HEAVY ION SINGLE EVENT EFFECTS RADIATION TEST REPORT

Part Type : UC1706

Dual Output Driver

Manufacturer : Texas Instruments

Report Reference : ESA_QCA0413S_C

Issue : 01

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Heavy ion SEE characterization of UC1706, Dual Output Driver

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1 Abstract

Under ESA Contract No 13528/99/NL/MV COO-16 dated 05/01/04 covering "Radiation Evaluation of COTS Semiconductor Components: “Radiation evaluation of parts for the ATV project“, the Texas Instruments, UC1706, Dual Output Driver was radiation assessed.

Heavy ion radiation results, focusing on Single Event Errors (SEE) effects, are reported in this report.

2 INTRODUCTION

This report presents the results of a Single Event Effects (SEE) test program carried out on UC1706 Dual Output Driver from Texas Instruments.
Test was conducted on 2 flight lot samples delivered by the ESA ATV project.
These devices were used during heavy ion tests carried out at the European Heavy Ion Irradiation Facility (HIF) at Cyclone, Université Catholique de Louvain – June 2004.
This work was performed for ESA/ESTEC under ESA Contract No 13528/99/NL/MV COO-16 dated 05/01/04.

3 REFERENCE DOCUMENTS

RD1. UC1706 data sheet
RD2. Annex1 of ATV/MMS/EPG/FX/026.04 dated 13/02/0-4
RD3. Single Event Effects Test method and Guidelines ESA/SCC basic specification No 25100
RD4. The Heavy Ion Irradiation Facility at CYCLONE, UCL document, Centre de Recherches du Cyclotron (IEEE NSREC'96, Workshop Record, Indian Wells, California, 1996)

4 DEVICE INFORMATION

4.1 UC1706

The UC1706 is a Dual Output Driver in a 16-PIN ceramic DIP package.

Relevant device identification information is presented here after and photos of device with die identification and die dimensions are shown in Figure 1.

Part type:	UC1706
Manufacturer:	Texas Instruments
Package:	16-Pin Cerdip
Quality Level:	Hi-Rel
Date Code:	9914
Top marking:	see photo in Figure 1

4.2 Sample preparation

Three samples were delidded mechanically.

Photo 1 – Top marking

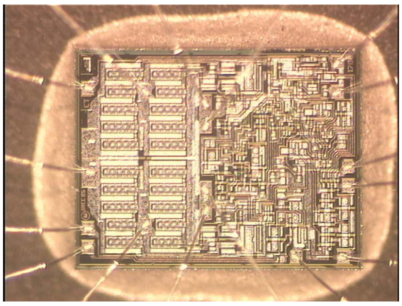


Photo 2 – die, full view

Die dimensions:
2.1 mm x 2.7 mm

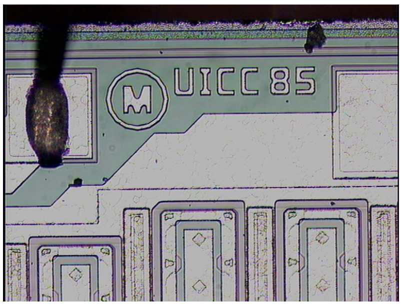


Photo 3 – die, marking, detail 1

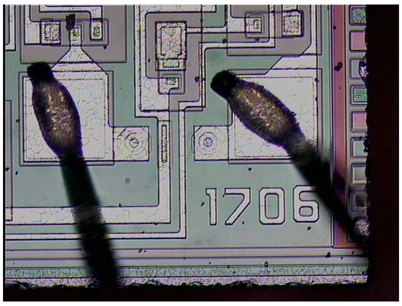


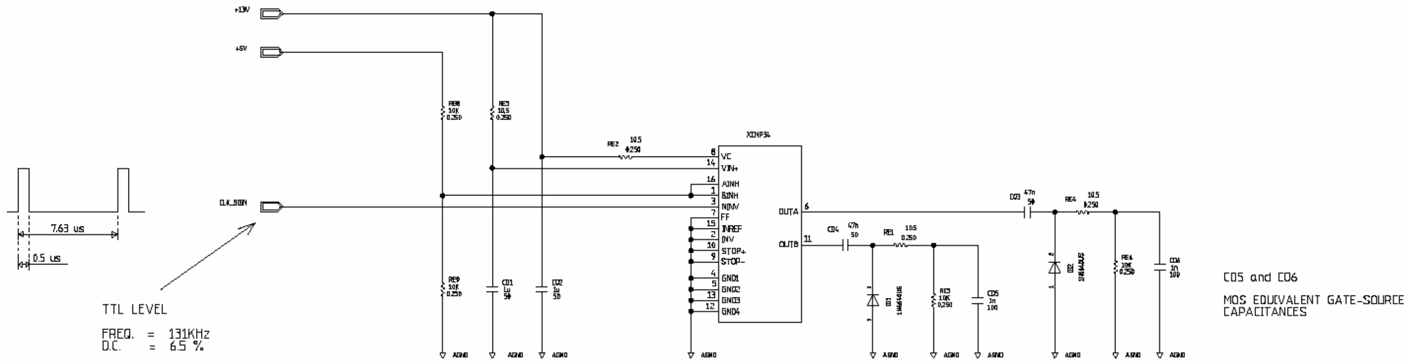
Photo 4 – die, marking, detail 2

Figure 1 – UC1706 sample identification

5 Test Definition

5.1 Test Configuration

In accordance with RD2, set-up conditions used are presented here below.



5.2 Test conditions

The basic set-up consists in monitoring DUT output A or B with an oscilloscope and count the number of single event effects errors (SEE). Figure 2 shows the nominal waveforms at A and B output.
To detect the occurrence of SEE errors, two different trigger conditions have been used either at output A or B, both A and B outputs being monitored.

Cond1: Trigger level at half the output signal height and pulse width > 20µs
Cond2: Trigger level at half the output signal height and pulse width < 19µs

All SEE errors occurring during each run are recorded.

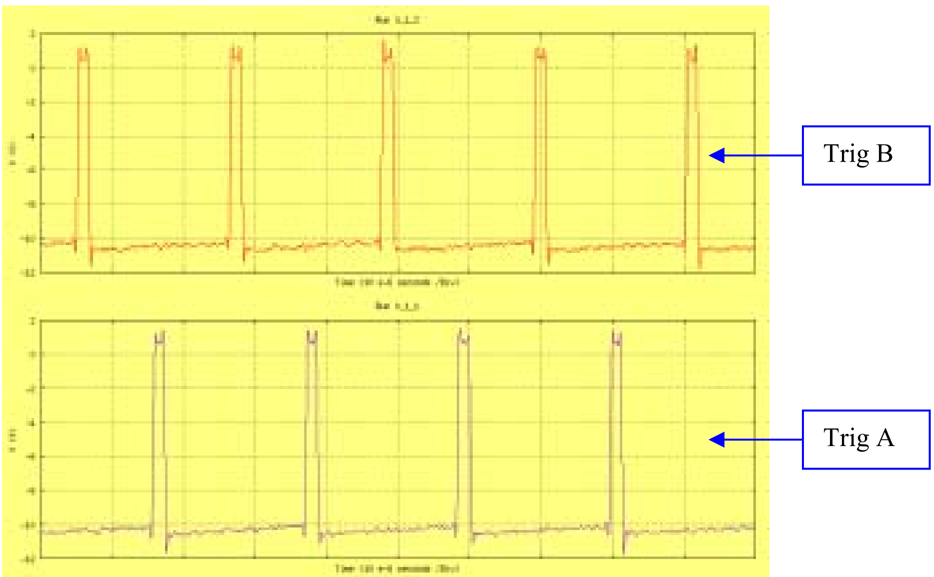


Figure 2 – Output signal waveforms

6 UCL TEST FACILITY

Test at the cyclotron accelerator was performed at Université de Louvain (UCL) in Louvain-La-Neuve (Belgium) under HIREX Engineering responsibility.

6.1 Beam Source

In collaboration with the European Space Agency (ESA), the needed equipment for single events studies using heavy ions was built and installed on the HIF beam line in the experimental hall of Louvain-La-Neuve cyclotron.
CYCLONE is a multi particle, variable energy, cyclotron capable of accelerating protons (up to 75 MeV), alpha particles and heavy ions. For the heavy ions, the covered energy range is between 0.6 MeV/AMU and 27.5 MeV/AMU. For these ions, the maximal energy can be determined by the formula:

$$110\ Q^2/M,$$

where Q is the ion charge state, and M is the mass in Atomic Mass Units.
The heavy ions are produced in a double stage Electron Cyclotron Resonance (ECR) source. Such a source allows producing highly charged ions and ion "cocktails". These are composed of ions with the same or very close M/Q ratios. The cocktail ions are injected in the cyclotron, accelerated at the same time and extracted separately by a fine tuning of the magnetic field or a slight changing of the RF frequency. This method is very convenient for a quick change of ion (in a few minutes) which is equivalent to a LET variation.

6.2 Dosimetry

The current UCL Cyclotron dosimetry system and procedures were used.

6.3 Used ions

The UCL ions used are listed in the table below.

Ion	Energy	LET	Range (Si)
	(MeV)	(MeV.cm²/mg)	µm
20Ne4	78	5.85	45
40Ar8	150	14.1	42
84Kr17	316	34	43

Table 1- UCL ions and features thereof

6.4 Beam set-up

The use of a tilt angle allows for additional effective LET values.
For each run, the following information is given in the detailed results tables provided in the next paragraph (paragraph 7) :

- Run Number
- Device S/N
- Ouput #
- Trig Condition
- Ion type
- Tilt angle
- LET
- Fluence
- Test Duration
- Averaged flux
- Type 1 SEE
- Type 2 SEE
- Total SEE

7 RESULTS

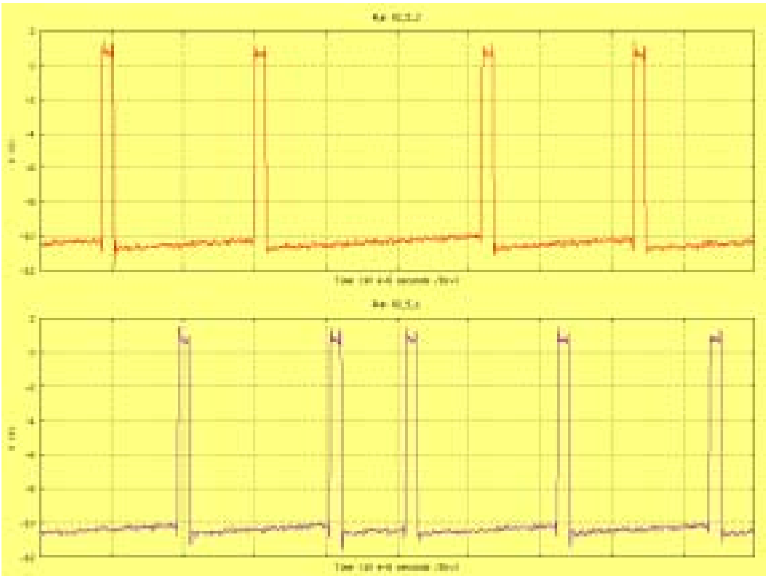
Two types of events have been observed:

- Type1: the two outputs are affected by the event.
- Type2: one output only is concerned.

With trigger condition #1 (trigger level at half the output signal height and pulse width >20µs), examples of SEE errors type1 are presented in Figure 3, and examples of type2 in Figure 4 and Figure 5.

With trigger condition #2 (trigger level at half the output signal height and pulse width <19µs), examples of SEE errors type1 are presented in Figure 6, and examples of type2 in Figure 7.

Detailed results per run together with the corresponding number of both types of errors, type1 and type 2, are presented in Table 2.



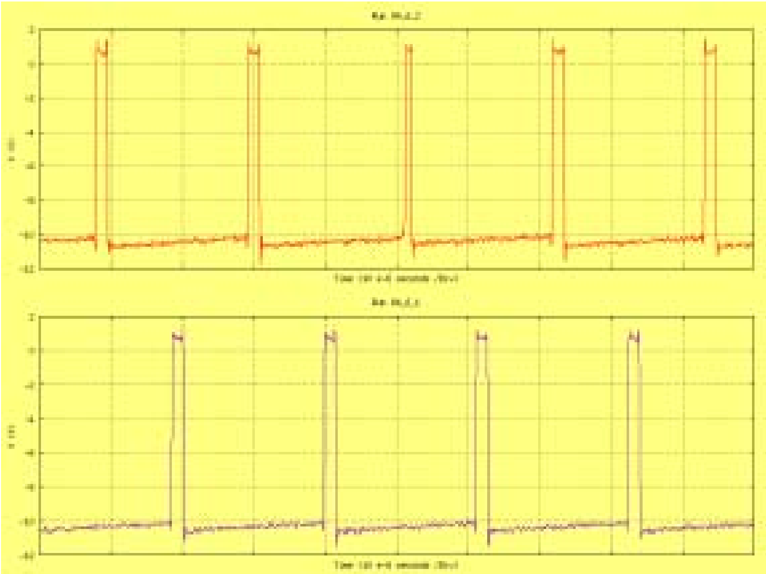
Run82, Event #05

Trig cond.1 on Output B
(pulse width (↓)>20µs)

Output B

Output A

Figure 3 – Trig condition #1, SEE error type1

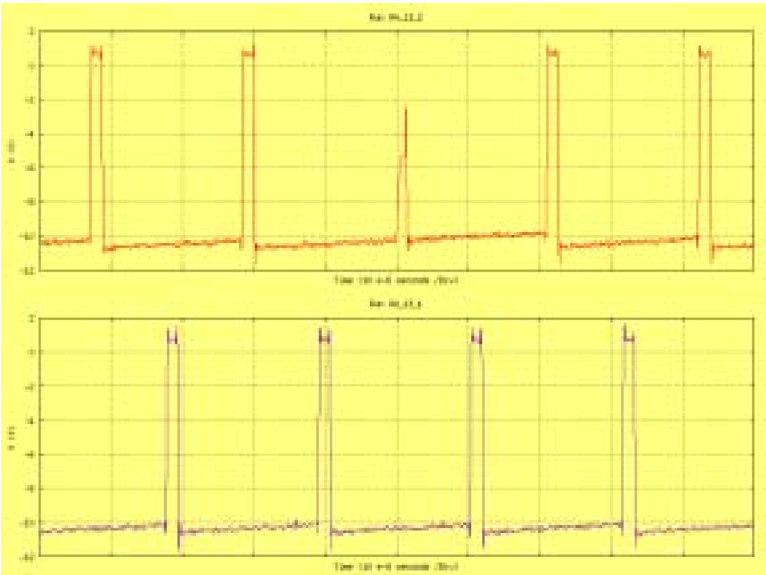


Run84, Event #06

Trig cond.1 on Output B
(pulse width (↓)>20µs)

Output B

Output A



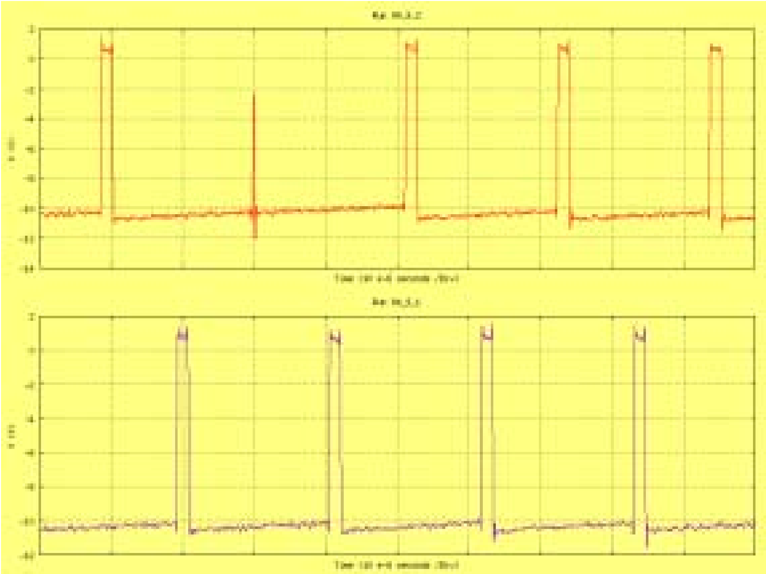
Run84, Event #13

Trig cond.1 on Output B
(pulse width (↓)>20µs)

Output B

Output A

Figure 4 – Trig condition #1, SEE error type2

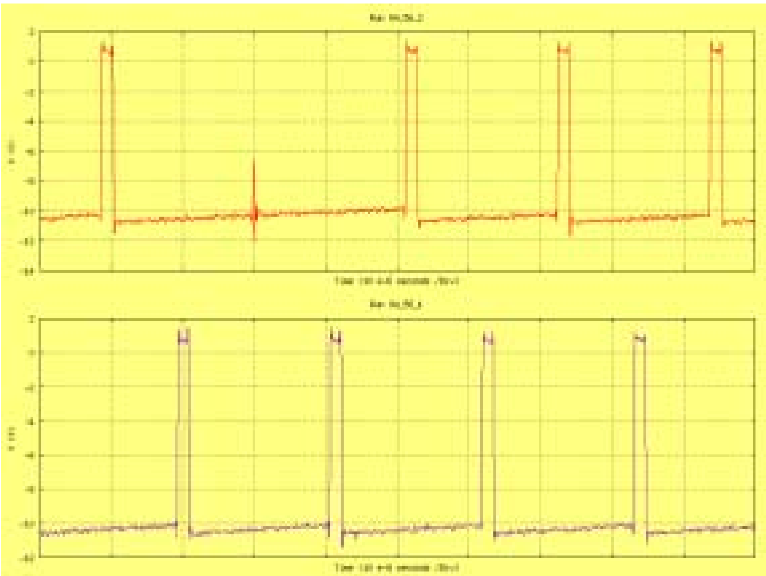


Run84, Event #09

Trig cond.1 on Output B
(pulse width (↓)>20µs)

Output B

Output A



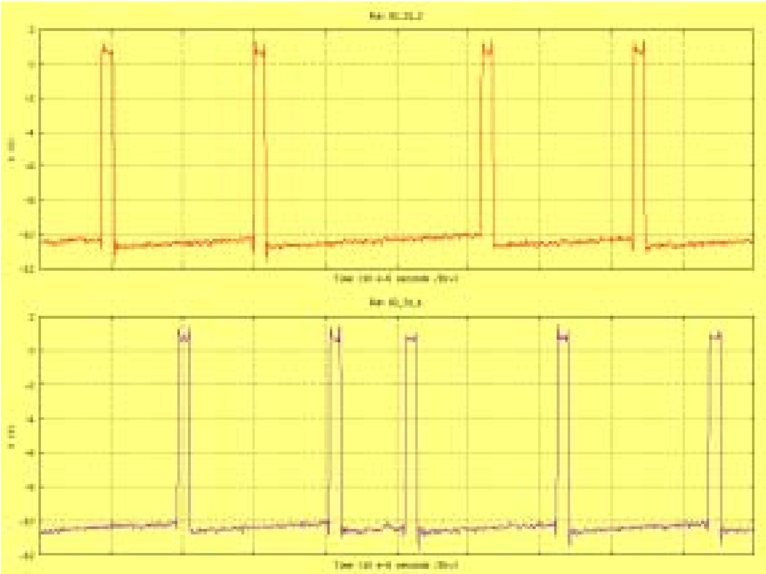
Run84, Event #56

Trig cond.1 on Output B
(pulse width (↓)>20µs)

Output B

Output A

Figure 5 – Trig condition #1, SEE error type2

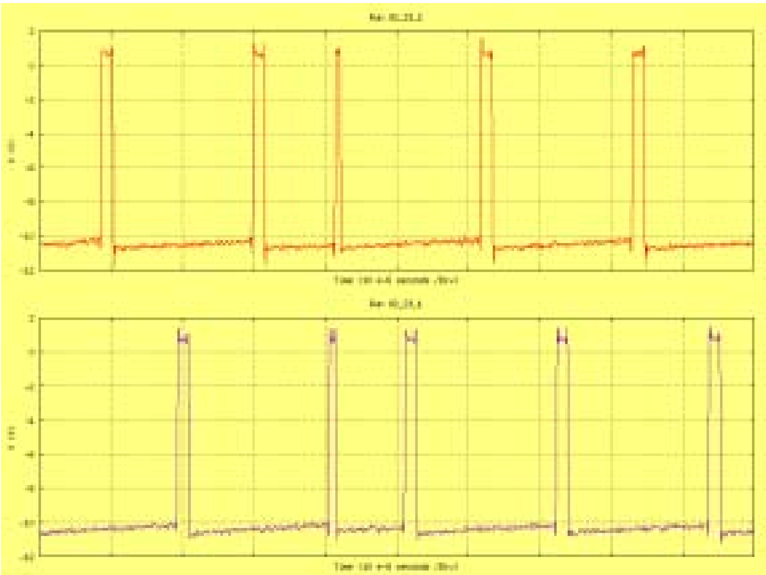


Run82, Event #31

Trig cond.2 on Output A
(pulse width (↓)<19µs)

Output B

Output A



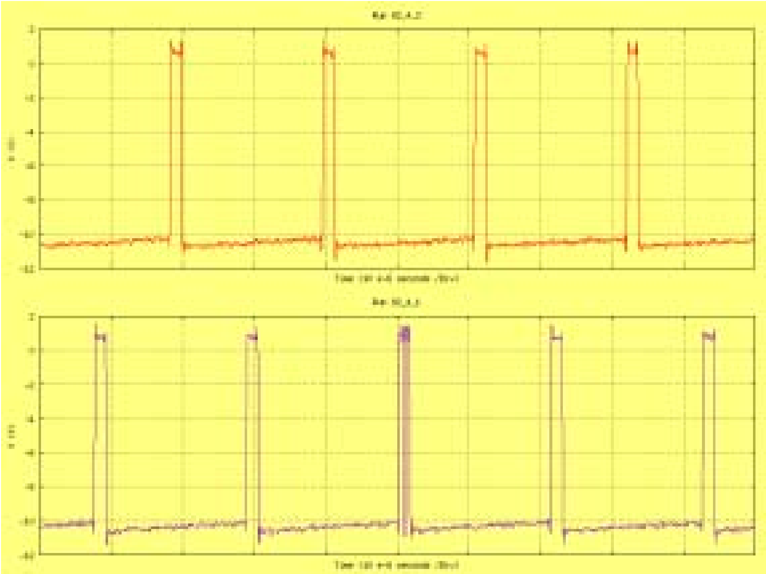
Run82, Event #23

Trig cond.2 on Output A
(pulse width (↓)<19µs)

Output B

Output A

Figure 6 – Trig condition #2, SEE error type1

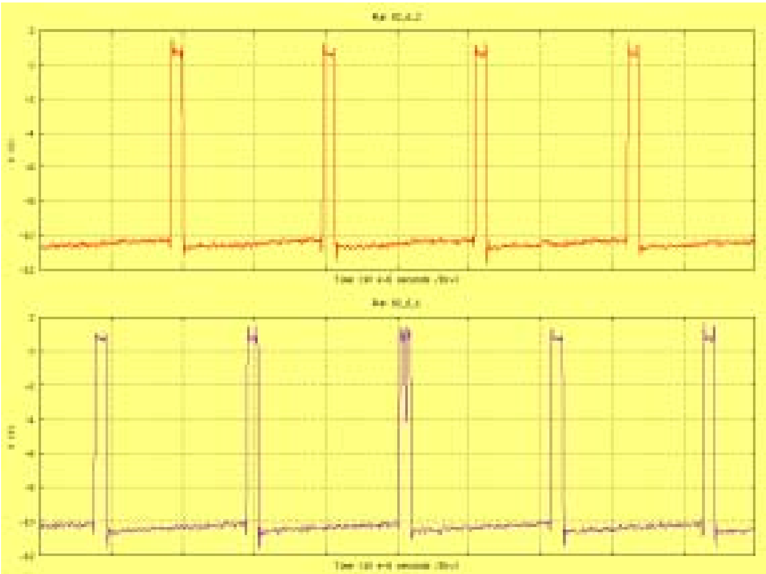


Run82, Event #04

Trig cond.2 on Output A
(pulse width (↓)<19µs)

Output B

Output A



Run82, Event #06

Trig cond.2 on Output A
(pulse width (↓)<19µs)

Output B

Output A

Figure 7 – Trig condition #2, SEE error type2

Table 2 – Detailed results per run

Run #	Device S/N	Ouput #	Trig Condition	Ion	Tilt angle (deg.)	LETeff MeV/(mg/cm²)	Fluence (#/cm²)	IradTime (s)	MeanFlux (#/cm²*s)	Type 1 SEE #	Type 2 SEE #	Total SEE #
Run109	1	A	>20µs	20Ne4	0	5.85	2.51E+06	241	10388	0	1	1
Run110	1	A	>20µs	20Ne4	45	8.27	2.50E+06	340	7370	1	0	1
Run106	1	A	>20µs	40Ar8	0	14.1	2.51E+06	264	9492	1	45	46
Run105	1	B	>20µs	40Ar8	0	14.1	2.51E+06	268	9380	3	34	37
Run89	1	A	>20µs	84Kr17	0	34	2.50E+06	408	6142	4	53	57
Run88	1	A	>20µs	84Kr17	45	48.08	2.51E+06	305	8226	2	64	66
Run85	1	B	>20µs	84Kr17	45	48.08	2.51E+06	339	7405	4	88	92
Run79	1	A	>20µs	84Kr17	60	68	1.00E+06	303	3305	3	14	17
Run80	1	A	>20µs	84Kr17	60	68	3.72E+06	812	4587	6	95	101
Run84	1	B	>20µs	84Kr17	60	68	2.51E+06	414	6054	9	85	94
Run102	2	B	>20µs	40Ar8	45	19.94	2.51E+06	342	7337	3	30	33
Run101	2	B	>20µs	40Ar8	60	28.2	2.50E+06	311	8031	1	30	31
Run97	2	B	>20µs	84Kr17	0	34	2.52E+06	143	17618	1	60	61
Run96	2	B	>20µs	84Kr17	45	48.08	2.50E+06	294	8520	2	74	76
Run92	2	A	>20µs	84Kr17	60	68	2.50E+06	404	6187	4	54	58
Run93	2	B	>20µs	84Kr17	60	68	2.51E+06	386	6499	2	50	52
Run108	1	A	<19µs	20Ne4	0	5.85	2.50E+06	235	10652	0	0	0
Run107	1	A	<19µs	40Ar8	0	14.1	2.51E+06	189	13279	0	9	9
Run90	1	A	<19µs	84Kr17	0	34	2.50E+06	384	6521	1	7	8
Run87	1	A	<19µs	84Kr17	45	48.08	2.50E+06	375	6674	11	14	25
Run86	1	B	<19µs	84Kr17	45	48.08	2.50E+06	427	5854	5	12	17
Run81	1	A	<19µs	84Kr17	60	68	3.30E+06	515	6401	18	27	45
Run82	1	A	<19µs	84Kr17	60	68	2.50E+06	386	6486	19	12	31
Run83	1	B	<19µs	84Kr17	60	68	2.50E+06	390	6416	11	23	34
Run104	2	B	<19µs	40Ar8	0	14.1	2.50E+06	265	9433	0	2	2
Run103	2	B	<19µs	40Ar8	45	19.94	2.50E+06	386	6484	0	17	17
Run100	2	B	<19µs	40Ar8	60	28.2	2.50E+06	561	4460	1	8	9
Run99	2	B	<19µs	40Ar8	60	28.2	2.51E+06	458	5474	2	5	7
Run98	2	B	<19µs	84Kr17	0	34	2.51E+06	123	20348	3	14	17
Run95	2	B	<19µs	84Kr17	45	48.08	2.51E+06	277	9074	1	18	19
Run91	2	A	<19µs	84Kr17	60	68	2.50E+06	591	4228	9	12	21
Run94	2	B	<19µs	84Kr17	60	68	2.50E+06	361	6938	6	16	22

8 CONCLUSION

Heavy ion tests were conducted on 2 flight lot parts for the ATV project, UC1706, Dual Output Driver from Texas Instruments, using the heavy ions available at the European Heavy Ion Irradiation Facility (HIF) at Cyclone, Université Catholique de Louvain, Belgium.

Test was done in accordance with the user set-up requirement (see RD2).

Devices have been tested on a LET range from 5.85 to 68 MeV/(mg/cm²) and the events detected could affect either one output only or simultaneously the two outputs.