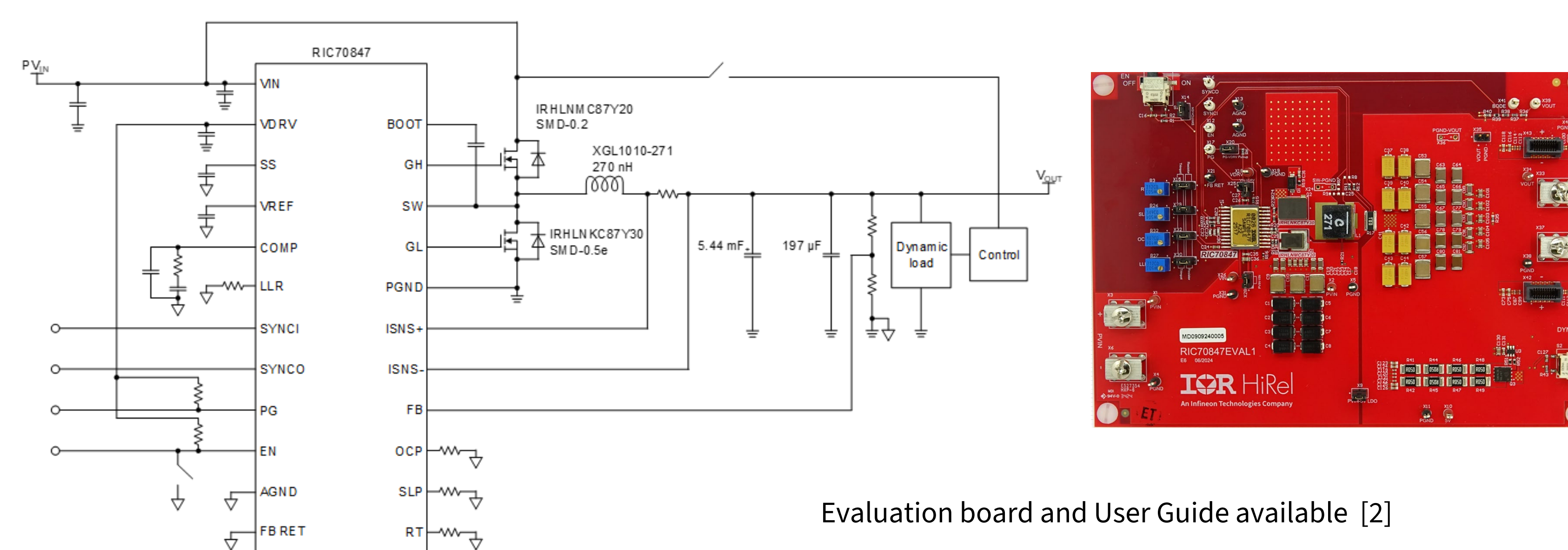
Device Details



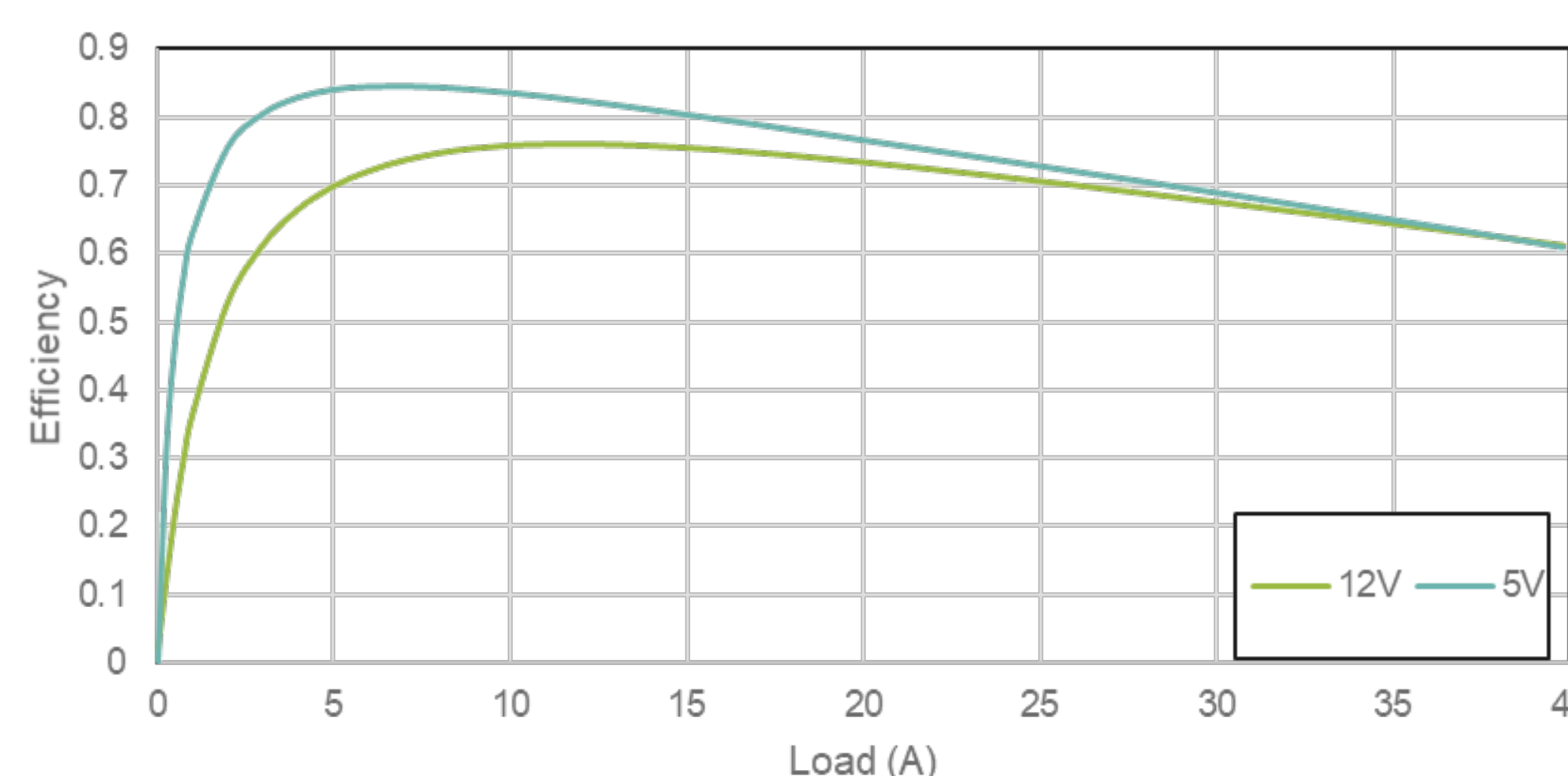
Parameter	Value
Part number	RIC70847
Package	24 pin flatpack
Qualification	MIL-PRF-38535 Class V*
Mil part number	5962R2320601VXA
CAGE Code	67210
V _{IN} (abs max)	17.1 V
V _{OUT}	0.6 V to 5.25 V
V _{REF} +V _{OSEA}	600 mV ±1%
t _{min on}	27 nsec
TID rating	100 krad
SEE rating	81.8 MeV.cm ² /mg (Si)

* MIL-PRF-38535 qualification pending

Typical Implementation and Performance

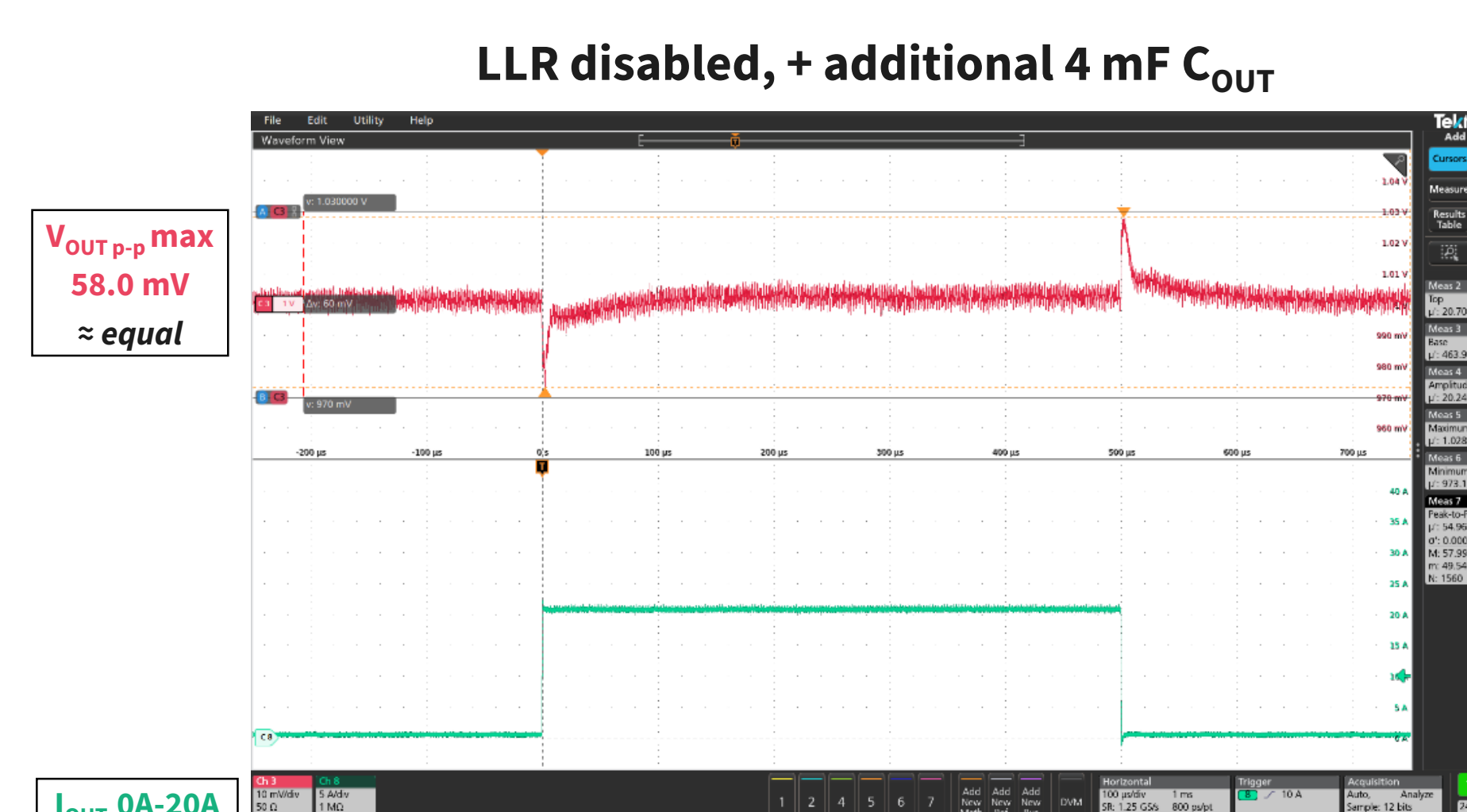
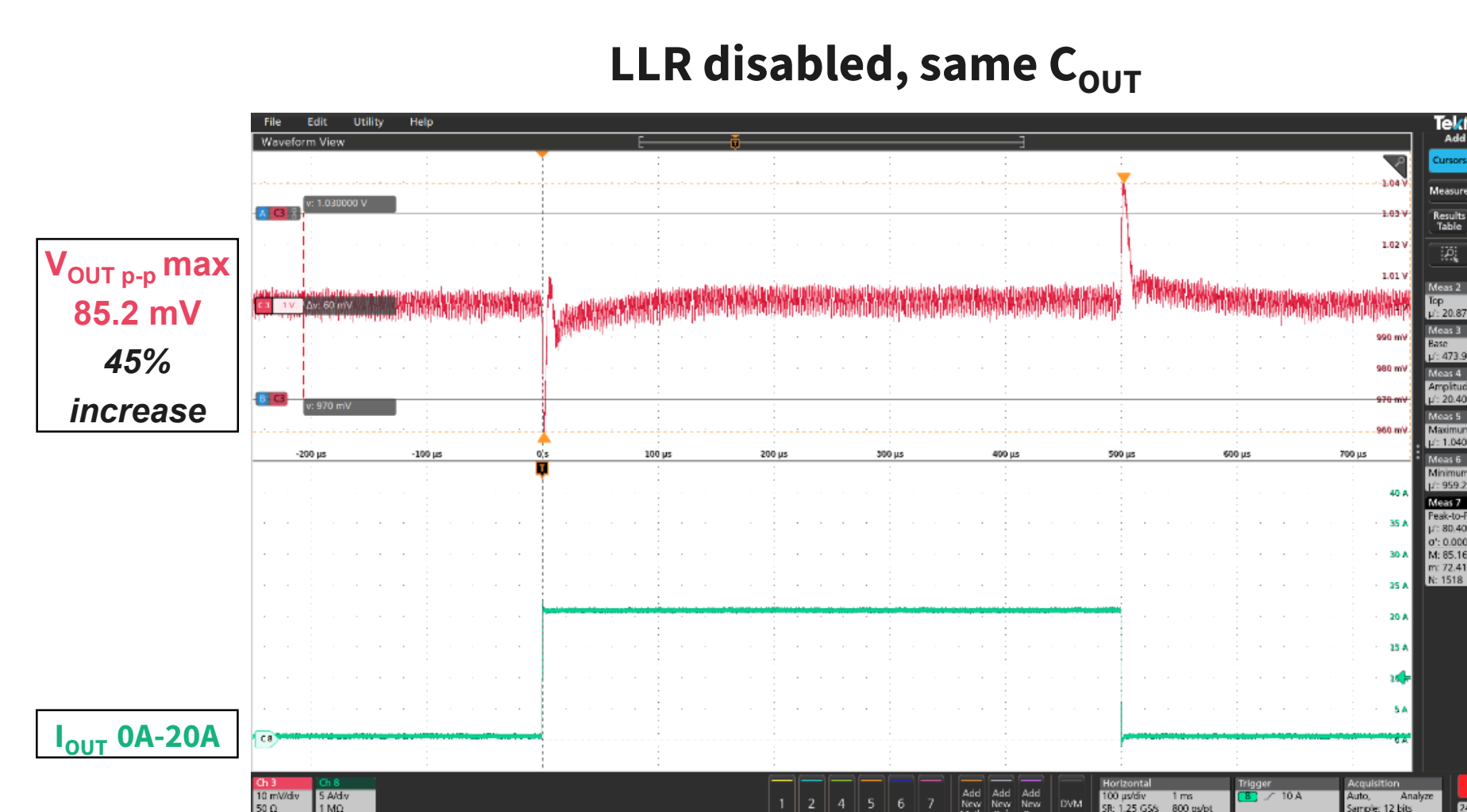
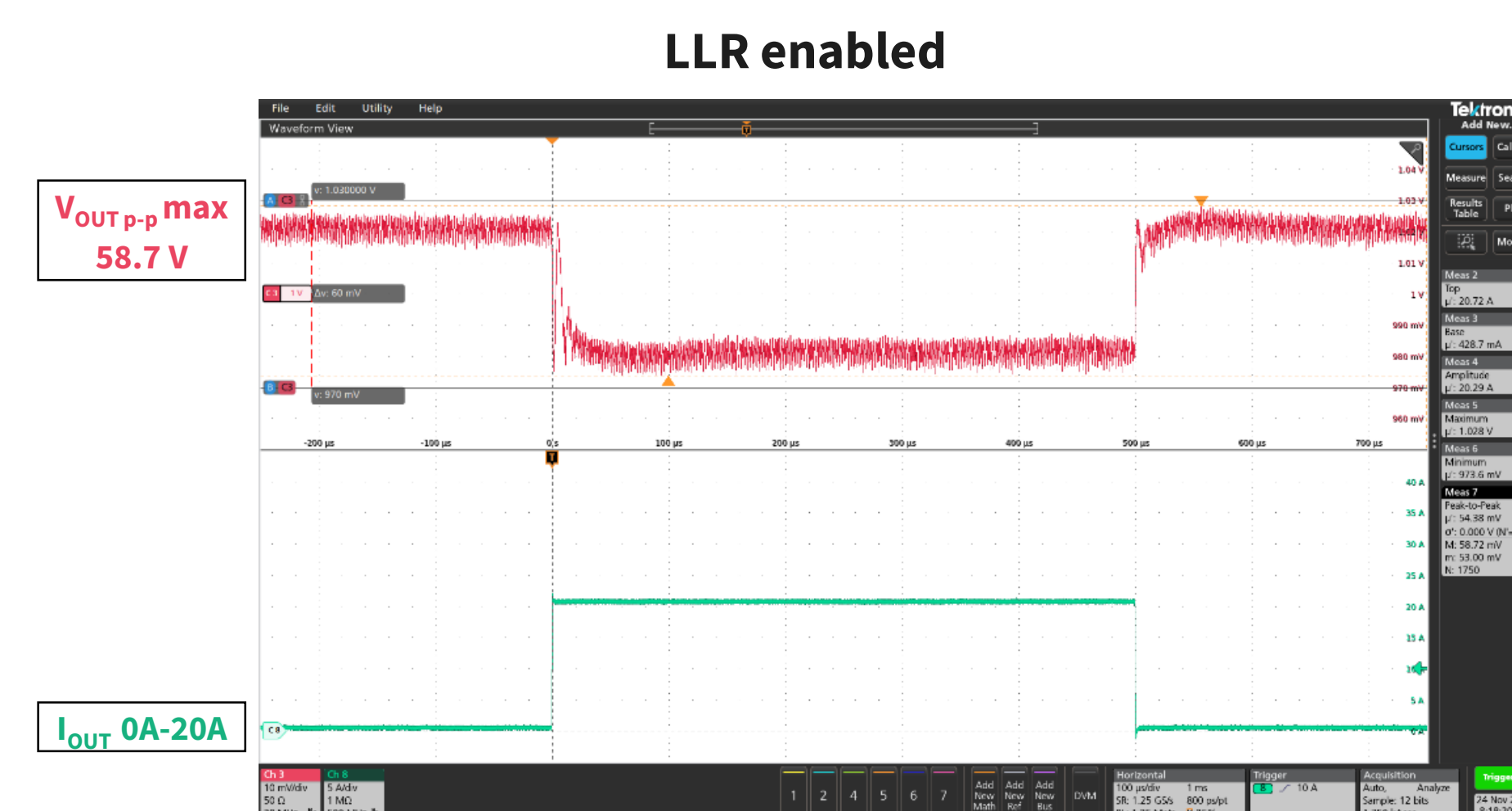
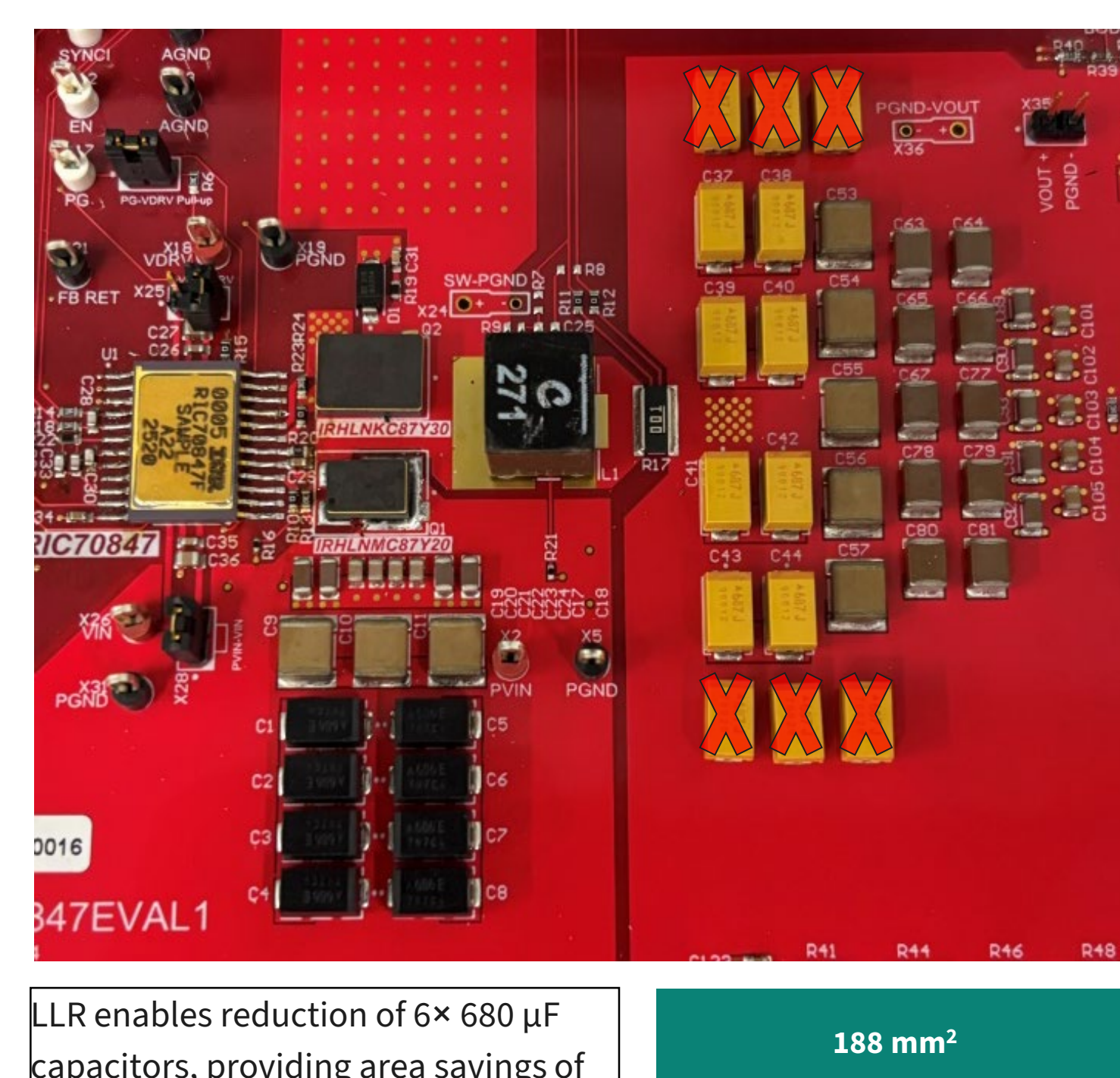


Efficiency over load at 500 kHz. V_{IN}=5 V and 12 V, V_{OUT}=1 V, L=271 nH, C_{OUT}= 11,268 uF with R8 RH MOSFETs IRHLMC87Y20 (HS) and IRHNKC87Y30 (LS).



Load Line Regulation (LLR)

FPGA and ASIC dynamic power requirements become more challenging with each generation accommodated by adding more output capacitors which add size, weight, and cost. LLR adjusts PoL output voltage to stay within FPGA minimum and maximum voltage requirements. LLR advantages are lower power dissipation, reduced output capacitor size, simpler compensation, and promotes natural current sharing in a multiphase design.



Radiation Performance

Single Event Effect Test Conditions

Parameter	Value
Beam incidence	0 degree
Fluence	≥100 errors or ≥10 ⁷ ions/cm ²
Flux	10 ² to 10 ⁵ ions/cm ² /sec
Range	≥20 micrometer
Temperature	125°C for SEL 25°C for SEB and SEGR
LET	81.8 MeV.cm ² /mg
# of Wafer Lots	3 Wafer Lots

Single Event Effect Results

Results	Tc	Vin	Wafer Lots
No SEL	125°C	16.7 V	ZA439254.3
No SEB	25°C	16.7 V	ZA441136.3
No SEGR	25°C	16.7 V	ZA442250.2

Total Ionizing Dose (TID)

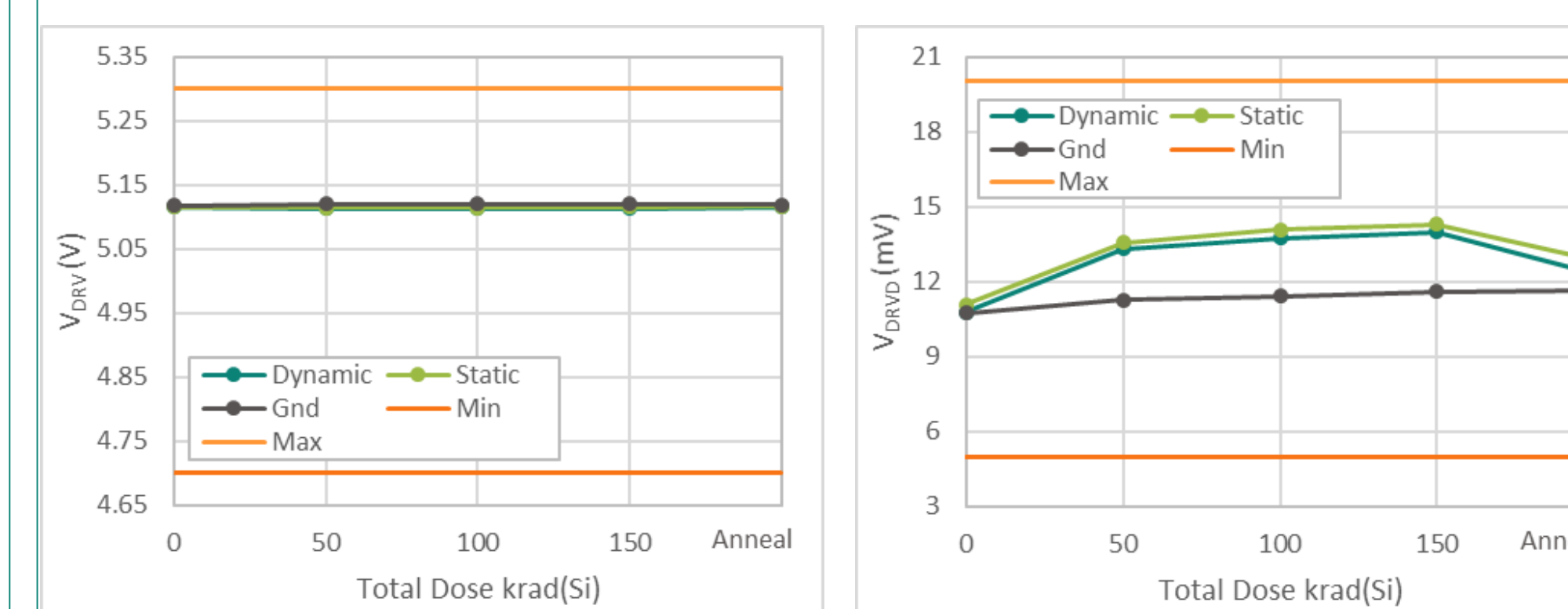
A total of 36 samples from three wafer lots were assembled and irradiated at VPT Rad facility. Two samples were biased in a dynamic condition, two samples were biased in static condition, and two samples were grounded during irradiation to 150 krad (Si) per MIL-STD-884 TM1019 which required an over-test factor of 1.5x. Dose rate was 152 rad/sec (Si).

All samples were annealed at 100°C for 161 hours. All devices from three wafer lots pass electrically.

TID Result up to 150 krad(Si) with 100°C Anneal

Results	Bias	Sample	Wafer Lot
Pass	Dynamic	4 each lot	ZA439245.3
Pass	Static	4 each lot	ZA441136.3
Pass	Grounded	4 each lot	ZA442250.2

V_{DRV} and V_{DRVD} (dropout voltage V_{IN}-V_{DRV}) as a function of TID and anneal. Comprehensive TID report can be found in [3].



References

- RIC70847 Datasheet
- RIC70847 Evaluation Board and User Guide
- RIC70847 TID Test Report

