Evaluation and Qualification of RadHard Infineon Power MOSFETs

The 25th Microelectronics Workshop (MEWS25)

DLR

Agenda

- Initial situation
- Various Activities Improving the Availability of Power MOSFETs
- Development, Evaluation and Qualification Activities at DLR
- Results
- Conclusion

Initial situation

- RadHard Power MOSFETs are needed in almost ever space equipment
- Worldwide only one space qualified U.S. manufacturer of RadHard Power MOSFETs
  - ☹ Quality problems
  - ☹ Monopoly situation
  - ☹ Stringent export regulations (ITAR)
  - ☹ Success of European Space Industry depends on the U.S. supply
- → European activities started several years ago to develop RadHard MOSFETs

Various Activities Improving the Availability of Power MOSFETs

- 2004 CNES started Development, Evaluation and Qualification Activities on ST Microelectronic (France) Power MOSFETs:
  - Listed in ESCC QPL since October 2010
  - Power MOSFET, N-CHANNEL, Type: STRH100N10FSY3
  - $V_{DS,Max}$ = 100 V
  - $r_{DS(on)}$ = 35 mΩ, (V_{GS}=12V, I_D=24A)
- IR Power MOSFETs:
  - Disadvantages (see previous slide)
  - Part IRHNJ57234SE (Jedec:2N7487U3):
    - $V_{DS,Max}$ = 250 V
    - $r_{DS(on)}$ = 400 mΩ

Development, Evaluation and Qualification Activities at DLR

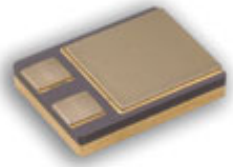
- 2004 – 2005 Analysis and Simulation of Radiation Damages on Infineon MOSFETs
- 2006 – 2008 Investigation of Necessary Measures to get RadHard Infineon CoolMOS Transistors
- 2008 – 2009 Development of RadHard Infineon PowerMOSFETs

- **2009 – 2012 Evaluation and Qualification of RadHard Infineon PowerMOSFETs**
  - Power MOSFET, N-CHANNEL, Type: BUY **CS***
  - $V_{DS,Max}$ = 250 V
    - $r_{DS(on)}$ = 130 mΩ, (V_{GS}=10V, I_D=34A)
    - $r_{DS(on)}$ = 30 mΩ, (V_{GS}=10V, I_D=8A)

2009 – 2012 Evaluation and Qualification of RadHard Infineon PowerMOSFETs

- Target applications (Easy Drop In):
  - DC/DC converters Buck-Boost, Switch Mode, etc.
  - Motor Controls
  - Switch with low loss
- Best in class RadHard Technology:
  - TID up to 300krad on request
  - SEE up to LET 55@90µm (Xe) and LET38@279µm (Xe)
- **Listed in ESCC QPL in August 2012**
- More Information: http://www.infineon.com/RadHardMos

Type	RDSon	IDC	QG	Umax	Package
BUY25CS12J-01	100mOhm	12A	42nC	250V	SMD0.5
BUY10CS12J-01	100mOhm	12A	42nC	100V	SMD0.5
BUY25CS54A-01	25mOhm	54A	180nC	250V	SMD2



Results

TID (Pre- and Post-Irradiation) Tests by Infineon

Sample type BUY25CS12J (SMD05):

- I_{DSS}(200V)
- I_{GSS}(+/-20V),
- R_{DSON}(8A, Ugs=10V),
- V_{SD}(12.4A),
- $V_{gs(th)}$(1mA),

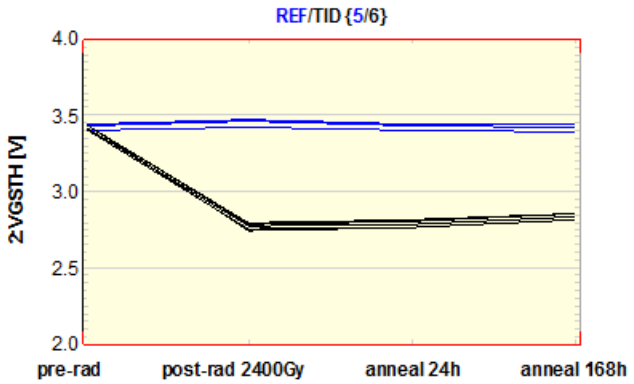
Sample type BUY25CS54A (SMD2):

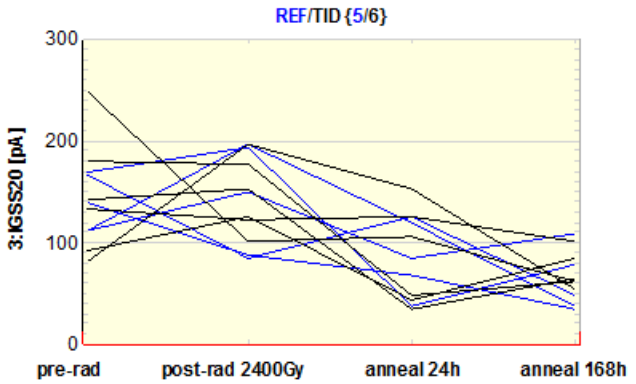
- I_{DSS}(200V),
- I_{GSS}(+/-20V),
- R_{DSON}(34A, Ugs=10V),
- V_{SD}(54A),
- $V_{gs(th)}$(1mA),

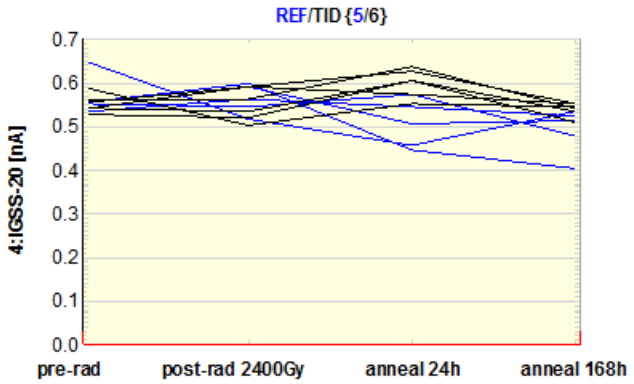
Results

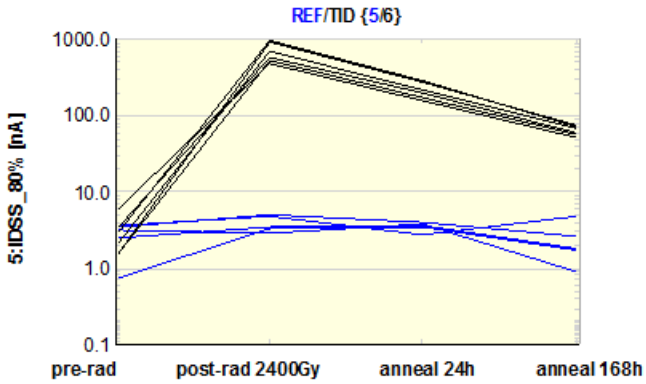
TID (Pre- and Post-Irradiation) Tests by Infineon

BUY25CS12J-01 / L5490B / SMD05





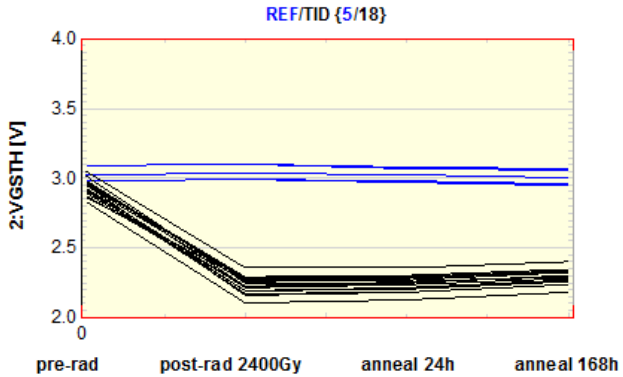


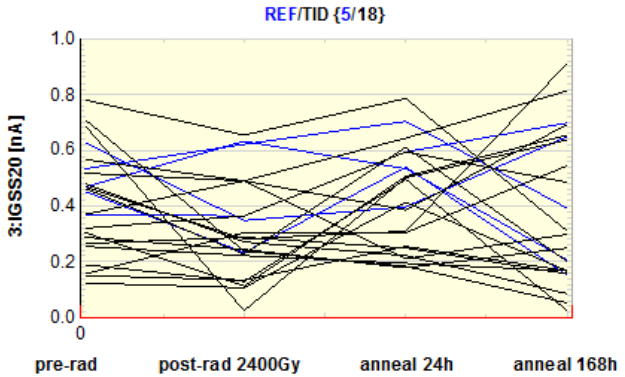


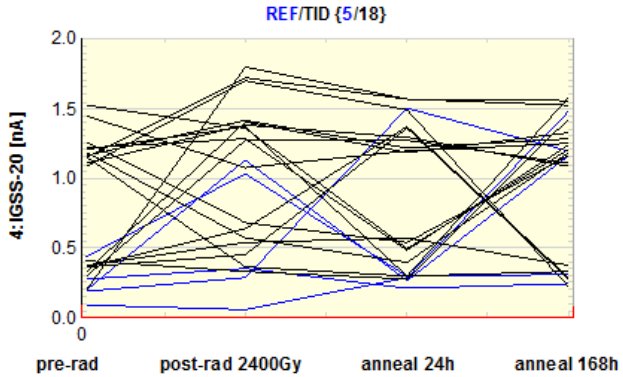
Results

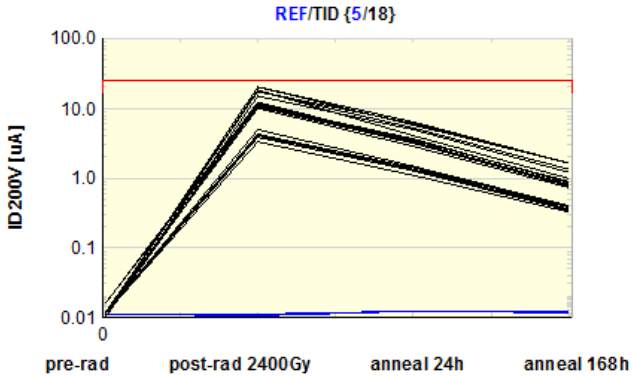
TID (Pre- and Post-Irradiation) Tests by Infineon

BUY25CS54A-01 / L5491A / SMD2



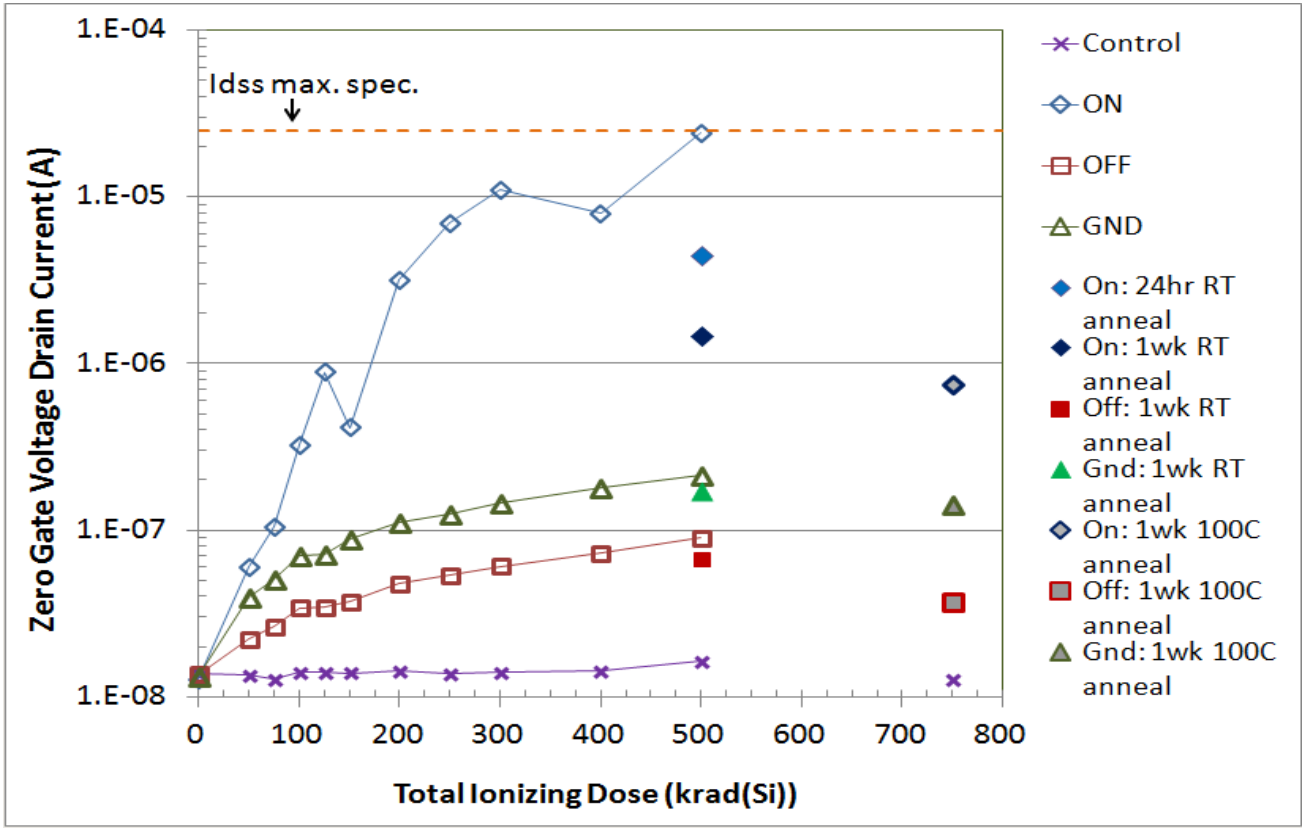






Results

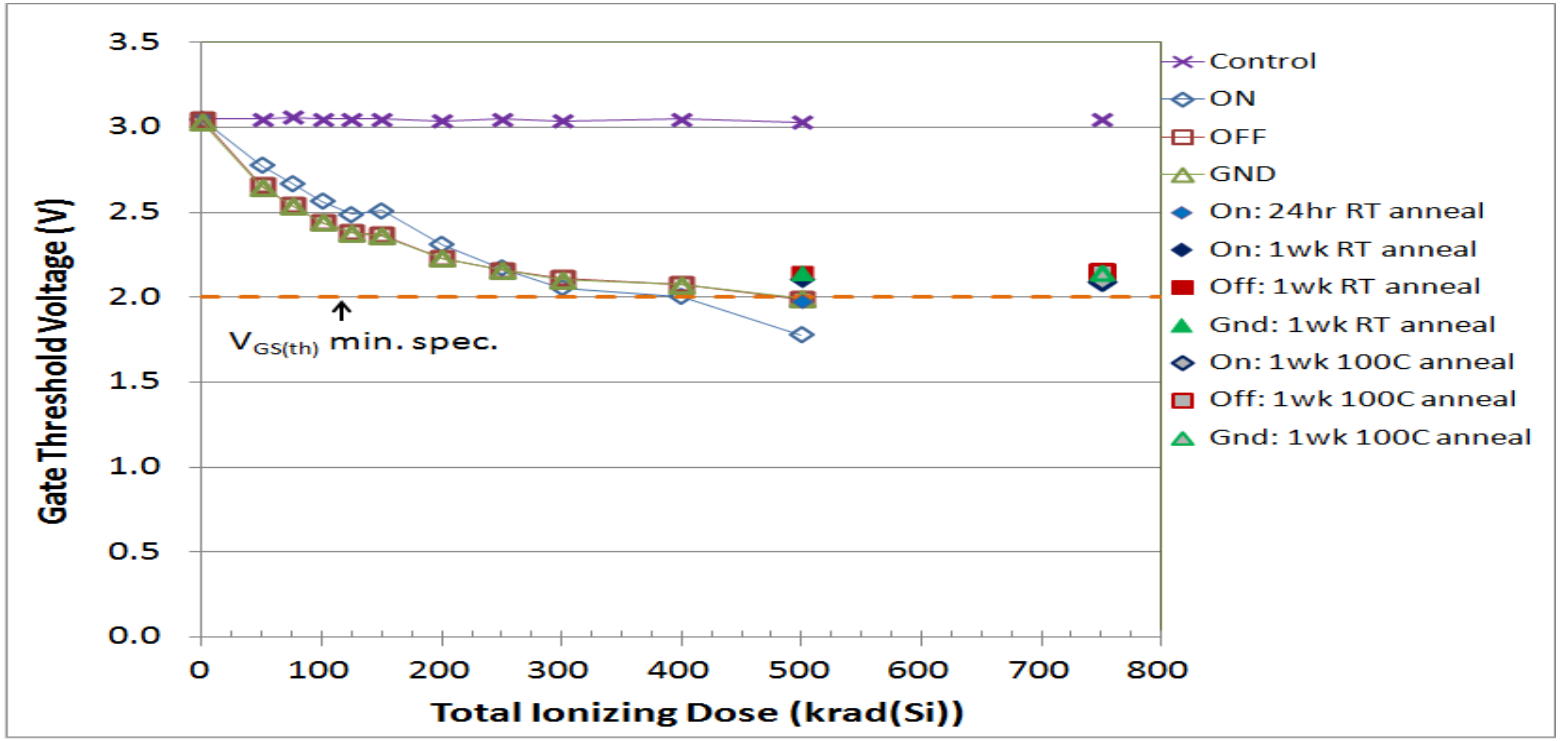
TID Tests by NASA



Average I_{DSS} as a function of total accumulated dose (open symbols) and annealing (filled symbols). Standard error bars are smaller than the data point symbols and thus are not shown. Dashed line demarcates datasheet specification for the maximum I_{DSS}.

Results

TID Tests by NASA



Change in average gate threshold voltage as a function of total accumulated dose (open symbols) and annealing (filled symbols). Standard error bars are smaller than the data point symbols and thus are not shown. On-state biased samples exhibited a slight recovery during the overnight dose rate of 26.4 rad(Si)/min between the 125 krad(Si) and 150 krad(Si) total dose steps. Dashed line demarcates datasheet specification for the minimum $V_{GS(th)}$.

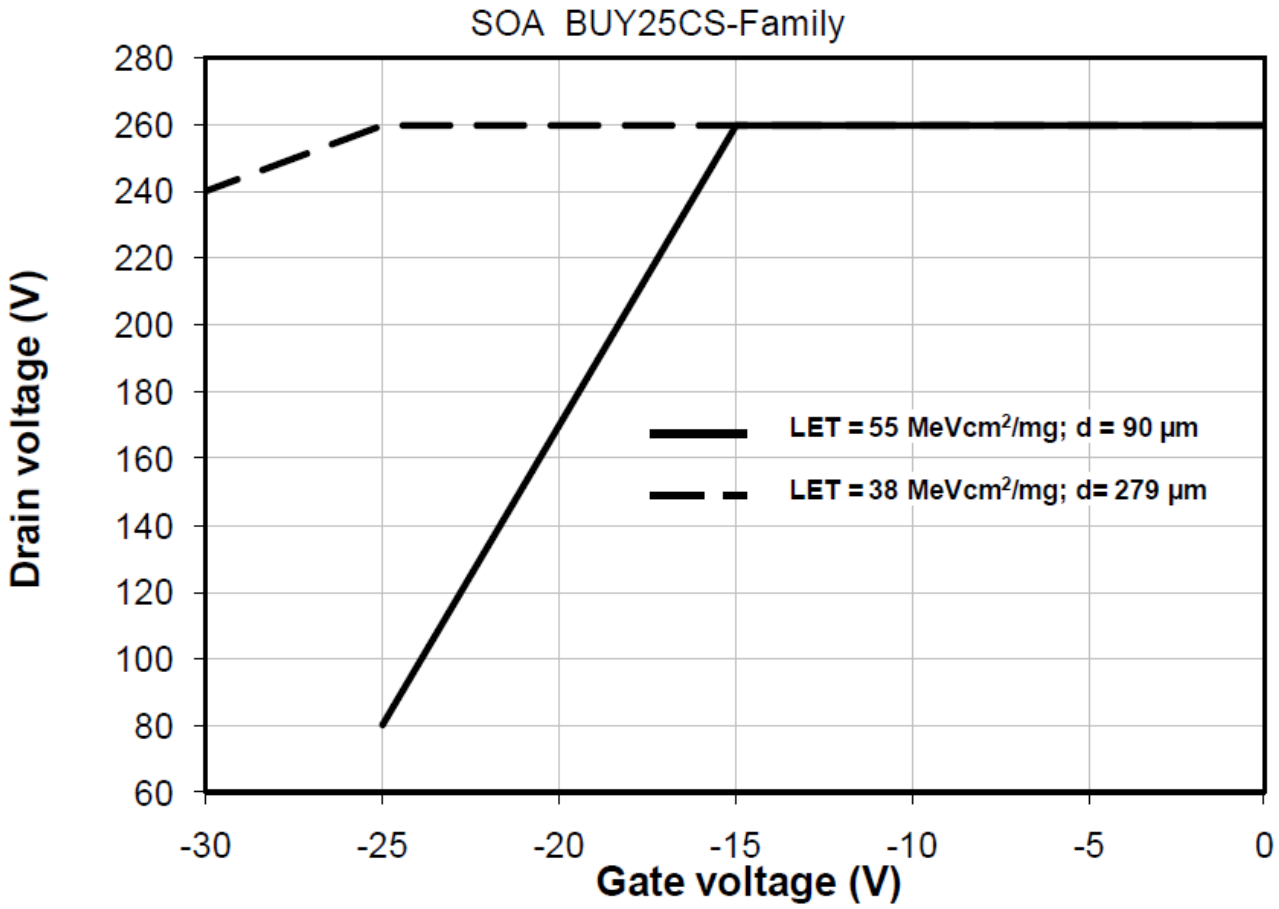
Results
SEE Tests by Infineon

Table 5-1: GANIL beam characteristics for 129Xe (TRIM based).

Run	Setting	Degrader	Air [mm]	LET [MeVcm^2/mg]	Range [µm]
GANIL2		Al 500µm	98	55.14	90.03
GANIL3	A	Al 500µm	93	55.1	90.28
GANIL3	B	Al 300µm	150	38.02	278.9

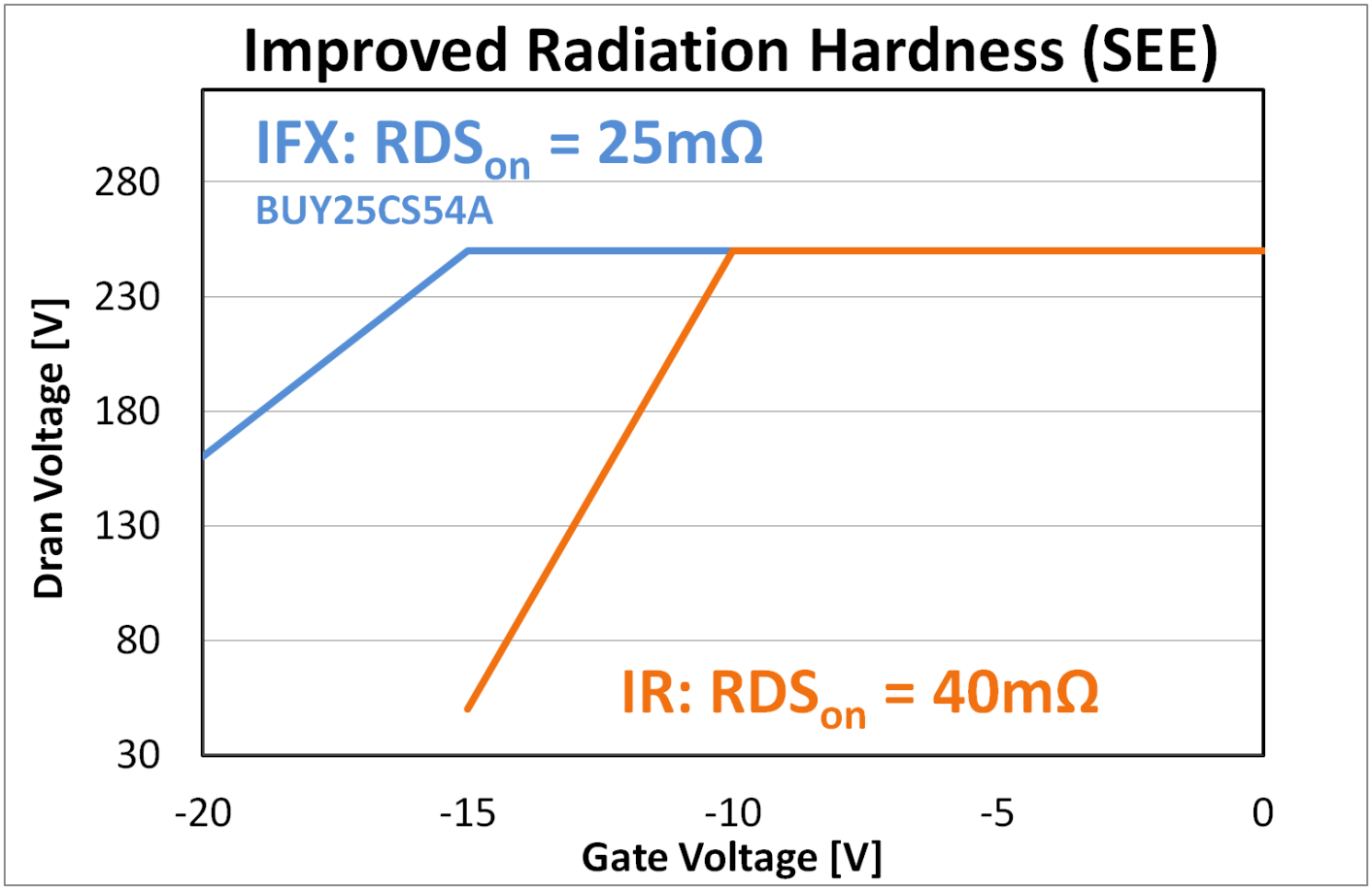
Results

SEE Tests by Infineon



Results

SEE Tests by Infineon / Comparison



Results

Competitor Analysis

BUY25CS12J – SMD05

	IR R5	IR R6	IR R5	IR R6	Infineon
	2N7487U3	IRHNJ67234	2N7486U3	IRHNJ67230	BUY25CS12J
BVDSS/V @25°C	250	250	200	200	250
RDS(on)/m Ohm @25°C	**400**	**210**	**220**	**130**	**130**
RDS(on)/m Ohm @125°C	750		462		300
QG/nC	28	40	35	42	42
RDS(on)*Q G /Ohm*nC	11,2	8,4	7,7	5,46	5,46
ID/A @25°C	10	12	12	16	12
IDM/A	40	49.7	48	64	50
PD/W	75	75	75	75	75
SOA current/A @10ms, 80%V	ca. 0.25	ca. 0.22	ca. 0.3	ca. 0.25	ca. 0.25
EAS/mJ	58	56	60	60	60

BUY25CS54A – SMD2

	IR R5	IR R6	IR R5	IR R6	Infineon
	IRHNA57264 (2N7474U2)	IRHNA67264	IRHNA57260 (2N7473U2)	IRHNA67260	BUY25CS54A
BVDSS/V @25°C	250	250	200	200	250
RDS(on)/m Ohm @25°C	**60**	**40**	38	28	**30**
RDS(on)/m Ohm @125°C	126		80		70
QG/nC	165	220	155	240	180
RDS(on)*Q G /Ohm*nC	9,9	8,8	5,89	6,72	5,4
ID/A @25°C	45	50	53.3	56	54
IDM/A	180	200	214	224	214
PD/W	250	250	250	250	250
SOA current/A @10ms, 80%V	ca. 0.5	ca. 0.35	ca. 0.7	ca. 0.6	ca. 0.5
EAS/mJ	222	240	380	268	380

Conclusion

- The 250V RadHard Power MOSFETs of Infineon are the first European qualified RH Power-switches in this Voltage range
- They fulfill all requirements concerning radiation hardness
- The components are ITAR free
- The electrical parameters are superior compared to the devices in the market
- **They are available as ESCC qualified flight parts**

Thank you for your attention!

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