ESA UNCLASSIFIED – For ESA Official Use Only

# L6982 SEE TEST REPORT

## L6982, 38 V, 2 A synchronous step-down converter with 20 µA quiescent current

| | |
|---|---|
| Prepared by | Philipp Mand |
| Document Type | RP |
| Reference | ESA-TECQEC-RP-2024-000357 |
| Issue/Revision | 1 |
| Date of Issue | 01/02/2024 |
| Status | N/A |

→ THE EUROPEAN SPACE AGENCY

# APPROVAL

| | | | |
|---|---|---|---|
| Title | L6982 SEE Test Report | | |
| Issue Number | 1 | Revision Number | [Revision] |
| Author | Philipp Mand | Date | 01/02/2024 |
| Approved By | Viyas Gupta | Date of Approval | |

# CHANGE LOG

| Reason for change | Issue Nr | Revision Number | Date |
|---|---|---|---|
| | | | |

# CHANGE RECORD

| Issue Number 1 | Revision Number | | |
|---|---|---|---|
| Reason for change | Date | Pages | Paragraph(s) |
| | | | |

# DISTRIBUTION

| Name/Organisational Unit |
|---|
| |

## Table of Contents

# 1. DISCLAIMER

The information contained herein is presented for informational purposes only. ESA does not make, and disclaims, any representation or warranty, express or implied, of the correctness and completeness of this information, and its fitness for a particular purpose. This information does not constitute or imply an ESA endorsement or approval for the use of any tested part in ESA activities or third-party activities. In particular, but without limitation, this is due to traceability which cannot be guaranteed on commercial components but is an important pre-requisite for the reusability of TID, TNID and SEE radiation test results. The information herein can therefore not be reused without further justifications which may vary depending on the type of space activity concerned.

Reproduction of parts of the test summary is authorised on the condition that clear reference is made to the test report number and this disclaimer.

ESA reserves the right to alter, revise, or rescind this document due to subsequent developments or additional test results. ESA intends, but cannot guarantee, that the ESARAD database always contains latest versions of the test reports.

# 2. INTRODUCTION

The aim of this Single Event Effect test campaign was to evaluate the SEE radiation hardness level of the L6982 buck converter component from Linear Technologies, especially regarding destructive 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) of 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 L6982, is given:

*Table 2: List and Description of the DUTs*

| Manufacturer | PM | Year, die | Product | Uin,max (V) | Uout,max (V) | Uout,min (V) | Id,cont,max (A) | frequency (MHz) |
|---|---|---|---|---|---|---|---|---|
| ST | 9224 | 2017 | L6982 | 38 | 38 | 0.85 | 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.

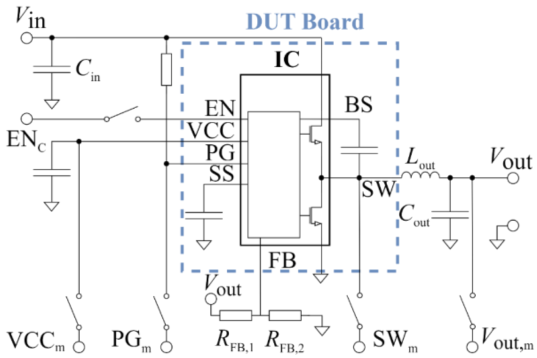


*Figure 1: Typical application synchronous buck converter*

In Figure 2, the capsulated component is given. Figure 3 the Block diagram of the device is shown and in Figure 4 the decapsulated die can be seen.

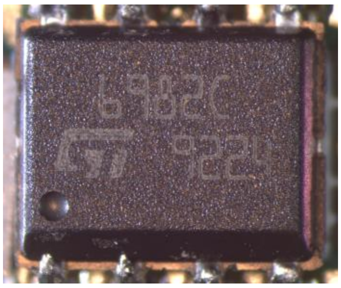


*Figure 2: Package of the L6982 component*

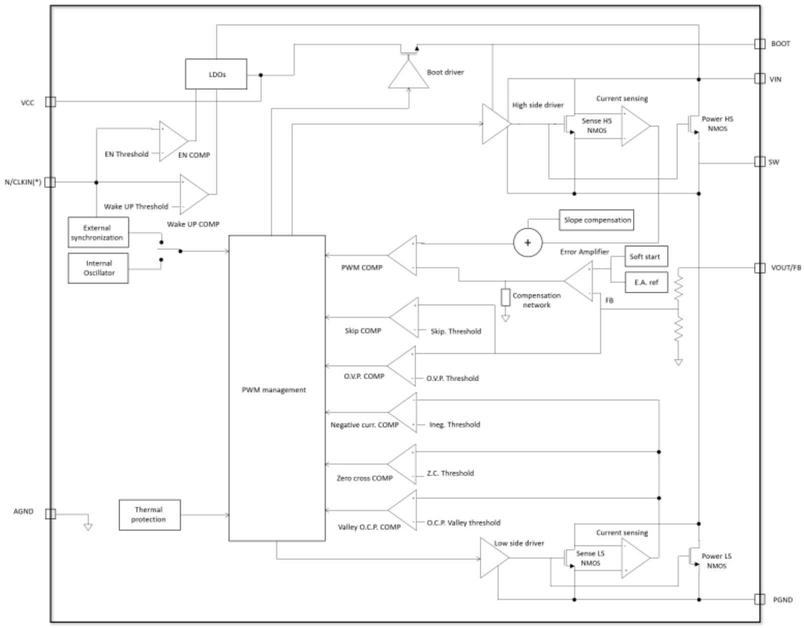


*Figure 3: Block diagram of the L6982*

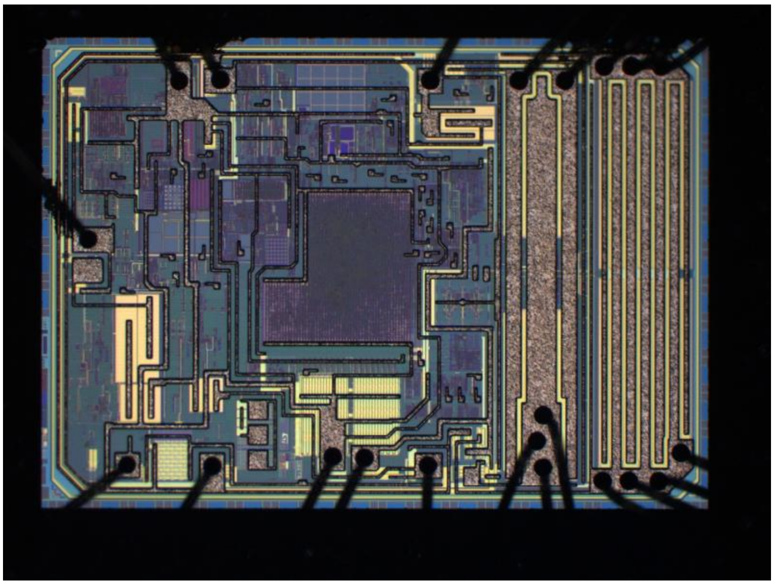

*Figure 4: die of the L6982*

# 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 L6982 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 |
| 1x Laptop | | To acquire data and to set the test setup |

In Figure 5 the basic test setup with the equipment and the test boards inside the vacuum chamber is visualized. Besides the L6982, multiple different buck converters have been tested during the campaign.

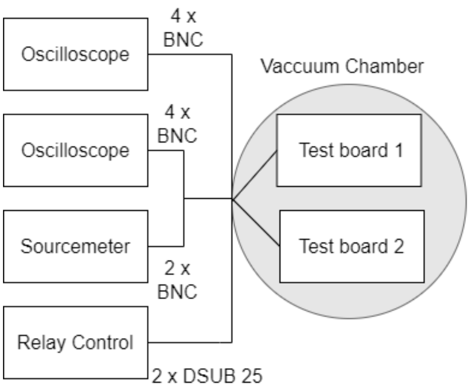


*Figure 5: Test setup*

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 6 the DUT board can be seen. This board is then mounted on the radiation-test-board in Figure 7. 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.

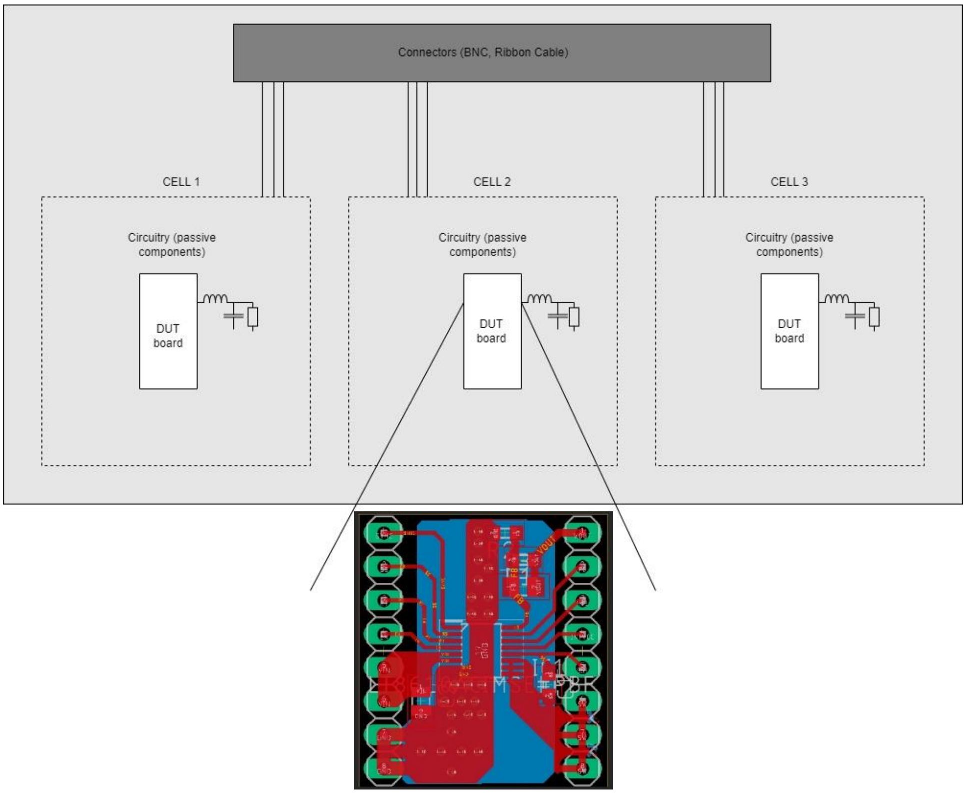


*Figure 6: Visualization of the radiation-test-boards*

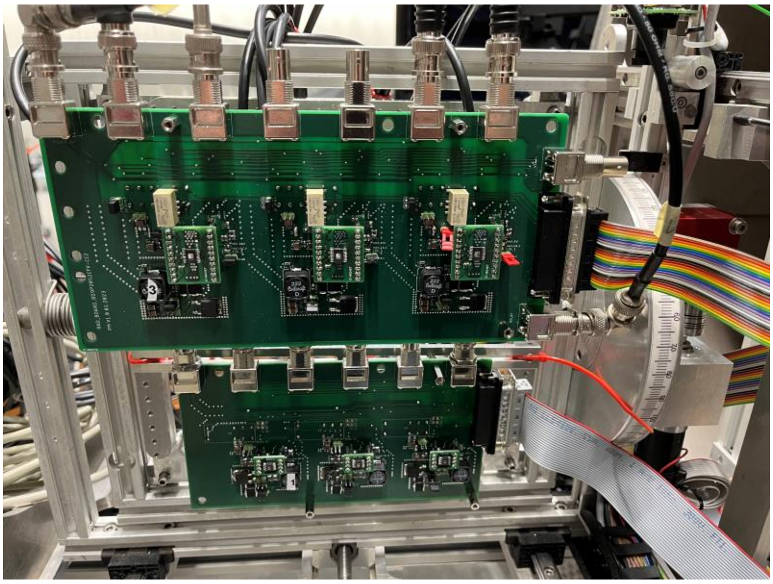

*Figure 7: Test setup with the L6982 board on the bottom side*

In Figure 8 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 = 22 µH. The input & output conditions are summarised together with the results in Table 8.

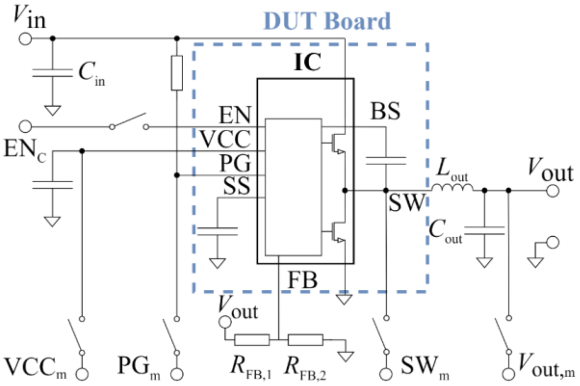


*Figure 8: Simplified test setup with Cout = 80 µF, Cin = 30 µF, Lout = 22 µH with varying input and output conditions described in Table 8.*

## 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 |
|---|---|---|---|---|
| SW | Switching node | O | yes | SW Voltage & (Frequency) |
| BOOT | Bootstrap pin | I | no | - |
| VCC | LDO output | I/O | no | - |
| FB | Feedback input | I | no | - |
| EN | Enable input pin | I | no | - |
| AGND | Analog GND | | no | - |
| Vin | Input voltage | I | yes | Input Voltage & Current |
| PGND | Power GND | | 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. All changes in the output voltage are due to functional interrupts of the switching of the L6982. 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:

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

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.
- $N_{\text{events}}$, 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 #/ions/cm$^2$ | Upper-bound cross-section #/ions/cm$^2$ | Fluence in ions/cm$^2$ | Duration of SEFI in s | Number (#) of Events | Description |
|---|---|---|---|---|---|---|---|
| Shutdown SEFI | Fig. 8. | $7.7 \cdot 10^{-6}$ | $9.6 \cdot 10^{-6}$ | $1 \cdot 10^{7}$ | Up to $3 \cdot 10^{-2}$ | 77 | After overvoltage situation decrease to 0.4 V of nominal 3.3 Vout |
| Reset SEFI | - | $6 \cdot 10^{-7}$ | $1.3 \cdot 10^{-6}$ | $1 \cdot 10^{7}$ | Until reset | 6 | Shut down of the device, reset over enable pin necessary |
| Power Cycle SEFI | - | $5 \cdot 10^{-7}$ | $1.17 \cdot 10^{-6}$ | $1 \cdot 10^{7}$ | Until PC | 5 | 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*

| SEFIS with effect on Vout | Reference Figure | Cross section $cm^2$ | Upper-bound cross-section $cm^2$ | Fluence in $ions/cm^2$ | Duration of SEFI in s | Number (#) of Events | Description |
|---|---|---|---|---|---|---|---|
| Small undervoltage SET | Fig. 8. | $2.1 \cdot 10^{-6}$ | $7.23 \cdot 10^{-6}$ | $1 \cdot 10^{7}$ | Up to $1 \cdot 10^{-4}$ | 21 | decrease to 2.9 V of nominal 3.3 Vout |
| Overvoltage SET | Fig. 9. | $7.7 \cdot 10^{-6}$ | $1.5 \cdot 10^{-5}$ | $1 \cdot 10^{7}$ | Up to $1 \cdot 10^{-4}$ | 77 | Increase of up to 4.3 V of nominal 3.3 Vout |

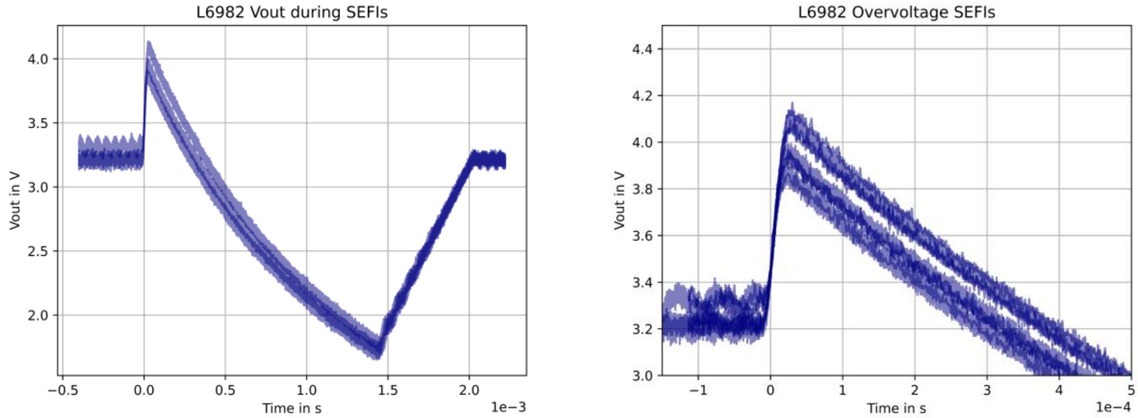


*Figure 9: Overvoltage transient that led to an undervoltage condition on the load with an overlay of multiple the overvoltage SETs and SEFIs (left) and multiple overvoltage SETs (right) during Rh-ion irradiation at Vin = 12 V, Rload = 50 Ohm and incident angle of 0˚*

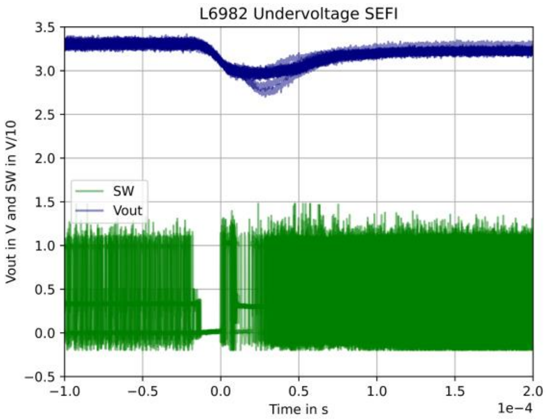


*Figure 10: SET that lead to an undervoltage condition on the load with multiple SETs during Rh-ion irradiation at Vin = 12 V, Rload = 50 Ohm and incident angle of 0˚*

## 7.2. Impact of the Load on Non-destructive Single Event Effects

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 (0.6 A) 85 events for a Fluence of 1 x10$^{7}$ ions/cm$^{2}$ have been observed, while at 0.06 A output current the number of events has been higher. Table 7 displays the results. This test was carried out under Rh-ion irradiation. This test was not performed under Xe-ion irradiation.

*Table 7: Total number of Events at different Load conditions under Rh-ion irradiation*

| Load condition | 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 |
|---|---|---|---|---|---|---|
| Vin= 12 V, Iout = 0.06 A | $1.09 \cdot 10^{-5}$ | $1.31 \cdot 10^{-5}$ | $1 \cdot 10^{7}$ | Up to $1 \cdot 10^{-4}$ | 109 | Effects as shown above, here combined: undervoltage that led to SEFI & undervoltage SET |
| Vin = 12 V Iout = 0.6 A | $8.5 \cdot 10^{-6}$ | $1.05 \cdot 10^{-5}$ | $1 \cdot 10^{7}$ | Up to $7 \cdot 10^{-4}$ | 85 | Effects as shown above, here combined: undervoltage that led to SEFI & undervoltage SET |

## 7.3. 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 11, 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 12 V and a low load the device survived the Rh-ion and Xenon-ion irradiation at an incident angle of 0°. No SEL occurred during any of the test runs & test conditions.

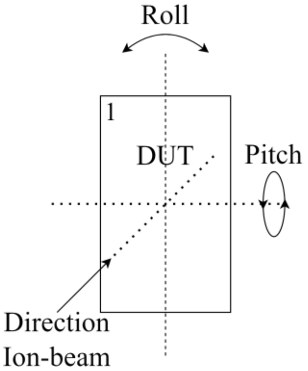


*Figure 11: Display of the Roll and Pitch during tilting of the DUT. The DUT is irradiated with the first pin on the upper right and then tilted to the direction of the Ion-beam in the given directions.*

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

| Vin (LET 46 $\mathrm{MeV \cdot cm^2/mg}$) | 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)** | **High Load (0.6 A)** | **High Load (0.6 A)** |
| 10V | S2 | S5 | | |
| 12V | S1, S3, S5 | S2, S3, S5 | S4 | S6 |
| 15V | | | | |
| 19V | ~~S1, S2~~ | ~~S3~~ | ~~S4~~ | ~~S6~~ |
| 24V | - | - | | |
| 29V | - | - | | |
| 42V | - | - | | |

*Table 9: DSEEs and Safe Operating Area during Xe-ion irradiation*

| Vin (LET 60 $\mathrm{MeV \cdot cm^2/mg}$) | 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)** | **High Load (0.6 A)** | **Very High Load (0.6 A)** |
| 10V | | | | |
| 12V | | S7, S8 | S9 | S10 |
| 15V | | | | |
| 19V | | ~~S7~~ | ~~S9~~ | ~~S10~~ |
| 24V | | - | - | - |
| 29V | | | | |
| 42V | | | | |

In Figure 12 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.

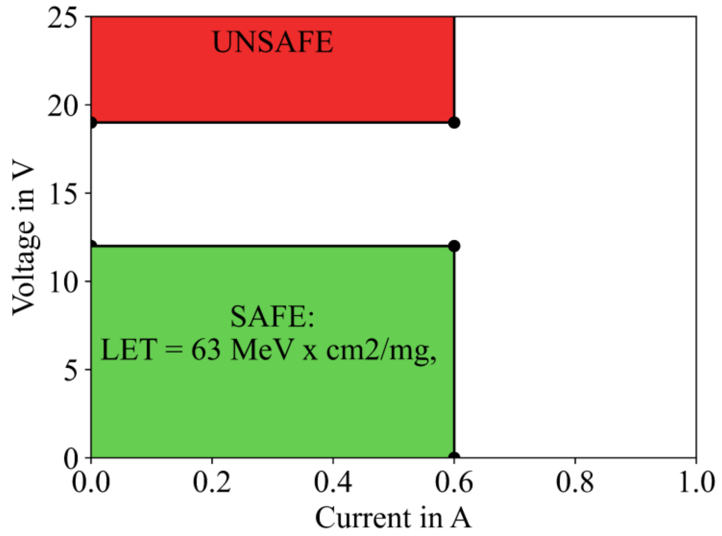


*Figure 12. Safe Operating Area for the L6982 with the unsafe are (red), and safe area with tilting (green)*

In Figure 13. A destructive event is visualized. An earlier voltage increase of the SW pin was observed. The switching application was interrupted and the SW voltage staid 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 destruction of the high side. The low side shut down is observable. This destructive effect can also be observed in Figure 14 here the high side showed a clear burnout.

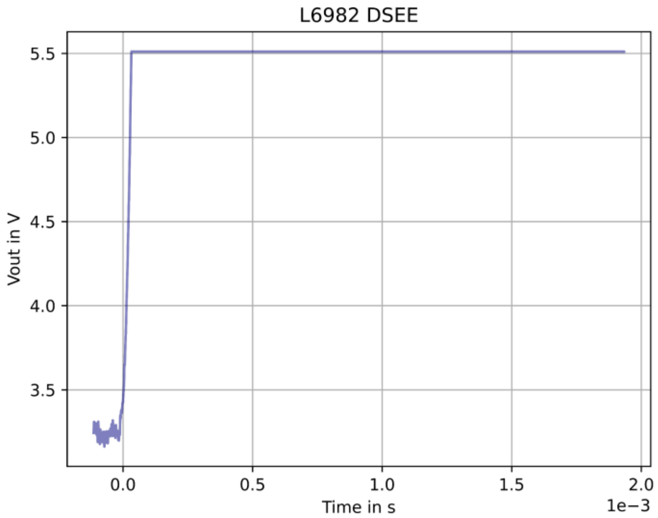


*Figure 13: DSEE at Vin = 28 V during Rh-ion irradiation at incident angle of 0°*

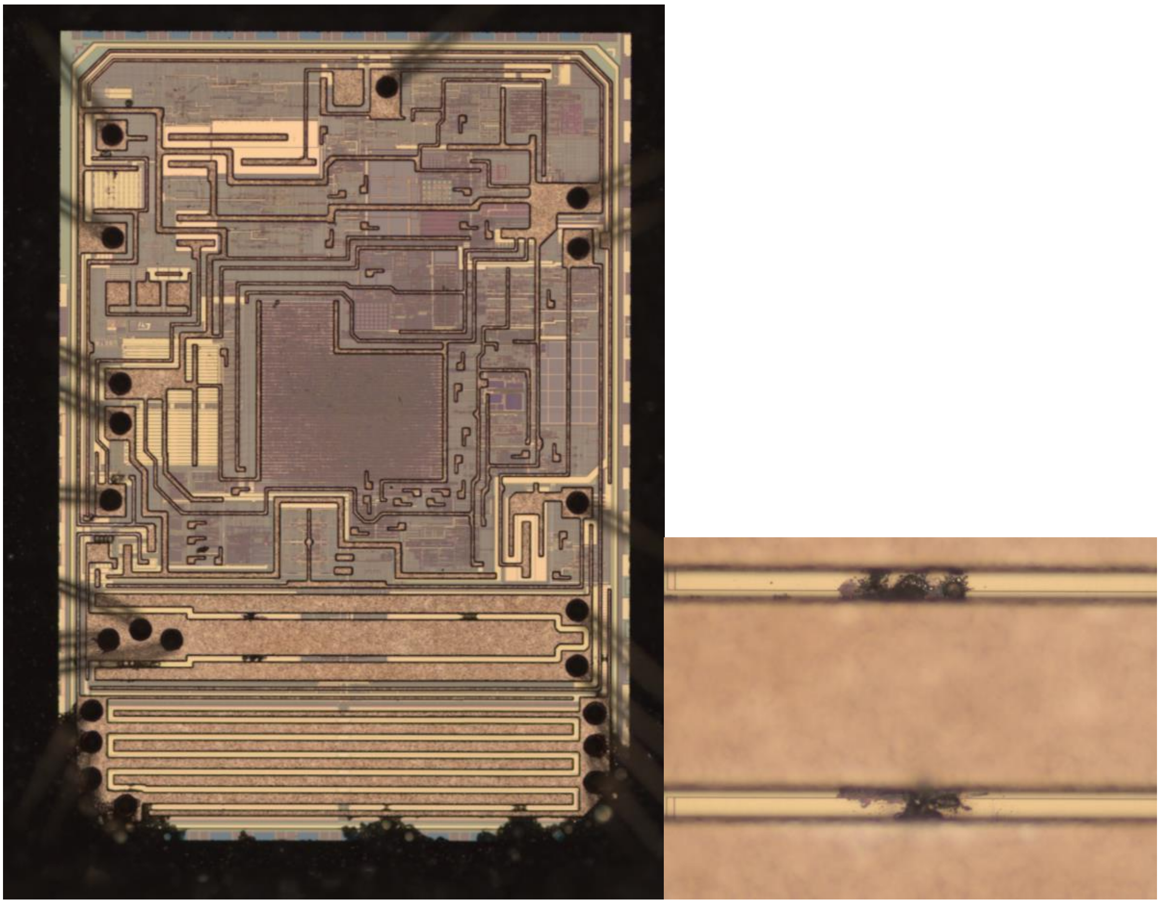

*Figure 14 Closeup (right) and full die (left) of a L6982 after a DSEE*

## 8. CONCLUSION

The aim of this test campaign is to evaluate the radiation hardness of the COTS L6982 buck converter component (date code 9224) tested at 2 LET and room temperature against NDSEE and DSEE.

The L6982 showed DSEE outside of the safe operating area. The SOA can be defined as follows:

- 12 V up to 0.6 A for an LET of 62 $\mathrm{MeV \cdot cm^2/mg}$ including partial results at tilting angles.

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 Single Event Latchups have been observed during the testing. 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 different synchronous buck converter devices for destructive SEE and SET/SEFI |
| Biasing Conditions | 1. various input voltages and output currents<br>2. steady output voltage 3.3 V and steady switching frequency (850 kHz) |
| Sample size | 3 devices to be tested for each final biasing condition for result confirmation |
| LET | $46\ \mathrm{MeV}\cdot\mathrm{cm}^2/\mathrm{mg}$ and $60\ \mathrm{MeV}\cdot\mathrm{cm}^2/\mathrm{mg}$ |
| Fluence | 1. $10^7\ \mathrm{ions/cm^{-2}}$ for DSEE<br>2. various for SET and SEFI characterization |
| Environmental condition | Room temperature condition |
| Results | Safe Operating Area for DSEE:<br>1. high load and 12 Vin @ $62\ \mathrm{MeV}\cdot\frac{\mathrm{cm}^2}{\mathrm{mg}}$,<br>2. Low load and 12 Vin @ $62\ \mathrm{MeV}\cdot\frac{\mathrm{cm}^2}{\mathrm{mg}}$,<br>Soft-error & non-destructive SEL sensitivity (Rh irradiation):<br>1. Shutdown-SEFI, Reset-SEFI and power cycle SEFI<br>2. Undervoltage SET, Overvoltage SET<br>3. No SEL observed |

# 9. REFERENCES

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

[2] ST microelectronics, L6982, 38 V, 2 A synchronous step-down converter with 20 µA quiescent current, L6982 - 38 V, 2 A synchronous step-down converter with low quiescent current - STMicroelectronics

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

# 10. 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 (°) | 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) | am Homogenity (%) | Type of test / Mode/SW tested... | Scope Trigger | SEL current threshold (mA) | nominal current (mA) | Start time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | 8 | OK | L6982 - S1* (new) | 12 | 0.6A | 0 | 0 | Yes | C2*2 | Xe | 995 | 63 | 63 | 73 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | DSEE SoA. | Vout pos. @ 3.32V, then Vout neg. @2.71 V | 400 | 200.00 | 14:16 |
| 47 | 9 | ok | L6982-S1* | 19 | 0.6A | 0 | 0 | Yes | C2*2 | Xe | 995 | 63 | 63 | 73 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | DSEE SoA. | Vout pos. @ 3.32V | 400 | 120.00 | 14:31 |
| 48 | 10 | ok | L6982-S2 | 12 | 0.6A | 0 | 0 | Yes | C2*2 | Xe | 995 | 63 | 63 | 73 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | confirmation run | Vout pos. @ 3.32V Vout neg @ 2.9V | 400 | 190.00 | 14:35 |
| 53 | 15 | OK | L6982 - S2* | 10, then 12, then 19 | 0.6A | 0 | 45 | Yes | C2*2 | Xe | 995 | 63 | 88 | 73 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | Testing with tilt 45° | Vout pos. @ 3.5V | 400 | 240.00 | 16:01 |
| 54 | 16 | ok | L6982-S4* | 10 | 0.6A | 90 | 45 | Yes | C2*2 | Xe | 995 | 63 | 88 | 73 | 1,5E4 | 1.00E+07 | ##### | 10 | Testing with tilt 45 and pitch 90 | Vout pos. @ 3.5V | 400 | 230.00 | 16:36 |
| 70 | 32 | - | L6982-S7* | 12V, then 19V | 0.6A | 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° | Vout neg. @ 2.5V | 400 | 194.00 | 22:04 |
| 71 | 33 | - | L6982-S6* | 12V | 0.6A | 0 | 60 | Yes | C2*2 | Rh | 957 | 46 | 92 | 87 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | Testing with tilt 60 and pitch 0° | Vout neg. @ 0.4V | 400 | 190.00 | 22:11 |
| 73 | 35 | - | L6982-S10* | 12V, then 19V. | 0.6A | 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 neg. @ 0.4V | 400 | 190.00 | 22:48 |

| Run | 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 /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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46 | 736 | 1.00E+07 | 1.00E+07 | 13586.957 | 1.00E+01 | 1.00E+01 | OK | | | | | | 2 | | |
| 47 | 17 | 1.00E+05 | 1.00E+05 | 5882.3529 | 1.00E-01 | 1.00E-01 | OK | | | 1DSEE | | | | | |
| 48 | 713 | 1.00E+07 | 1.00E+07 | 14025.245 | 1.00E+01 | 1.00E+01 | OK | | | | | | | | |
| 53 | 564 | 4.34E+06 | 4.34E+06 | 7695.0355 | 4.34E+00 | 4.34E+00 | OK | | | | | | | several not counted | |
| 54 | 760 | 5.10E+06 | 5.10E+06 | 6710.5263 | 5.10E+00 | 5.10E+00 | OK | | | | | | | | |
| 70 | 255 | 2.12E+06 | 2.12E+06 | 8313.7255 | 1.56E+00 | 1.56E+00 | OK | | | 1 DSEE | | | | | |
| 71 | 291 | 2.07E+06 | 2.07E+06 | 7113.4021 | 1.53E+00 | 1.53E+00 | OK | | | 1DSEE | | | | | |
| 73 | 218 | 2.07E+06 | 2.07E+06 | 9495.4128 | 1.53E+00 | 1.53E+00 | OK | | | 1DSEE | | | | | |

| 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 (/cm$^2$/s) | Fluence target (/cm$^2$) | 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 (/cm$^2$) | Cumulative Fluence (/cm$^2$) | Flux actual (/cm$^2$/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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 1 | L6982 - S1 | 19 | 0.06 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.00E+03 | 1.00E+07 | 10000 | 10 | Exploration run & SE | Vout@ 3.1V (low SET) | 200 | - but mayl | 12:21 | 639 | 2.13E+05 | 2.13E+05 | 333.333333 | 1.57E-01 | 1.57E-01 | OK | - | 0 | 1 | 0 | 0 | 15 | 0 (although all the 15 SEFI needed a PC, reset was done so fast that most likely did not have time to discharge as we can see on the LDO line hence all 15 counted as soft SEFI) | 0 |
| 19 | 2 | L6982 - S2 | 10 | 0.06 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 0 then chan | 1.00E+07 | ##### | 10 | SEL/SEB/SEGR | Vout@ 3.1V (low SET) | 100 | 61.00 | 12:37 | 1694 | 1.00E+07 | 1.00E+07 | 5903.18772 | 7.38E+00 | 7.38E+00 | OK | | 0 | 0 | 0 TBC | probably several (need to check the saved data) | 11 (duty cycle) up to F=1.5E6 4 (chip down) (see note @ F=3.8E5 & later) | 0 (one occurred but the soft reset was done too fast counted as soft SEFI) | 0 |
| 20 | 3 | L6982 - S2 | 12 | 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@ 3.46V (high SET) | 100 | 53.00 | 13:08 | 770 | 1.00E+07 | 2.00E+07 | 12987.013 | 7.38E+00 | 1.48E+01 | OK | - | | | | several (Vout goes down to 0 then recovers automatically). | 6 (chip down) several (duty cycle) | 1 (actual one here) | |
| 21 | 4 | L6982 - S2 | 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@ 3.46V (high SET) | 100 | 31.00 | 13:26 | ? | 1.70E+05 | 2.02E+07 | #VALUE! | 1.25E-01 | 1.49E+01 | OK | - | 0 | 1 | - | - | - | - | - |
| 22 | 5 | L6982 - S3 | 12 | 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@ 3.1V (low SET) | 100 | 53.00 | 13:31 | 704 | 1.00E+07 | 1.00E+07 | 14204.5455 | 7.38E+00 | 7.38E+00 | OK | - | 0 | 0 | 0 | veral (on Vou | 11 (chip down) several (duty cycle) | 0 | 0 |
| 28 | 11 | L6982 - S5 | 12 | 0.6 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 200 | 60.00 | 15:41 | 695 | 1.00E+07 | 1.00E+07 | 14388.4892 | 7.38E+00 | 7.38E+00 | OK | - | 0 | 0 | ?? | ?? | ?? | 0 | 0 |
| 29 | 12 | L6982 - S4 | 12 | 0.6 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 400 | 197.00 | 15:56 | 932 | 1.00E+07 | 1.00E+07 | 10729.6137 | 7.38E+00 | 7.38E+00 | OK | - | 0 | 0 | ?? | Yes but high flux | Yes | 3 | 0 |
| 30 | 13 | L6982 - S3 | 12 | 0.6 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 400 | 197.00 | 16:14 | 676 | 1.00E+07 | 1.00E+07 | 14792.8994 | 7.38E+00 | 7.38E+00 | OK | - | 0 | 0 | ?? | Yes but high flux | Yes | 0 | 0 |
| 31 | 14 | L6982 - S3 | **19** | 0.6 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 400 | 131.00 | 16:27 | ?? | 5.35E+05 | 1.05E+07 | #VALUE! | 3.95E-01 | 7.77E+00 | OK | - | 0 | 1 | - | - | - | - | - |
| 37 | 20 | L6982 - S5 | 12 | 0.6 | 0 | Yes | C2*2 | Rh | 957 | 46 | 46 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 400 | 200.00 | 17:38 | 726 | 1.00E+07 | 1.00E+07 | 13774.1047 | 7.38E+00 | 7.38E+00 | OK | - | 0 | 0 | several | ? | ? | 5 | 0 |
| 38 | 21 | L6982 - S5 | 12 | 0.6 | 45 | Yes | C2*2 | Rh | 957 | 46 | 65 | 87.3 | 1.50E+04 | 1.00E+07 | 666.7 | 10 | SEL/SEGR/SEB | Vout@ 3.1V (low SET) | 400 | 200.00 | ? | ? | 2.60E+06 | 1.26E+07 | #VALUE! | 1.92E+00 | 9.29E+00 | OK | - | ? | ? | ? | ? | ? | ? | 0 |