LMR38020 SEE TEST REPORT

Texas Instruments, LMR38020 4.2V to 80 V,2 A, Synchronous SIMPLE SWITCHER Power Converter with 40 uA Iq

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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 LMR38020 buck converter component from Texas Instruments, especially regarding single event effects, Single Event Functional Interrupts (SEFI), 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 MeV · cm^2/mg and 62 MeV · cm^2/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 UC-Louvain 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 Effects
PC	Power Cycle
SEB	Single Event Burnout
SEE	Single Event Effect
SEFI	Single Event Functional Interrupts
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 HIF of UC-Louvain in Belgium. 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.

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) are given.

Table 2: Description of the DUT

Manufacturer	Date Code	Product	Uin,max (V)	Uout,max (V)	Uout,min (V)	Id,cont,max (A)	frequency (MHz)
Texas Instruments	32A	LMR38020	80	75	1	2	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.

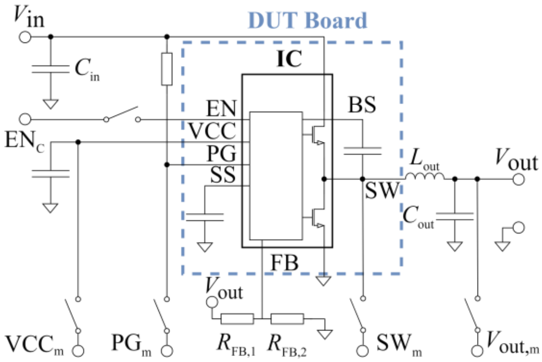

Figure 1: Typical application synchronous buck converter

In Figure 2 the Block diagram of the device is shown and in Figure 3 the decapsulated die can be seen.

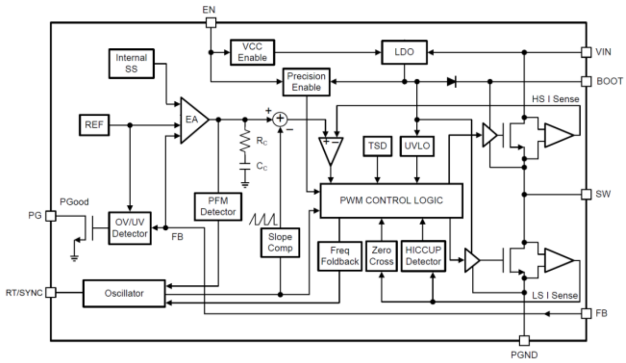

Figure 2: Block Diagram of the LMR38020 [2]

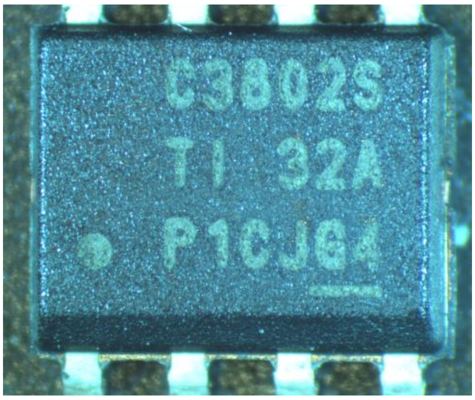

Figure 3:Microscope Picture of a LMR38020

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 LMR38020 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 shall be performed with heavy ion irradiation at UCLouvain. The irradiation will be performed in vacuum. The test will be done in application. For the test, the following equipment, Table 3, is to be 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. Multiple different buck converters have been tested during the campaign. one of the test boards consist of the LMR38020.

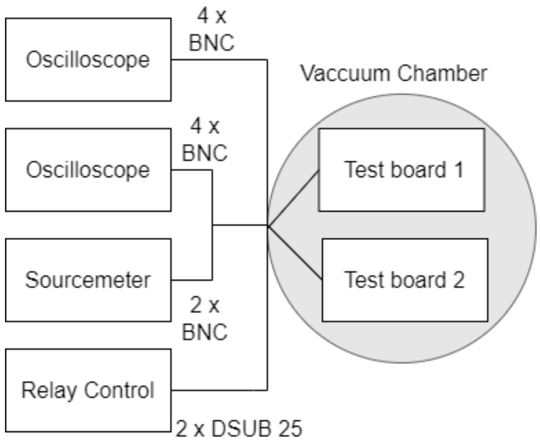

Figure 4: Test setup

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.

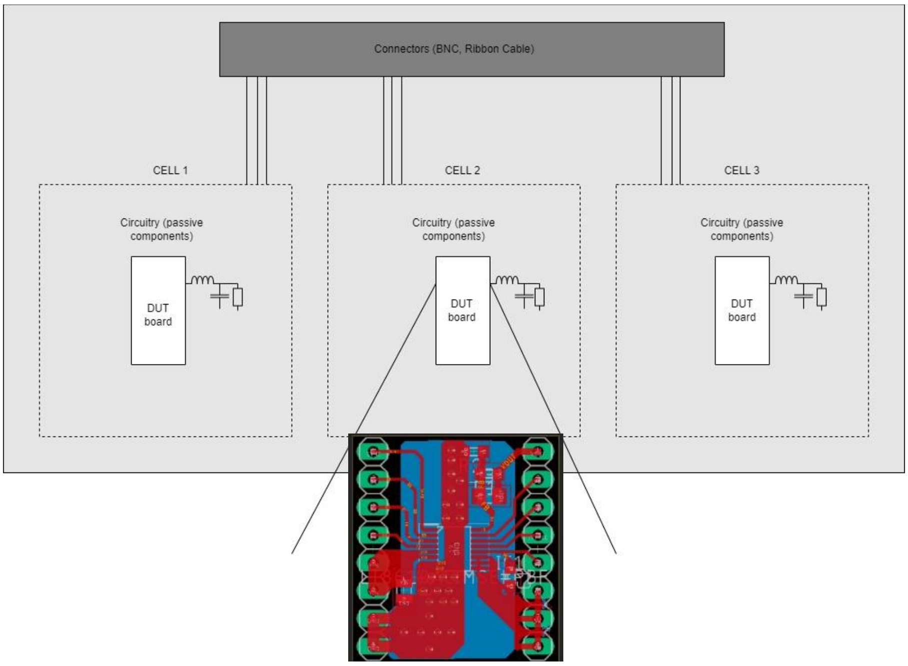

Figure 5: Visualization of the radiation-test-board

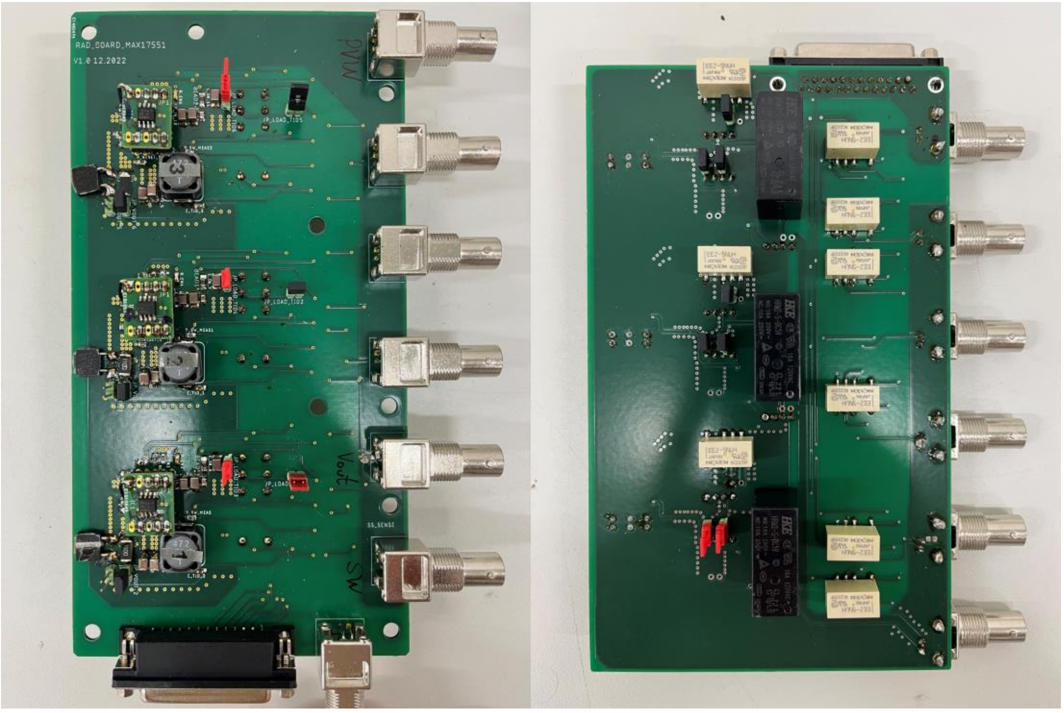

Figure 6: Top-side (left) and bottom-side (right) of the LMR39020 test board

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.

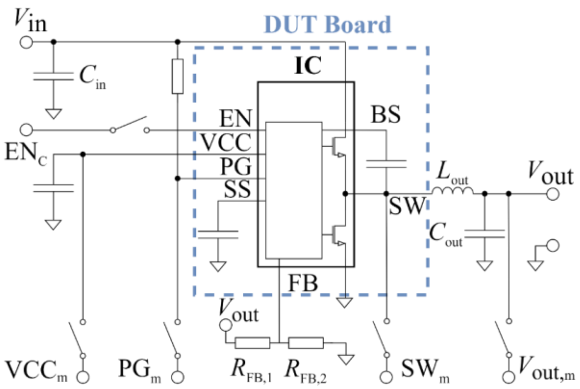

Figure 7: Simplified test setup

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/RT	CLK sync Pin to set frequency	I/O	no	-
EN	Enable pin	I	no	-
Vin	Supply input	I	yes	Input Voltage & Current
SW	Switching node	O	yes	SW Voltage & Frequency
BOOT	Bootstrap pin	I	no	-
PG	Power Good	O	yes	Voltage
FB	Feedback pin	I	no	-
Vout	Filtered output voltage		yes	Voltage

6.4. Acquisition of Data

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. 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.

NDSEE were solely captured during irradiation under Rhodium and not under Xenon.

All changes in the output voltage are due to functional interrupts of the switching of the LMR38020.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 SEEs under Rh-ion irradiation and an Input voltage of 30 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 SEFI in s	Number (#) of Events	Description
Shutdown SEFI	Fig. 8	$3.18 \cdot 10^{-5}$	$3.7 \cdot 10^{-5}$	$5 \cdot 10^{6}$	Up to $3 \cdot 10^{-2}$	159	decrease to 2 V of nominal 5 Vout
Reset SEFI	-	0	$7.38 \cdot 10^{-7}$	$5 \cdot 10^{6}$	Until reset	0	Shut down of the device, reset over enable pin necessary
Power Cycle SEFI	-	0	$7.38 \cdot 10^{-7}$	$5 \cdot 10^{6}$	Until PC	0	Shut down of the device, full power cycle necessary
Power Good SEFI	Fig. 9.	$9.6 \cdot 10^{-6}$	$1.26 \cdot 10^{-5}$	$5 \cdot 10^{6}$	Until reset	48	Leads to a PG low signal with no effect on Vout or other parameters, reset via the enable pin necessary

Table 6: Description of the measured non-destructive SETs under Rh-ion irradiation and an Input voltage of 30 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 SEFI in s	Number (#) of Events	Description
Undervoltage SET	-	$1.6 \cdot 10^{-6}$	$3.16 \cdot 10^{-6}$	$5 \cdot 10^{6}$	Up to $1 \cdot 10^{-4}$	8	decrease to 2.9 V of nominal 5 Vout
Overvoltage SET	-	0	$7.38 \cdot 10^{-5}$	$5 \cdot 10^{6}$	Up to $7 \cdot 10^{-4}$	0	Increase of nominal 5 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 5 V.

Auto-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 7. 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 2-2.5 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.

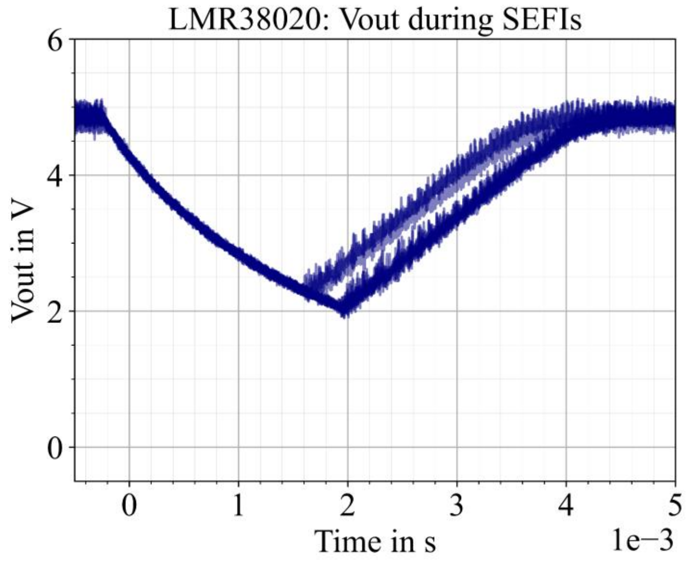

Figure 8: Vout SET of the LMR38020 with the PG pin and the SW signal under Rh-ion irradiation and an Input voltage of 30 V and output current of 0.06 A

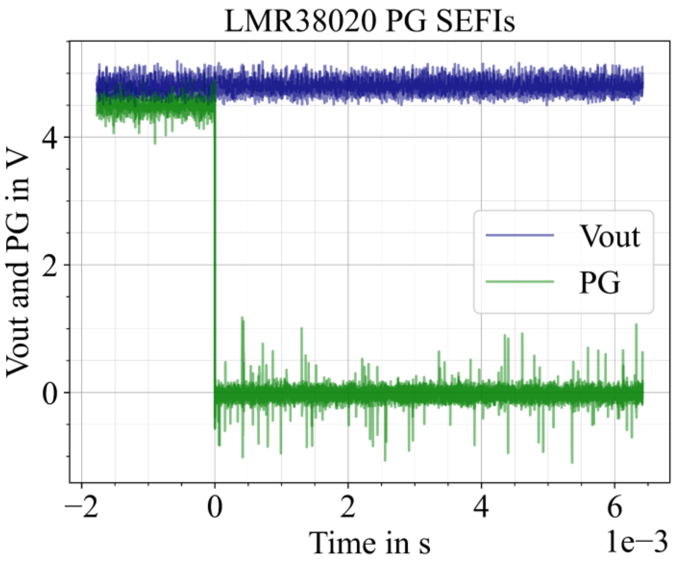

Figure 9: SEFI that lead to a low of the PG pin without any effect on the Vout under Rh-ion irradiation and an Input voltage of 30 V and output current of 0.06 A

7.2. DSEE Results

*7.2.1. Latchups**

**A high inrush current was observed together with the overvoltage situations. However, since the exact functionality is not clear it might not be a Latch-up but another effect with a similar behaviour.*

The LMR38020 experience Latch-ups during irradiation. With the used delatching system, a destructive event could be prevented. Without the delatching system the devices got destroyed. The Latch-ups led to high overcurrent spikes that potentially harm the device and the load. The number of SELs are indicated in the Safe Operating Area tables stated in the next chapter. In Figure 10 and Figure 11 example latchups are shown. A fast and constant high increase in the voltage and an inrush current in the device have been observed. The PG pin indicated low for a short time and went high again indicating, wrongful, a correct functionality. There are different kind of overvoltage situations that went to different heights as can be seen in Figure 10. These events have been also observed at a low LET of 15.

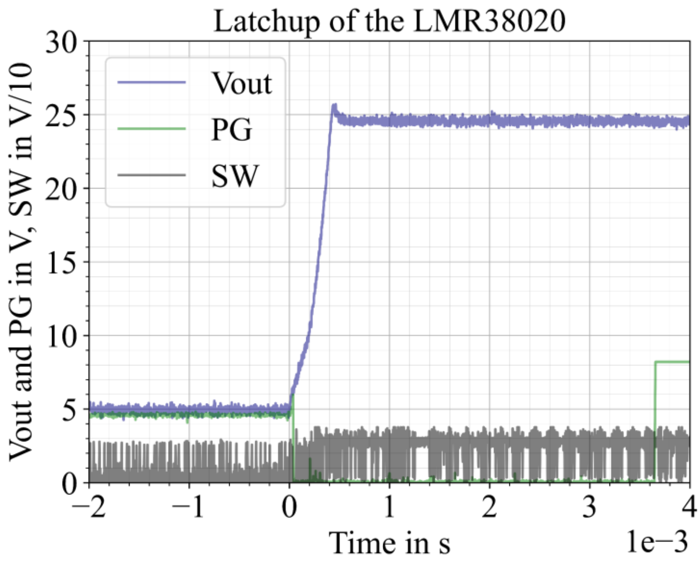

Figure 10: Example Latchup with PG and switching signal under Rh-ion irradiation and an Input voltage of 30 V and output current of 0.06 A

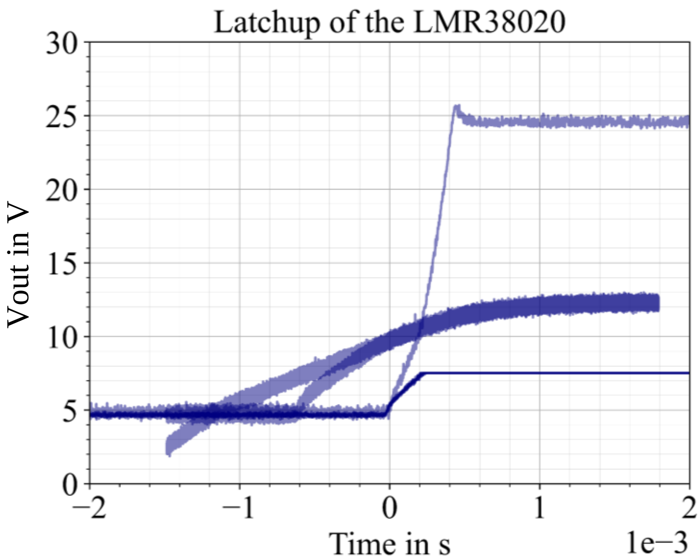

Figure 11:Overlay of latchups of the LMR38020 under Rh-ion irradiation and an Input voltage of 30 V and output current of 0.06 A

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}. At an input voltage of 30 V and a low load the device survived the Rh-ion and Xenon-ion irradiation at an incident angle of 0. In

Figure 12 the direction of the ion beam with tilting is displayed. No difference was observed during the tilting.

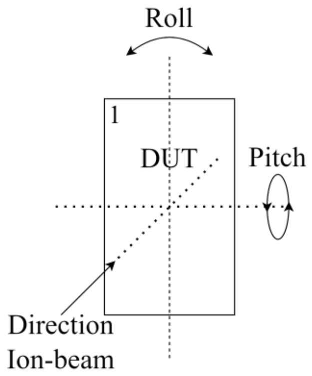

Figure 12: Display of the Roll and Pitch during tilting of the DUT. The DUT is irradiated with the first pin on the upper right and then tilted to the direction of the Ion-beam in the given directions.

Table 7: DSEEs and Safe Operating Area during Rh-ion irradiation

Vin (LET 46 MeV · cm^2/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 (1.2 A)	Very High Load (2 A)	Very High Load (2 A)
15V					
19V					
24V				S4	
30V	S1 (2 SEL) S2 (4 SEL)		S1, S2, S3	S4	S3
40V	S1 (2 SEL)		~~S1~~	~~S4~~	~~S3~~

Table 8: DSEEs and Safe Operating Area during Xe-ion irradiation

Vin (LET 46 MeV · cm^2/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)
15V					
19V					
24V					
30V			S9 (9 SEL), S11 (10 SEL)	S6, S7	S8
40V			~~S5~~		

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, it is important to note, that potential latchups occurred on all devices, hence the green area is with an included latchup system. 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.

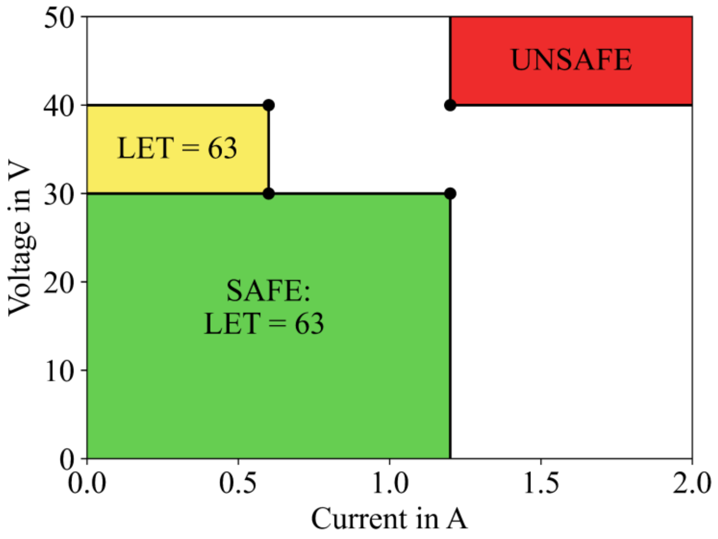

Figure 13. Safe Operating Area of the LMR38020 with the Unsafe are (red), safe area (green)(Just with Latchup-protection), and one device tested without destruction (yellow) but success criteria not met

7.3. Conclusions

The aim of this test campaign is to evaluate the radiation hardness of the COTS LMR38020 buck converter component with the date code 32A tested at 2 LET and room temperature against NDSEE and DSEE.

The LMR38020 showed DSEE outside of the safe operating area. The SOA can be defined as follows:

- 30 V and 1.2 A for an LET of 62 $\mathrm{MeV \cdot cm^2/mg}$ including tilting with pitch and roll.

The component showed not only DSEE but potentially SELs and also a variety of non-destructive effects all of which need consideration in assessing the use of this device. The devices exhibit overvoltage situations that could potentially damage the load. In Table 10 a SEE summary is given.

Table 9: SEE Summary

Item	Description
Aim	SEE sensitivity evaluation of different synchronous buck converter devices for destructive SEE and SET/SEFI
Biasing Conditions	1. various input voltages and output currents 2. steady output voltage (<3.3 V) and 500 kHz switching frequency
Sample size	3 devices to be tested for each final biasing condition for result confirmation
LET	$46\ \mathrm{MeV}\cdot\frac{\mathrm{cm}^2}{\mathrm{mg}}$, $60\ \mathrm{MeV}\cdot\mathrm{cm}^2/\mathrm{mg}$ 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	Safe Operating Area for DSEE: 1. high load and 30 Vin, LET of 62 $\mathrm{MeV}\cdot\frac{\mathrm{cm}^2}{\mathrm{mg}}$. 2. Low load and 30 Vin for an LET of 62 $\mathrm{MeV}\cdot\frac{\mathrm{cm}^2}{\mathrm{mg}}$. Soft-error & non-destructive SEL sensitivity (Rh irradiation): 1. No Shutdown-SEFI observed, 2. Reset-SEFI and power cycle SEFI observed, 3. Undervoltage SET, Overvoltage SET observed, 4. SELs observed.

8. REFERENCES

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

[2] Texas Instruments, LMR38020 4.2V to 80 V,2 A, Synchronous SIMPLE SWITCHER Power Converter with 40 uA Iq, LMR38020 4.2-V to 80-V, 2-A, Synchronous SIMPLE SWITCHER Power Converter with 40-µA IQ datasheet (Rev. E) (ti.com)

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

9. ANNEX

In the following tables the whole test campaign including different COTS devices is given.

Run	Facility log #	Reminder Philipp file name	DUT	Vinput	Rout (Ohm)	Pitch (°)	Tilte (°)	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)	am Homogeneity (%)	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)
7	7	OK	LMR38020 - S1	24, then 30	1.2	0	0	Yes	C2*2	Rh	957	46	46	87	1.10E+03	1.00E+07		10	No trigger, exploration run, then PG neg.	PG neg. @ 1.5V	100, then 500, then we increase to 100A, then 300 mA.	53.00	14:16	1645	1.00E+07	1.00E+07	6079.0274	7.38E+00	7.38E+00	OK			SEL: 2	several	several	0	0	0
8	8	OK	LMR38020 - S1	30	0.6	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	3.00E+06	200	10	Just to finish this run for DSEE	PG neg. @ 1.5V	300	53	14:46	203	3.03E+06	1.30E+07	14926.108	2.23E+00	9.61E+00	OK			SEL: 0	several	several	0	0	0
9	9	OK	LMR38020 - S1	30	1.2A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	DSEE check?	PG neg. @ 1.18V, then Vout neg. @ 4V. Then Vout pos. @ 5V (4.5V nominal)	600	260.00	14:53	1537	1.00E+07	2.30E+07	6506.1809	7.38E+00	1.70E+01	OK			SEL: 0	??	several	3		
10	10	OK	LMR38020 - S1	40	1.2A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	DSEE check?	?	600	200.00	15:26	101	3.60E+05	3.60E+05	3564.3564	2.66E-01	2.66E-01	OK			DSEE: 1		several			
11	11	OK	LMR38020 - S2	30	1.2A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Checking that it can survive DSEE (2nd sample)	Vout pos. @ 5V, then Vout neg. @ 2.7V	600	260.00	15:30		1.00E+07	1.00E+07	#DIV/0!	7.38E+00	7.38E+00	OK			DSEE: 0					
12	12	OK	LMR38020 - S2	30	0.6	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Checking that it survives at 30V at low load	Vout pos. @ 5.3V, now Vout neg @ 4.5V, now PG neg. @ 1.18V	300	45.00	15:46	819	1.00E+07	2.00E+07	12210.012	7.38E+00	1.48E+01	OK			SEL: 4					
13	13	OK	LMR38020 - S2	40	0.6	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Checking low load V=40V if DSEE.	PG neg. @ 1.18V	300	40.00	16:02		1.00E+07	3.00E+07	#DIV/0!	7.38E+00	2.21E+01	OK			SEL: 2					
14	14	OK	LMR38020 - S2	40	0.6	0	0	Yes	C2*2	Rh	957	46	46	87	1.00E+03	1.00E+07	10000	10	Low flux, to get some data on soft errors & check SEL w/o protection.	Trigger on many signals (did not follow)	300	40.00	16:20	1147	7.17E+06	3.72E+07	6251.0898	5.29E+00	2.74E+01	OK			SEL: 5					
18	18	OK	LMR38020 - S3	30	1.2A	0	0	Yes	C2*2	Rh	957	46	46	87	1.50E+04	1.00E+07	666.7	10	Checking on 3rd sample DSEE OK	Vout pos. @ 5.3V	600	260.00	17:20	654	1.00E+07	1.00E+07	15290.52	7.38E+00	7.38E+00	OK								
36	36	OK	LMR38020 - S4	30	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	DSEE SoA.	Vout pos. @ 5.3V, then PG neg. @ 0.2V	400	129.00	23:25	771	1.00E+07	1.00E+07	12970.169	1.00E+01	1.00E+01	OK			SEL: 9					
37	37	OK	LMR38020 - S5	30	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	DSEE SoA.	Vout neg. @ V	400	130.00	23:40	-	1.00E+07	1.00E+07	#VALUE!	1.00E+01	1.00E+01	OK			SEL: 10					
38	38	OK	LMR38020 - S5	30	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Testing the SEL w/o protection.	Vout pos. @ 5.5V	N/A	130.00	23:52	-	6.31E+06	6.31E+06	#VALUE!	6.31E+00	6.31E+00	OK			several but no SEL threshold.					
38bis	38bis	OK	LMR38020 - S5	40	2A	0	0	Yes	C2*2	Xe	995	63	63	73	1.50E+04	1.00E+07	666.7	10	Testing the SEL w/o protection.	Vout pos. @ 5.5V	N/A	??	-	-	1.47E+06	1.47E+06	#VALUE!	1.47E+00	1.47E+00	OK			1 DSEE					
56	18	ok	LMR38020 - S4*	24, then 30 then 40V	1.2A	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. @ 5.6V, PG neg @ 0.5V, then Vout neg. 5.6V	400	120.00	17:29	1252	8.00E+06	8.00E+06	6389.7764	8.00E+00	8.00E+00	OK			SEL: 1+1+1+2		1, etc...	2, etc...		
58	20	ok	LMR38020 - S3*	30 then 40V	1A	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°	Vout low @ 4V	300	150.00	18:26	925	2.61E+06	2.61E+06	2821.6216	2.61E+00	2.61E+00	OK								
60	22	OK	LMR38020 - S6*	24V, then 30V.	1.2A	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 @ 6V	300	150.00	19:20	599	5.02E+06	5.02E+06	8380.6344	3.70E+00	3.70E+00	OK								
64	26	-	LMR38020 - S8*	30V, then 40V	1.2A	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	120.00	20:40	838	7.02E+06	7.02E+06	8377.0883	5.18E+00	5.18E+00	OK								
75	37	OK	LMR38020 - S8*	30V	1.2A	0	0	Yes	C2*2	Cr	505	16	16	106	1.50E+04	1.00E+07	666.7	10	New ion for characterisation at LET around 15 & back to normal irradiation.	PG neg. @ 0.5V, then Vout neg. @ 4.26V, then Vout pos @ 5.2V	600 then 1500	126.00	23:28	791	1.04E+07	#REF!	13147.914	2.68E+00	#REF!	OK			SEL: 4 & more not counted...					
76	38	OK	LMR38020 - S8*	30V	0.06A	0	0	Yes	C2*2	Cr	505	16	16	106	1.50E+04	1.00E+07	666.7	10	Testing also the response at low load for information.	Vout low @ 3.9V	1500	45.00	23:43	167	1.23E+06	1.23E+06	7365.2695	3.17E-01	3.17E-01	OK			1 DSEE					
77	39	OK	LMR38020 - S10*	30V	0.06A	0	0	Yes	C2*2	Cr	505	16	16	106	1.50E+04	1.00E+07	666.7	10	Low load but we put a low SELth limit (in case it failed because of DSEL S8*).	Vout low @ 3.9V	100	45.00	23:48	286	4.01E+06	4.01E+06	14020.979	1.03E+00	1.03E+00	OK								
78	40	OK	LMR38020 - S10*	30V	1.2A	0	0	Yes	C2*2	Cr	505	16	16	106	1.50E+04	1.00E+07	666.7	10	Testing again a high	Vout low @ 4.33V	1500	126.00	23:55	373	4.48E+06	4.48E+06	12010.724	1.15E+00	1.15E+00	OK								