LT8610AC SEE TEST REPORT

COTS SYNCHRONOUS BUCK CONVERTER 42V, 3.5A

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2. INTRODUCTION

The aim of this Single Event Effect test campaign is to evaluate the SEE radiation hardness level of the LT8610 buck converter component from Linear Technologies, especially regarding destructive single event effects, Single Event Functional Interrupts (SEFIs), and Single Event Transients (SET), as well as their dependence on bias voltage and load. Tests were performed at room temperature and at LET of 46 MeVcm²/mg and 62 MeVcm²/mg.
The component is selected from an ESA internal list of Commercial Of-The-Shelf (COTS) components, which contains components of high importance for ESA projects. The reported data can be used to derive information of a Safe-Operating-Area (SOA) for this device.

The test was carried out on 20-21 March and on the 8-9 June 2023 at UCLouvain in Belgium.

3. ACRONYMS

HIF	Heavy Ion Facility
COTS	Commercial-Off-The-Shelf
DSEE	Destructive Single Event Effect
DUT	Devices Under Test
HIF	Heavy Ion Facility
LDMOS	Lateral-Diffused Metal-Oxide Semiconductor
LET	Linear Energy Transfer
MIP	Microwaved Induced Plasma
MOSFET	Metal-Oxide-Semiconductor-Field-Effect Transistor
NDSEE	Non-Destructive Single Event Effect
PC	Power Cycle
SEB	Single Event Burnout
SEE	Single Event Effect
SEFI	Single Event Functional Interrupt
SEGR	Single Event Gate Rupture
SEL	Single Event Latchup
SET	Single Event Transient

SOA	Safe Operating Area

4. HEAVY ION IRRADIATION FACILITY

The heavy ion facility used for this test campaign is the Heavy Ion Facility (HIF) of UC-Louvain in Belgium [1]. The facility offers a cocktail of 9 ions including Xe-ions and Rh-ions which are used during this campaign. In the following table the available particles inside the cocktail are displayed. In this study Xe and Rh-ions where used.

Table 1: Available Ions at UCL (from [1])

M/Q	Ion	Energy [MeV]	Range [µm]	LET [MeV/(mg/cm²)]
3,25	$^{13}C^{4+}$	131	269.3	1,3
3,14	$^{22}Ne^{7+}$	238	202,0	3,3
3,37	$^{27}Al^{8+}$	250	131,2	5,7
3,27	$^{36}Ar^{11+}$	353	114,0	9,9
3,31	$^{53}Cr^{16+}$	505	105,5	16,1
3,22	$^{58}Ni^{18+}$	582	100,5	20,4
3,35	$^{84}Kr^{25+}$	769	94,2	32,4
3,32	$^{103}Rh^{31+}$	957	87,3	46,1
3,54	$^{124}Xe^{35+}$	995	73,1	62,5

5. DEVICES UNDER TEST

In Table 2 the parameters of the Device under Test (DUT), the LT8610, is given [2].

Table 2: Description of the DUT

Manufacturer	Die marking	Date Code	Product	Uin,max (V)	Uout,max (V)	Uout,min (V)	Id,cont,max (A)	frequency (MHz)
Analog Devices (old LTC)	2010	HY29	LT8610	42	30	3.3	2.5	0.2-2.2

This device is a synchronous buck converter with a half bridge configuration which is used to step down a voltage with a switching application. For the device a specific application close to the usual application as presented in the datasheet, was developed. In Figure 1, a usual application for this synchronous buck converter with the internal MOSFETs (LDMOS) is given.

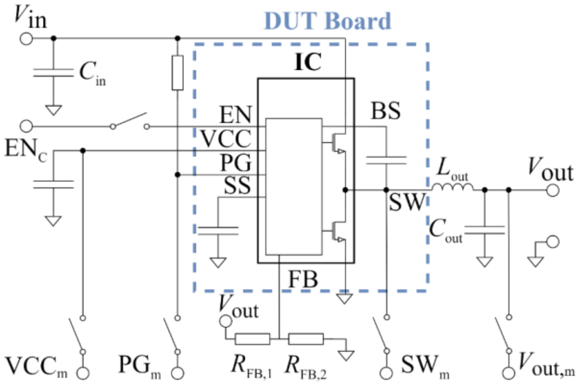

Figure 1: Typical application synchronous buck converter

In Figure 2, the block diagram of the device is shown and in Figure 3 the decapsulated die as well as the package marking can be seen.

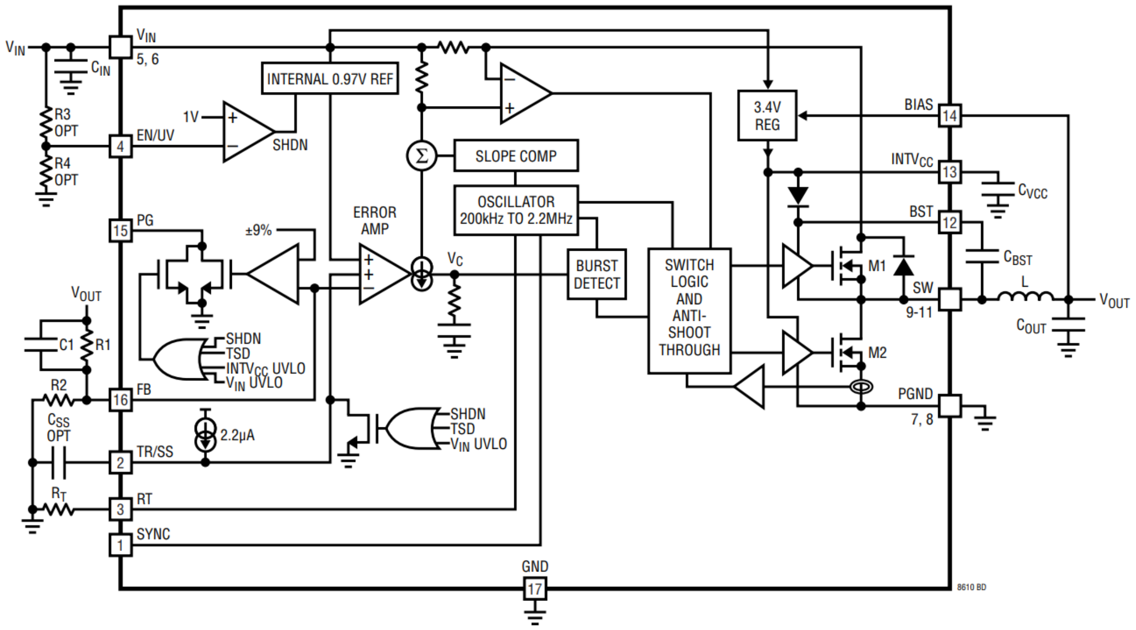

Figure 2: Block Diagram of the LT8610 [2]

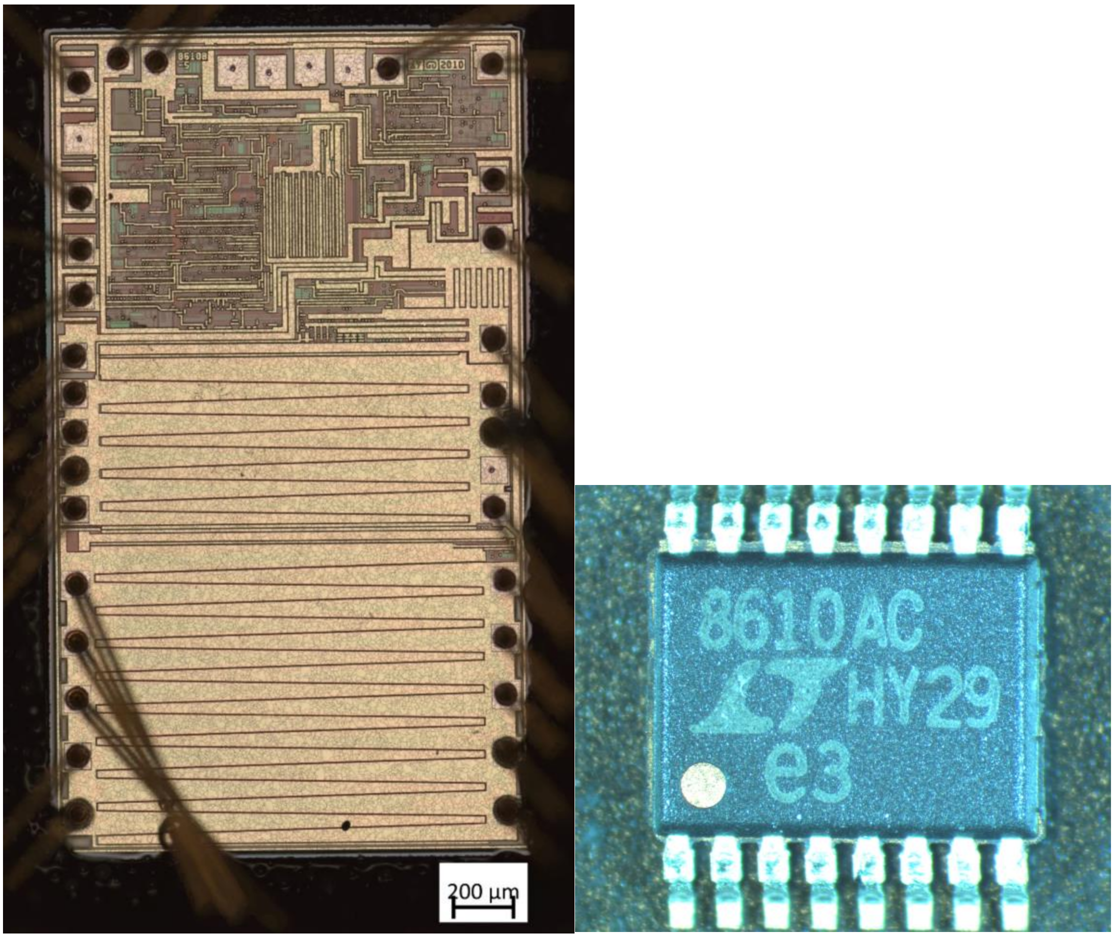

Figure 3:Microscope picture of a decapsulated LT8610 die (left) and picture of the external marking (right)

6. TEST PREPARATION

6.1. Sample preparation

Due to the limited penetration depth of Xe-ions (75 µm in silicon), it is necessary to decapsulate the component to directly irradiate the die of the device. For the decapsulation procedure ESA internal equipment was used, including a laser to thin down the plastic capsulation and the use of a Microwave Induced Plasma (MIP) etcher, that etches down organic material and do not modify any inorganic material like silicon or metals. With these two tools a safe decapsulation was possible and in total 12 LT8610 devices have been decapsulated for the heavy ion test. After each procedure a full functionality test was performed to validate the nominal operation.

6.2. Test set-up

The test was performed with heavy ion irradiation at UCLouvain. The irradiation was performed in vacuum. The test was done in different application conditions. For the test, the following equipment, Table 3, was used:

Table 3: Test Equipment

Equipment	Name	Description
2x Source meter	Keithley 2612A	Providing the bias voltage/current and the Relay supply current
1 x Voltage source	Keysight N6705C	Used to test voltages above 35 V (if no DSEE happened at lower voltage)
1x 4 channel oscilloscope	Keysight DSOS804A	To observe all the parameters mentioned in Table 4
1x Laptop		To acquire data and to set the test setup

In Figure 4 the basic test setup with the equipment and the test boards inside the vacuum chamber is visualized. Besides the LT8610, multiple different buck converters have been tested during the campaign.

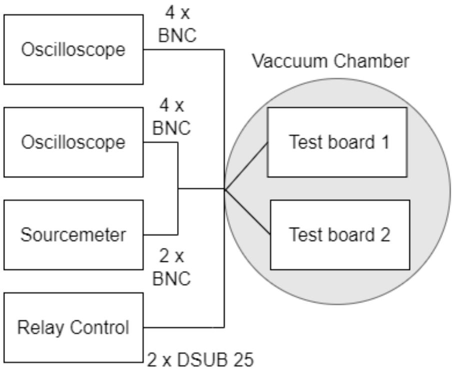

Figure 4: Test setup

For fast DUT sample exchange, a DUT board was designed and used for every different device type. This DUT board is mounted via pin headers on a second board, named “radiation-test-board” with the application circuitry and measurement and control connections to the outside. In the following a basic overview of the setup is given.

In Figure 5 the DUT board can be seen. This board is then mounted on the radiation-test-board in Figure 6. Specific values for the capacitances and inductances were calculated for each board to ensure a worst-case electrical stress while maintaining stability of the device. The biasing can flexibly be adjusted by jumpers and relays. The relays can be used to switch between the DUTs. In addition, the parameters of the device can be measured individually, and the device can be enabled and disabled. The relays are controlled outside the chamber with a specific designed relay-control-board.

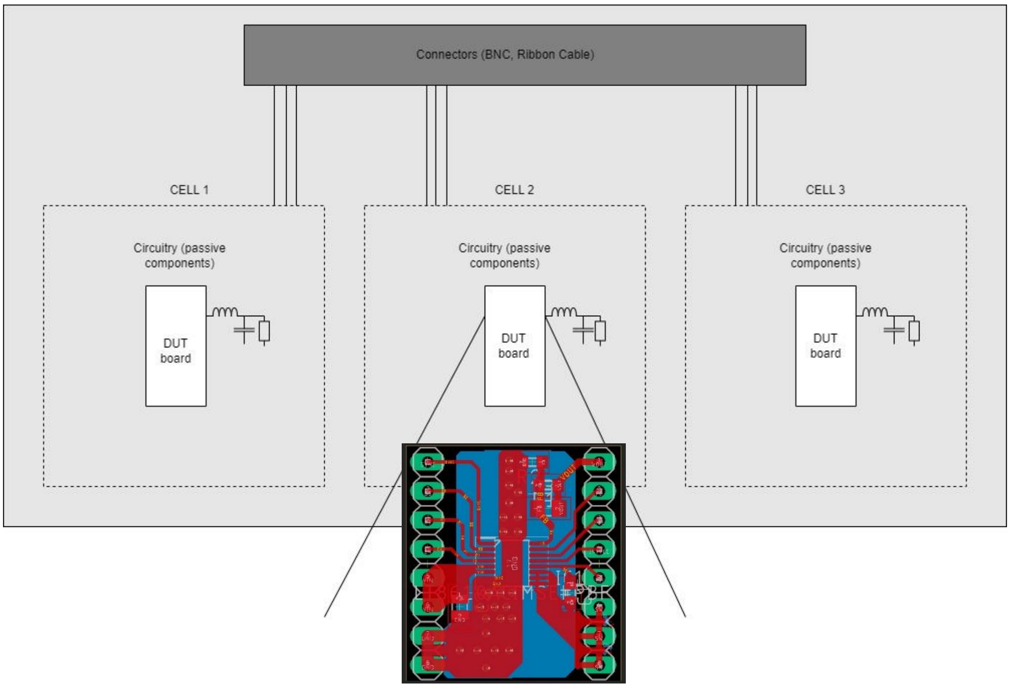

Figure 5: Visualization of the radiation test board the mezzanine DUT board below

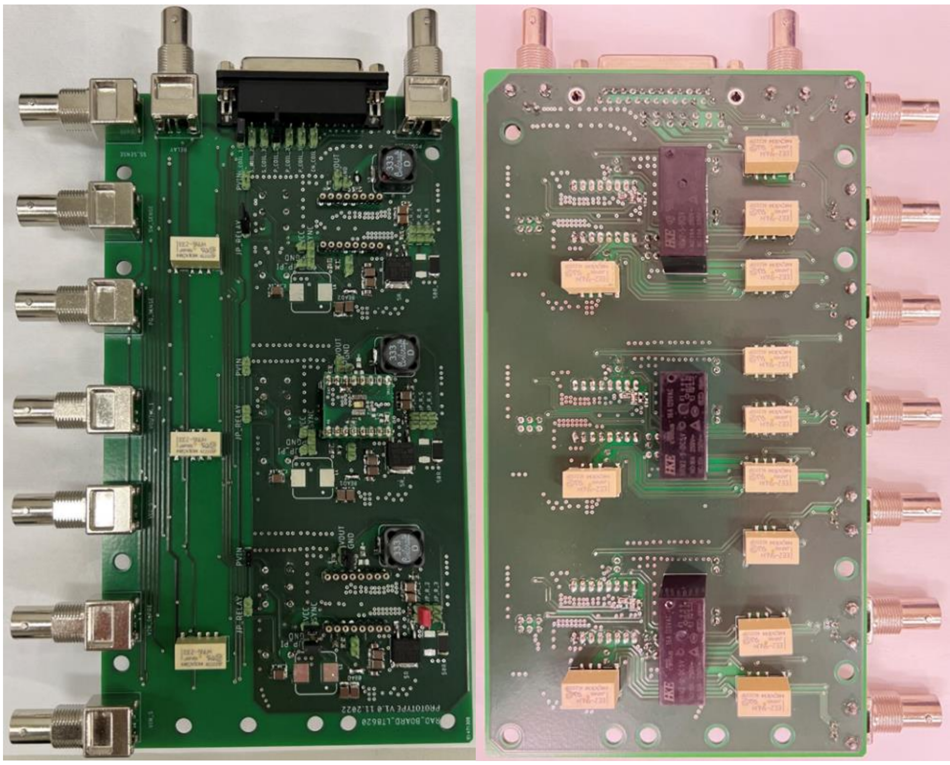

Figure 6: Top-side (left) and bottom-side (right) of the LT8610 test board

In Figure 7 an overview with the important capacitances is given. The value of the output capacitance is calculated to Cout = 80 µF, the input capacitance is Cin = 30 µF the output Inductance is Lout = 4.2 µH. The input & output conditions are summarised together with the results in Table 8.

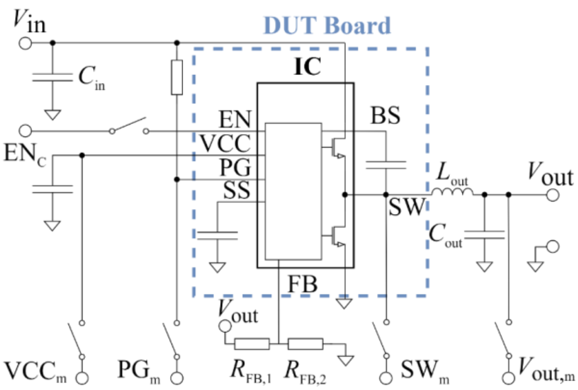

Figure 7: Simplified test setup with Cout = 80 µF, Cin = 30 µF, Lout = 4.2 µH *with varying input and output conditions described in Table 8.*

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6.3. Measurement

As stated above, the use of relays allows an individual measurement for each DUT on the radiation-test-boards. All-important measurable device parameters are provided in Table 4.

Table 4: Measurement Parameters

PIN/Parameter	Description	I/O	Measured	Type of Measurement
SYNC	CLK sync	I/O	no	-
SS	Soft Start	I	yes	Voltage
RT	Pin to set frequency	I	no	-
EN	Enable pin	I	no	-
Vin	Supply input	I	yes	Input Voltage & Current
SW	Switching node	O	yes	SW Voltage & Frequency
BST	Bootstrap pin	I	no	-
VCC	input internal LDO	I/O	no	-
BIAS	Internal supply	I	yes	Voltage & Current
PG	Power Good	O	yes	Voltage
FB	Feedback pin	I	no	-
Vout	Filtered output voltage		yes	Voltage

6.4. Data acquisition

The most important parameter of the DUT is the output voltage. Therefore, a trigger of the oscilloscope is set to the output voltage to observe whether the parameters are within the operating range. Also triggers on the PG have been set. As soon as the output voltage or PG voltage leaves the operating range, the oscilloscope acquires the data of SW pin, Vcc pin, Pgood pin and the output voltage. During the acquisition, the flux of the beam was adapted to not oversaturate the scope. That meaning, the saving time of the acquisition lead to the adjustment of the flux in such a way, that a safe acquisition of every SET was possible without the danger of losing the acquisition of other SETs, here the acquisition time was set to 10 % of the average occurrence of a SET which was in the range of 0.5s. In addition, current measurements have been carried out to observe overcurrent situations, and, in the event of an overcurrent event, an internal designed delatching system was used to power off the device quickly to prevent a destruction in the event of a Single Event Latch up.

7. SINGLE EVENT EFFECTS RESULTS

7.1. Non-destructive Single Event Effects Results

In Table 5 an overview of the kind and number of the non-destructive SEEs is given. All changes in the output voltage are due to functional interrupts of the switching of the LT8610. NDSEE were solely captured during irradiation under Rhodium and not under Xenon.

There are different kinds of SEFIs measured and presented in Table 5. Each SEFI type was grouped based on the different behaviours of the device. No Power Cycle SEFI was measured during the irradiation. In Table 6 the number and kind of observed SETs is visualized. The number of events achieved was a trade-off between having enough statistical data & overall beamtime schedule. The observed SEFIs are dependent on the chosen SS time. As can be seen in Figure 9, this takes the longest for the device to be operable again. A cross section and an upper bound cross section, calculated with the Upper-N_{events} is presented in Table 5 and 6 and is calculated as follows [3]:

$$UpperN_{\text{events}} = 0.5 * CHISQ.INV.RT((1-CL)/2,2x(N_{\text{events}}+1) \ ,$$

With:

- $UpperN_{\text{events}}$, the upper limit of the confidence interval N_{events} *of* observed.
- $CHISQ.INV.RT$, returns the inverse of the right-tailed probability of the chi-squared distribution.
- CL, Confidence Limits, here the 95% confidence limit shall be used.
- N_{events}, the number of observed events.

Table 5: Description of the measured non-destructive SEFIs under Rh-ion irradiation and an Input voltage of 12 V and output current of 0.06 A

SEFIS with effect on Vout	Reference Figure	Cross section cm^2	Upper-bound cross-section cm^2	Fluence in $ions/cm^2$	Maximum duration of SEFIs in s	Number (#) of Events	Description
Auto SEFI	Fig. 7.	$2 \cdot 10^{-5}$	$3.09 \cdot 10^{-5}$	$1 \cdot 10^{6}$	Up to $3 \cdot 10^{-2}$	20	decrease to 0.5 V of nominal 3.3 Vout
Reset SEFI	-	$2 \cdot 10^{-6}$	$7.22 \cdot 10^{-6}$	$1 \cdot 10^{6}$	Until reset	2	Shut down of the device, reset over enable pin necessary
Power Cycle SEFI	-	-	$3.69 \cdot 10^{-6}$	$1 \cdot 10^{6}$	Until PC	0	Shut down of the device, full power cycle necessary

Table 6: Description of the measured non-destructive SETs under Rh-ion irradiation and an Input voltage of 12 V and output current of 0.06 A

SETs with effect on Vout	Reference Figure	Cross section cm^2	Upper-bound cross section cm^2	Fluence in $ions/cm^2$	Maximum duration of SETs in s	Number (#) of Events	Description
Undervoltage SET	Fig. 7.	$3.3 \cdot 10^{-5}$	$5.14 \cdot 10^{-5}$	$6 \cdot 10^{5}$	Up to $1 \cdot 10^{-4}$	20	decrease to 2.9 V of nominal 3.3 Vout
Overvoltage SET	Fig. 8.	$12 \cdot 10^{-4}$	$3.95 \cdot 10^{-4}$	$6 \cdot 10^{5}$	Up to $7 \cdot 10^{-4}$	50	Increase of up to 5.3 V of nominal 3.3 Vout

Different kind of SETs can be observed on all devices. The undervoltage SET is a decrease of up to 2.9 V of the nominal 3.3 V. An example is visible in Figure 8.

Auto-SEFIs and reset- SEFIs can be observed on all DUTs. All SEFIs that lead to a shutdown are similar on the negative edges. This effect is due to a shutdown of the devices. As an example, typical SEFIs are shown in Figure 9. The figure shows an overlay of all SEFIs during a run. Once triggered, the auto-SEFI causes the device to shut down until a low voltage, about 0.3 V, is reached. The device then resumes back to normal operations automatically. The reset-SEFI can be observed as well and leads to a complete shutdown. After a reset or power cycle, the device restarts normally with the set soft start time, that was set via external capacitors. As soon as the output voltage leaves the nominal operating range, the PG pin triggers. In Figure 9 an overvoltage event is visualized that may harm a load if not mitigated.

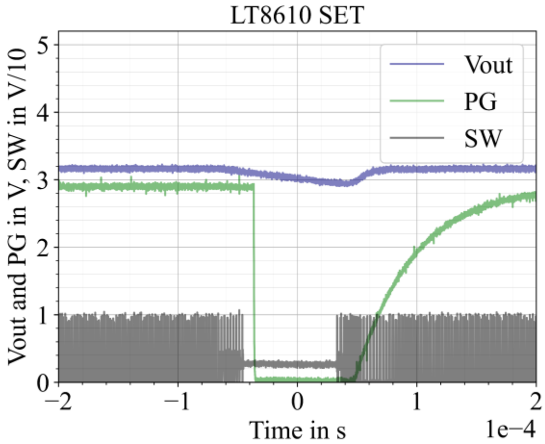

Figure 8: Vout SET of the LT8610 with the PG pin and the SW signal.

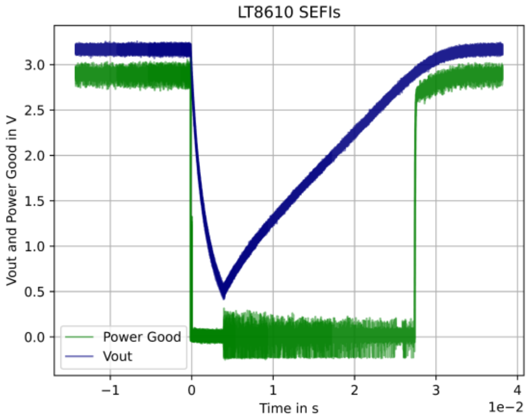

Figure 9: Overlay of all Auto-SEFIs that lead to an undervoltage condition on the load with 41 Auto SEFIs during Rh-ion irradiation at Vin = 12 V, Iout = 0.06 A and incident angle of 0˚

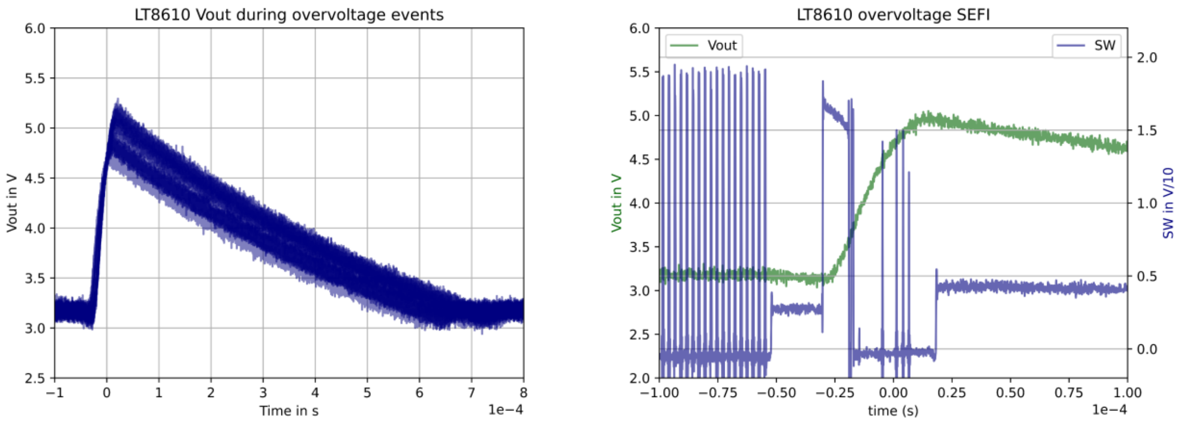

Figure 10: Overvoltage SET that lead to an overvoltage condition on the load with 27 SEFIs above 4.5 V (left) and an overvoltage SEFI with the Switching Node pin (right) during Rh-ion irradiation at Vin = 12 V, Rload = 50 Ohm and incident angle of 0˚

7.1.1. Worst Case Condition for non-destructive SEE

The previously presented results for non-destructive SEEs can be considered as the worst-case condition. In fact, not only the Safe operation of the device regarding DSEE is dependent on their bias condition but also the non-destructive SEEs. It has been observed, that at the maximum output current tested (2 A) 67 event for a Fluence of 6 $\cdot 10^5$ ions/cm^2 have been observed, while at 0.06 A output current the number of events has been over 60 % higher. The number of events is shown in Table 5.

Table 7: Total number of all events observed at different Load conditions for an LET of 46 MeV · cm²/mg

Load condition	Cross section cm^2	Upper-bound crosssection cm^2	Fluence in ions/cm^2	Maximum duration of SEFI in s	Number (#) of Events	Description
Vin= 19 V, Iout = 0.06 A	$6.76 \cdot 10^{-3}$	$8.15 \cdot 10^{-3}$	$6 \cdot 10^5$	Up to $1 \cdot 10^{-4}$	113	Combined number of all effects
Vin = 19 V Iout = 2 A	$4.02 \cdot 10^{-3}$	$5.1 \cdot 10^{-3}$	$6 \cdot 10^5$	Up to $7 \cdot 10^{-4}$	67	Combined number of all effects, different intensities of the effect, e.g. lower overvoltage overshoots as can be observed in Figure 11.

Not only the number of events but also the shapes are different for the loads. The highest overvoltage event, as can be seen in Figure 11 for the LT8610 at 2 A is now below 4 V while it was over 5 V for the 0.06 A condition. The Auto-SEFIs in this plot led to a complete shutdown to nearly 0 V until an automatic restart occurred. Due to the long soft-start time, the rise is not completely visualized in Figure 11. Also, the overvoltage events have a different shape than the ones for 0.06 A condition.

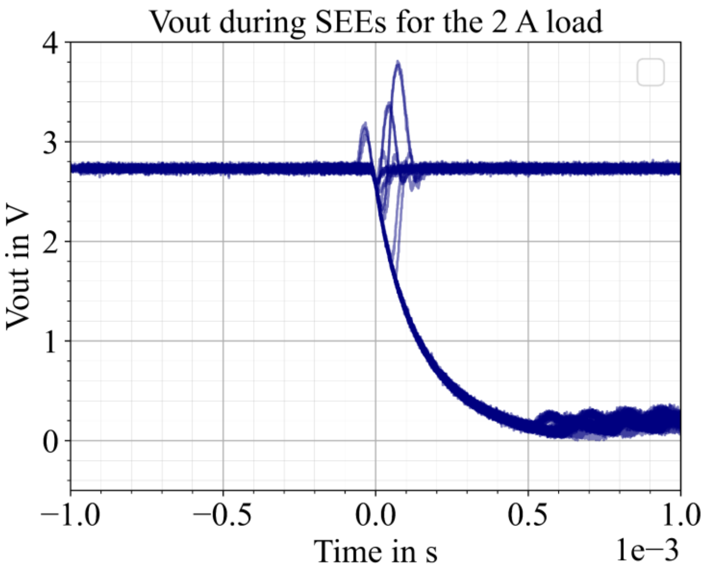

Figure 11: All SEEs are combined in this plot for a 2 A condition

7.2. DSEE Results

The device was tested against DSEE during Rh-ion irradiation at a normal incidence angle of 0°. In Table 8 and Table 9 a SOA is given. The success criteria for validating a given test conditions (electrical, angle & LET) was to have 3 different DUT tested & fully functional after the same test conditions at a fluence of F = $1 \cdot 10^7$ cm^{-2}. In Figure 12, a device is given with Roll and Pitch direction and in Table 8 and Table 9 the angle in the shown direction is given.

At an input voltage of 19 V and a low load the device survived the Rh-ion and Xenon-ion irradiation at 15 V at an incident angle of 0°.

No SEL occurred during any of the test runs & test conditions.

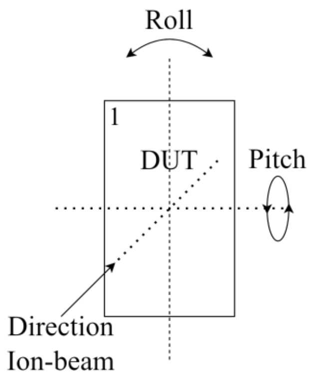

Figure 12: Display of the Roll and Pitch during tilting of the DUT. The DUT is irradiated with the first pin on the upper right and then tilted to the direction of the Ion-beam in the given directions.

Table 8: DSEEs and Safe Operating Area during Rh-ion irradiation with green (safe area), red (unsafe) and blue for devices tested with tilting, but the success criteria is not met.

Vin (LET 46 MeV · cm²/mg)	Incident Angle @ 0°			Incident Angle @ Roll 0° & Pitch 45°	Incident Angle @ Roll 90° & Pitch 45°
	Low load (0.06 A)	High load (0.6 A)	Very High Load (2 A)	Very High Load (2 A)	Very High Load (2 A)
10V	S1				
12V					
15V				S11, S12	S12
19V	S1, S2, S4	S5, S2	S1, S2, S9		~~S12~~
24V	~~S2~~	S3			
29V	~~S1~~	-			
42V	-	-			

Table 9: DSEEs and Safe Operating Area during Xe-ion irradiation with green (safe area), red (unsafe) and blue for devices tested with tilting, but the success criteria is not met.

Vin (LET 62 MeV · cm²/mg)	Incident Angle @ 0°			Incident Angle @ pitch 0° & tilt 45°	Incident Angle @ pitch 90° & tilt 45°
	Low load (0.06 A)	High load (0.6 A)	Very High Load (2 A)	Very High Load (2 A)	Very High Load (2 A)
10V					
12V					
15V			S9, S11	S19, S12	S13
19V		S10	S9, ~~S11~~		~~S13~~
24V			~~S9~~		
29V					
42V					

In Figure 13 a visualization of the SOA is given. The red area is the unsafe area where a destructive event has been observed. The yellow area is an area usable for high-risk missions when a LET of 46 MeV · cm²/mg or below is acceptable. The green area is characterized in terms of DSEE at nominal incidence at LET of 63 MeV · cm²/mg. The Figure is displayed at normal incident. Tilting is not included as the success criteria of three devices per condition is not met. However, in the Tables above the information regarding the tilting can be observed.

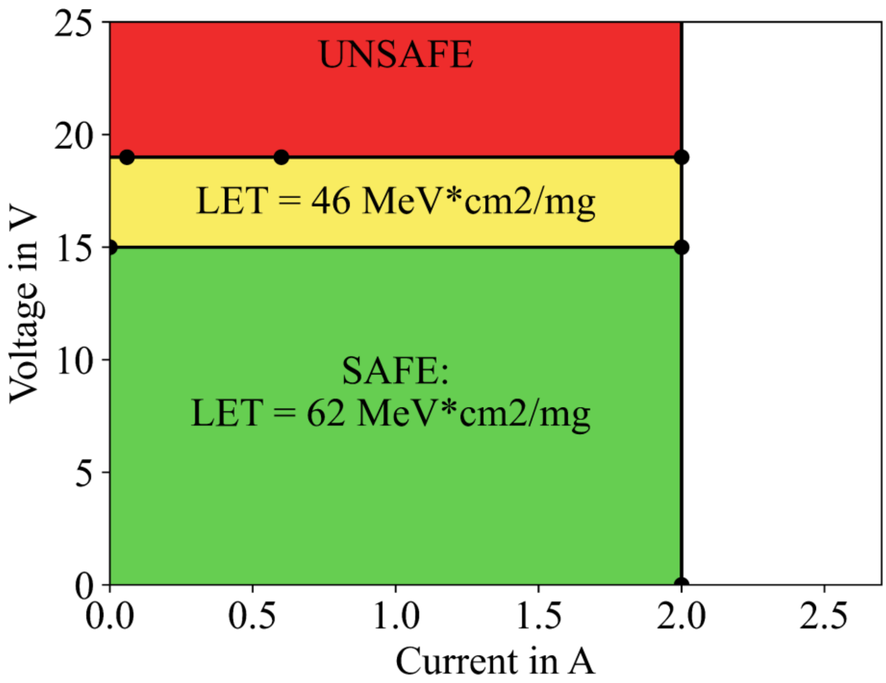

Figure 13. Safe Operating Area of the LT8610 with the Unsafe are (red), safe for high-risk missions (yellow), and safe area (green) with testing in normal incident.

In Figure 14. A destructive event is visualized. As can be seen from the SW pin. The device is switching normally before the DSEE. Then an earlier voltage increase of the SW pin can be observed. The switching application was interrupted, and the SW voltage stayed high. This can be explained by a short on the power bus that was created by turning on both, high- and low-side MOSFET at the same time that led to the immediate destruction of the high side. The low side shut down afterwards and an increase in the Vout is observable. This destructive effect can also be observed in Figure 15 here the high side showed a clear burnout. A complete melting of the metallization area is shown in Figure 15. Also, a GND bond wire melted.

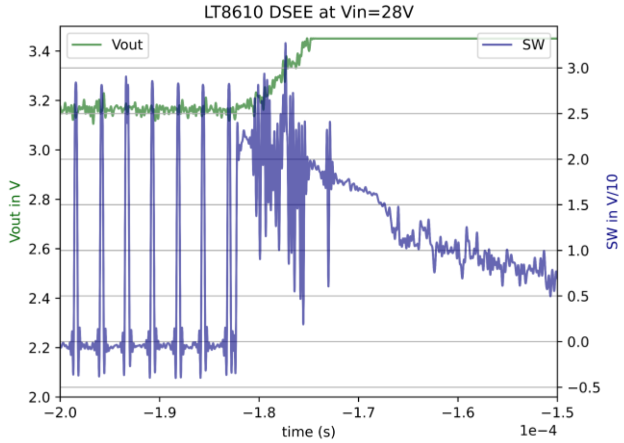

Figure 14: DSEE at Vin = 28 V during Rh-ion irradiation at incident angle of 0°

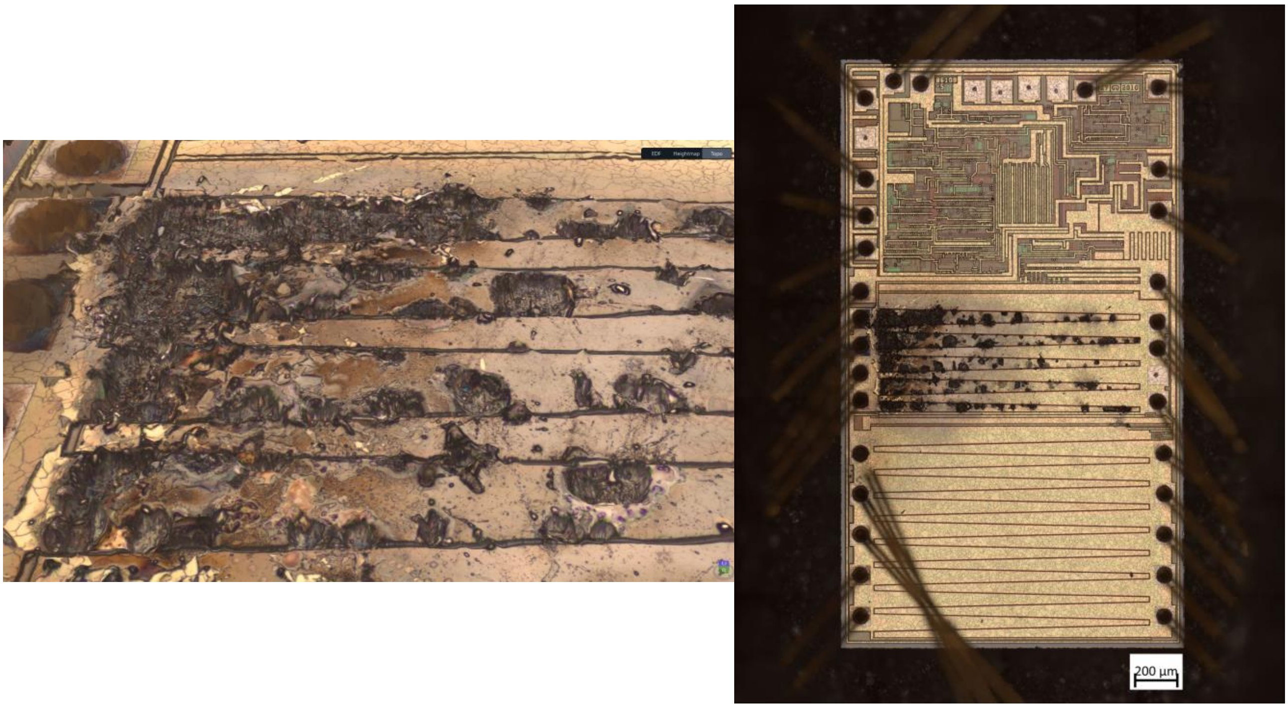

Figure 15: decapsulated LT8610 component after a DSEE with the whole die (right) and a 3D image of the melted metallization layer (right)

8. CONCLUSION

The aim of this test campaign is to evaluate the radiation hardness of the COTS LT8610 buck converter component (date code HY29) tested at 2 LET and room temperature against NDSEE and DSEE.

The LT8610 showed DSEE outside of the safe operating area. The SOA can be defined as follows:

- 15 V and 2 A for an LET of 62 $\mathrm{MeV} \cdot \mathrm{cm}^2/\mathrm{mg}$ including partial results at tilting angles.
- 19 V and 2 A for an LET of 46 $\mathrm{MeV} \cdot \mathrm{cm}^2/\mathrm{mg}$

The component showed not only DSEE but also a variety of non-destructive effects all of which need consideration in assessing the use of this part. The devices exhibit overvoltage situations that could potentially damage the load. No SEL occurred during any of the test runs & test conditions. In Table 10 a SEE summary is given.

The data provided in the report should be handled with caution considering traceability challenges in the use of COTS. However, the data gives an overview of different kinds of SEE and allows preparation for validation test campaigns and be able to identify possible mitigation techniques.

Table 10: SEE Summary

Item	Description
Aim	SEE sensitivity evaluation of LT8610 for destructive & non-destructive SEE
Biasing Conditions	1. various input voltages and output currents 2. steady output voltage (<3.3 V) and steady output switching frequency (500 kHz)
Sample size	3 devices to be tested for each final biasing condition for result confirmation
LET at surface	46 $\mathrm{MeV} \cdot \frac{\mathrm{cm}^2}{\mathrm{mg}}$, 60 $\mathrm{MeV} \cdot \frac{\mathrm{cm}^2}{\mathrm{mg}}$ and higher $\mathrm{LET}_{\mathrm{eff}}$ with tilting
Fluence	1. 10^7 $\mathrm{ions/cm^{-2}}$ for DSEE 2. various for SET and SEFI characterization
Environmental condition	Room temperature condition
Results	DSEE evaluation normal incident: no DSEE at for an LET of 46 $\mathrm{MeV} \cdot \frac{\mathrm{cm}^2}{\mathrm{mg}}$ 1. high load and 19 Vin, 2. Low load and 19 Vin. no DSEE at for an LET of 62 $\mathrm{MeV} \cdot \frac{\mathrm{cm}^2}{\mathrm{mg}}$ at 1. high load and 15 Vin, 2. Low load and 15 Vin. Soft-error & non-destructive SEL sensitivity (Rh irradiation): 1. Shutdown-SEFI, Reset-SEFI 2. Undervoltage SET, Overvoltage SET 3. No SEL observed

9. REFERENCES

[1] UC-Louvain, Heavy Ion Facility, Heavy Ion Facility (HIF) | UCLouvain\

[2] Analog Devices, 42V, 2.5A Synchronous Step-Down Regulator with 2.5µA Quiescent Current, Rev. B. 2021 Device, LT8610 LT8610 (Rev. B) (analog.com)

[3] ESCC, Single Event Effect Test Method and Guidelines, ESCC Basic specification No. 25100

10. ANNEX

In the following tables the test campaign with the different tested devices is given.

Run	Facility log #	DUT	Vinput	Iout	Title (°)	Vacuum (Y/N)?	Beam collimation (Shape, size & position)	Particle	Energy (MeV)	LET Normal in Si (90°) [For P see "SRIM"]	LET Effective (in Si)	Range (um)	Flux target (/cm²/s)	Fluence target (/cm²)	Duration Target (sec)	Beam Homogenity (%)	Type of test / Mode/SW tested...	Scope Trigger	SEL current threshold (mA)
1	1	LT8610 - S1	10	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.00E+03	1.00E+07	10000	10	Exploration run	Vout @ 2.86V then 3V (-150 mV), then 3.3V (+150 mV)	500
2	2	LT8610 - S1	10	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @1.28V (for SEFI)	500
3	3	LT8610 - S1	19	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	L/SEB/SEGR & pos. S	Vout @1.28V (for SEFI)	500
4	4	LT8610 - S1	19	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	L/SEB/SEGR & neg. S	Vout @3V (for SET)	500
5	5	LT8610 - S1	29	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @3V (for SET)	500
6	6	LT8610 - S2 (actually LT8610-S1)	24	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @3.25V (for SET)	100
7	7	LT8610 - S2	24	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @3.25V (for SET)	100
8	8	LT8610 - S3	24 (instead of 19)	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @3.25V (for SET)	100
9	9	LT8610 - S3	19	0.06	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @3.25V (for SET)	100
15	15	LT8610 - S4	19	6mA	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Pgood @ 2.6V (neg)	100
16	16	LT8610 - S3	19	0.6	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @ 2.70V	100
17	17	LT8610 - S5	12	0.6	0	Yes	C2*2	Rh	957	46	46	87.3	1.50E+04	1.00E+07	666.7	10	SEL/SEB/SEGR	Vout @ 2.70V	100

Run	nominal current (mA)	Start time	Duration actual (sec)	Fluence actual (/cm²)	Cumulative Fluence (/cm²)	Flux actual (/cm²/s)	Run dose (krad)	Total dose (krad)	Test OK/NOK	Measured SEL level w/o protection (mA)	# NDSEL (approximatively - to be postreated)	# DSEE (SEGR/SEB/DSEL) (approximatively)	# SET (approximatively)	# auto-SEFI (approximatively)	# soft-SEFI (approximatively)	# PC-SEFI (approximatively)	# Other SEE (approximatively)
1	54.00	14:43	2900	1.20E+06	1.20E+06	4.14E+02	8.85E-01	8.85E-01	OK	-	0	0	several	several	2	0	e comment
2	54.00	15:38	879	1.00E+07	1.12E+07	11376.5643	7.38E+00	8.26E+00	OK	-	0	0	several	several	7	0	0
3	34.00	16:00	847	1.00E+07	2.12E+07	11806.3754	7.38E+00	1.56E+01	OK	-	0	0	several (up to 5.6V approx)	several	6	0	0
4	34.00	16:19	102	1.26E+06	2.25E+07	12352.9412	9.29E-01	1.66E+01	OK	-	0	0	several neg. SET	several	1	0	0
5	26.00	16:22	few seconds	6.56E+04	2.25E+07	#VALUE!	4.84E-02	1.66E+01	OK	-	?	1	?	?	?	0	0
6	32.00	16:35	52	5.55E+05	5.55E+05	10673.0769	4.09E-01	4.09E-01	NOK	-	-	-	-	-	-	-	-
7	32.00	16:38	??	5.12E+06	5.12E+06	#VALUE!	3.78E+00	3.78E+00	OK	-	2 (but most likely due to DSEL)	1	several neg. SET	several	1	0	0
8	31.00	16:50	0	0.00E+00	0.00E+00	#DIV/0!	0.00E+00	0.00E+00	NOK	-	-	-	-	-	-	-	-
9	36.00	16:53	664	1.00E+07	1.00E+07	15060.241	7.38E+00	7.38E+00	OK	-	0	0	several neg. SET	several	1	0	0
15	33.00	19:28	698	1.00E+07	1.00E+07	14326.6476	7.38E+00	7.38E+00	OK	-	0	0	No	several	0	0	0
16	150.00	19:43	150	6.50E+05	6.50E+05	4333.33333	4.79E-01	4.79E-01	OK	-	0	1	??	??	3	0	0
17	207.00	19:48	690	1.00E+07	1.00E+07	14492.7536	7.38E+00	7.38E+00	OK	-	0		??	several	10	0	0

Run	Facility log #	Reminder Philipp file name	DUT	Vinput	Rout (Ohm)	Pitch (°)	Title (°)	Vacuum (Y/N)?	Beam collimation (Shape, size & position)	Particle	Energy (MeV)	LET Normal in Si (90°) [For P see "SRIM"]	LET Effective (in Si)	Range (um)	Flux target (/cm²/s)	Fluence target (/cm²)	Duration Target (sec)	Beam Homogenity (%)	Type of test / Mode/SW tested…	Scope Trigger	SEL current threshold (mA)	nominal current (mA)	Start time	Duration actual (sec)	Fluence actual (/cm²)	Cumulative Fluence (/cm²)	Flux actual (/cm²/s)	Run dose (krad)	Total dose (krad)	Test OK/ NOK	Measured SEL level w/o protection (mA)	# NDSEL (approximatively - to be postreated)	# DSEE (SEGR/SEB /DSEL) (approximatively)	# SET (approximatively)	# auto-SEFI (approximatively)	# soft-SEFI (approximatively)	# PC-SEFI (approximatively)	# Other SEE (approximatively)
19	19	OK	LT8610 - S4 (new) ??	12	2A	0	0	Yes	C2*2	Rh	957	46	46	87	1.00E+03	1.00E+07	10000	10	DSEE SoA.	Vout pos. @ 3.6V, Vout neg. @ 2.5V, then PG neg. @ 0.2V	700	420.00	17:52	1268	1.00E+07	1.00E+07	7886.4353	7.38E+00	7.38E+00	OK						6		
40	2	OK	LT8610 - S9	15	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	DSEE SoA.	Vout pos. @ 5.0V then reduced to 3.18V	700	350.00	12:46	715	1.00E+07	1.00E+07	13986.014	1.00E+01	1.00E+01	OK			0		1	1		
41	3	OK	LT8610 - S9	19	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	DSEE SoA.	Vout pos. @ 3.18V, Vout neg @ 2.37V	700	290.00	13:00	718	1.00E+07	1.00E+07	13927.577	1.00E+01	1.00E+01	OK								
42	4	OK	LT8610 - S9	24	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Checkinf if it gets killed like for Rh	Vout pos. @ 3.18V, Vout neg @ 2.37V	700	290.00	13:13	46	6.00E+05	6.00E+05	13043.478	6.00E-01	6.00E-01	OK			1 DSEE					
43	5	OK	LT8610 - S10	19	0.6A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Going down to only HL to see…	Vout pos. @ 3.18V, Vout neg @ 2.37V	700	132.00	13:15	699	1.00E+07	1.00E+07	14306.152	1.00E+01	1.00E+01	OK						2		
44	6	OK	LT8610 - S10	19	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Confirmation run	Vout pos. @ 3.18V	700	340.00	13:28	95	1.75E+05	1.75E+05	1842.1053	1.75E-01	1.75E-01	OK			1 DSEE					
45	7	OK	LT8610 - S11	15	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Confirmation run	Vout pos. @ 3.18V, Vout pos. @ 4.7V	700	380.00	13:33	715	1.00E+07	1.00E+07	13986.014	1.00E+01	1.00E+01	OK								
57	19	ok	LT8610 - S9*	12V then 15V.	2A	0	45	Yes	C2*2	Xe	995	63	88	73	1.50E+04	1.00E+07	666.7	10	Testing with tilt 45 and pitch 0°	Vout pos. @ 5.2V	1000	520.00	17:56	917	8.02E+06	8.02E+06	8745.9106	8.02E+00	8.02E+00	OK			SEL: 2					
59	21	-	LT8610 - S12*	12V, then 15V	2A	90	45	Yes	C2*2	Xe	995	63	88	73	1.50E+04	1.00E+07	666.7	10	Testing with tilt 45 and pitch 90°	-	1000	440.00	18:47	520	4.26E+06	4.26E+06	8192.3077	4.26E+00	4.26E+00	OK								
62	24	OK	LT8610 - S12*	12V then 15V, then 19V.	2A	90	45	Yes	C2*2	Rh	957	46	65	87	1.50E+04	1.00E+07	666.7	10	Testing with tilt 45 and pitch 90°	Vout pos. @ 4.2V	1000	438.00	19:47	754	5.35E+06	5.35E+06	7095.4907	3.95E+00	3.95E+00	OK								
66	28	-	LT8610 - S11*	12V, then 15V.	2A	0	45	Yes	C2*2	Rh	957	46	65	87	1.50E+04	1.00E+07	666.7	10	Testing with tilt 45 and pitch 0°	No trig.	1000	500.00	21:01	414	4.22E+06	4.22E+06	10193.237	3.11E+00	3.11E+00	OK								
67	29	-	LT8610 - S11*	15V	0.6A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Confirmation normal incidence to get some more confidence on data	Vout pos. @ 3.1V	1000	160.00	21:10	155	1.92E+06	1.92E+06	12408.584	1.42E+00	1.42E+00	OK								
68	30	-	LT8610 - S11*	19V	0.6A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Confirmation normal incidence to get some more confidence on data	Vout pos. @6V	1000	130.00	21:14	881	1.33E+07	1.33E+07	15096.481	9.81E+00	9.81E+00	OK								