Total Dose Steady-State Irradiation Test Report of Power MOSFETs
*****BUY06CS family*****

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§1 SCOPE

This Test Report describes Total Dose Steady-State Irradiation (TID) tests and results of radiation-hardened power MOSFETs from Infineon Technologies, types BUY06CS, in accordance to ESCC Basic Specification 22900.

Tests TID37 and TID43 have been performed at facility A in Germany, on the 18.4.2017 and 18.10.2017 respectively. Test TID47 has been performed at facility B in Germany on the 26.7.2018. Addresses of the two facilities are available on request

TID	Date	Facility	Dose Rate	Total Dose (100%)
37	18.04.2017	A	23.25 krad/h (Note 1)	110.44 krad
43	18.10.2017	A	21.77 krad/h (Note 1)	111.76 krad
47	26.07.2018	B	38.70 krad/h (Note 2)	143.28 krad

Table 1: Overview of TID Tests for BUY06CS.

Notes:
1. Dose rate performance of the source is updated monthly and recorded in the test report.
2. Dose rate performance measured during the test.

§2 DEVICE INFORMATION

Chip type	Part Type	BVdss [V]	Vgs(th) [V]	Rds(on) [mOhm]	Idmax [A]
L5442A	BUY06CS23K	60	2.0 – 4.0	40	23 (RT)
	BUY06CS35J			35	35 (RT)
L5444A	BUY06CS45B	60	2.0 – 4.0	15	45 (RT)
L5441A	BUY06CS80A	60	2.0 – 4.0	6.5	80 (RT)

Table 2: Overview irradiated chip types and correlation to parts.

§2.1 APLICABLE DOCUMENTS

- BUY06CS ESCC Draft Detail Specification for HiRel RadHard Power-MOS 60V family, Version October 2018.
- ESCC Basic Specification 22900

§2.2 DEVICES MARKINGS AND SAMPLE PREPARATION

In order to contact devices with the test sockets on bias boards, chips have been soldered and bonded to respective 3-pin PCB-TO-adapter boards to connect Gate/Drain/Source contacts of the MOSFETs.

Devices' numbers are written on the PCB with a permanent marker. The number correlates in the sample list to the lot and wafer number.

§2.3 PRE- AND POST-IRRADIATION ELECTRICAL TESTS

Test samples have passed on-wafer tests, notably BVDSS, Vgs(th), RDSON, IDSS, IGSS with their parameters within predetermined upper/lower limits.

The following parameters were measured for test samples of type BUY06CS (see Tab. 2):

- IDSS(48V),
- IGSS(+/-20V),
- RDSON(ID, Ugs=10V)
  L5442A: ID = 15A
  L5444A: ID = 35A
  L5441A: ID = 60A,
- VSD(ID)
  L5442A: ID = 23A
  L5444A: ID = 45A
  L5441A: ID = 80A,
- Vgs(th)(1mA),
- BVDSS(0.25mA).

§3 IRRADIATION FACILITIES

§3.1 FACILITY A

The facility is designed with a Co60 irradiation source.
Dose rate varies by +/-20% within the irradiation chamber. However, a lead moderator aids in achieving a more uniform field. Sample placement is such that position-dependent dose rate variation is from 95% to 100%, therefore, stays within +/-10% of nominal (fig. 2)

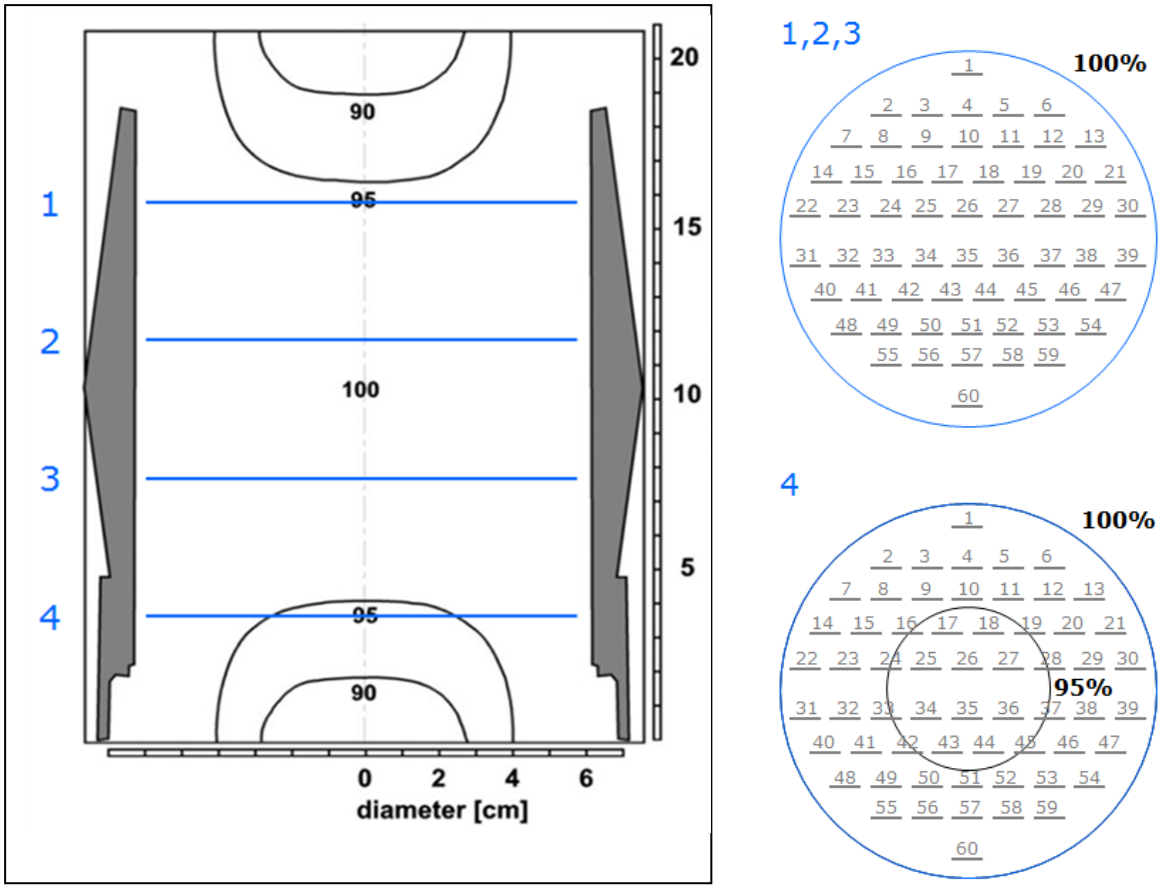


Fig. 2: Gamma intensity within Co60 irradiation chamber with moderator. Samples are positioned in levels 1-4 at defined locations #1-60. The right schematics indicate the position-dependent intensity with respect to nominal 100%.

§3.2 FACILITY B

The facility is designed to irradiate large volumes of palletized products. The irradiation source is Co60.

For irradiations in this facility the samples are placed in an aluminium-lead container as recommended in ESCC 22900 §4.1.2. The irradiation field in the container has been determined by means of dose mapping. Dose rate varies from 91.4% to 105.7% which is in the +/-10% allowed window. Samples are placed such that the dose rate variation across the field of interest is between 94.2% and 105.7%.

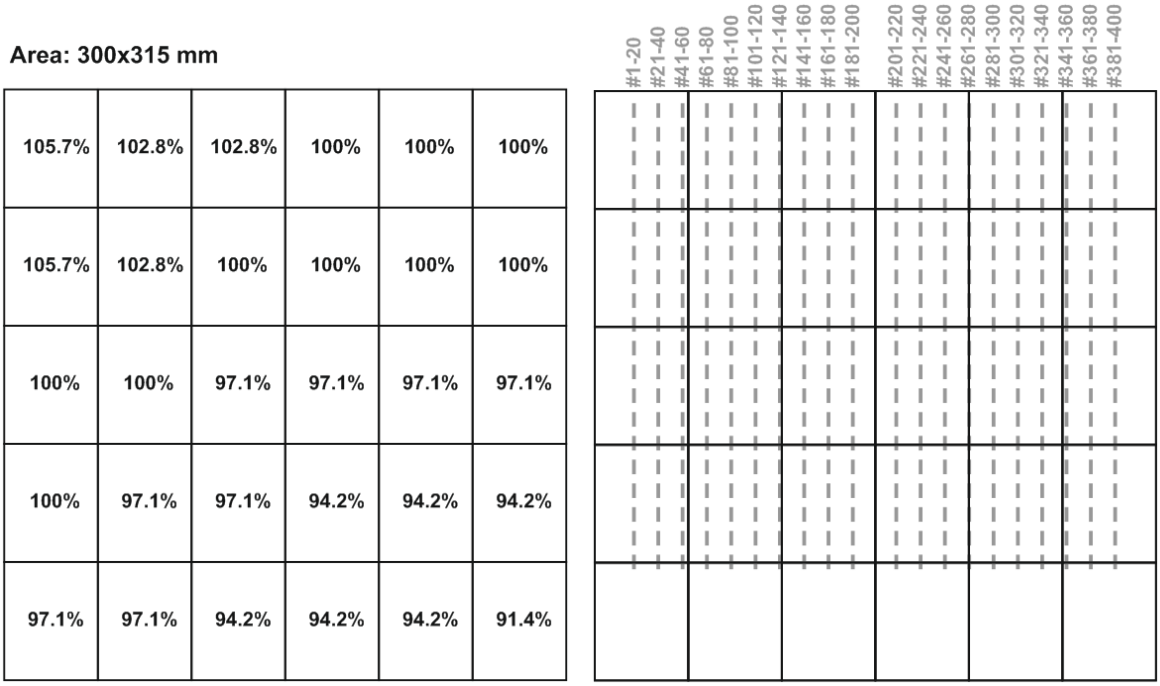


Fig. 2: Left: Gamma intensity within the container. Right: sample positions #1-400 with respect to the characterized irradiation plane.

§4 TEST CONDITION AND SEQUENCE

§4.1 ELECTRICAL BIAS DURING IRRADIATION

Condition	VDS(V)	VGS(V)
C1	0	+20
C2	0	-20
C3	60	0

Table 3 Electrical bias conditions during irradiation and subsequent annealing.

§4.2 RADIATION EXPOSURE AND TEST SEQUENCE

Irradiation- anneal- and characterization steps according to the FLOW CHART FOR QUALIFICATION TESTING of Basic Specifications ESCC22900.

1. Sample serialization,
2. Electrical pre-test according to §2.3,
3. Irradiation with a dose rate and total dose as specified in Tab. 1, in one irradiation step,
4. Parameter measurements according to §2.3,
5. Room temperature anneal for 24 hours under the same bias as during irradiation, followed by parameter measurements according to §2.3,
6. Accelerated aging under the same bias as during irradiation: 168 hours at 100°C,
7. Electrical post-rad/post anneal test, according to §2.3.

§5 TEST RESULTS

In the following, each of the electrically parameters listed in §2.3 is plotted for four points of the testing sequence, i.e.

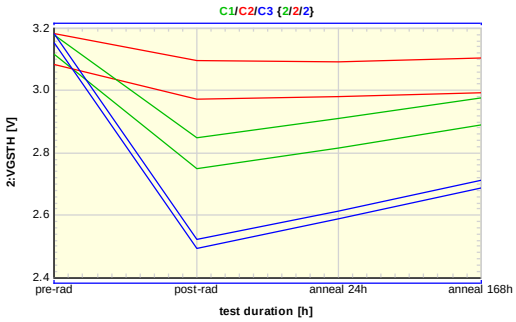
1. Prior to irradiation (pre-rad),
2. Post-irradiation (post-rad),
3. Posterior to room-temperature anneal of 24 hours (anneal 24h),
4. Posterior to 168 hours of anneal at 100°C (anneal 168h).

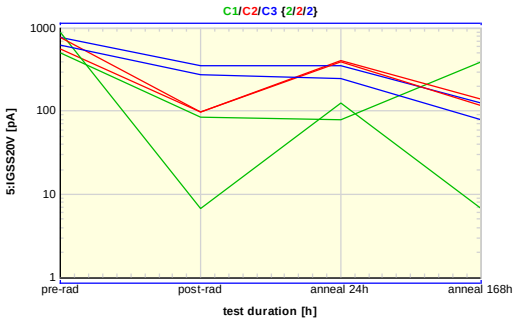
Four groups of graphs are given coded by line-color (see tab. 1 and tab. 2):

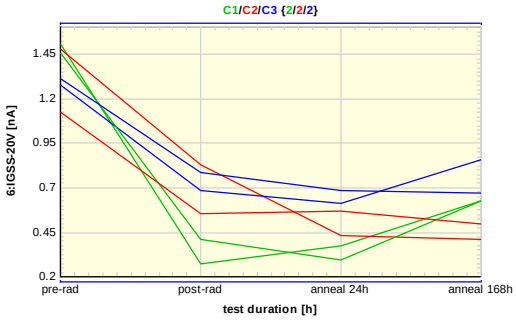
1. Unirradiated control (reference) devices (legend: ***Ref*** in BLACK)
2. Irradiated devices Bias Condition C1 (legend: ***C1*** in GREEN)
3. Irradiated devices Bias Condition C2 (legend: ***C2*** in RED)
4. Irradiated devices Bias Condition C3 (legend: ***C3*** in BLUE)

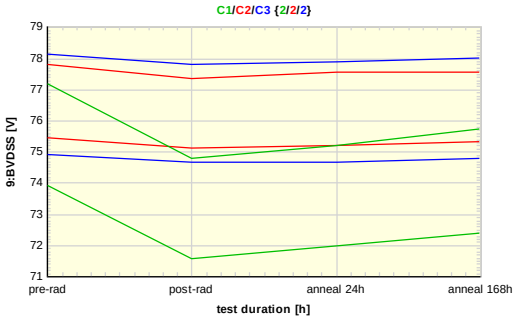
§5.1 L5442A – BUY06CS23K / BUY06CS35J

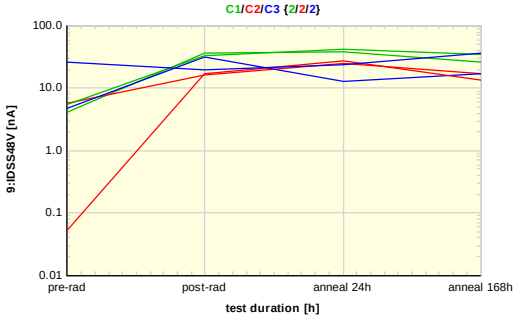
BUY06CS23K / L5442A / TID37

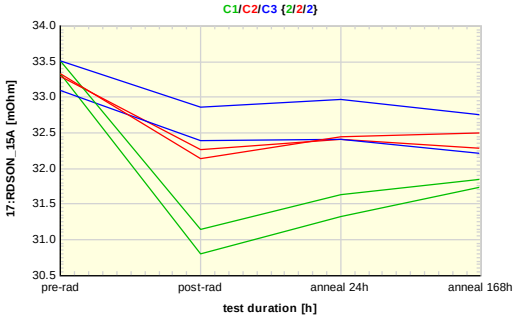


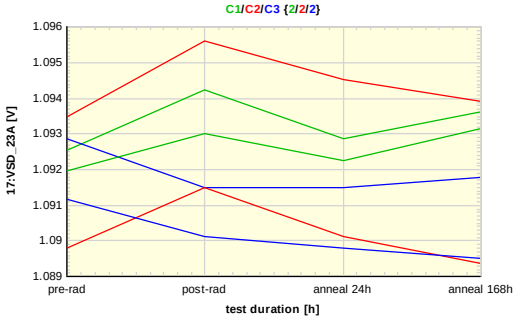




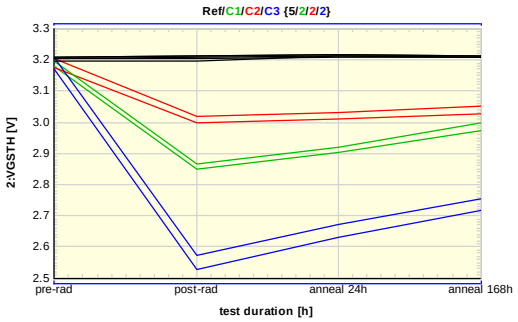


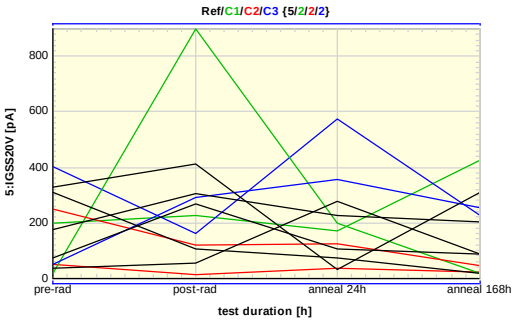


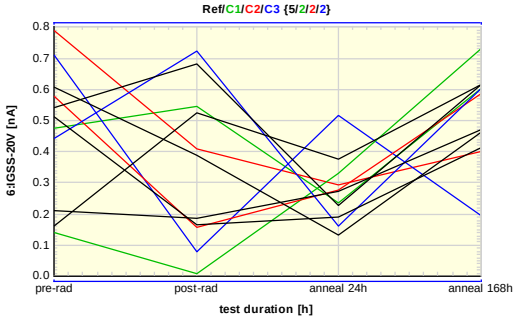


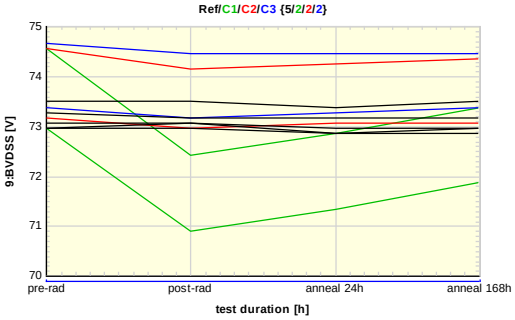


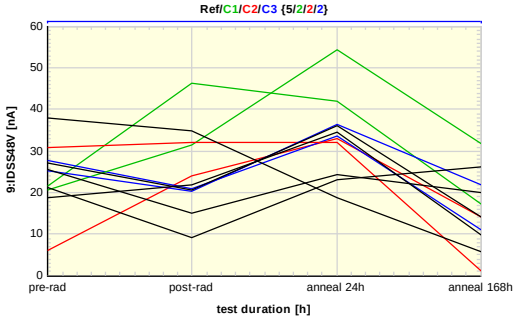
BUY06CS23K / L5442A / TID43

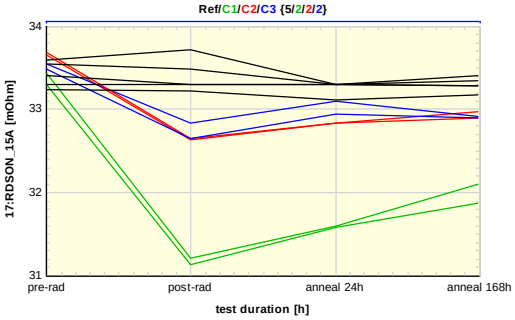


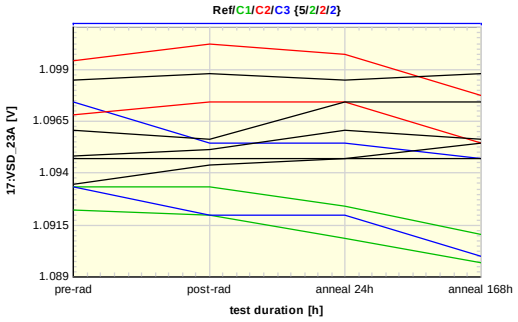






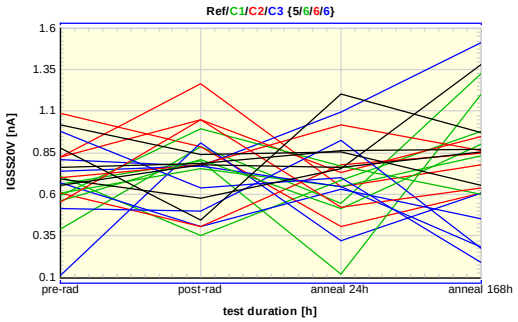


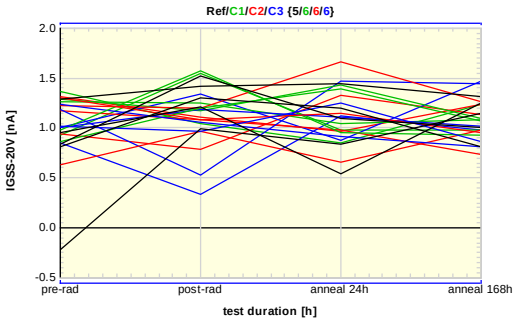


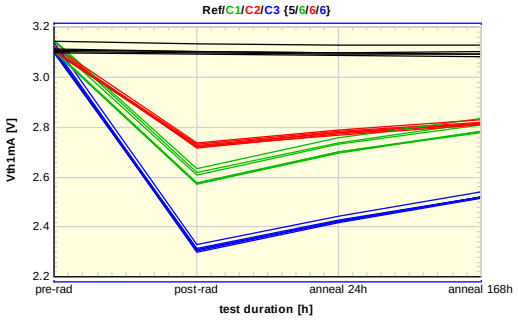


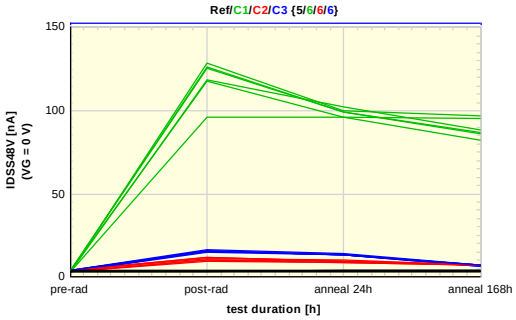
§5.2 L5444A – BUY06CS45B

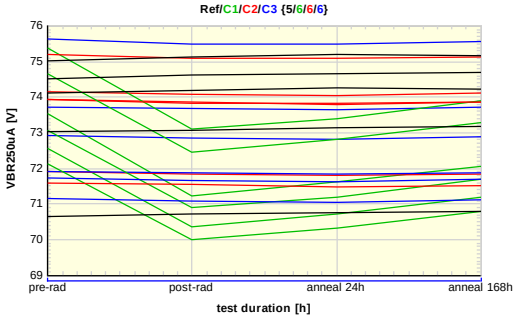
BUY06CS45B / L5444A / TID47

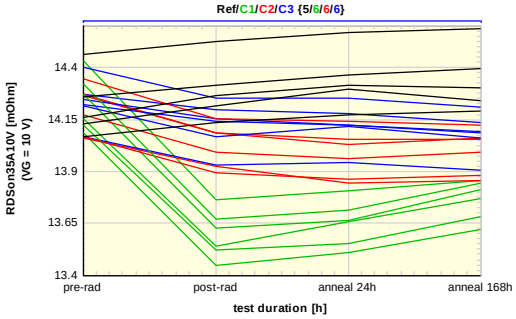


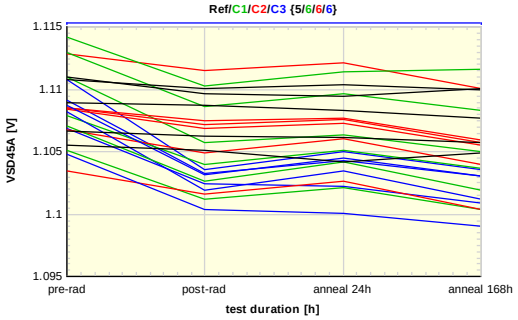






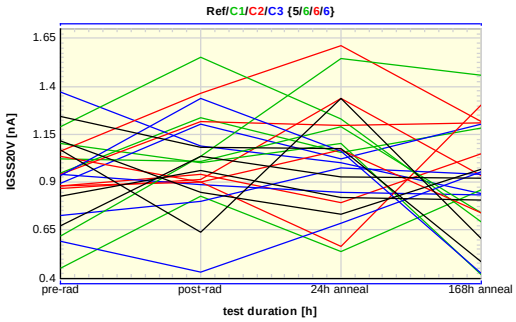


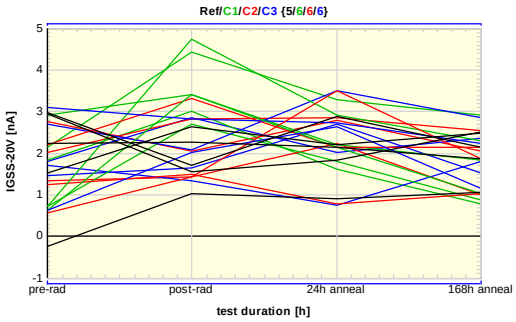


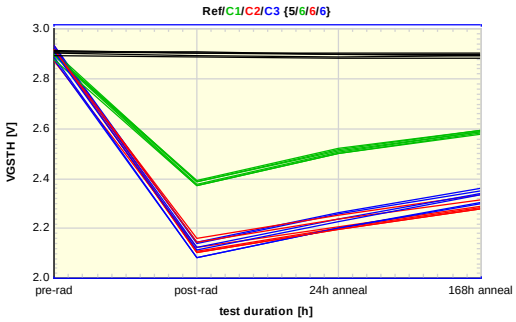


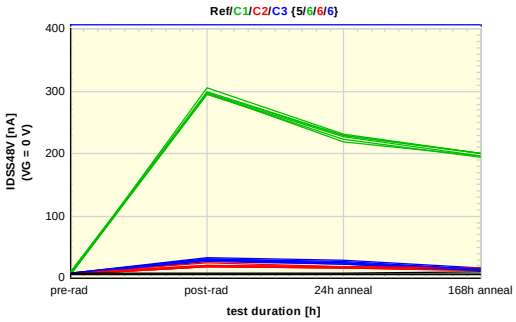
§5.3 L5441A – BUY06CS80A

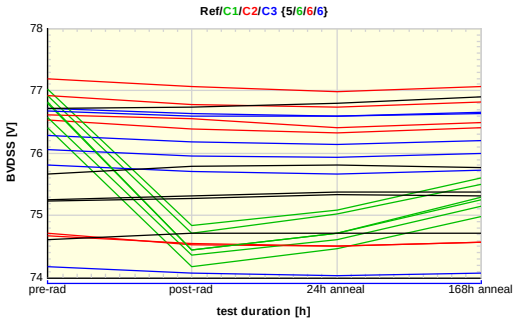
BUY06CS80A / L5441A / TID47

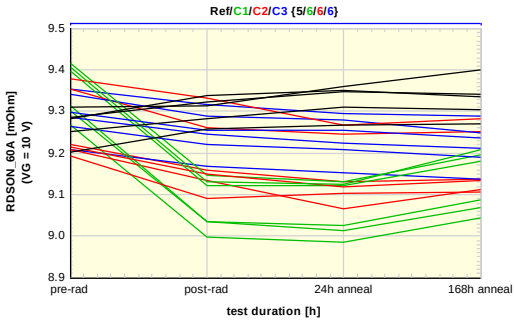


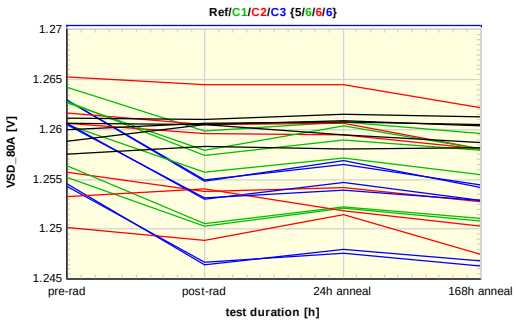












§6 SUMMARY AND SAMPLE LIST

This report shows that the BUY06CS family is radiation hard up to a minimum of 100krad and can be classified with a Total Dose Radiation Level – **R**.

TID 37 – Facility A							
SN	**Type**	**Lot**	**Wafer**	**Cond.**	**Level**	**Position**	**Result**
40	BUY06CS23K	VE712018	17	C1	4	14	pass
41	BUY06CS23K	VE712018	17	C2	3	14	pass
42	BUY06CS23K	VE712018	17	C3	1	14	pass
43	BUY06CS23K	VE712018	17	C1	4	15	pass
44	BUY06CS23K	VE712018	17	C2	3	15	pass
45	BUY06CS23K	VE712018	17	C3	1	15	pass
TID 43 – Facility A							
SN	**Type**	**Lot**	**Wafer**	**Cond.**	**Level**	**Position**	**Result**
13	BUY06CS23K	VE737633	3	C1	2	35	pass
14	BUY06CS23K	VE737633	3	C2	3	5	pass
15	BUY06CS23K	VE737633	3	C3	1	1	pass
16	BUY06CS23K	VE737633	3	C1	2	36	pass
17	BUY06CS23K	VE737633	3	C2	3	6	pass
18	BUY06CS23K	VE737633	3	C3	1	2	pass
19	BUY06CS23K	VE737633	3				Control
20	BUY06CS23K	VE737633	3				Control
21	BUY06CS23K	VE737633	3				Control
22	BUY06CS23K	VE737633	3				Control
23	BUY06CS23K	VE737633	3				Control
TID 47 – Facility B							
SN	**Type**	**Lot**	**Wafer**	**Cond.**	**Level**	**Position**	**Result**
115	BUY06CS80A	VE751933	1	C1		229	pass*
116	BUY06CS80A	VE751933	1	C2		269	pass*
117	BUY06CS80A	VE751933	1	C3		285	pass*
118	BUY06CS80A	VE751933	1	C1		230	pass*
119	BUY06CS80A	VE751933	1	C2		270	pass*
120	BUY06CS80A	VE751933	1	C3		286	pass*
121	BUY06CS80A	VE751933	2	C1		231	pass*
122	BUY06CS80A	VE751933	2	C2		271	pass*
123	BUY06CS80A	VE751933	2	C3		287	pass*
124	BUY06CS80A	VE751933	2	C1		232	pass*
125	BUY06CS80A	VE751933	2	C2		272	pass*
126	BUY06CS80A	VE751933	2	C3		288	pass*
127	BUY06CS80A	VE751933	3	C1		233	pass*
128	BUY06CS80A	VE751933	3	C2		273	pass*
129	BUY06CS80A	VE751933	3	C3		289	pass*

130	BUY06CS80A	VE751933	3	C1		234	pass*
131	BUY06CS80A	VE751933	3	C2		274	pass*
132	BUY06CS80A	VE751933	3	C3		290	pass*
133	BUY06CS80A	VE751933	3				Control
134	BUY06CS80A	VE751933	3				Control
135	BUY06CS80A	VE751933	3				Control
136	BUY06CS80A	VE751933	3				Control
137	BUY06CS80A	VE751933	3				Control
138	BUY06CS45B	VE752485	3	C1		235	pass
139	BUY06CS45B	VE752485	3	C2		275	pass
140	BUY06CS45B	VE752485	3	C3		291	pass
141	BUY06CS45B	VE752485	3	C1		236	pass
142	BUY06CS45B	VE752485	3	C2		276	pass
143	BUY06CS45B	VE752485	3	C3		292	pass
144	BUY06CS45B	VE752485	4	C1		237	pass
145	BUY06CS45B	VE752485	4	C2		277	pass
146	BUY06CS45B	VE752485	4	C3		293	pass
147	BUY06CS45B	VE752485	4	C1		238	pass
148	BUY06CS45B	VE752485	4	C2		278	pass
149	BUY06CS45B	VE752485	4	C3		294	pass
150	BUY06CS45B	VE752485	5	C1		239	pass
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153	BUY06CS45B	VE752485	5	C1		240	pass
154	BUY06CS45B	VE752485	5	C2		280	pass
155	BUY06CS45B	VE752485	5	C3		296	pass
156	BUY06CS45B	VE752485	5				Control
157	BUY06CS45B	VE752485	5				Control
158	BUY06CS45B	VE752485	5				Control
159	BUY06CS45B	VE752485	5				Control
160	BUY06CS45B	VE752485	5				Control

Table 4: List of irradiated and control devices

*due to the mounting process for these tests and very high currents, VSD (80A) and RDSon (60A, 10V) absolute values are higher than specified in the Draft Detail Specification for the SMD2 packaged devices – see also control samples. Nevertheless, drift values are within limits.