PROJECT

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TITLE

Heavy Ion Effects of Low Voltage LVDS Line Driver/Receiver from National Semiconductor

EUROPEAN SPACE AGENCY
CONTRACT REPORT

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SUMMARY

Four LVDS components from National Semiconductor (2 drivers and 2 receivers) were irradiated at the CYClotron of Louvain la Neuve (CYCLONE). The devices were tested at room temperature and at nominal bias conditions (3,3Volt). Both the driver and the receiver were found to exhibit single event latch-up starting around 30 MeVcm2/mg. Error calculation using CREME96 and intergalactic orbit point to an LU error rate of 1,5E-6 LU/device and day, which likely is a factor of 10 higher than the device hardware Fit error rate.
Depending on project requirements, this device could be used as replacement for ITAR types of the same kind, but would likely require usage of a LU protection circuitry.

DOCUMENT CHANGE RECORD

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1. ABSTRACT

This report presents the Single Event Effects results from heavy ion tests of LVDS quad differential 3,3V line driver/receiver DS90LV31B/DS90LV32B from National Semiconductor. Both types were found to latch-up at a LET threshold of about 30 MeVcm2/mg. Single Event Transient pulses were observed at a cross section of about 1.0E-6 cm2.

2. INTRODUCTION

DS90LV31B and DS90LV32B are quad differential 3,3V line driver/receiver from National Semiconductor. These devices are design to support high data rates utilizing Low Voltage Differential Signalling (LVDS) technology and are normally used in a point-to-point configuration. The receiver is connected to the driver through a balanced media, which may be a standard twisted cable, a parallel pair cable or PCB traces.

Earlier heavy ion tests of National Semiconductor LVDS devices in 5 Volt technology have indicated that latch-up may occur [1, 4]. However, the manufacturer has modified the devices to eliminate the latch-up [2, 4]. The devices from National Semiconductor are not radiation hardened but ITAR-free and therefore of special interest for European usage.

This paper discusses the use of National Semiconductor LVDS for low-power/high speed data transmission in space borne applications. Heavy ion induced single event latch-up (SEL) and single event transients (SET) are reported for both LVDS drivers and receivers.

3. REFERENCES

[1] http://klabs.org/richcontent/Misc_Content/LVDS/Lvds0997_Sep_97.PDF
[2] http://klabs.org/richcontent/Misc_Content/LVDS/LVDS_September_1999.htm
[3] D-PL-REP-5162-SE / ESA-QCA0202S_C; Saab Ericsson Space Test Report
[4] HRX/SEE/0010 / ESA_QCA00163S_C, HIREX test report , 27 July 2000

4. DS90LV31B/DS90LV32B from National Semiconductor

4.1 Test Samples

Four test samples were prepared for heavy ion tests, two of each driver/receiver DS90LV31B/DS90LV32B. Fig 4.1.1 shows the package marking, while Figs 4.1.2 and 4.1.3 show the die and the die marking of the two types.

Part Type:	Driver DS90LV31B	Receiver DS90LV32B
Manufacturer:	National Semiconductor	National Semiconductor
Date Code	0343A	0343A
Quality:	QML 5962-9865101QFA	QML 5962-9865201QFA
Bias Condition	3,3 Volt	3,3 Volt
Package	FP-16	FP-16
Serialization	S/N 1, S/N 2	S/N 3, S/N 4

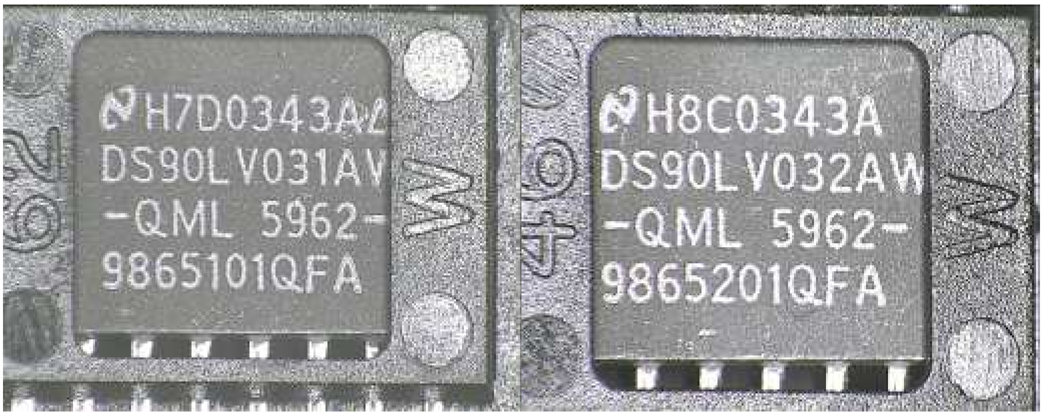

Figure 4.1.1.Package marking of Line Driver (Left) and Line Receiver (Right)

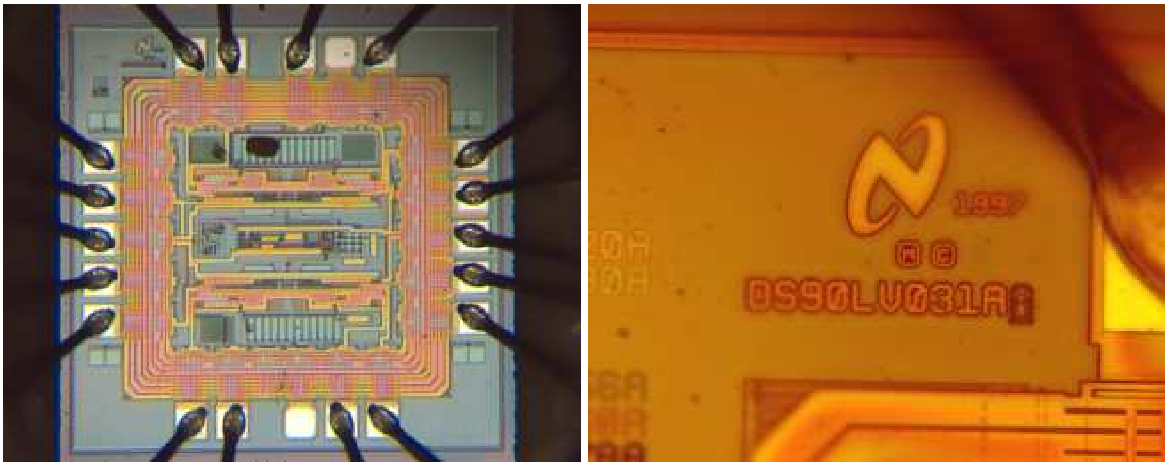

Fig 4.1.2 Line Driver, Left; Picture of a die, Right; Die marking.

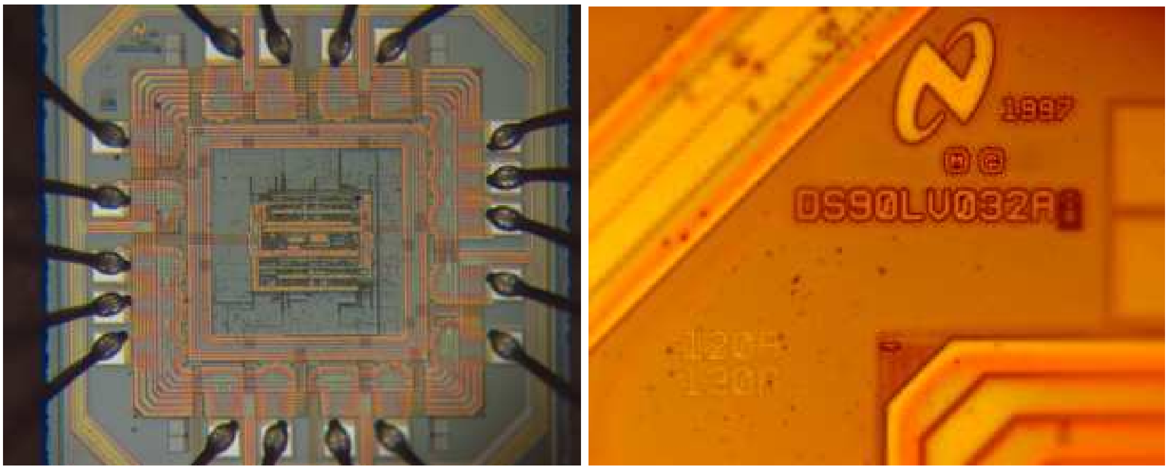

Fig 4.1.3 Line Receiver, Left; Picture of a Die, Right; Die marking.

5. TEST TECHNIQUES

5.1 Test Set-up

Single Event Transient (SET) pulses were measured using a feeding-and-counting technique developed by M. Wiktorson et al [3]. A receiver and a driver board connected together were prepared for heavy ion irradiation and placed inside the vacuum chamber. This assembly was than connected to a driver and a receiver outside the vacuum chamber. Dynamic tests were performed by feeding the driver outside the chamber with a very accurate known frequency (30.00000000 MHz) and measuring the response at the receiver side outside the chamber after the frequency train has passed the receiver and the driver inside the chamber, which one at the time were exposed to heavy ions. The results were logged on a PC. The test software was developed by use of “Labview software” for the GPIB communication between the computer, frequency generator and the frequency counter. A schematic drawing is shown in Fig 5.1.1.
A typical error picture is illustrated in Fig 5.1.2

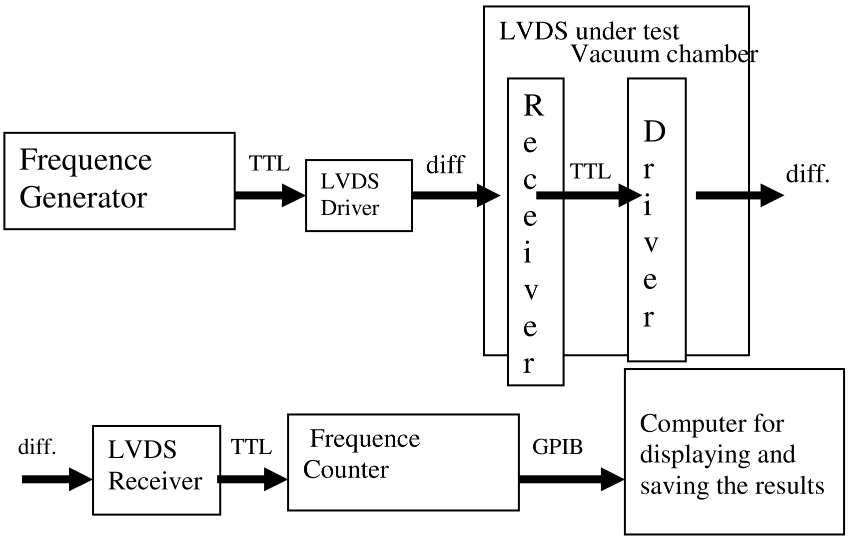

Fig 5.1.1 Schematic drawing of heavy ion test sequence

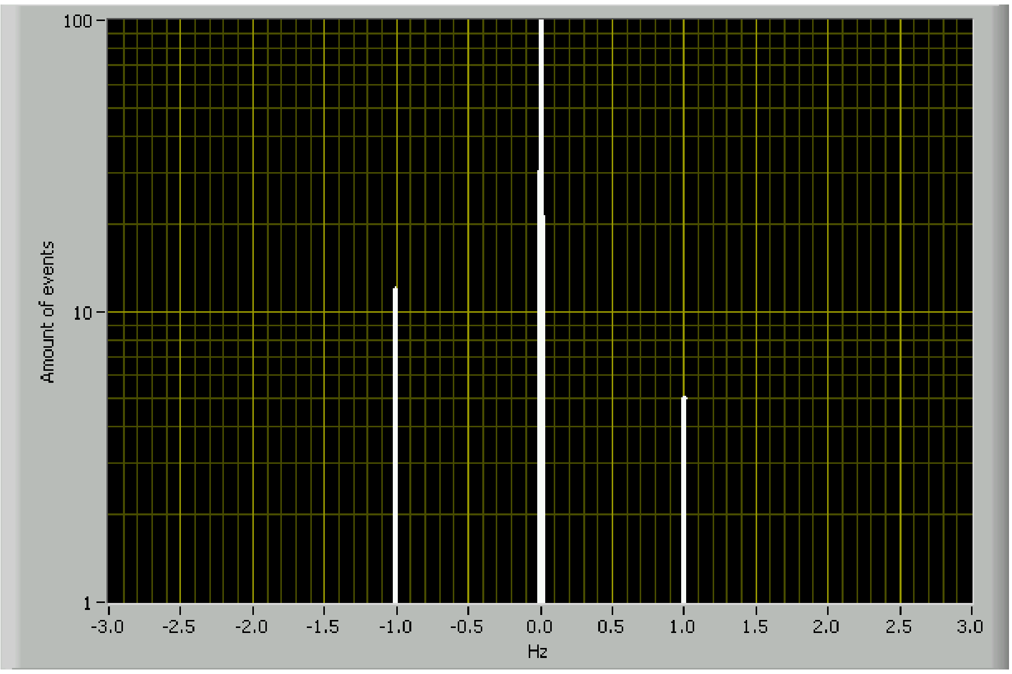

Fig 5.1.2 Error picture after the measured frequency have been subtracted from the initial frequency fed to the driver under test. The picture shows 12 events where the one Hz has been lost and 5 events where one Hz has been added to the operating frequency of 30 MHz. The data are from run #101, fluence = 6,2E+6 ions/cm2, # LU= 21.

5.2 Heavy Ion Test Facility

Heavy ion tests were performed at the CYClotron of Louvain la Neuve (CYCLONE) in Belgium. Both the low energy ion cocktail (M/Q=4.94) and the high energy ion cocktail (M/Q=3,33) were used in order to ensure sufficient penetration depth in Silicon. The ions used are given in the Tables 5.1 below. Test data as ion beams, flux, fluence, number of LU and SET for the various test runs are given in Appendix A.

TABLE 5.1 HEAVY IONS USED AT LOUVAIN LA NEUVE IN BELGIUM

Element	**Energy** MeV	**Range(Si)** µm	**LET value (Si)** [$MeV/mg/cm^2$]
$^{84}Kr^{17+}$ (Old)	316	43	34,0
$^{132}Xe^{26+}$ (Old)	459	43	55,9
$^{84}Kr^{25+}$ (New)	756	100	32,4

6. RESULTS

6.1 Single Event Latch-up

The range in Silicon of the heavy ions used is believed to be long enough to achieve adequate latch-up experiment in modern technologies. Measurements of the operating current indicate that the observed sudden increase of current likely is limited latch-ups locally triggered in the components. As can be seen in Fig 6.1.1, where the latch-up protection limit has been set to 800 mA, two successive heavy ion induced increase of current add about 300 of mA each to the total current. During high current mode, the function of the driver/receiver was affected. However, the devices did not indicate any sign of permanent damage or increased leakage current after the high current mode, even though some of the test runs lasted for several hundred seconds with the LU protection circuitry inactivated.

The latch-up cross section for the driver and the receiver is shown in Fig 6.1.2. The latch-up threshold is found to be around LET=30 MeVcm2/mg

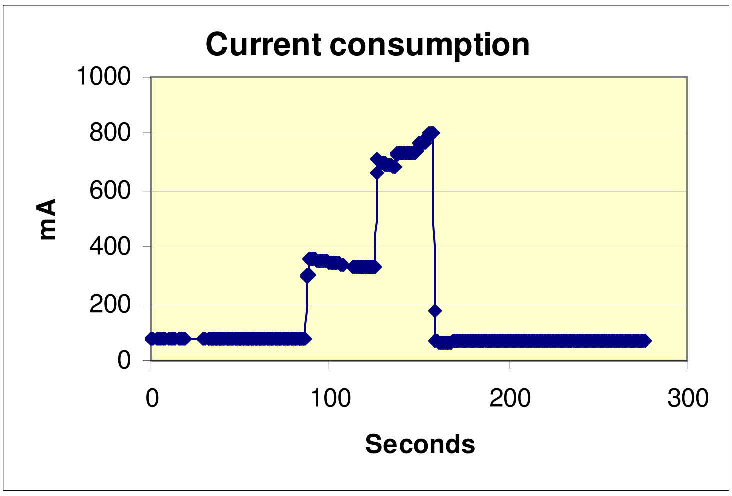

Fig 6.1.1 Heavy ion induced increase of operating current of the Driver. The latch-up cut off limit was set to 800 mA. The first SEL increased the current to about 350 mA, while the second SEL added another 350 mA. After the second SEL, the operating current increased slowly up to the cut off limit for the latch-up protection.

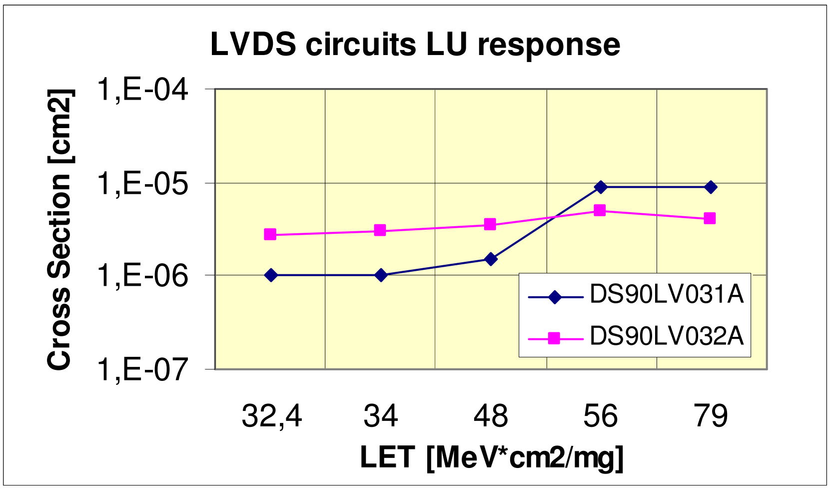

Fig 6.1.2 Latch-up cross section of the driver and the receiver

6.2 Single Event Transients

Data transmission errors were found for both the driver and the receiver at 30 MHz. A graph of SET Cross-section vs. LET was not made since the test set-up may be affected by the occurred latch-ups. It cannot be determined if the observed data transmission errors are single events or simply an effect following from latch-ups. The detected SET cross sections are comparable with the cross sections for LU at each test runs. No difference in SET rate was detected when the devices were transmitting data at 100 MHz. Integrated over one second; the transmitted errors were a loss of less than maximum 6 pulses.

7. DISCUSSIONS

In earlier heavy ion tests [1] latch-up have been detected on certain die revisions on 5V LVDS devices from National Semiconductor (DS90C032 LVDS receiver). These devices were modified by the manufacturer to eliminate the latch-up sensitivity [2]. Tests performed on these modified devices [2] indicate observation of Single Event Transients (SET). However, no SET cross section data were published due to the fact that the test set-up was optimized for latch-up.
SET data from the present test technique [3] developed by M. Wiktorson et al are given in Fig 5.1.2. The graph shows the data taken in a high fluence test run (Fluence=6,2E+6, SET=17, LU=21). During high current LU mode, the function of the driver/receiver was found to be disturbed. During the time when the latch-up protection circuitry is activated, the error signals are several MHz from nominal value. However, there is a certain possibility that accidentally few Hz errors could be registered in the same time as an ion strike leading to latch-up.

8. CONCLUSION

Four LVDS components from National Semiconductor (2 drivers and 2 receivers) were irradiated at the CYClotron of Louvain la Neuve (CYCLONE). The devices were tested at room temperature and at nominal bias conditions (3,3Volt). Both the driver and the receiver were found to exhibit single event latch-up starting around a LET of 30 MeVcm2/mg. Error calculation using CREME96 and intergalactic orbit point to an LU error rate of 1,5E-6 LU/device and day, which likely is a factor of 10 higher than the device hardware Fit error rate.
Depending on project requirements, this device could be used as replacement for ITAR types of the same kind, but would likely require usage of a LU protection circuitry.

9. Appendix A

Raw data from the test runs.

RUN#	ION	Angle of incident	LET	FLUENCE	Flux	Sample	LU	SET
84+89	Xe	0	56	E6	2000	Driver #1	9	2
85	Xe	45	79	E6	2000	Driver #1	9	1
86	Xe	45	79	E6	1500	Rec #1	4	
87+88	Xe	0	56	2E6	1500	Rec #1	10	4
91	Kr	45	48	E6	3000	Driver #1	2	
92	Kr	0	34	E6	4000	Driver #1	1	2
93	Kr	45	48	E6	4000	Rec #1	5	1
94	Kr	0	34	E6	4000	Rec #1	1	1
96	Kr	45	48	E6	4000	Driver #2	1	
97	Kr	0	34	E6	4000	Driver #2	1	1
98	Kr	0	34	E6	4000	Rec #2	3	2
99	Kr	45	48	E6	4000	Rec #2	2	2
100*	Kr	45	48	E6	4000	Rec #2	2	
101	Kr	0	34	6,2E6	4500	Rec #2	21	17
102	Kr	0	32,4	E6	4000	Rec #1	2	
103	Kr	0	32,4	E6	4000	Driver #1	1	1

*Test run #100 has been performed at 100 MHz.