HS-2420EH

Total Dose Testing

TR015
Rev 0.00
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Introduction

This document reports the results of low and high dose rate total dose test of the HS-2420EH sample/hold. The test was conducted to provide a first-order assessment of total dose hardness of the part. Samples were irradiated under bias and with all pins grounded. The data was derived from production wafer-by-wafer acceptance testing.

Two versions of the HS-2420EH have been offered, differing in total ionizing dose acceptance testing. The HS-2420RH was acceptance tested on a wafer-by-wafer basis to 100krad(Si) at high dose rate (50–300 rad(Si)/s) only. The current production HS-2420EH is acceptance tested on a wafer-by-wafer basis to 100krad(Si) at high dose rate (50–300 rad(Si)/s) and to 50krad(Si) at low dose rate (0.01rad(Si)/s). The HS-2420RH used silicon nitride passivation and is now obsolete. The current production HS-2420EH uses Silox passivation and this report discusses HS-2420EH results only.

Reference Documents

MIL-STD-883 test method 1019

HS-2420EH datasheet

Standard Microcircuit Drawing (SMD) 5962-95669

Part Description

The HS-2420EH is a radiation hardened sample/hold consisting of a high performance operational amplifier with its output in series with an ultra-low leakage analog switch and MOSFET input unity gain amplifier. With an external hold capacitor connected to the switch output, a versatile, high performance sample-and-hold or track-and-hold circuit is formed. When the switch is closed, the device behaves as an operational amplifier, and any of the standard op amp feedback networks may be connected around the device to control gain, frequency response, etc. When the switch is opened the output will remain at its last level.

Performance as a sample-and-hold compares favorably with other monolithic, hybrid and discrete circuits. Accuracy to better than 0.01% is achievable over the full military temperature range. Fast acquisition is coupled with superior droop characteristics, even at high temperature. High slew rate, wide bandwidth, and low acquisition time produce excellent dynamic characteristics. The device may also be used as a versatile operational amplifier with a gated output for applications such as analog switches, peak holding circuits, etc. The part is packaged in the hermetic 14-pin solder-sealed side brazed flatpack (CDIP2-T14) package.

Specifications

Specifications for QML devices are controlled by the Defense Logistics Agency, Land and Maritime (DLA). Electrical specifications for the device are contained in SMD 5962-95669

- Acquisition time, 10V step to 0.1% . . . . 4µs maximum
- Acquisition time, 10V step to 0.01% . . . . . . 6µs maximum
- Maximum drift current . . . . 10nA maximum
- Input offset voltage . . . . -6mV to 6.0mV
- Input bias current. -400nA to 400nA
- Open-loop gain . . . . 87.96dB (25kV/V) minimum
- Power supply rejection ratio . . . . 80dB minimum
- Power supply current . . . . 5.5mA (ICC), -3.5mA (IEE)
- Operating temperature range . . . . -55°C to +125°C

Test Description

Irradiation Facilities

High dose rate testing was performed at approximately 60rad(Si)/s using a Gammacell 220 ^{60}Co irradiator located in the Palm Bay, Florida Intersil facility. Low dose rate testing was performed at 0.01rad(Si)/s using the Intersil Palm Bay N40 panoramic ^{60}Co irradiator.

Test Fixturing

Figure 1 shows the configuration used for biased irradiation. The grounded irradiation configuration simply grounds all pins.

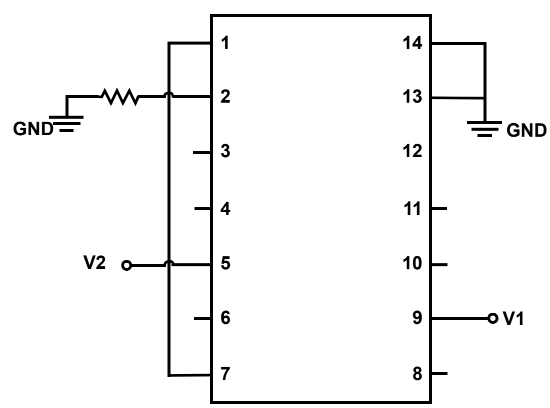

FIGURE 1. IRRADIATION BIAS CONFIGURATION FOR THE HS-2420EH PER SMD 5962-95669. V1 is +15V, V2 is -15V and R is 100kΩ

Characterization Equipment and Procedures

All electrical testing was performed outside the irradiator using the production Automated Test Equipment (ATE) with datalogging at each downpoint. Downpoint electrical testing was performed at room temperature.

Experimental Matrix

Total dose irradiation proceeded in accordance with the guidelines of MIL-STD-883 Test Method 1019.7. The experimental matrix consisted of 28 samples irradiated at low dose rate under bias, 28 samples irradiated at low dose rate with all pins grounded, 15 samples irradiated at high dose rate under bias and 13 samples irradiated at high dose rate with all pins grounded.

Samples of the HS-2420EH were drawn from preproduction inventory lot G2W2MDEH and were packaged in the hermetic 14-pin solder-sealed side brazed flatpack (CDIP2-T14) package. Samples were processed through the standard burnin cycle before irradiation, as required by MIL-STD-883, and were screened to the ATE limits at room temperature prior to the test.

Downpoints

Downpoints for the low dose rate tests were zero, 10, 30, 50, 75 and 100krad(Si), with anneals after 75krad(Si) and 100krad(Si). For the 75krad(Si) anneals, several samples were pulled from the population and were not further irradiated after the anneal. The 100krad(Si) anneal was performed ('Anneal 1' and 'Anneal 2') on the remaining samples after irradiation to 100krad(Si).

Downpoints for the biased high dose rate test were zero (see Table 1 for details), 30 and 150krad(Si) and were followed by an anneal ('Anneal 3'). Downpoints for the grounded high dose rate test were zero, 50 and 150krad(Si); no anneal was carried out after this test.

Results

Attributes Data

Table 2 shows the attributes data for the test.

TABLE 1. HS-2420EH TOTAL DOSE TEST ATTRIBUTES DATA

PART NUMBER	DOSE RATE (Note 1)	BIAS	SAMPLE SIZE	DOWNPOINT	PASS (Note 2)	REJECTS
HS-2420EH	LDR	Biased	27	Preirradiation	27	
				10krad(Si)	27	0
				30krad(Si)	27	0
				50krad(Si)	27	0
				75krad(Si)	27	0
				Anneal	14	0
				100krad(Si)	13	0
				Anneal	13	0
HS-2420EH	LDR	Grounded	12	Preirradiation	12	
				10krad(Si)	12	0
				30krad(Si)	12	0
				50krad(Si)	12	0
				75krad(Si)	12	0
				Anneal	8	0
				100krad(Si)	4	0
				Anneal	4	0
HS-2420EH	HDR	Biased	15	Preirradiation	15	
				30krad(Si)	15	0
				150krad(Si)	15	0
				Anneal	15	0
HS-2420EH	HDR	Grounded	13	Preirradiation	13	
				50krad(Si)	13	0
				150krad(Si)	13	0

NOTES:

1. LDR indicates low dose rate (0.01rad(Si)/s), as specified in TM1019. HDR indicates high dose rate (50-300 rad(Si)/s) also as specified in MIL-STD-883 TM1019; the actual dose rate for these tests was 60rad(Si)/s
2. Pass indicates a sample that passes all post-irradiation SMD limits.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following.

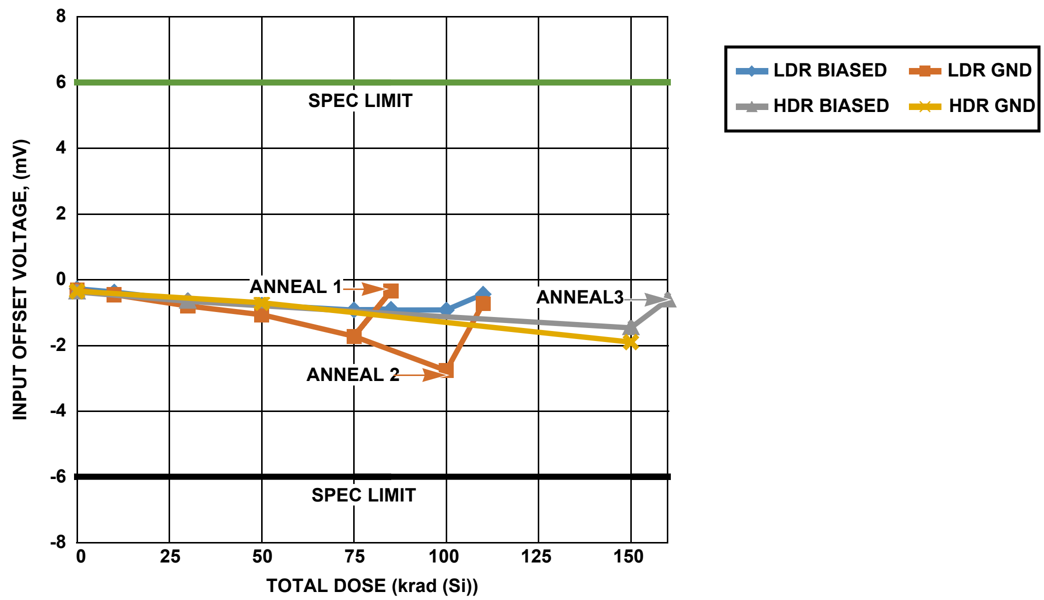

FIGURE 2. Median HS-2420EH input offset voltage as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -6mV to 6mV.

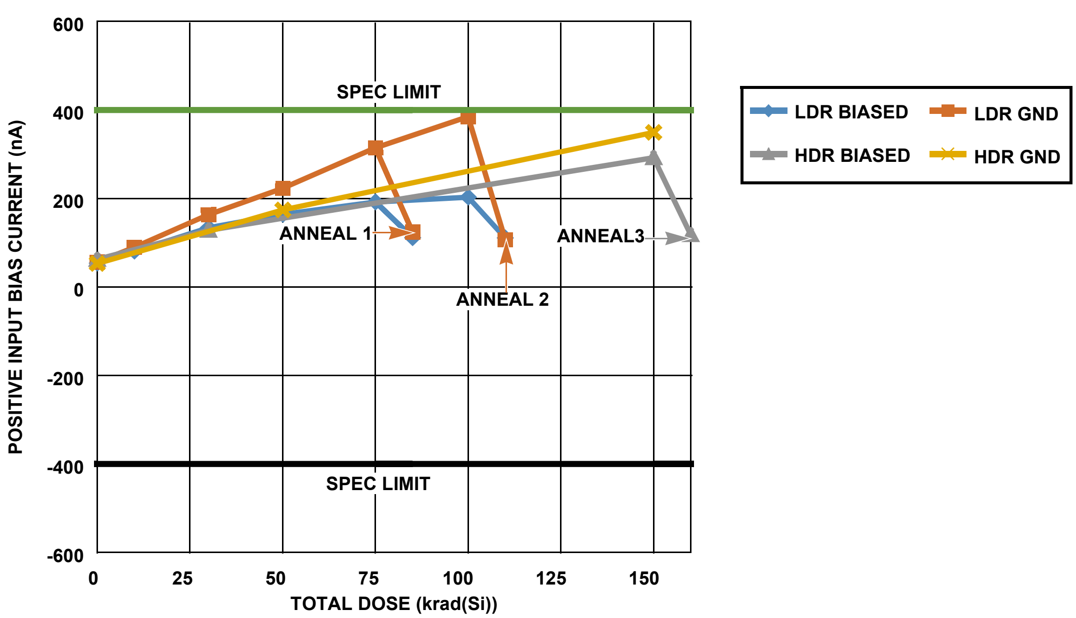

FIGURE 3. Median HS-2420EH positive input bias current as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100 krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -400nA to 400nA.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

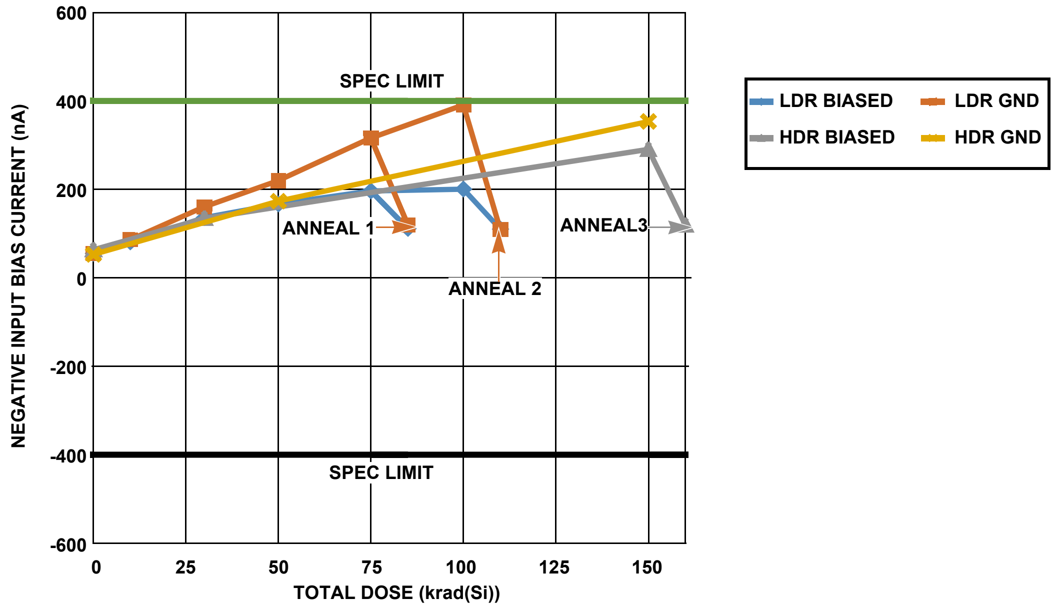

FIGURE 4. Median HS-2420EH negative input bias current as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -400nA to 400nA.

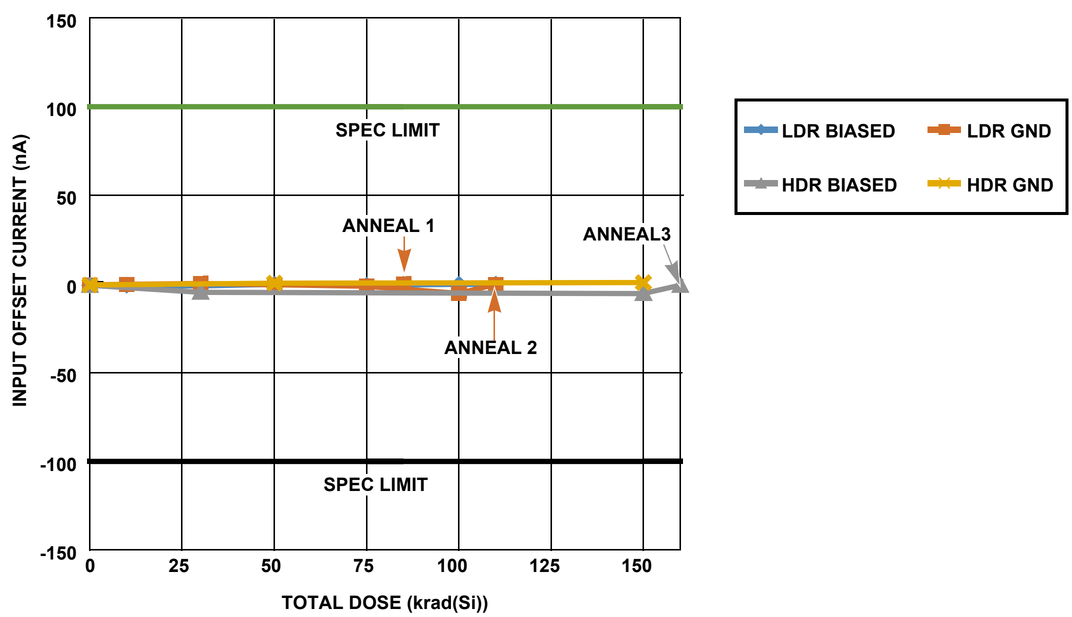

FIGURE 5. Median HS-2420EH input offset current as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -100nA to 100nA.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

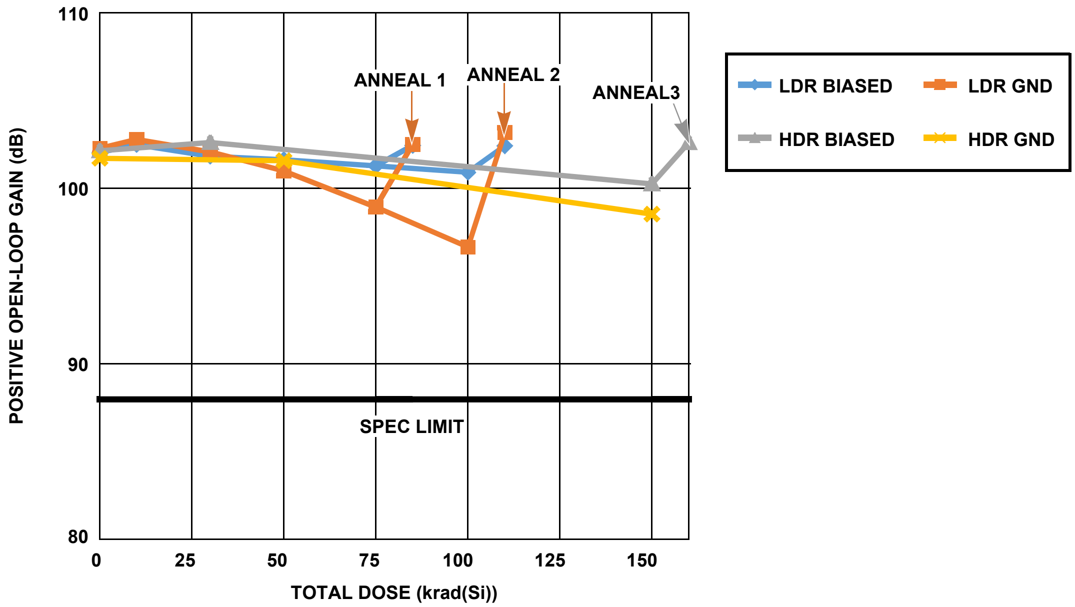

FIGURE 6. Median HS-2420EH positive open-loop gain as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100 krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 87.96dB (25kV/V) minimum.

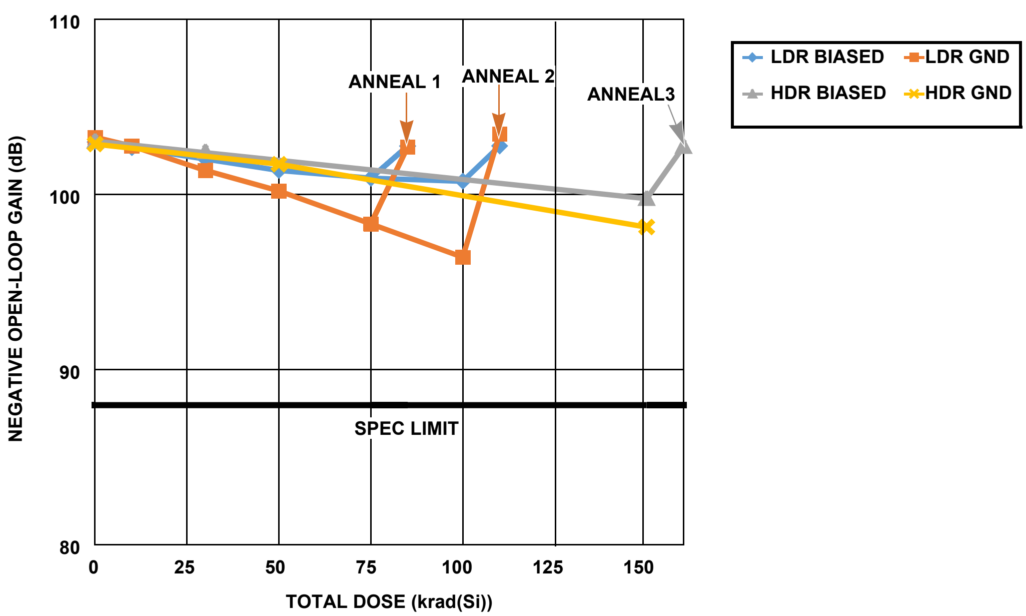

FIGURE 7. Median HS-2420EH negative open-loop gain as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 87.96dB (25kV/V) minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

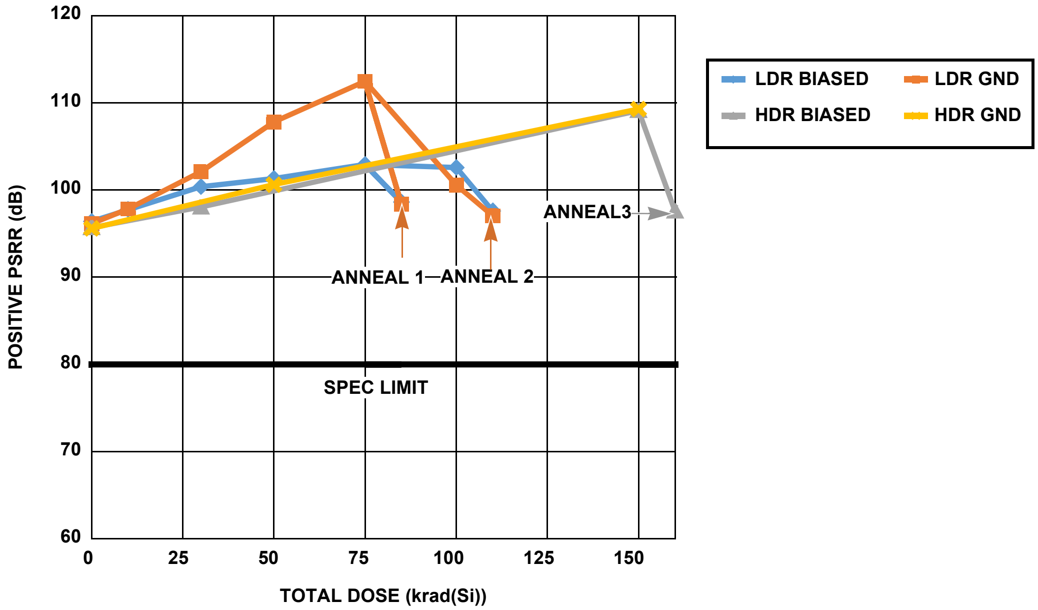

FIGURE 8. Median HS-2420EH positive power supply rejection ratio as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 80dB minimum.

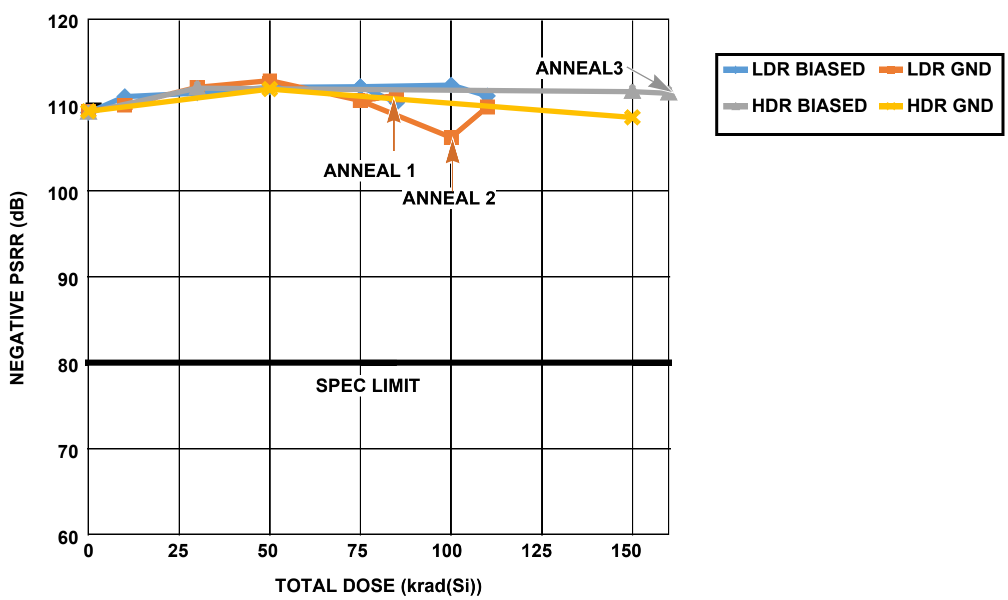

FIGURE 9. Median HS-2420EH negative power supply rejection ratio as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 80dB minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

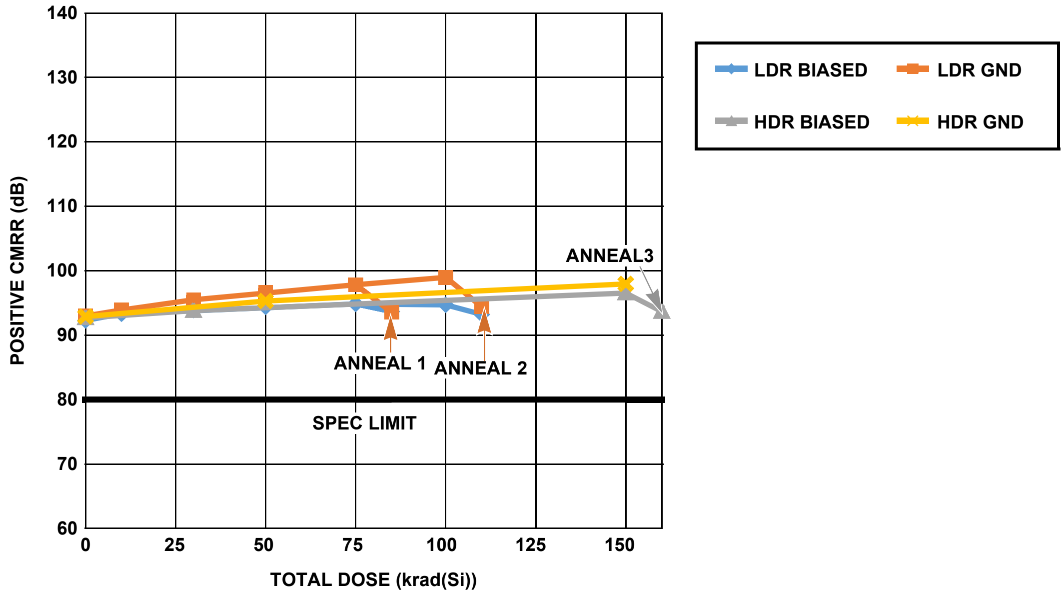

FIGURE 10. Median HS-2420EH positive common mode rejection ratio as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100 krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 80dB minimum.

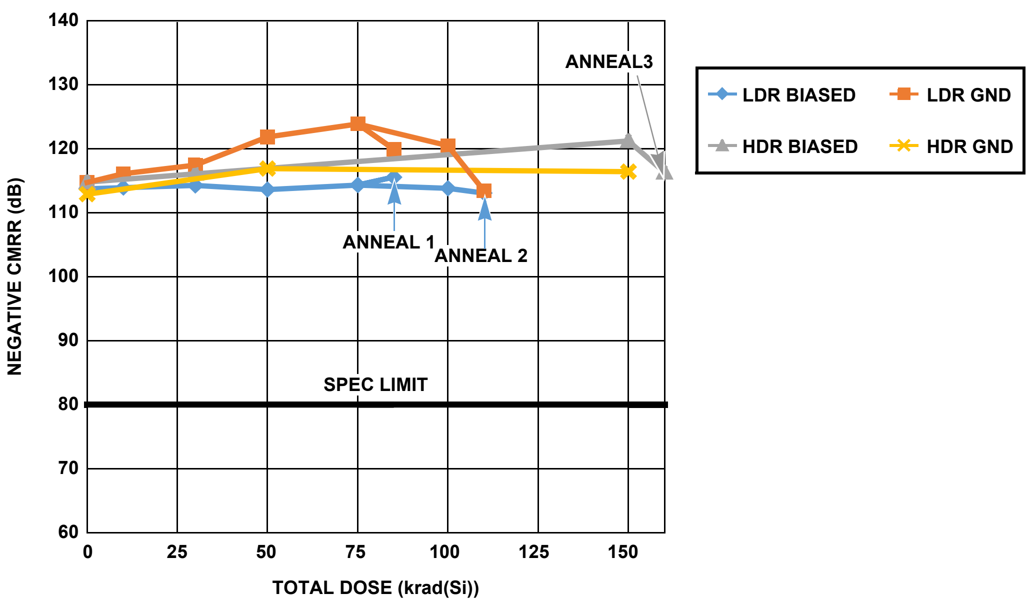

FIGURE 11. Median HS-2420EH negative common mode rejection ratio as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 80dB minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

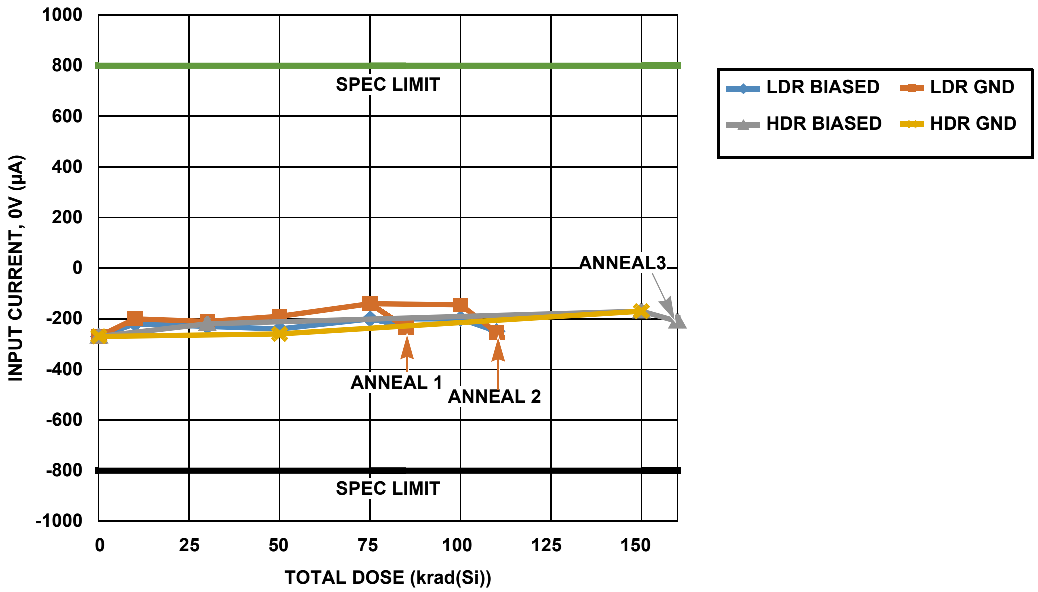

FIGURE 12. Median HS-2420EH digital input current, 0.0V input, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -800µA to 800µA.

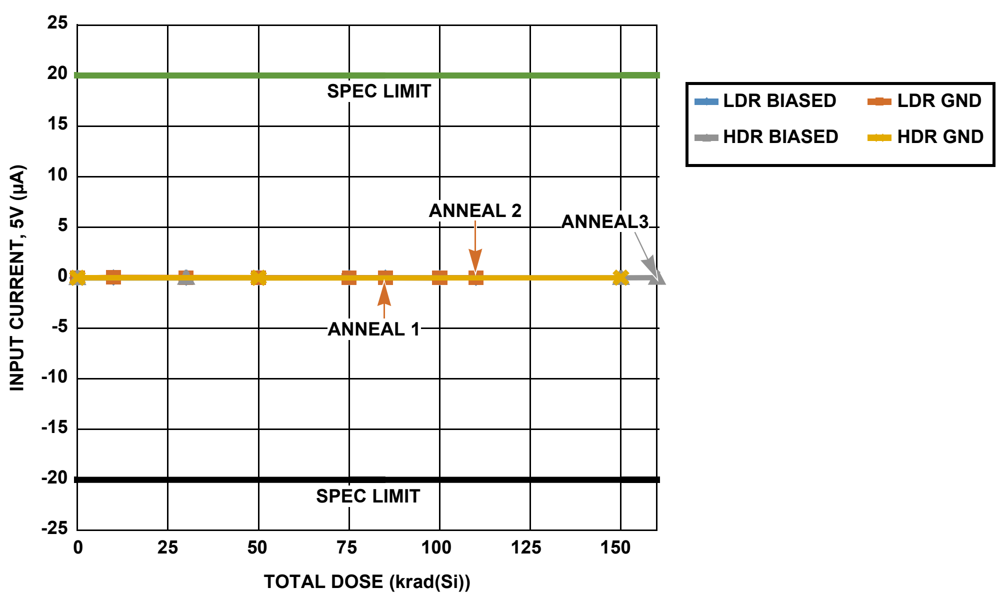

FIGURE 13. Median HS-2420EH digital input current, 5V input, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -20µA to 20µA.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

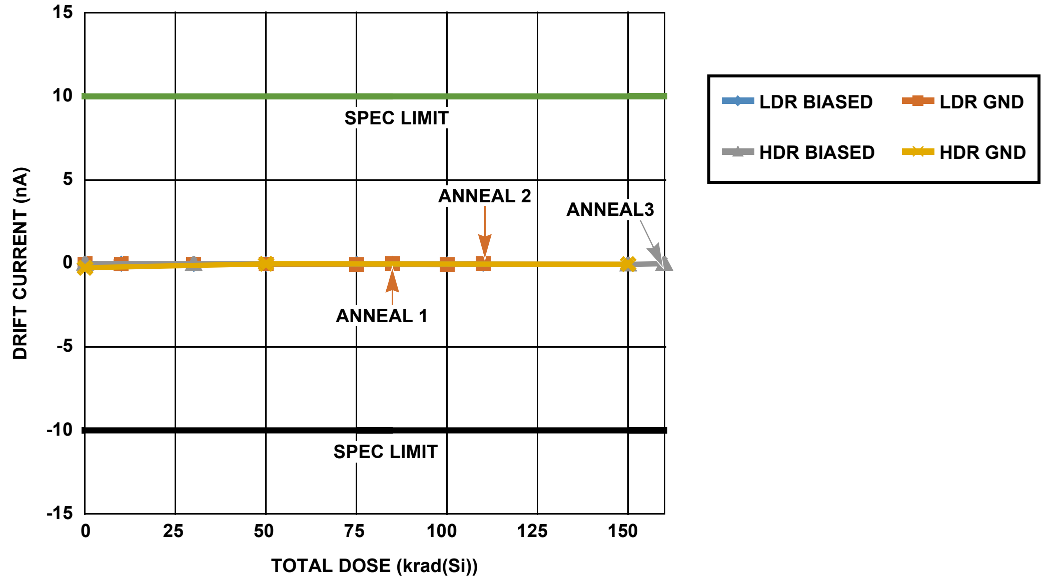

FIGURE 14. Median HS-2420EH drift current as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are -10nA to 10nA.

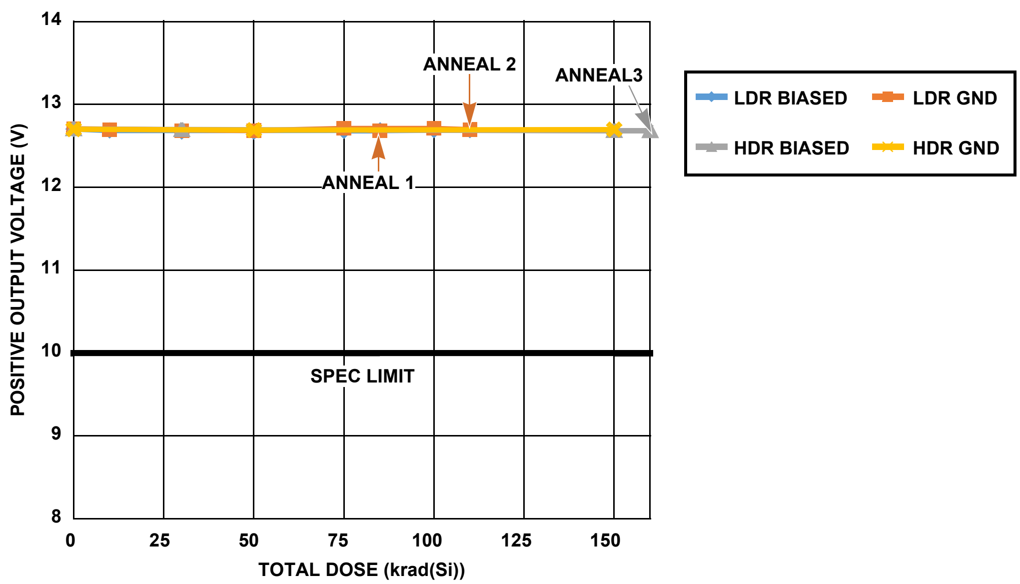

FIGURE 15. Median HS-2420EH positive output voltage as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 10V minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

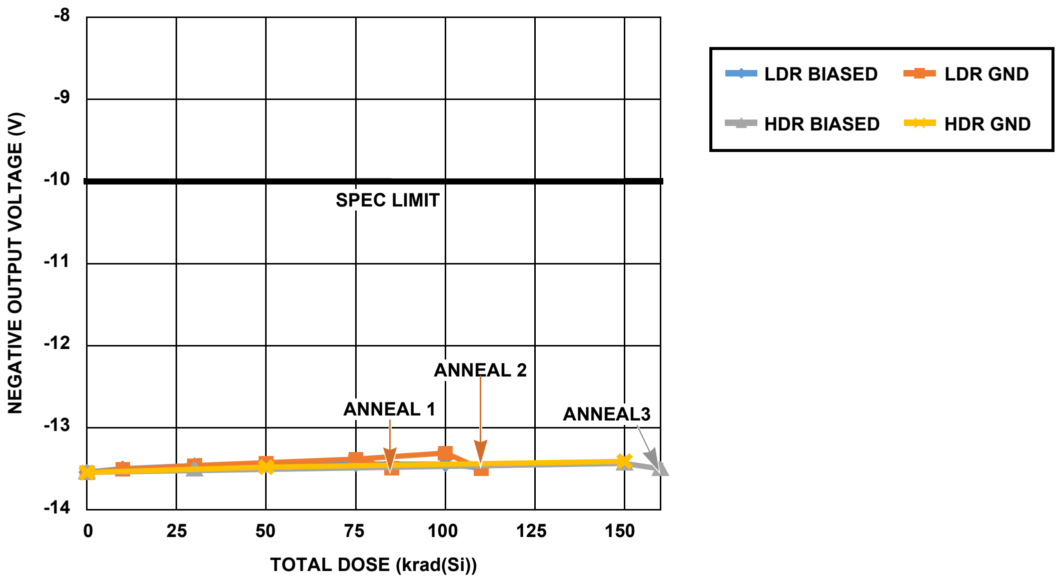

FIGURE 16. Median HS-2420EH negative output voltage as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is -10V maximum.

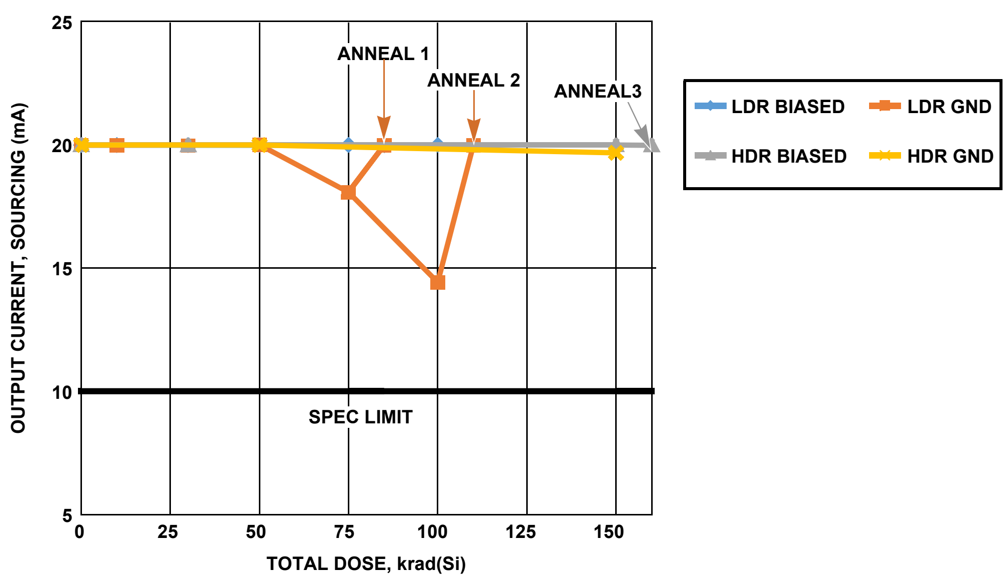

FIGURE 17. Median HS-2420EH output current, sourcing, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75 krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 10mA minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

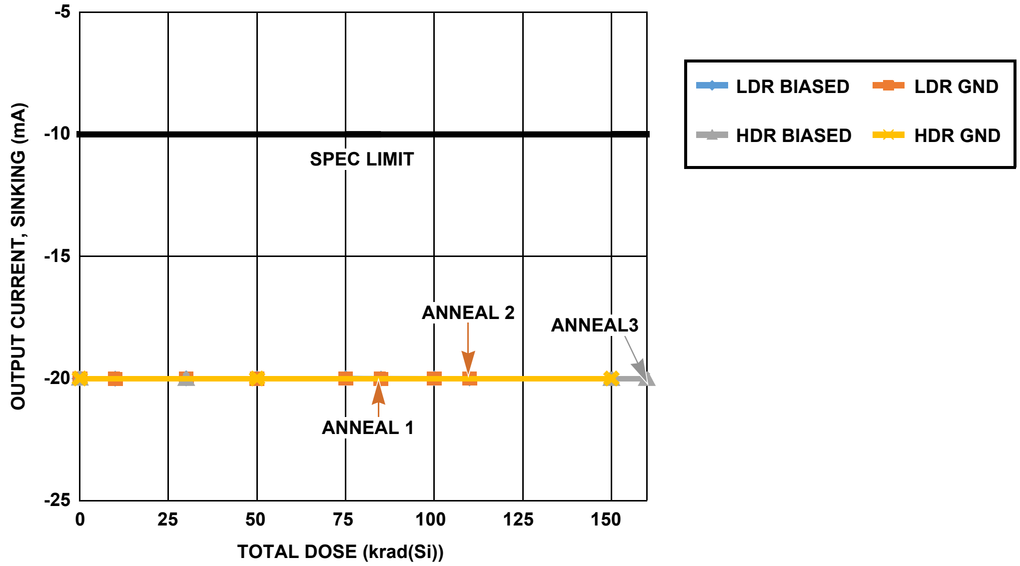

FIGURE 18. Median HS-2420EH output current, sinking, as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is -10mA maximum.

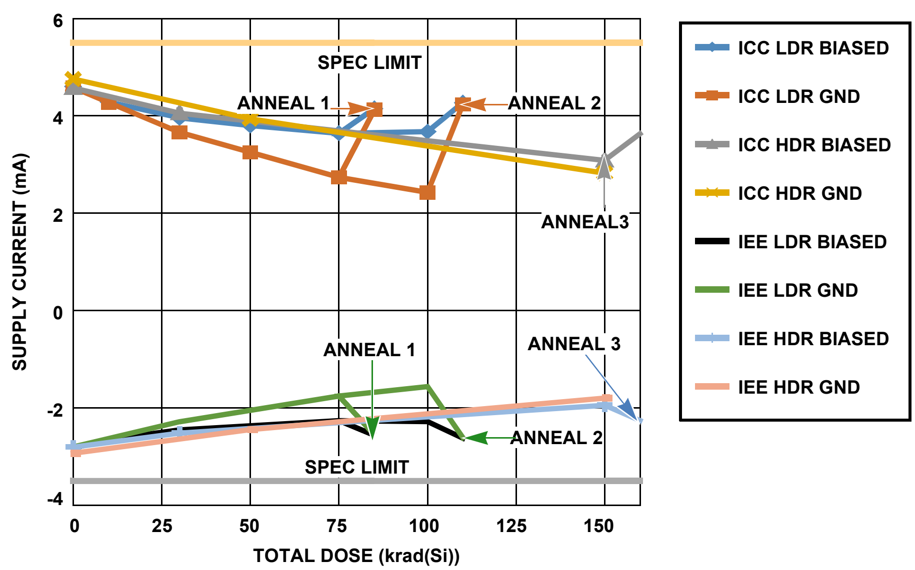

FIGURE 19. Median HS-2420EH power supply current, positive (ICC) and negative (IEE), as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limits are 5.5mA maximum (ICC) and -3.5mA minimum (IEE).

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

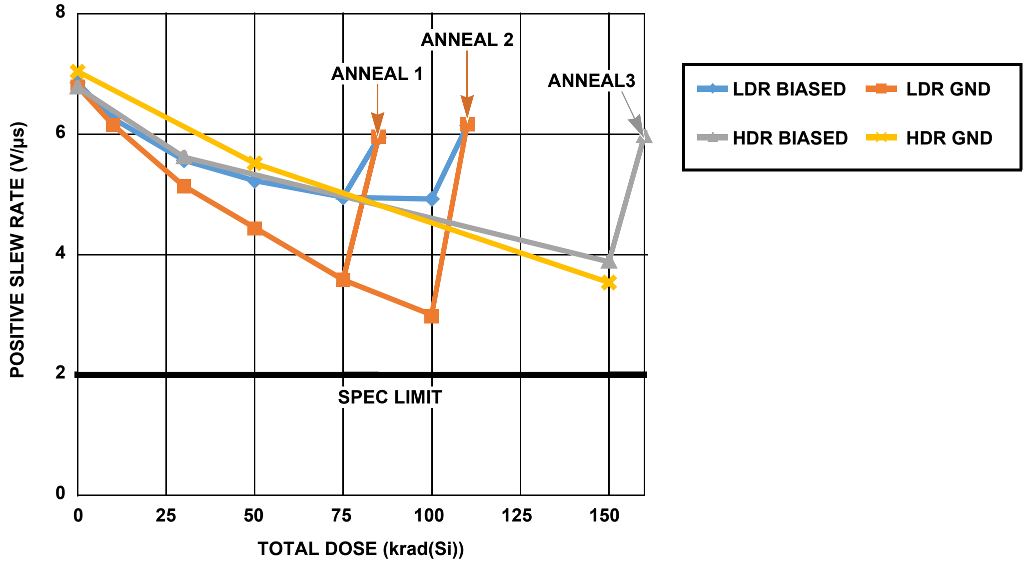

FIGURE 20. Median HS-2420EH positive slew rate as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 2V/µs minimum.

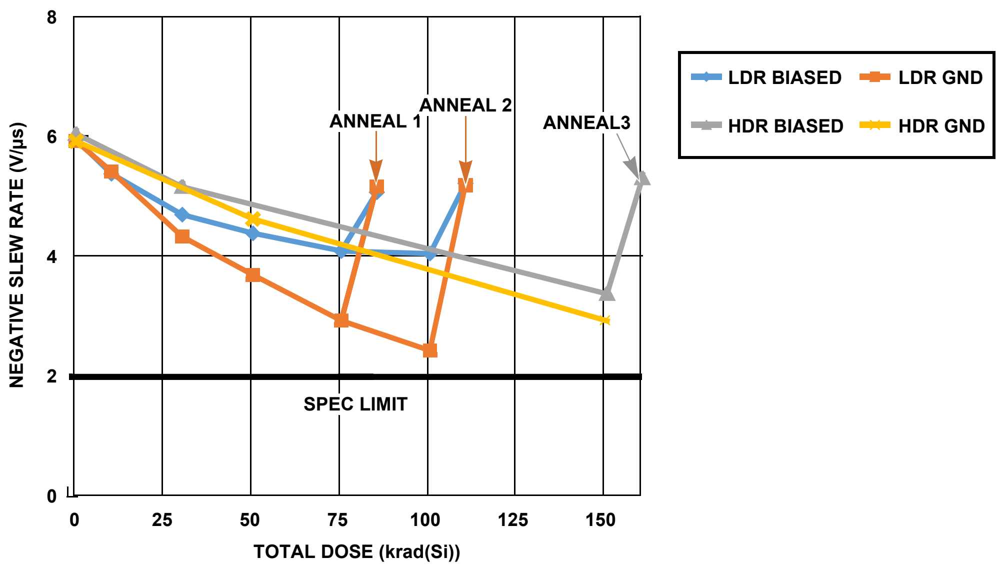

FIGURE 21. Median HS-2420EH negative slew rate as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 2V/µs minimum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

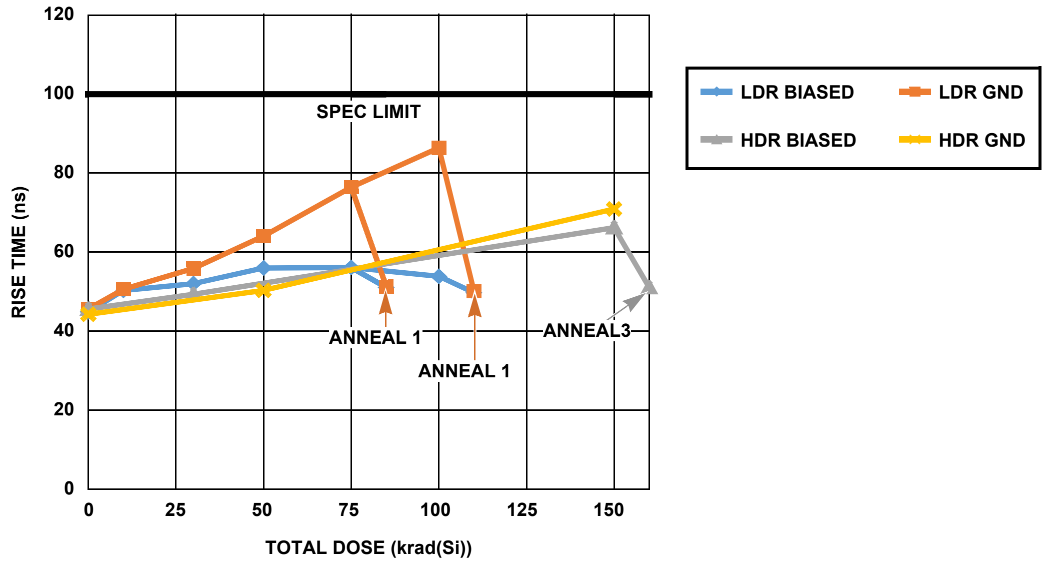

FIGURE 22. Median HS-2420EH rise time as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01 rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 100ns maximum.

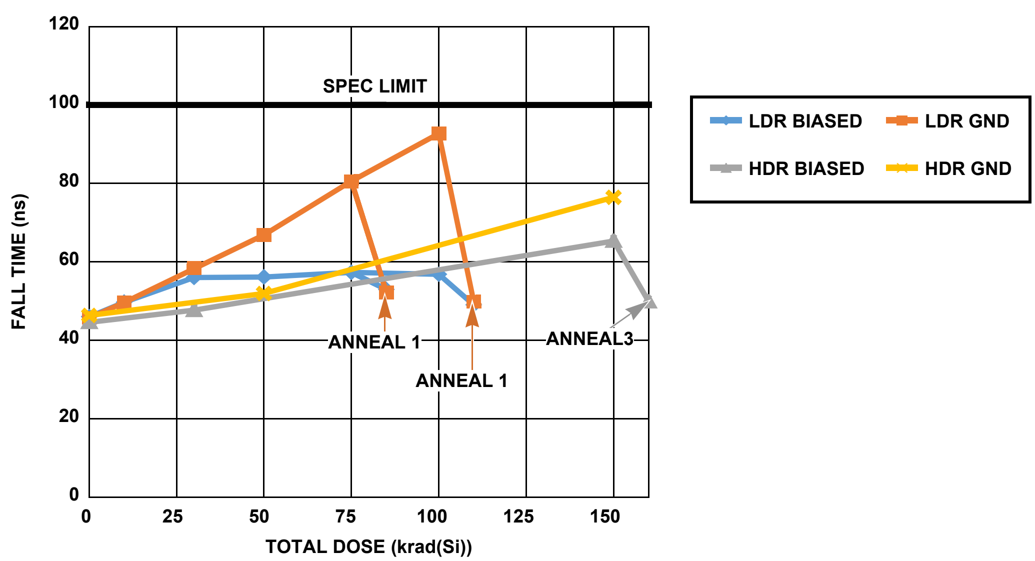

FIGURE 23. Median HS-2420EH fall time as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 100ns maximum.

Variables Data

The plots in Figures 2 through 25 show data for key SMD parameters at all downpoints. The plots show the median of the parameters as a function of low and high dose rate total dose for each of the two irradiation conditions and as a function of subsequent anneals. The plots also show the SMD post-irradiation limits for reference. A discussion of each parameter's total dose and anneal response will be presented in the following. **(Continued)**

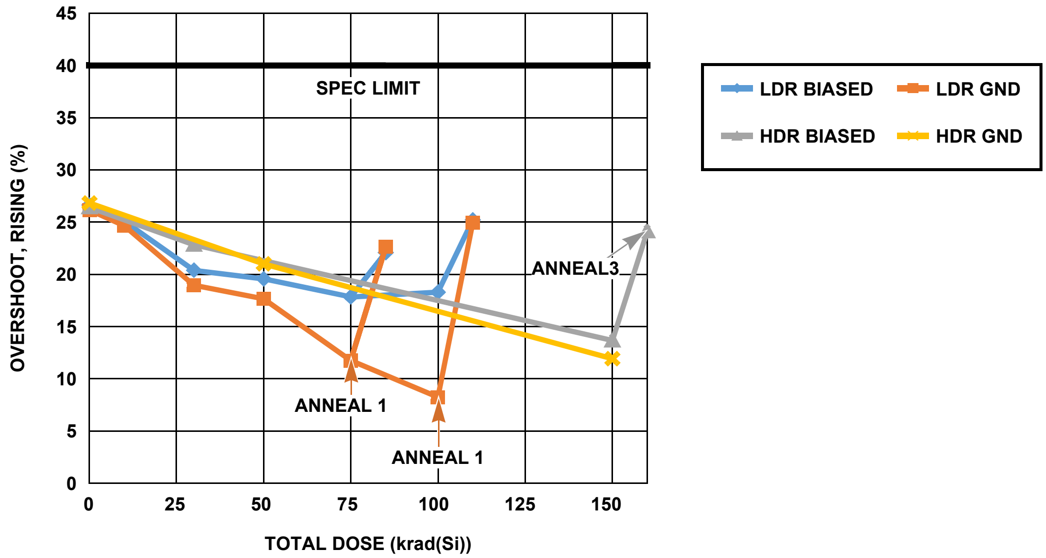

FIGURE 24. Median HS-2420EH rising overshoot as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 40% maximum.

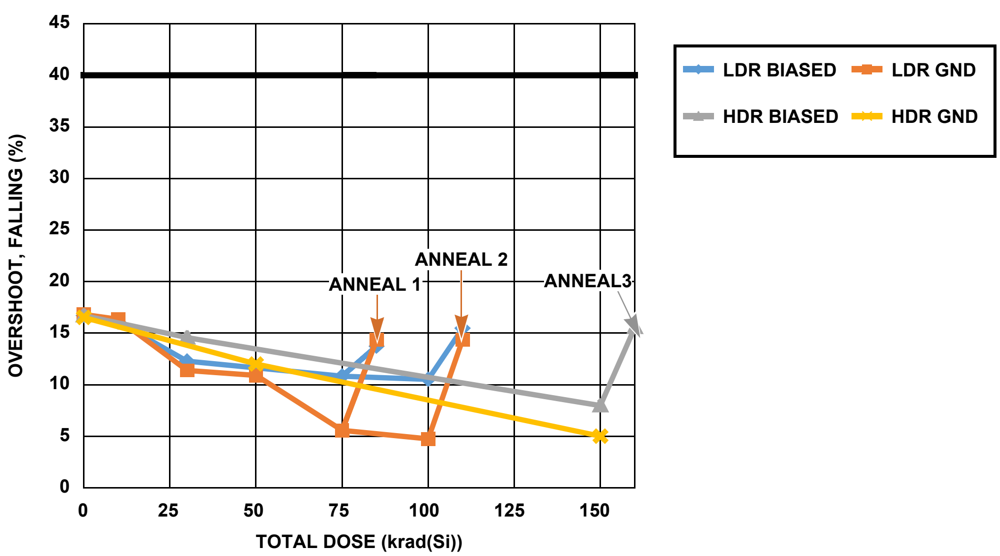

FIGURE 25. Median HS-2420EH falling overshoot as a function of total dose irradiation at low and high dose rate for the biased (per Figure 1) and unbiased (all pins grounded) cases. The dose rate was 0.01rad(Si)/s for low dose rate irradiation and 60rad(Si)/s for high dose rate irradiation. Three anneals were performed, after 75krad(Si) and 100krad(Si) at low dose rate and after 150krad(Si) at high dose rate. The sample sizes are given in Table 1. The post-irradiation SMD limit is 40% maximum.

Discussion and Conclusion

This document reports results of low and high dose rate total dose irradiation and subsequent anneals of the Intersil HS-2420EH sample/hold. Parts were tested at low and high dose rate under biased and unbiased conditions as outlined in MIL-STD-883 Test Method 1019, at 0.01rad(Si)/s and 65rad(Si)/s respectively. The low dose rate tests were run to 100krad(Si) and the high dose rate tests were run to 150krad(Si). Both the biased and grounded samples were annealed at high temperature (+100°C) under bias, with the groups split after 75krad(Si) ('Anneal 1') and 100krad(Si) ('Anneal 2'); see Table 1 on page 2. The biased high dose rate samples were subjected to a high temperature biased anneal ('Anneal 3') for 168 hours at +100°C; the grounded high dose rate samples were not annealed. No rejects to the SMD post-radiation limits were encountered at any of the downpoints.

The input offset voltage (Figure 2, on page 3) was stable over high dose rate irradiation, with considerable range at all downpoints. The parameter showed increased change over low dose rate irradiation compared to the high dose rate samples but remained within the SMD post-irradiation limits of -6mV to 6mV. The part must hence be considered low dose rate sensitive (see MIL-STD-883, TM1019, section 3.13.1.1). The annealed samples showed a considerable recovery towards the preirradiation parameter values. Grounded low dose rate irradiation was clearly worst case.

The positive and negative input bias current (Figures 3 and 4) remained within the SMD post-irradiation limits after irradiation to the SMD levels of 50krad(Si) and 100krad(Si) at low and high dose rate, respectively. The parameters were stable over low and high dose rate irradiation but showed a more pronounced increase over low dose rate while remaining well within the SMD post-irradiation limits of -400nA to 400nA. The part must again be considered low dose rate sensitive. All annealed samples showed a considerable recovery towards the preirradiation parameter values, and grounded low dose rate irradiation was again worst case.

The input offset current (Figure 5, on page 4) was very stable at both dose rates with no anneal signature.

The positive and negative open-loop gain (Figures 6 and 7) showed dose rate sensitivity but remained well within the SMD limits at both dose rates. Both parameters showed significant anneal signatures towards the pre-irradiation values.

The positive power supply rejection ratio (Figure 8, on page 6) showed an increase over both low and high dose rate irradiation and a pronounced recovery towards the pre-irradiation values over anneal. The negative common mode rejection ratio (Figure 9, on page 6) was stable at both dose rates and showed no anneal signature.

The positive and negative common mode rejection ratio (Figures 10 and 11) were stable at both dose rates and showed only moderate anneal signatures.

The low and high state input currents into the sample/hold control pin (Figures 12 and 13) showed good stability, with the LOW input current displaying some anneal response.

The drift current (Figure 14, on page 9) was very stable at both dose rates and showed no anneal signature.

The positive and negative output voltage (Figures 15 and 16) were stable at both dose rates and showed either no anneal signature or a very small response (in the case of the negative output voltage).

The sourcing output short circuit current (Figure 17, on page 10) showed a pronounced degradation after 50krad(Si) at grounded low dose rate only, with an equally pronounced recovery over anneal. The samples did remain well within the SMD limits during these changes. The other three conditions showed good stability and showed no anneal signature.

The sinking output short circuit current (Figure 19, on page 11) showed good stability and displayed no anneal signature.

The positive and negative supply currents (Figure 19) showed a gradual decrease as a function of both high and low dose rate irradiation, with some dose rate sensitivity, and also showed anneal signatures in the direction of recovery towards the preirradiation values.

The positive and negative slew rates (Figures 20 and 21) showed significant decrease as a function of both low and high dose rate irradiation but remained within the SMD post-irradiation limits, with a pronounced anneal signature recovering towards the preirradiation values. The low dose rate grounded configuration was worst case for both parameters.

The positive and negative rise time (Figures 22 and 23) showed significant increase as a function of both low and high dose rate irradiation but remained within the SMD post-irradiation limits, with a pronounced anneal signature recovering towards the preirradiation values. The low dose rate grounded configuration was again worst case for both parameters.

The rising and falling overshoot (Figures 24 and 25) showed significant decrease (which is actually a performance *improvement* but is indicative of the slew rate reductions seen in Figures 20 and 21) as a function of both low and high dose rate irradiation but remained within the SMD post-irradiation limits, with a pronounced anneal signature recovering towards the preirradiation values. The low dose rate grounded configuration was worst case for both parameters.

We conclude that the HS-2420EH shows good performance through the SMD limits of 50krad(Si) at low dose rate and after 100krad(Si) at high dose rate. The part shows low dose rate sensitivity in many of its parameters and thus must be considered low dose rate sensitive. We also observed significant differences in total dose response between biased and grounded low dose rate irradiation for any parameters, with the grounded configuration the worst case in all cases.

Appendices

TABLE 2. REPORTED PARAMETERS

FIGURE	PARAMETER	LIMIT, LOW	LIMIT, HIGH	UNIT	NOTES
2	Input offset voltage	-6	6	mV	
3	Positive input bias current	-400	400	nA	
4	Negative input bias current	-400	400	nA	
5	Input offset current	-100	100	nA	
6	Positive open loop gain	87.96	-	dB	25kV/V
7	Negative open loop gain	87.96	-	dB	25kV/V
8	Positive power supply rejection ratio	80	-	dB	
9	Negative power supply rejection ratio	80	-	dB	
10	Positive common-mode rejection ratio	80	-	dB	
11	Positive common-mode rejection ratio	80	-	dB	
12	Digital input current	-800	800	µA	0VIN
13	Digital input current	-20	20	µA	5VIN
14	Drift current	-10	10	nA	
15	Positive output voltage	10	-	V	
16	Negative output voltage	-	-10	V	
17	Output current	10	-	mA	Sourcing
18	Output current	-	-10	mA	Sinking
19	Power supply current	5.5	-3.5	mA	ICC and IEE
20	Positive slew rate	2	-	V/µs	
21	Negative slew rate	2	-	V/µs	
22	Rise time	-	100	ns	
23	Fall time	-	100	ns	
24	Overshoot	-	40	%	Rising
25	Overshoot	-	40	%	Falling

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