

<b>Infineon</b> technologies  <b>HiRel Discrete &amp; MW Semiconductors</b>	ESCC Comp. No.: 520503302R	Page: 1
	Wafer Lot: VE840444	Rep.No.: VE840444TID Issue: Iss. 1, Jun. 2020
	<b>Total Dose Steady-State Irradiation Test Report</b> <b>BUY65CS28A-01(ES)</b>	

## §1 COVER SHEET

### • Component and Test Identification

<b>Comp. Type</b>	BUY65CS28A-01(ES)
<b>ESCC Comp. No.</b>	520503302R
<b>Lot Ident.</b>	Wafer Lot No. VE840444
	Assembly Lot n.a.
	ESA Date Code n.a.
	Radiation Testing Level R: 100kRad
<b>Test data</b>	Test Plan TPIFX1827A
	Tested Sample Serial No.s 3-20
	Control Sample Serial No.s R350-R354

### • Applicable Documents

<b>Detail Specification</b>	ESCC 5205/033 Issue 1, May 2020
<b>Generic Specification</b>	ESCC 5000 Issue 8, Jun. 2019
<b>Process Identification Document</b>	A63500-L5491-P000_Detail_PID_BUY25CS_8
<b>Irradiation Specification</b>	ESCC Basic Specification No. 22900 Iss. 5, June 2016

### • Manufacturer / Facility

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<b>Assembly &amp; Testing</b>	Infineon Technologies AG Am Campeon 1-15, D 85579 Neubiberg, Germany

### • Report Issue, Date / Manufacturers Signatures

Iss. 1, Jun. 2020

Total Number of Pages:

10 plus Appendix

Process	Department	Name	Signatures
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### §3 SCOPE AND TEST INFORMATION

This Test Report describes Total Dose Steady-State Irradiation (TID) tests and results of radiation-hardened power MOSFETs from Infineon Technologies, types BUY65CS28A-01(ES), in accordance to Chart F2 - Production Control Para. 5.2.5 in ESCC Generic Specification 5000.

This report contains the Total Dose Steady-State Irradiation Test results of wafer lot VE840444 for type BUY65CS28A-01(ES) (ESCC detail specification No. 5205/033).

Test campaign TID 50 has been performed at the facility JS-9000 in Germany on the 23.7.2019.

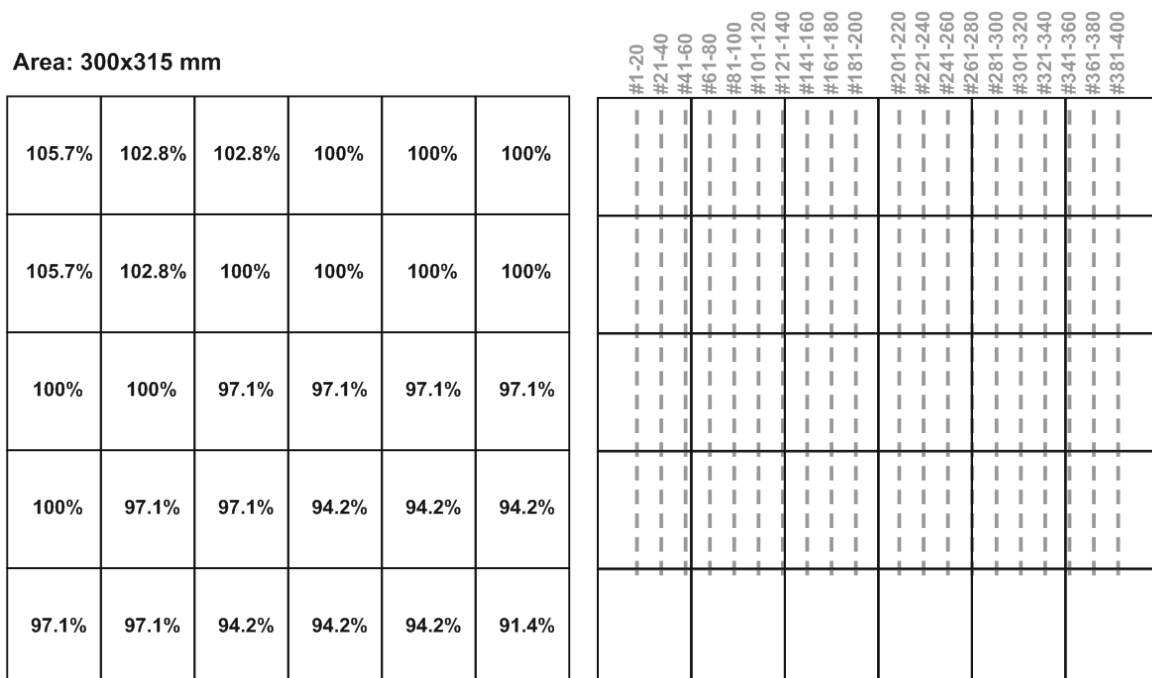
The read and record data from the electrical measurements of the tested and control samples is given in §7.2 of this report.

### §4 IRRADIATION FACILITY – JS-9000

The JS-9000 irradiator is a pallet facility 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%.

Total Dose performance is measured during the test with an alanine dosimeter and recorded in the test report. Irradiation takes place at room temperature.



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

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## §5 DEVICES MARKINGS AND SAMPLE PREPARATION

In order to contact devices with the test sockets on bias boards, chips have been soldered with AuZn solder material and bonded with 125µm Al wires to respective 3-pin PCB-TO-adaptor 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.

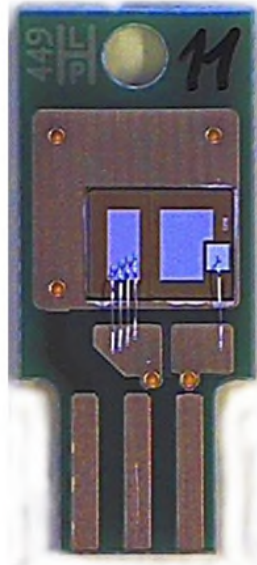


Fig. 2: Die mounted on PCB for TID testing – soldered and wire-bonded

## §6 IRRADIATION CONDITIONS

The irradiation step had a duration of 3h 48 min at a dose rate of 33.2 krad/h which yields a total ionizing dose of 126 krad.

The tested devices were electrically biased according to the table below (remote test):

Electrical Bias Condition	Bias Circuit	Supply voltages		
		Gate	Drain	Source
C1	Fig. 3	+20 V	0 V	0 V
C2	Fig. 3	-20 V	0 V	0 V
C3	Fig. 3	0 V	650 V	0 V

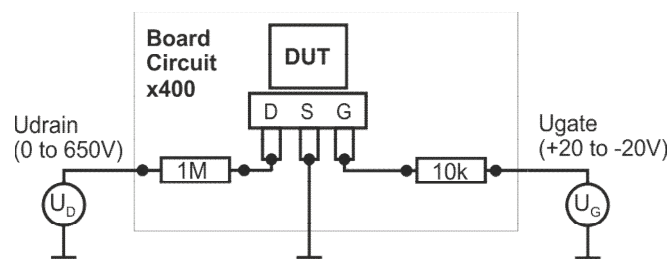


Fig. 3 Bias circuit for TID tests

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## §7 IRRADIATION TEST SEQUENCE

Irradiation- anneal- and electrical measurement steps follow the FLOW CHART FOR QUALIFICATION AND LOT ACCEPTANCE TESTING of Basic Specifications ESCC22900.

The test data is documented in an Infineon internal data package. It includes a summary listing total submitted and rejected numbers of components to the performed processes and tests.

The following table certifies which tests have been actually performed and certifies the availability of data.

**TID Test Overview**

Process / Test	Perfor- med	Data Avail.	Remarks / Notes
Serialisation	x	x	
Initial electrical measurements – pre-TID	x	x	Acc. Table 2, DC in ESCC Det. Spec.
Irradiation in one step	x	x	Conditions specified in §6
Parameter Drift Values – post-TID	x	x	Acc. §2.10.2 in ESCC Det. Spec.
Room temperature anneal for 24 hours	x	x	Same bias as during irradiation
Parameter Drift Values – 24h@RT	x	x	Acc. §2.10.2 in ESCC Det. Spec.
Accelerated aging: 168 hours at 100°C	x	x	Same bias as during irradiation
Parameter Drift Values – 168h@100°C	x	x	Acc. §2.10.2 in ESCC Det. Spec.
Check for Lot Failure	x	x	

### §7.1 ATTRIBUTES RECORD OF MEASUREMENTS, TESTS AND INSPECTIONS

The following table gives the results of the total dose steady-state irradiation tests actually performed in terms of total quantity to test, rejected quantity in test, pass quantity in test.

**Attributes Record of Measurements, Tests and Inspections Performed**

Process / Test	to Test	Fail.	Pass	Data	Remarks / Notes, S/Ns of Failures and WDs
Initial Measurements	23	0	23	avail.	5 control samples included
Irradiation / Drift Value	23	0	23	avail.	5 control samples included
24h @ RT anneal / Drift Value	23	0	23	avail.	5 control samples included
168h @ 100°C / Drift Value	23	0	23	avail.	5 control samples included

**Sample distribution within the bias conditions**

Item	Qty	Part Notation in R&R Tables	
		Subgroup	Part SG S/Ns
BUY65CS28A-01(ES) silicon chips used for C1 condition	6	C1	#3,6,9,12,15,18
BUY65CS28A-01(ES) silicon chips used for C2 condition	6	C2	#4,7,10,13,16,19
BUY65CS28A-01(ES) silicon chips used for C3 condition	6	C3	#5,8,11,14,17,20
BUY65CS28A-01(ES) silicon chips used as control samples (not irradiated, not annealed)	5	control	#R350-R354

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## §7.2 READ AND RECORD DATA OF ELECTRICAL MEASUREMENTS

This documentation contains the data from all tested parts and control samples.

### §7.2.1 INITIAL MEASUREMENTS (TABLE 2, DC)

S/N	V(BR)DSS [V]	VGS(th) [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS(ON) [mOhm]	VSD [V]	WaferLot/WaferNo.
min	650	2						
max	4	100	100	25	150	1.2		
3	724	3.20	1.5	2.8	0.002	124	1.023	VE840444 #10
4	729	3.22	1.4	2.6	0.002	124	1.023	VE840444 #10
5	736	3.25	1.5	2.5	0.002	125	1.026	VE840444 #10
6	738	3.24	1.4	3.3	0.002	128	1.022	VE840444 #10
7	740	3.21	1.3	2.5	0.002	127	1.024	VE840444 #10
8	739	3.21	1.4	2.6	0.002	127	1.022	VE840444 #10
9	720	3.26	1.8	2.8	0.002	123	1.026	VE840444 #11
10	716	3.25	1.2	2.8	0.002	123	1.028	VE840444 #11
11	727	3.23	1.3	2.9	0.002	123	1.026	VE840444 #11
12	734	3.23	1.3	2.6	0.002	125	1.026	VE840444 #11
13	731	3.20	1.8	2.9	0.002	125	1.026	VE840444 #11
14	732	3.20	1.4	2.7	0.002	125	1.026	VE840444 #11
15	705	3.20	1.5	2.8	0.002	124	1.026	VE840444 #12
16	713	3.22	1.5	2.6	0.002	124	1.025	VE840444 #12
17	721	3.21	1.3	2.8	0.002	124	1.025	VE840444 #12
18	734	3.19	1.4	2.6	0.002	126	1.025	VE840444 #12
19	730	3.20	1.4	2.8	0.002	125	1.025	VE840444 #12
20	724	3.20	1.5	2.6	0.002	125	1.023	VE840444 #12
R350	724	3.22	1.5	2.4	0.002	127	1.026	
R351	727	3.19	1.5	2.8	0.002	129	1.027	
R352	725	3.23	1.6	2.9	0.002	126	1.026	
R353	717	3.23	1.5	2.5	0.002	126	1.027	
R354	718	3.25	1.3	2.7	0.002	126	1.029	

### §7.2.2 ELECTRICAL MEASUREMENTS AFTER IRRADIATION

S/N	Drift Deltas post irradiation						Absolute Values post irradiation							Bias Cond.
	BV(DSS) [%]	VGS(th) [%]	IGSS [nA]	IGSS- [nA]	RDS(ON) [%]	VSD [%]	BV(DSS) [V]	VGS(th) [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS(ON) [mOhm]	VSD [V]	
min	-20%	-50%	-20nA	-20nA	-20%	-10%	650	2						
max	+20%	+10%	+20nA	+20nA	+20%	+10%	4	100	100	25	150	1.2		
3	-0.7	-17.6	-0.8	-1.4	-1.6	-0.0	719	2.64	0.7	1.4	1.385	122	1.022	C1
4	-0.1	-12.0	-0.8	-1.4	-0.6	0.1	729	2.83	0.7	1.2	0.036	124	1.024	C2
5	-6.1	-26.2	-0.8	-1.4	-0.1	-0.0	691	2.40	0.7	1.0	0.249	124	1.026	C3
6	-0.7	-18.0	-0.8	-1.7	-1.4	0.1	733	2.66	0.6	1.6	1.652	126	1.023	C1
7	-0.0	-11.5	-0.6	-1.4	-0.5	0.2	740	2.84	0.7	1.2	0.035	126	1.026	C2
8	-4.4	-26.1	-0.7	-1.6	-0.2	-0.0	707	2.37	0.7	1.1	0.236	126	1.022	C3
9	-0.6	-17.7	-1.1	-1.4	-1.4	-0.0	716	2.68	0.7	1.4	1.695	121	1.026	C1
10	-0.1	-13.1	-0.5	-1.6	-0.5	0.1	715	2.82	0.7	1.2	0.037	122	1.029	C2
11	-0.2	-25.8	-0.6	-1.8	-0.1	0.0	725	2.40	0.7	1.1	0.175	123	1.026	C3
12	-0.6	-18.0	-0.7	-1.1	-1.3	0.1	729	2.65	0.7	1.5	1.826	124	1.027	C1
13	0.0	-14.3	-1.1	-1.7	-0.2	0.0	732	2.75	0.6	1.1	0.037	125	1.026	C2
14	-5.3	-26.0	-0.7	-1.6	-0.1	0.0	694	2.37	0.7	1.1	0.205	125	1.026	C3
15	-0.7	-17.1	-0.8	-1.4	-1.4	0.0	700	2.65	0.7	1.4	1.341	123	1.027	C1

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	Drift Deltas post irradiation						Absolute Values post irradiation							Bias Cond.
S/N	BV <sub>(DSS)</sub> [%]	VGS <sub>(th)</sub> [%]	IGSS [nA]	IGSS- [nA]	RDS <sub>(ON)</sub> [%]	V <sub>SD</sub> [%]	BV <sub>(DSS)</sub> [V]	VGS <sub>(th)</sub> [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS <sub>(ON)</sub> [mOhm]	V <sub>SD</sub> [V]	
16	-0.0	-13.3	-0.9	-1.5	-0.4	0.2	713	2.79	0.7	1.1	0.037	123	1.027	C2
17	-2.7	-26.3	-0.6	-1.8	-0.0	-0.1	702	2.37	0.7	1.0	0.256	124	1.024	C3
18	-0.6	-17.7	-0.7	-1.2	-1.4	0.1	729	2.62	0.6	1.4	1.541	124	1.025	C1
19	-0.0	-13.2	-0.7	-1.7	-0.2	0.1	730	2.78	0.7	1.1	0.037	125	1.026	C2
20	-0.5	-25.9	-0.9	-1.5	0.0	-0.1	721	2.37	0.6	1.1	0.206	125	1.022	C3
R350	-0.1	0.2	-0.5	-1.9	-0.8	-0.1	723	3.22	1.0	0.6	0.004	126	1.025	Control
R351	-0.0	0.0	-0.9	-1.8	-0.3	-0.1	727	3.19	0.6	1.0	0.004	128	1.026	Control
R352	-0.0	0.0	-1.0	-1.9	-0.3	-0.1	724	3.24	0.6	1.0	0.004	126	1.025	Control
R353	-0.0	0.0	-0.8	-1.4	-0.3	-0.1	717	3.23	0.7	1.0	0.004	125	1.026	Control
R354	-0.0	-0.0	-0.7	-1.6	-0.1	-0.2	718	3.24	0.6	1.1	0.004	126	1.027	Control

## §7.2.3 ELECTRICAL MEASUREMENTS AFTER 24 HOURS ANNEAL AT ROOM TEMPERATURE

	Drift Deltas post 24h anneal at RT						Absolute Values post 24h anneal at RT							Bias Cond.
S/N	BV <sub>(DSS)</sub> [%]	VGS <sub>(th)</sub> [%]	IGSS [nA]	IGSS- [nA]	RDS <sub>(ON)</sub> [%]	V <sub>SD</sub> [%]	BV <sub>(DSS)</sub> [V]	VGS <sub>(th)</sub> [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS <sub>(ON)</sub> [mOhm]	V <sub>SD</sub> [V]	
min	-20%	-50%	-20nA	-20nA	-20%	-10%	650	2						
max	+20%	+10%	+20nA	+20nA	+20%	+10%		4	100	100	25	150	1.2	
3	-0.6	-13.7	-0.8	-1.6	-1.3	0.0	719	2.76	0.7	1.2	0.227	123	1.023	C1
4	-0.0	-10.9	-0.8	-1.5	-0.3	0.1	729	2.87	0.7	1.1	0.035	124	1.024	C2
5	-0.1	-23.8	-0.8	-1.3	-0.1	0.0	735	2.48	0.7	1.1	0.048	124	1.027	C3
6	-0.6	-14.1	-0.8	-2.1	-1.2	0.1	734	2.78	0.7	1.2	0.237	126	1.023	C1
7	-0.0	-10.4	-0.6	-1.5	-0.3	0.1	740	2.87	0.7	1.1	0.034	127	1.026	C2
8	-0.0	-24.0	-0.7	-1.5	-0.1	0.0	739	2.44	0.7	1.1	0.048	126	1.023	C3
9	-0.5	-13.8	-1.1	-1.6	-1.2	-0.1	716	2.80	0.7	1.2	0.255	122	1.026	C1
10	-0.0	-11.9	-0.5	-1.7	-0.2	0.1	716	2.86	0.7	1.1	0.036	122	1.029	C2
11	-0.1	-23.4	-0.6	-1.8	-0.1	-0.0	725	2.47	0.7	1.1	0.047	123	1.025	C3
12	-0.6	-14.1	-0.7	-1.4	-1.1	0.0	730	2.77	0.7	1.2	0.256	124	1.026	C1
13	-0.0	-12.9	-1.1	-1.8	-0.3	0.1	731	2.79	0.7	1.1	0.035	125	1.027	C2
14	-0.1	-23.8	-0.7	-1.6	-0.0	-0.0	732	2.44	0.7	1.1	0.048	125	1.025	C3
15	-0.6	-13.2	-0.9	-1.6	-1.3	-0.0	701	2.77	0.6	1.2	0.242	123	1.026	C1
16	-0.0	-12.1	-0.9	-1.5	-0.2	0.0	713	2.83	0.7	1.1	0.036	123	1.026	C2
17	-0.2	-23.9	-0.6	-1.7	-0.0	0.0	720	2.44	0.7	1.1	0.048	124	1.026	C3
18	-0.6	-13.8	-0.7	-1.5	-1.0	0.1	730	2.75	0.7	1.1	0.243	124	1.026	C1
19	-0.0	-12.0	-0.8	-1.7	-0.2	0.1	730	2.82	0.6	1.1	0.035	125	1.026	C2
20	-0.2	-23.7	-0.7	-1.5	0.0	0.0	723	2.44	0.7	1.1	0.048	125	1.023	C3
R350	-0.1	0.1	-1.2	-1.2	-0.4	-0.1	723	3.22	0.3	1.2	0.004	126	1.025	Control
R351	0.0	-0.1	-0.9	-1.7	0.1	-0.1	727	3.19	0.6	1.1	0.004	129	1.026	Control
R352	0.0	-0.1	-0.9	-1.9	0.1	-0.1	725	3.23	0.7	1.0	0.004	126	1.025	Control
R353	0.0	-0.0	-0.8	-1.4	0.1	-0.1	718	3.23	0.6	1.1	0.004	126	1.026	Control
R354	0.0	-0.1	-0.7	-1.6	0.1	-0.2	718	3.24	0.7	1.1	0.004	126	1.027	Control

## §7.2.4 ELECTRICAL MEASUREMENTS AFTER 168 HOURS ANNEAL AT 100°C

	Drift Deltas post 168h anneal at 100°C						Absolute Values post 168h anneal at 100°C							Bias Cond.
S/N	BV <sub>(DSS)</sub> [%]	VGS <sub>(th)</sub> [%]	IGSS [nA]	IGSS- [nA]	RDS <sub>(ON)</sub> [%]	V <sub>SD</sub> [%]	BV <sub>(DSS)</sub> [V]	VGS <sub>(th)</sub> [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS <sub>(ON)</sub> [mOhm]	V <sub>SD</sub> [V]	
min	-20%	-50%	-20nA	-20nA	-20%	-10%	650	2						
max	+20%	+10%	+20nA	+20nA	+20%	+10%		4	100	100	25	150	1.2	
3	-0.5	-10.3	-0.8	-1.8	-2.9	0.0	720	2.87	0.6	1.0	0.141	121	1.023	C1
4	-0.2	-9.1	-0.8	-1.5	-2.4	-0.0	728	2.93	0.6	1.1	0.018	121	1.023	C2



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	Drift Deltas post 168h anneal at 100°C						Absolute Values post 168h anneal at 100°C							Bias Cond.
S/N	BV <sub>(DSS)</sub> [%]	VGS <sub>(th)</sub> [%]	IGSS [nA]	IGSS- [nA]	RDS <sub>(ON)</sub> [%]	V <sub>SD</sub> [%]	BV <sub>(DSS)</sub> [V]	VGS <sub>(th)</sub> [V]	IGSS [nA]	IGSS- [nA]	IDSS [uA]	RDS <sub>(ON)</sub> [mOhm]	V <sub>SD</sub> [V]	
5	-0.2	-19.1	-0.8	-1.4	-2.0	-0.1	735	2.63	0.7	1.0	0.018	122	1.026	C3
6	-0.5	-10.7	-0.9	-2.3	-2.9	0.0	734	2.89	0.5	1.0	0.140	124	1.023	C1
7	0.0	-8.9	-0.7	-1.5	-1.3	-0.1	740	2.92	0.6	1.1	0.019	126	1.024	C2
8	-0.2	-19.2	-0.8	-1.6	-2.2	-0.1	738	2.60	0.7	1.0	0.018	124	1.022	C3
9	-0.5	-10.4	-1.1	-1.7	-2.7	-0.1	716	2.92	0.7	1.1	0.152	120	1.025	C1
10	-0.1	-10.0	-0.5	-1.8	-2.3	-0.0	715	2.92	0.6	1.0	0.018	120	1.028	C2
11	-0.2	-18.8	-0.6	-1.8	-2.2	-0.1	725	2.62	0.7	1.1	0.018	121	1.025	C3
12	-0.5	-10.5	-0.7	-1.5	-2.7	-0.0	730	2.89	0.7	1.1	0.148	122	1.026	C1
13	-0.2	-10.8	-1.1	-1.8	-2.3	0.0	730	2.86	0.7	1.1	0.018	122	1.026	C2
14	-0.1	-19.1	-0.7	-1.8	-2.0	0.1	732	2.59	0.6	1.0	0.018	122	1.027	C3
15	-0.6	-9.8	-0.9	-1.8	-2.7	-0.1	701	2.88	0.6	1.0	0.157	121	1.026	C1
16	-0.2	-10.1	-0.9	-1.6	-2.5	0.0	712	2.89	0.6	1.0	0.018	121	1.026	C2
17	-0.2	-19.2	-0.7	-1.8	-2.2	-0.1	720	2.60	0.6	1.0	0.018	121	1.024	C3
18	-0.5	-10.3	-0.7	-1.6	-2.8	-0.1	730	2.86	0.7	1.0	0.146	122	1.024	C1
19	-0.2	-10.0	-0.8	-1.8	-2.2	-0.0	729	2.88	0.6	1.0	0.018	122	1.025	C2
20	-0.1	-19.0	-0.9	-1.6	-2.0	-0.1	723	2.60	0.6	1.0	0.018	123	1.022	C3
R350	-0.2	0.3	-0.9	-1.4	-1.1	-0.0	722	3.23	0.5	1.0	0.004	126	1.025	Control
R351	-0.1	0.1	-0.9	-1.8	-0.5	-0.1	726	3.20	0.7	1.0	0.004	128	1.026	Control
R352	-0.1	0.1	-1.0	-1.9	-0.4	-0.0	724	3.24	0.6	1.0	0.004	126	1.025	Control
R353	-0.1	0.1	-0.8	-1.4	-0.4	-0.0	717	3.23	0.6	1.1	0.004	125	1.027	Control
R354	-0.1	0.1	-0.7	-1.6	-0.3	-0.1	718	3.25	0.6	1.0	0.004	126	1.027	Control

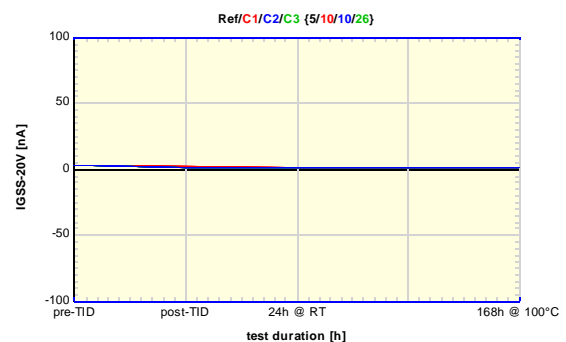
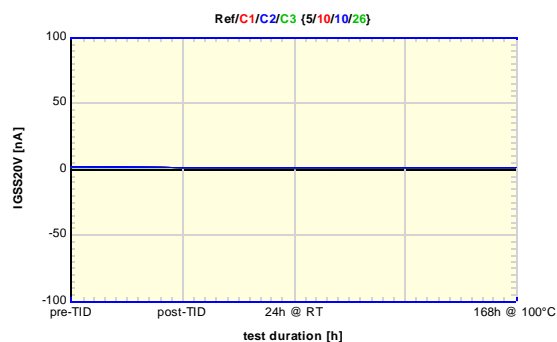
## §7.3 GRAPHICAL REPRESENTATION OF ELECTRICAL MEASUREMENTS

In the following, the electrical parameters listed in §7.2 are plotted for four points of the testing sequence, i.e.

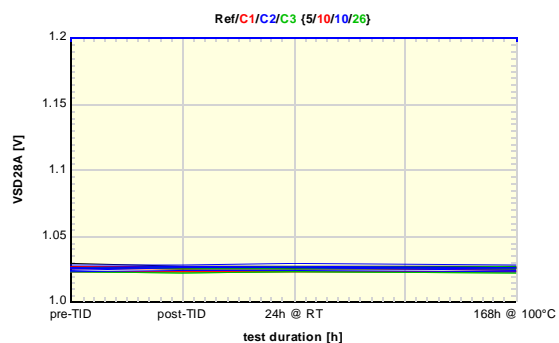
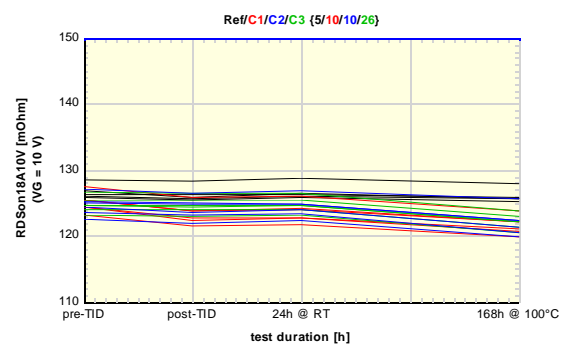
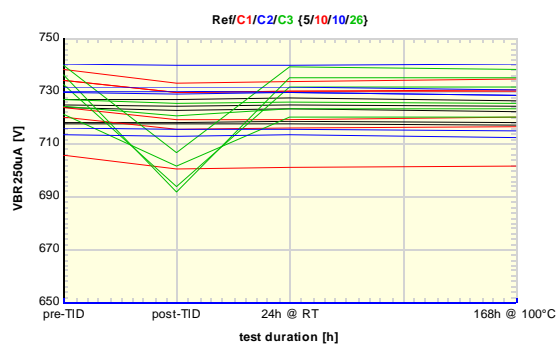
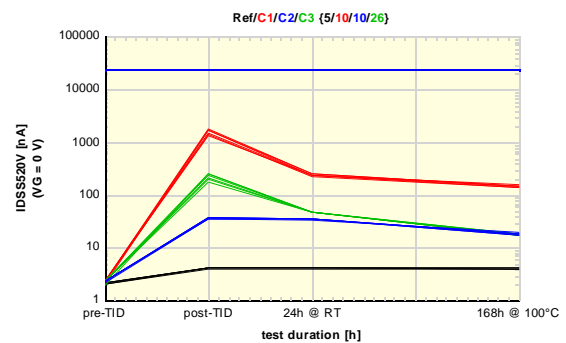
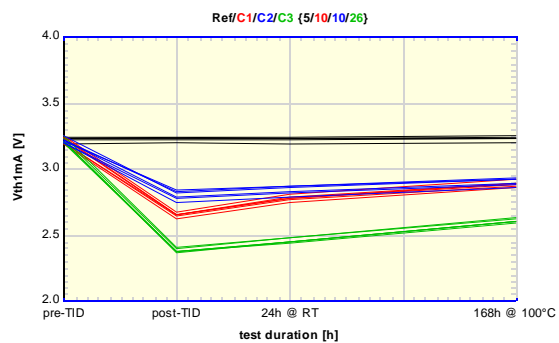
1. Prior to irradiation (pre-TID),
2. Post-irradiation (post-TID),
3. Posterior to room-temperature anneal of 24 hours (24h@RT),
4. Posterior to 168 hours of anneal at 100°C (168h@100°C) .

Four groups of samples are given coded by line-color:

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



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## §8 TOTAL IONIZING DOSE TESTING RESULT SUMMARY / CHECK FOR LOT FAILURE

TID Bias Condition	Minimum Required	Total to Condition	Failures Allowed	Failures Occurred	Condition Passed
C1	5	6	0	0	yes
C2	5	6	0	0	yes
C3	5	6	0	0	yes
Complete TID Tests					passed

The Wafer Lot passed the Total Dose Steady-State Irradiation Test.