HS-303ARH

Neutron Testing

TR030
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Introduction

This report summarizes results of 1MeV equivalent neutron testing of the HS-303ARH quad analog switch circuit. The test was conducted in order to determine the sensitivity of the part to Displacement Damage (DD) caused by neutron or proton environments. Neutron fluences ranged from $2x10^{12}n/cm^2$ to $1x10^{14}n/cm^2$. This project was carried out in collaboration with Boeing (El Segundo, CA), whose support is gratefully acknowledged.

Reference Documents

- MIL-STD-883 test method 1017
- HS-303ARH data sheet
- Standard Microcircuit Drawing (SMD) 5962-95813

Part Description

The HS-303ARH, HS-303AEH, HS-303BRH, HS-303BEH analog switches are monolithic devices fabricated using Intersil's dielectrically isolated Radiation Hardened Silicon Gate (RSG) process technology to insure latch-up free operation. They are pinout compatible and functionally equivalent to the HS-303RH, but offer improved 300krad(Si) total dose capability. These switches offer low-resistance switching performance for analog voltages up to the supply rails. The switch ON-resistance is low and stays reasonably constant over the full range of operating voltage and current. Break-before-make switching is controlled by 5V digital inputs. The HS-303ARH, HS-303AEH should be operated with nominal ±15V supplies, while the HS-303BRH, HS-303BEH should be operated with nominal ±12V supplies.

Specifications for radiation hardened QML devices are controlled by the Defense Logistics Agency (DLA) Land and Maritime. The SMD number listed in the following must be used when ordering. Detailed electrical specifications for the HS-303ARH, HS-303AEH, HS-303BRH, HS-303BEH are contained in SMD 5962-95813.

The HS-303ARH family of devices are acceptance tested to a total dose (TID) level of 300krad(Si) at a high dose rate (50-300rad(Si)/s). The HS-303AEH family of devices are acceptance tested to a total dose (TID) level of 300krad(Si) at a high dose rate (50-300rad(Si)/s) and to 50krad(Si) at a low dose rate (< 0.01rad(Si)/s).

TABLE 1. HS-303ARH PIN ASSIGNMENTS

TERMINAL NUMBER	TERMINAL SYMBOL	TERMINAL NUMBER	TERMINAL SYMBOL
1	NC	8	V+
2	S3	9	S4
3	D3	10	D4
4	D1	11	D2
5	S1	12	S2
6	IN1	13	IN2
7	GND	14	V-

Test Description

Irradiation Facilities

1MeV equivalent neutron irradiation was performed by the Boeing team at the White Sands Missile Range fast burst reactor. Dosimetry data can be furnished upon request. Parts were tested in an unbiased configuration with all leads shorted together in general accordance with TM 1017 of MIL-STD-883. As neutron irradiation activates many of the heavier elements found in a packaged integrated circuit, the parts exposed at the higher neutron levels required considerable 'cooldown' time before being shipped back to Intersil for electrical testing.

Test Fixturing

No formal irradiation test fixturing was involved. These DD tests are termed 'bag tests' in the sense that the parts are irradiated in an electrically inactive state with all leads shorted together.

Characterization Equipment and Procedures

Electrical testing was performed before and after irradiation using the Intersil Palm Bay, FL automated test equipment (ATE). All electrical testing was performed at room temperature.

Experimental Matrix

The experimental matrix consisted of 5 samples irradiated at $2x10^{12}n/cm^2$, 5 irradiated at $1x10^{13}n/cm^2$, 5 irradiated at $3x10^{13}n/cm^2$ and 5 irradiated at $1x10^{14}n/cm^2$. Five control units were used. The HS-303ARH samples were drawn from fabrication lot DWX7ABA and were packaged in the standard 14 Ld ceramic production package, code CDFP3-F14. Samples were screened to the SMD limits over temperature before the start of neutron testing.

Results

Neutron testing of the HS-303ARH is complete and the results are reported in the balance of this report. It should be carefully realized when interpreting the data that each neutron irradiation was performed on a different five-unit sample; this is not total dose testing, where the damage is cumulative over a number of downpoints.

Attributes Data

TABLE 2. HS-303ARH ATTRIBUTES DATA

PART	SERIAL	SAMPLE SIZE	FLUENCE, n/cm^2	PASS (Note 1)	FAIL	NOTES
HS-303ARH	1-5	5	2x10^{12}	5	0	All passed
HS-303ARH	6-10	5	1x10^{13}	5	0	All passed
HS-303ARH	11-15	5	3x10^{13}	5	0	All passed
HS-303ARH	16-20	5	1x10^{14}	5	0	All passed

NOTE:

1. 'Pass' indicates a sample that passes all SMD limits.

Variables Data

The plots in Figures 1 through 10 show data plots for key parameters before and after irradiation to each level. The reported parameters and their datasheet limits are shown in Table 3 on page 8.

The plots show the population median of each parameter as a function of neutron irradiation as well as population maximum and minimum error bars. We chose to plot the median because of the small sample sizes (five per cell) involved. We also show the applicable post-total dose electrical limits as taken from the SMD; it should be carefully noted that these limits are provided for *guidance only* as the HS-303ARH is not specified or guaranteed for the neutron environment. Intersil does not design, qualify or guarantee its parts for the DD environment, but has performed limited collaborative neutron testing for customer guidance.

Variables Data Plots

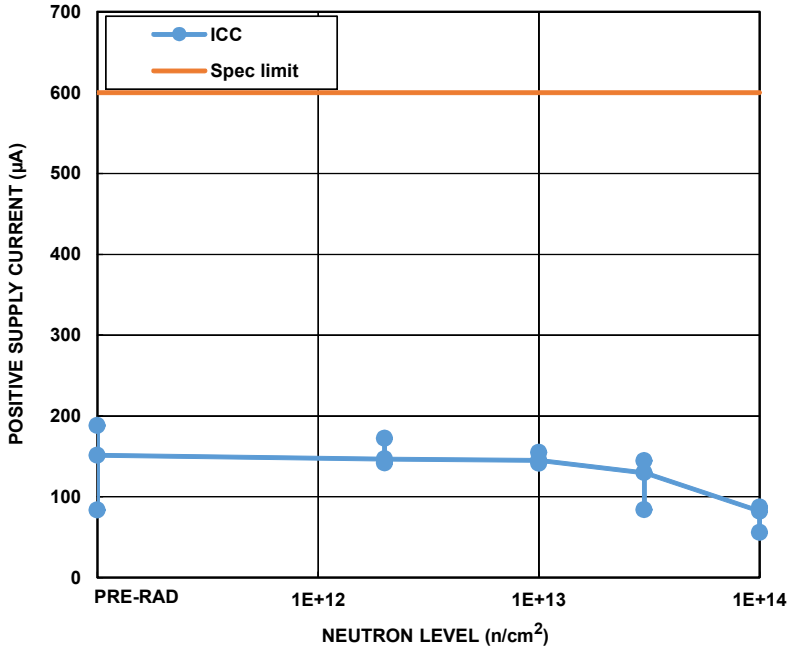

FIGURE 1. HS-303ARH positive supply current as a function of 1MeV equivalent neutron irradiation at 2x10^{12}n/cm^2, 1x10^{13}n/cm^2, 3x10^{13}n/cm^2 and 1x10^{14}n/cm^2. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limit is 600µA maximum.

Variables Data Plots (Continued)

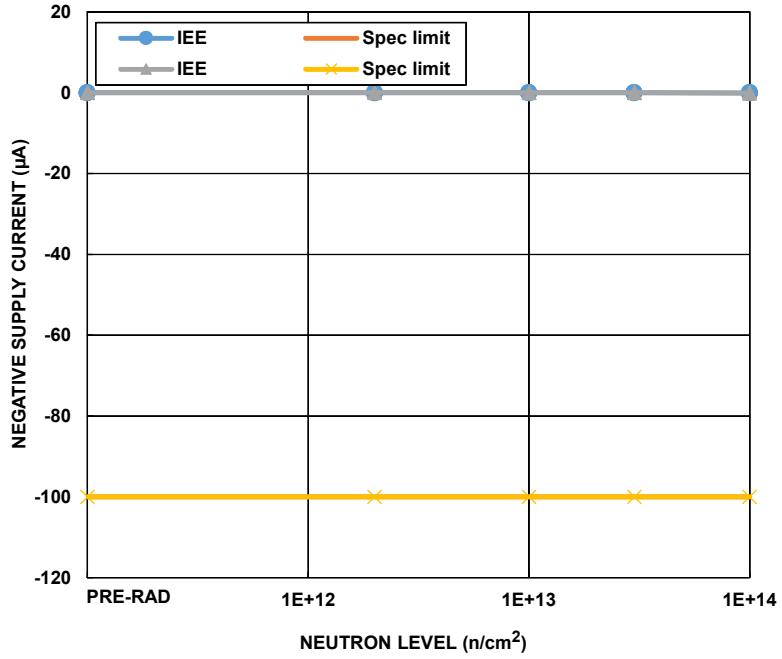

FIGURE 2. HS-303ARH negative supply current as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limit is -100µA minimum.

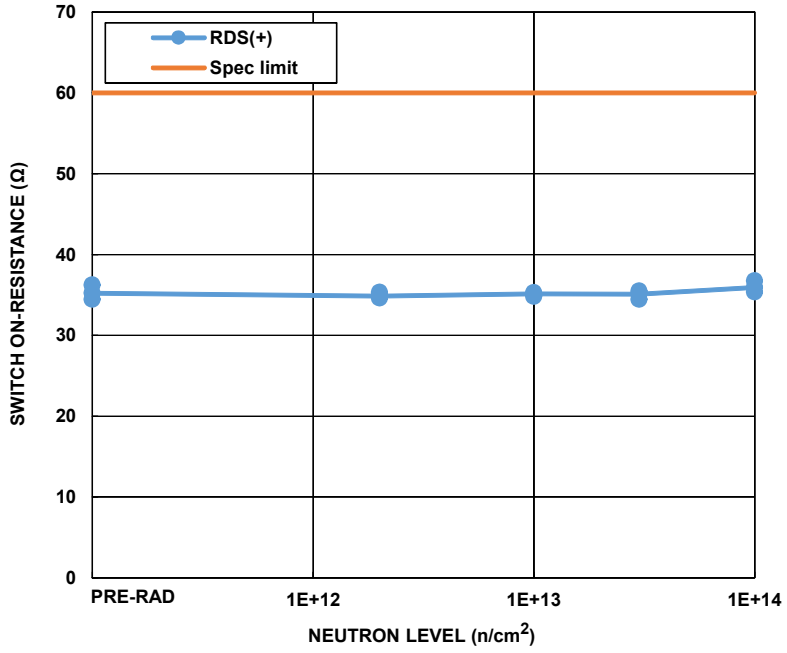

FIGURE 3. HS-303ARH switch ON-resistance, drain voltage +10V, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limit is 60Ω maximum.

Variables Data Plots (Continued)

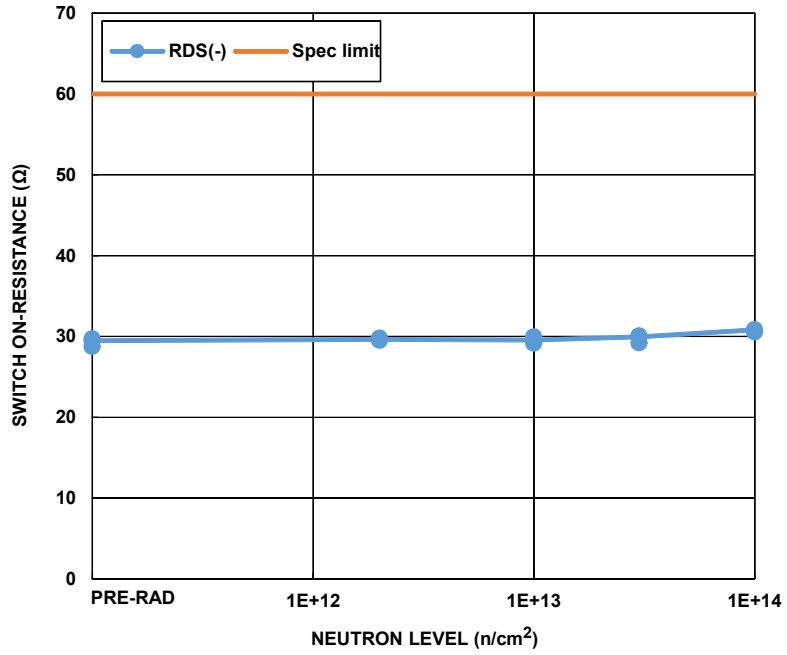

FIGURE 4. HS-303ARH switch ON-resistance, drain voltage -10V, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limit is 60Ω maximum.

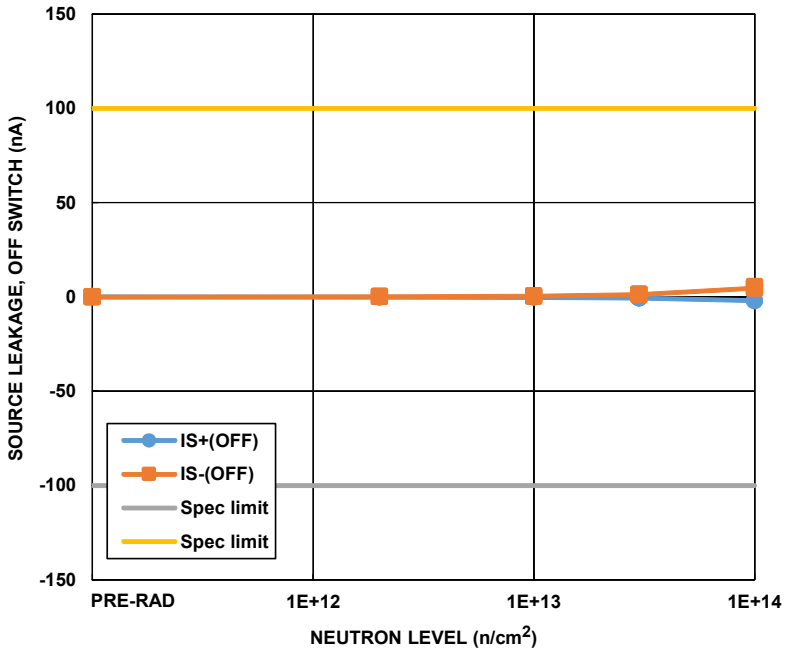

FIGURE 5. HS-303ARH leakage current into the source terminal of an OFF switch, Channel 1, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are -100nA to 100nA.

Variables Data Plots (Continued)

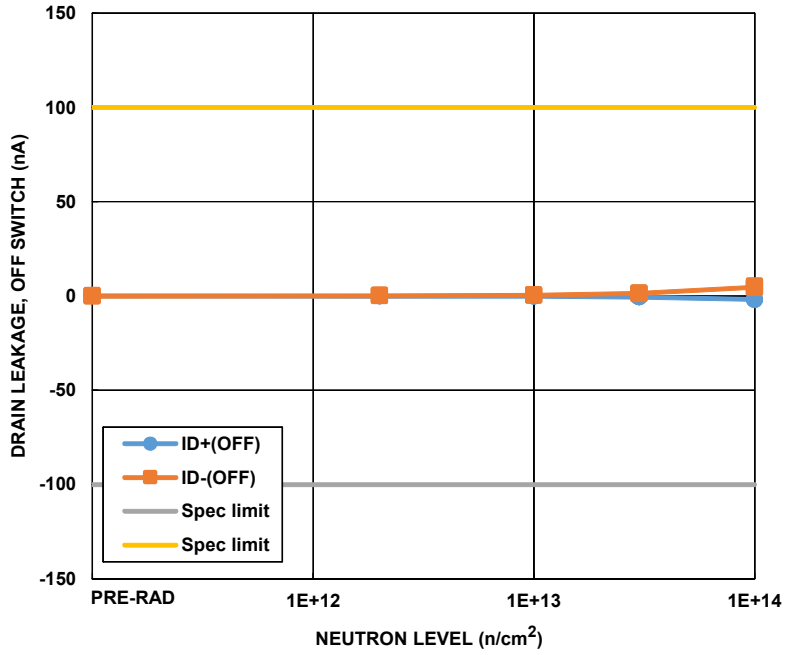

FIGURE 6. HS-303ARH leakage current into the drain terminal of an OFF switch, Channel 1, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are -100nA to 100nA.

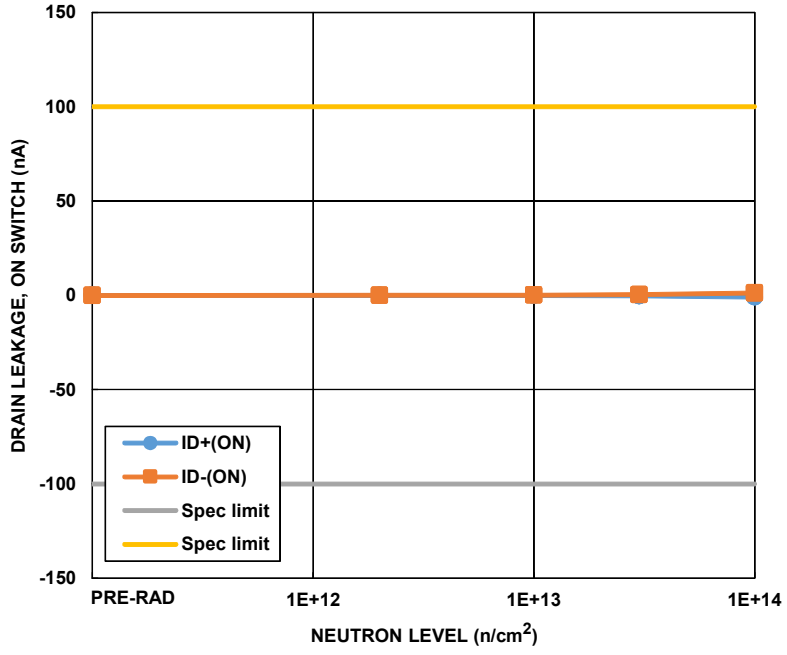

FIGURE 7. HS-303ARH leakage current into the drain terminal of an ON switch, Channel 1, as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are -100nA to 100nA.

Variables Data Plots (Continued)

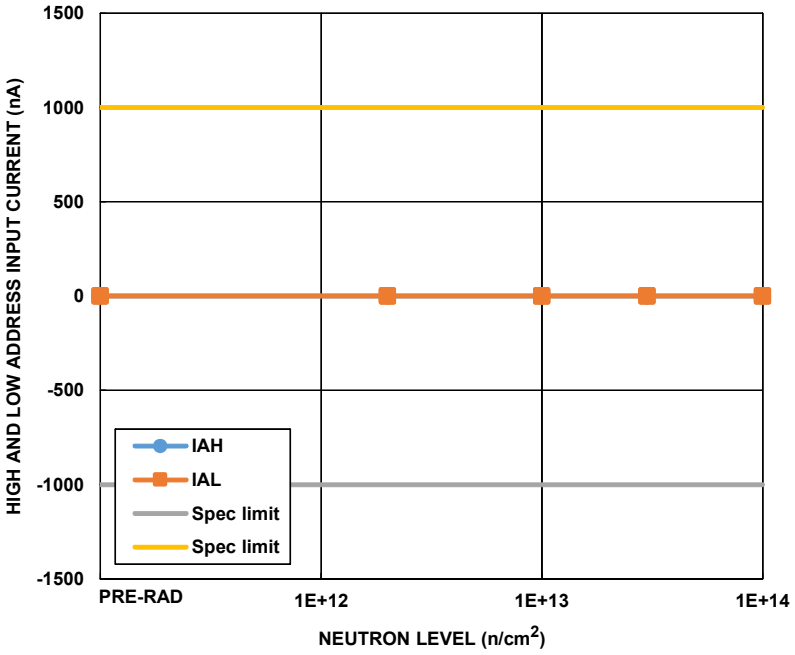

FIGURE 8. HS-303ARH HIGH and LOW address input current, address A1 as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are -1000nA to 1000nA.

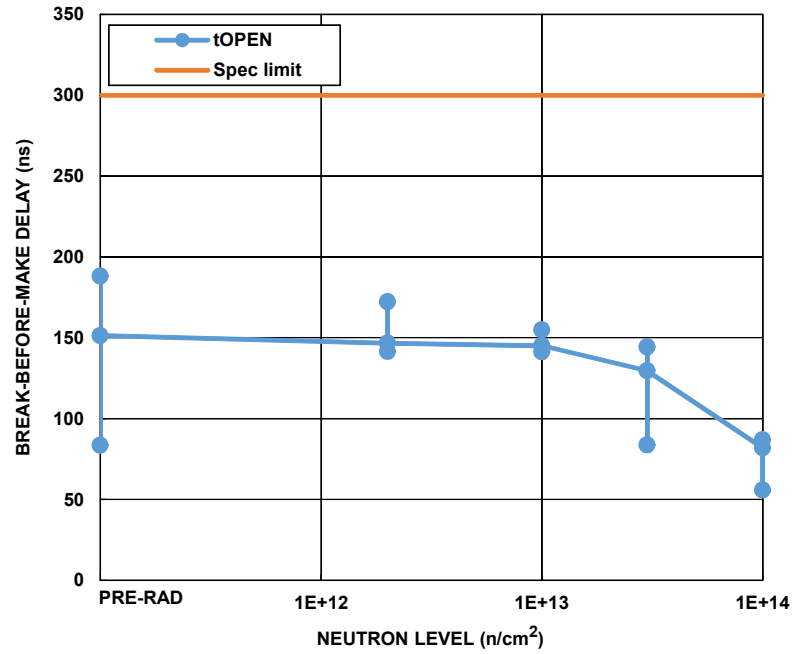

FIGURE 9. HS-303ARH break-before-make delay as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are 300ns maximum.

Variables Data Plots (Continued)

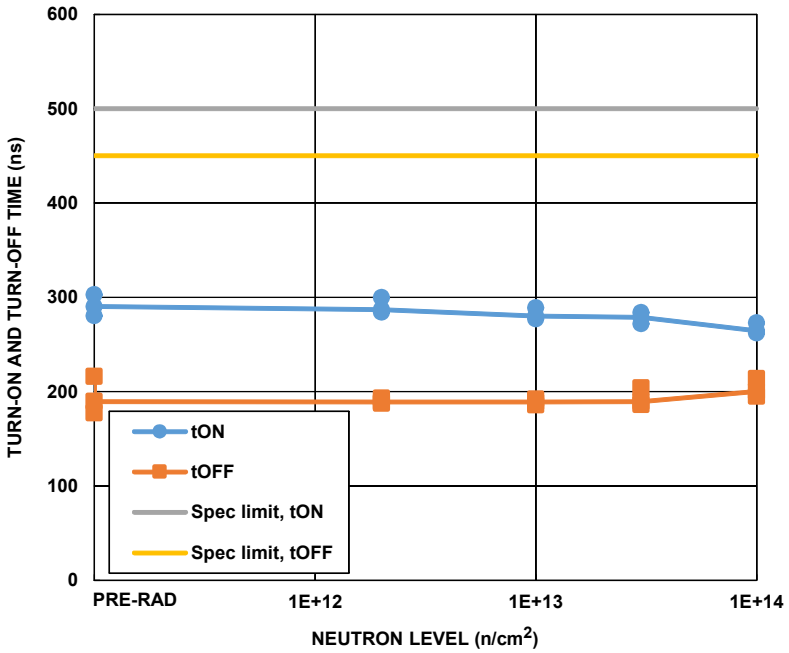

FIGURE 10. HS-303ARH switch turn-on and turn-off time as a function of 1MeV equivalent neutron irradiation at $2x10^{12}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$. The plot shows the population median and minimum and maximum error bars at each downpoint. Sample size for each cell was 5. The post-total dose irradiation SMD limits are 500ns maximum (turn-on time) and 450ns maximum (turn-off time).

Conclusion

This report summarizes results of 1MeV equivalent neutron testing of the HS-303ARH quad analog switch. The test was conducted in order to determine the sensitivity of the part to Displacement Damage (DD) caused by neutron or proton environments in space. Neutron fluences ranged from $2x10^{12}n/cm^2$ to $1x10^{14}n/cm^2$. This test was carried out as part of a collaborative project with Boeing (El Segundo, CA), whose support is gratefully acknowledged.

The samples met all specifications (Bin 1) after $2x10^{11}n/cm^2$, $1x10^{13}n/cm^2$, $3x10^{13}n/cm^2$ and $1x10^{14}n/cm^2$.

Appendices

Reported Parameters

Reported parameters are shown in Table 3. The limits are taken from the applicable SMD and are provided for guidance only as the part is not designed or guaranteed for the neutron environment. The plots show the population median and minimum and maximum error bars at each downpoint.

TABLE 3. REPORTED PARAMETERS

FIGURE	PARAMETER	LIMIT, LOW	LIMIT, HIGH	UNITS	NOTES
1	Positive Supply Current	-	600	µA	
2	Negative Supply Current	-100	-	µA	
3	Switch ON-Resistance	-	60	Ω	Drain voltage 10V
4	Switch ON-Resistance	-	60	Ω	Drain voltage 10V
5	Leakage, Source Terminal of an Off Switch	-100	100	nA	Channel 1
6	Leakage, Drain Terminal of an Off Switch	-100	100	nA	Channel 1
7	Leakage, Drain Terminal of an On Switch	-100	100	nA	Channel 1
8	Address Input HIGH Current	-1000	1000	nA	Address A1
	Address Input LOW Current	-1000	1000	nA	Address A1
9	Break-Before-Make-Delay	-	300	ns	
10	Switch Turn-On Time	-	500	ns	
	Switch Turn-Off Time	-	450	ns	

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