Unisys

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SUBJECT: Radiation Report on **AD7821 (Analog Devices) (LDC 9727)**
PROJECT: HST/COS

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A radiation evaluation was performed on **AD7821TQ/883B (5962-8951801RA) LC^{2}MOS High Speed, µP Compatible 8-Bit ADC with Track/Hold Function (Analog Devices)** to determine the total dose tolerance of these parts. The total dose testing was performed using a Co^{60} gamma ray source. During the radiation testing, eight parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The total dose radiation levels were 2.5. 5.0, 10.0, 20.0, 30.0, and 50.0kRads.[1] The average dose rate was 0.16kRads/hour (0.04Rads/s). See Table II for the radiation schedule and average dose rate calculation. After the 50.0kRad irradiation, the parts were annealed under bias at 25°C for 168 hours.[2] After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3] listed in Table III. An executive summary of the test results is provided below in bold, followed by a detailed summary of the test results after each radiation level and annealing step.

The AD7821 is capable of operating in four modes. The first mode is Read (Mode = 0) in which CS and RD are kept low until output data appears. Write-Read mode (Mode = 1) can be configured in three ways. They are $t_{RD} > t_{INTL}$ in which INT must go low before reading the data, $t_{RD} < t_{INTL}$ in which RD is brought low after the rising edge of WR to shorten conversion time, and CS = RD = 0 (stand alone operation) in which a conversion is initiated by bringing WR low. These modes appear in this order in Tables III and IV.

All parts passed all tests up to 30kRads. After the 50kRad irradiation, four parts had one Missing Code in all four Modes. One part marginally exceeded the specification limit for INL. After annealing the parts at 25°C for 168 hours, the parts showed significant recovery in Missing Codes and INL. No significant change was noted in any other parameter.

Initial electrical measurements were made on 10 samples. Eight samples (SN's 3, 4, 5, 6, 7, 8, 9, and 10) were used as radiation samples while SN's 1 and 2 were used as control samples. All parts passed all tests during initial electrical measurements.

All parts passed all tests up to 30.0kRads.

After the 50kRad irradiation, SN's 4, 6, 7, and 9 had one Missing Code in RD Mode and all three WR-RD Modes. SN 6 marginally exceeded the specification limit of 1.00lsb for INL WR-RD Mode 1 with a reading of 1.01lsb. **All parts passed all other tests.**

After annealing the parts for 168 hours at 25°C, SN 6 recovered in INL. The parts also showed some recovery in Missing Codes. SN 4 had a Missing Code in WR-RD Modes 2 and 3, SN 6 had a missing code in WR-RD Mode 3 and SN 9 had a Missing Code in RD and WR-RD Modes 1 and 3. No significant change was noted in any other parameter.

[1] The term Rads, as used in this document, means Rads (silicon). All radiation levels cited are cumulative.
[2] The temperature 25°C as used in this document implies room temperature.
[3] These are manufacturer's pre-irradiation data specification limits. The manufacturer provided no post-irradiation specification limits or radiation tolerance guarantees at the time these tests were performed.

Table IV provides a summary of the test results with the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Any further details about this evaluation can be obtained upon request. If you have any questions, please call us at (301) 731-8954.

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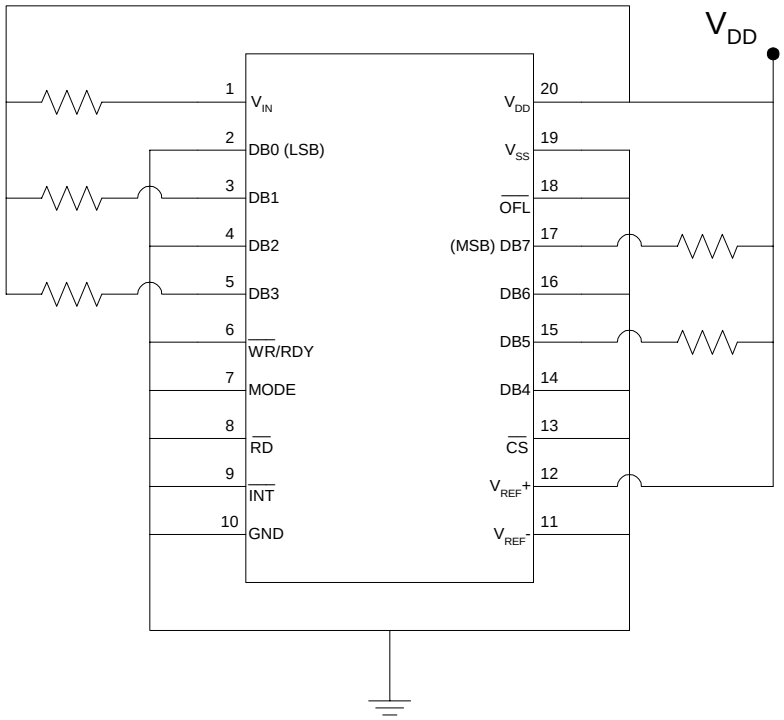
Figure 1. Radiation Bias Circuit for AD7821



Notes:
1. V_{DD} = 5.0V ±0.5V.
2. R = 2kΩ, 5%, ½W.

TABLE I. Part Information

Generic Part Number:	AD7821TQ/883B
HST/COS Part Number	5962-8951801RA
HST/COS TID Requirement	10kRads (RDM = 5)
Charge Number:	C00175
Manufacturer:	Analog Devices
Lot Date Code (LDC):	9727
Quantity Tested:	10
Serial Numbers of Control Samples:	1, 2
Serial Numbers of Radiation Samples:	3, 4, 5, 6, 7, 8, 9, 10
Part Function:	LC^2MOS High Speed, ADC w/ Track/Hold Function
Part Technology:	LC^2MOS
Package Style:	20 Pin DIP
Test Equipment:	A540
Test Engineer:	S. Archer-Davies

- The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II. Radiation Schedule for AD7821

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	12/13/99
2) 2.5 KRAD IRRADIATION (0.147 KRADS/HOUR)	12/15/99
POST-2.5 KRAD ELECTRICAL MEASUREMENT	12/16/99
3) 5.0 KRAD IRRADIATION (0.147 KRADS/HOUR)	12/16/99
POST-5.0 KRAD ELECTRICAL MEASUREMENT	12/17/99
4) 10.0 KRAD IRRADIATION (0.076 KRADS/HOUR)	12/17/99
POST-10.0 KRAD ELECTRICAL MEASUREMENT	12/20/99
5) 20.0 KRAD IRRADIATION (0.151 KRADS/HOUR)	12/20/99
POST-20.0 KRAD ELECTRICAL MEASUREMENT	12/23/99
6) 30.0 KRAD IRRADIATION (0.112 KRADS/HOUR)	12/23/99
POST-30.0 KRAD ELECTRICAL MEASUREMENT	12/27/99
7) 50.0 KRAD IRRADIATION (0.476 KRADS/HOUR)	12/27/99
POST-50.0 KRAD ELECTRICAL MEASUREMENT	12/30/99
8) 168 HOUR ANNEALING @25°C	12/30/99
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/05/00

Average Dose Rate = 50,000 RADS/313 HOURS=159.7 RADS/HOUR=0.04RADS/SEC

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS, SEE FIGURE 1.

Table III. Electrical Characteristics AD7821 (1)

Test #	Parameter	Units	Spec. Limit min	Spec. Limit max	Test Conditions (2)
	Read Mode				
100	Missing Codes			1	
101	INL (3)	lsb		1.00	
102	DNL (3)	lsb		1.00	
	Write-Read Mode 1 ($t_{RD} > t_{INTL}$)				t_{RD} = 250ns, t_{READ2} = 65ns, t_{ACC2} = 65ns
103	Missing Codes			1	
104	INL	lsb		1.00	
105	DNL	lsb		1.00	
	Write-Read Mode 2 ($t_{RD} < t_{INTL}$)				t_{RD} = 250ns, t_{READ1} = 160ns, t_{ACC1} = 160ns
106	Missing Codes			1	
107	INL	lsb		1.00	
108	DNL	lsb		1.00	
	Write-Read Mode 3 (CS =RW = 0)				t_{RD} = 250ns, $t_{INTL} + t_{ID}$ = 530ns
109	Missing Codes			1	
110	INL	lsb	-1.00	1.00	
111	DNL	lsb	-1.00	1.00	
	Parametric Tests				
200	wr_rdy IIL	µA	-1.00	1.00	CS, WR, RD and Mode inputs
201	mode IIL	µA	-1.00	1.00	CS, WR, RD and Mode inputs
202	rd IIL	µA	-1.00	1.00	CS, WR, RD and Mode inputs
203	cs IIL	µA	-1.00	1.00	CS, WR, RD and Mode inputs
205	wr_rdy IIH	µA	-1.00	3.00	WR input, V_{IH} = 5.25V, V_{IL} = 0V
206	mode IIH	µA	-1.00	200	Mode input, V_{IH} = 5.25V, V_{IL} = 0V
207	rd IIH	µA	-1.00	1.00	CS and RD inputs, V_{IH} = 5.25V, V_{IL} = 0V
208	cs IIH	µA	-1.00	1.00	CS and RD inputs, V_{IH} = 5.25V, V_{IL} = 0V
300-309	Voh	V	4.0		DB0-DB7, OFL, and INT outputs, I_{SOURCE} = -360µA
310-319	Vol	mV		400	DB0-DB7, OFL, and INT outputs, I_{SINK} = 1.6mA
400-407	Iozh	µA	-3.00	3.00	
450-457	Iozl	µA	-3.00	3.00	
500	IDD	mA	0	15.0	CD = RD = 0V
501	ISS	µA	-100	0	CS = RD = 0V
502	Power_Cons	mW		100	
600	Conversion Time	ns		700	

Notes:

(1) These are the manufacturer's non-irradiated data sheet specification limits. The manufacturer provided no post-irradiation limits at the time the tests were performed.
(2) V_{DD} = +5.0V, V_{REF+} = -5.0V, V_{REF-} = V_{SS} = GND = 0V, unless otherwise specified.
(3) INL = Integral Non-Linearity, DNL = Differential Non-Linearity.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD7821 (1)

Test #	Parameters	Units	Spec. Lim. (2) min	Spec. Lim. (2) max	Initial mean	Initial sd	Total Dose Exposure (kRads Si) 2.5 mean	2.5 sd	5.0 mean	5.0 sd	10.0 mean	10.0 sd	20.0 mean	20.0 sd	30.0 mean	30.0 sd	50.0 mean	50.0 sd	Annealing 168 hours @25°C mean	Annealing 168 hours @25°C sd
Read Mode																				
100	Missing Codes (3)			1	P		P		P		P		P		P		4P/4F		7P/1F	
101	INL	lsb		1.00	0.50	0.08	0.50	0.09	0.53	0.09	0.55	0.10	0.62	0.09	0.61	0.11	0.82	0.14	0.71	0.15
102	DNL	lsb		1.00	0.36	0.11	0.34	0.09	0.37	0.10	0.37	0.06	0.38	0.09	0.37	0.11	0.42	0.12	0.41	0.16
Write-Read Mode 1																				
103	Missing Codes			1	P		P		P		P		P		P		4P/4F		7P/1F	
104	INL	lsb		1.00	0.52	0.10	0.53	0.10	0.55	0.10	0.60	0.08	0.63	0.09	0.64	0.11	0.81	0.15	0.72	0.17
105	DNL	lsb		1.00	0.37	0.08	0.37	0.08	0.40	0.08	0.38	0.04	0.43	0.06	0.41	0.11	0.42	0.10	0.44	0.16
Write-Read Mode 2																				
106	Missing Codes			1	P		P		P		P		P		P		4P/4F		7P/1F	
107	INL	lsb		1.00	0.51	0.08	0.52	0.09	0.55	0.08	0.59	0.10	0.65	0.10	0.64	0.08	0.80	0.15	0.73	0.14
108	DNL	lsb		1.00	0.36	0.09	0.36	0.11	0.36	0.09	0.38	0.07	0.44	0.05	0.37	0.09	0.39	0.08	0.36	0.09
Write-Read Mode 3																				
109	Missing Codes			1	P		P		P		P		P		P		4P/4F		5P/3F	
110	INL	lsb	-1.00	1.00	0.51	0.07	0.52	0.08	0.53	0.10	0.56	0.08	0.64	0.09	0.66	0.12	0.81	0.15	0.75	0.16
111	DNL	lsb	-1.00	1.00	0.36	0.06	0.37	0.08	0.39	0.06	0.40	0.05	0.45	0.09	0.45	0.17	0.43	0.12	0.38	0.13
Parametric Tests																				
200	wr_rdy IIL	mA	-1.00	1.00	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
201	mode IIL	mA	-1.00	1.00	0.47	0.01	0.46	0.01	0.46	0.01	0.46	0.01	0.45	0.01	0.45	0.01	0.44	0.01	0.42	0.01
202	rd IIL	mA	-1.00	1.00	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
203	cs IIL	mA	-1.00	1.00	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
205	wr_rdy IIH	mA	-1.00	3.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01
206	mode IIH	mA	-1.00	200	44	0.5	43	0.7	43	0.7	43	1.0	42	1.0	42	1.0	43	0.9	39	1.4
207	rd IIH	mA	-1.00	1.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
208	cs IIH	mA	-1.00	1.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
300-309	Voh	V	4.0		5.0	0	5.0	0	5.0	0	5.0	0	5.0	0	5.0	0	5.0	0	5.0	0
310-319	Vol	mV		400	68	2.8	67	2.6	66	2.1	68	1.7	68	2.0	70	1.2	72	2.4	73	1.7
400-407	Iozh	mA	-3.00	3.00	0.2	0	0.2	0	0.2	0	0.2	0	0.2	0	0.2	0	0.2	0	0.2	0
450-457	Iozl	mA	-3.00	3.00	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0
500	IDD	mA	0	15.0	12.5	0.2	12.3	0.2	12.2	0.2	11.6	0.2	10.9	0.2	9.8	0.1	8.7	0.2	8.2	0.1
501	ISS	mA	-100	0	-14	5.2	-15	4.0	-16	2.9	-17	4.3	-16	5.1	-15	4.6	-16	3.3	-16	6.1
502	Power_Cons	mW		100	65	1.2	65	1.2	64	1.2	61	1.1	57	0.9	51	0.7	46	0.9	43	0.8
600	Conversion Time	ns		700	602	3	601	3	602	3	593	2	582	2	557	1	518	4	509	4

Notes:

(1) The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout testing and are not inclu

(2)

(3) P implies that all parts passed this test at this level, nP/mF implies that n parts passed and m parts failed this test at this level.

Radiation sensitive parameters: Missing Codes (all), INL (W-R Mode 1).