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DATE: January 31, 1994
TO: S. Pszczolka/311.1
FROM: K. Sahu/300.1
SUBJECT: Radiation Report on ISTP/SOHO/CELIAS
Part No. AD7672UQ05/8838 (AD7672)
Control No. 8792A

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on AD7672 (A-D Converter) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a cobalt-60 gamma ray source. During the radiation testing, two parts were irradiated under bias (see Figure 1 for bias configuration), and one part was used as a control sample. The total dose radiation levels were 2, 5, 10, 15, 20 and 50 krads*. The dose rate was between 0.08 and 1.58 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 50 krad irradiation, parts were annealed at 25°C for 168 hours, after which the parts were annealed at 100°C for 168 hours. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits listed in Table III.

All parts passed initial electrical measurements. Both irradiated parts passed all parametric tests up to and including the 2 krad irradiation level. At the 5 krad level, S/N 12 marginally exceeded the maximum specification limit of 5.2 uA for Conv. time, with a reading of 5.6 uA. At the 10 krad level, both parts failed Conv. time and also exceeded the maximum specification limit of 10 uA for DBO-11 ioh, with readings around the 50 uA level. At the 15 krad level, these failures continued and in addition, both parts also exceeded the maximum specification limit of 10 uA for DBO-11 iol, with readings around 20-30 uA. At 20 krads, both parts failed to meet the minimum specification limit of 4 V for DBO-11 voh, with readings of -0.02 V, and exceeded the maximum specification limit of 400 mV for DBO-11 vol, with readings of 2050 mV. In addition, both parts also began missing codes at the 20 krad level, and exceeded the maximum specification limit of 7 mA for IDD, with readings of 9.3 and 10.5 mA. All of these failures continued at the 50 krad level.

After annealing for 168 hours at 25°C and annealing for 168 hours at 100°C, virtually no recovery was observed.

Table IV provides the values for each parameter after different irradiation exposures and annealing steps. Individual values for DBO-11 voh and vol and DBO-11 ioh and iol are not given, but are available on request.

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

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

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TABLE I. Part Information

Generic Part Number:	AD7672
ISTP/SOHO/CELIAS Part Number:	AD7672UQ05/8838*
ISTP/SOHO/CELIAS Control Number:	8792A
Charge Number:	C33674
Manufacturer:	Analog Devices
Lot Date Code:	C9132
Quantity Tested:	3
Serial Number of Control Sample:	11
Serial Numbers of Radiation Samples:	12, 13
Part Function:	A-D Converter
Part Technology:	CMOS
Package Style:	24-pin DIP
Test Equipment:	Teradyne A540
Test Engineer:	C. Nguyen

* No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

TABLE II. Radiation Schedule for AD7672

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	12/14/93
2) 2 KRAD IRRADIATION (0.12 KRADS/HOUR)	12/14/93
POST-2 KRAD ELECTRICAL MEASUREMENT	12/15/93
3) 5 KRAD IRRADIATION (0.15 KRADS/HOUR)	12/15/93
POST-5 KRAD ELECTRICAL MEASUREMENT	12/16/93
4) 10 KRAD IRRADIATION (0.26 KRADS/HOUR)	12/16/93
POST-10 KRAD ELECTRICAL MEASUREMENT	12/17/93
5) 15 KRAD IRRADIATION (0.08 KRADS/HOUR)	12/17/93
POST-15 KRAD ELECTRICAL MEASUREMENT	12/20/93
6) 20 KRAD IRRADIATION (0.26 KRADS/HOUR)	12/21/93
POST-20 KRAD ELECTRICAL MEASUREMENT	12/21/93
7) 50 KRAD IRRADIATION (1.58 KRADS/HOUR)	12/21/93
POST-50 KRAD ELECTRICAL MEASUREMENT	12/22/93
8) 168-HOUR ANNEALING @25°C	12/21/93
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/04/94
9) 168-HOUR ANNEALING @100°C**	01/04/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/11/94

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

*High temperature annealing is performed to accelerate long term time dependent effects (TDE), namely, the "rebound" effect due to the growth of interface states after the radiation exposure. For more information on the need to perform this test, refer to MIL-STD-883D, Method 1019, Para. 3.10.1.

Table III. Electrical Characteristics of AD7672

Vdd = 5v Vss = -12v Vref =-5.0v unless otherwise specified

#	Test name	Sequencer	min limit	max limit	Conditions
1	IDD	isupply	0.00 ma	7.00 ma	CS=RD=Vdd, AIN1=AIN2=5v
2	ISS	isupply	-12.00 ma	0.00 ma	CS=RD=Vdd, AIN1=AIN2=5v
3	Pd	isupply		179.0 mW	
4	RD_ iil	in_leak	-10.00 ua	10.00 ua	Vil = 0.8v
5	CS_ iil	in_leak	-10.00 ua	10.00 ua	Vil = 0.8v
6	CLKIN iil	in_leak	-20.00 ua	20.00 ua	Vil = 0.8v
7	RD_ iih	in_leak	-10.00 ua	10.00 ua	Vih = 2.4v
8	CS_ iih	in_leak	-10.00 ua	10.00 ua	Vih = 2.4v
9	CLKIN iih	in_leak	-20.00 ua	20.00 ua	Vih = 2.4v
10	REFIN_i	vref_i	-3.00 ua	0.00 ua	Vref = -5v
11	DB11 voh	voh	4.00 v		Isource = 200ua
12	DB10 voh	voh	4.00 v		Isource = 200ua
13	DB9 voh	voh	4.00 v		Isource = 200ua
14	DB8 voh	voh	4.00 v		Isource = 200ua
15	DB7 voh	voh	4.00 v		Isource = 200ua
16	DB6 voh	voh	4.00 v		Isource = 200ua
17	DB5 voh	voh	4.00 v		Isource = 200ua
18	DB4 voh	voh	4.00 v		Isource = 200ua
19	DB3 voh	voh	4.00 v		Isource = 200ua
20	DB2 voh	voh	4.00 v		Isource = 200ua
21	DB1 voh	voh	4.00 v		Isource = 200ua
22	DB0 voh	voh	4.00 v		Isource = 200ua
23	DB11 vol	vol		400 mv	Isink = 1.6ma
24	DB10 vol	vol		400 mv	Isink = 1.6ma
25	DB9 vol	vol		400 mv	Isink = 1.6ma
26	DB8 vol	vol		400 mv	Isink = 1.6ma
27	DB7 vol	vol		400 mv	Isink = 1.6ma
28	DB6 vol	vol		400 mv	Isink = 1.6ma
29	DB5 vol	vol		400 mv	Isink = 1.6ma
30	DB4 vol	vol		400 mv	Isink = 1.6ma
31	DB3 vol	vol		400 mv	Isink = 1.6ma
32	DB2 vol	vol		400 mv	Isink = 1.6ma
33	DB1 vol	vol		400 mv	Isink = 1.6ma
34	DB0 vol	vol		400 mv	Isink = 1.6ma
35	BUSY voh	vo_BC	4.00 v		Isource = 200ua
36	CLK voh	vo_BC	4.00 v		Isource = 200ua
37	BUSY vol	vo_BC		400 mv	Isink = 1.6ma
38	CLK vol	vo_BC		400 mv	Isink = 1.6ma

Table III. Electrical Characteristics of AD7672 (cont.)

Vdd = 5v Vss = -12v Vref =-5.0v unless otherwise specified

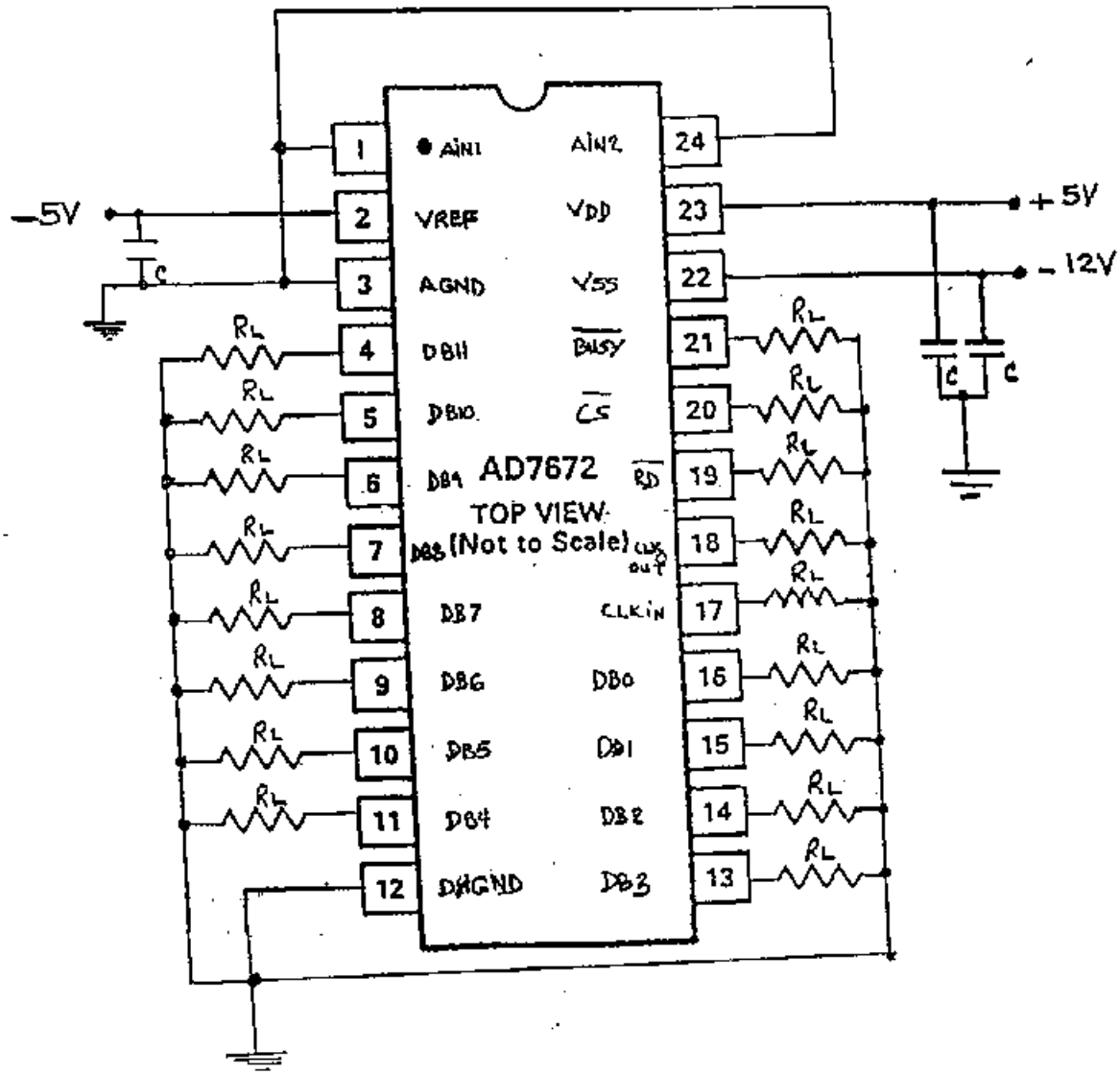
#	Test name	Sequencer	min limit	max limit	Conditions
39	DB11 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
40	DB10 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
41	DB9 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
42	DB8 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
43	DB7 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
44	DB6 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
45	DB5 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
46	DB4 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
47	DB3 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
48	DB2 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
49	DB1 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
50	DB0 iol	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=0v
51	DB11 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
52	DB10 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
53	DB9 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
54	DB8 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
55	DB7 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
56	DB6 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
57	DB5 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
58	DB4 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
59	DB3 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
60	DB2 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
61	DB1 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
62	DB0 ioh	out_leak	-10.00 ua	10.00 ua	CS=RD=Vdd, vtest=5v
63	Unipolar_il	analog_curr		3.500 ma	Unipolar, Vin = 0v
64	Unipolar_ih	analog_curr		3.500 ma	Unipolar, Vin =10v
65	Bipolar_il	analog_curr	-1.750 ma	1.750 ma	Bipolar, Vin =-5v
66	Bipolar_ih	analog_curr	-1.750 ma	1.750 ma	Bipolar, Vin =+5v
67	Missing codes	linearity		0.000	Bipolar, Vin = +/-5v
68	DNL	linearity	-0.90000	0.90000	Bipolar, Vin = +/-5v
69	INL	linearity	-0.50000	0.50000	Bipolar, Vin = +/-5v
70	Conv. time	tconv	4.800 us	5.200 us	Asyn. fCLK = 2.5Mhz
71	RD_BUSY delay	tconv	0.0 ns	230.0 ns	RD to Busy prop. time

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for AD7672*

Parameters		Spec. Lim.** min	Spec. Lim.** max	Initials S/N 12	Initials S/N 13	Total Dose Exposure (krads) 2 S/N 12	2 S/N 13	5 S/N 12	5 S/N 13	10 S/N 12	10 S/N 13	15 S/N 12	15 S/N 13	20 S/N 12	20 S/N 13	50 S/N 12	50 S/N 13	Annealing 168 hrs @25°C S/N 12	Annealing 168 hrs @25°C S/N 13	Annealing 168 hrs @100°C S/N 12	Annealing 168 hrs @100°C S/N 13
IDD	mA	0	7	2.87	3.03	2.87	3.02	2.94	3.08	3.12	3.24	4.62	4.97	6.27	6.47	6.64	7.21	6.73	7.50	7.52	8.35
ISS	mA	-12	0	-6.73	-7.01	-6.75	-7.28	-6.80	-7.07	-6.86	-7.09	-6.85	-7.11	-6.91	-7.15	-7.10	-7.35	-7.04	-7.29	-7.02	-7.25
Pd	mW		179	95.0	99.3	95.4	102.4	96.4	100.2	97.9	101.2	105.4	110.2	129.2	138.1	118.4	124.3	118.2	124.9	121.8	128.9
RD_ iil	µA	-10	10	-2.94	-2.75	-2.90	-2.75	-2.97	-2.83	-3.23	-3.01	-3.50	-3.35	-4.04	-3.86	-7.08	-6.80	-6.93	-6.60	-6.65	-6.36
CS_ iil	µA	-10	10	-0.18	-0.21	-0.21	-0.20	-0.22	-0.18	-0.22	-0.21	-0.19	-0.22	-0.18	-0.21	-0.23	-0.23	-0.22	-0.20	-0.21	-0.21
CLKIN iil	µA	-20	20	-0.24	-0.21	-0.19	-0.19	-0.17	-0.21	-0.20	-0.24	-0.21	-0.21	-0.15	-0.19	-0.16	-0.16	-0.20	-0.25	-0.23	-0.19
RD_ iih	µA	-10	10	1.97	1.88	2.09	2.02	2.39	2.30	3.04	2.90	3.60	3.43	4.33	4.13	-2.82	-2.68	-2.71	-2.58	-2.56	-2.47
CS_ iih	µA	-10	10	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.06	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.04	0.04
CLKIN iih	µA	-20	20	0.05	0.05	0.05	0.06	0.05	0.05	0.05	0.04	0.05	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.04	0.05
REFIN_i	µA	-3	0	-0.23	-0.23	-0.30	-0.27	-0.27	-0.27	-0.28	-0.25	-0.28	-0.17	-0.28	-0.19	-0.28	-0.23	-0.27	-0.19	-0.27	-0.23
DB0-11 voh***	V	4		PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	5P7F	8P4F	5P7F	8P4F	5P7F	8P4F	5P7F	8P4F
DB0-11 vol***	mV		400	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	7P5F	4P8F	7P5F	4P8F	7P5F	4P8F	7P5F	4P8F
BUSY voh	V	4		4.99	4.98	4.99	4.99	4.99	4.99	4.96	4.96	4.63	4.66	0.01	0.00	-0.00	-0.01	-0.00	-0.01	-0.00	0.03
CLK voh	V	4		4.97	4.96	4.97	4.97	4.96	4.96	4.96	4.96	4.96	4.96	4.91	4.89	4.91	4.88	4.91	4.86	4.91	4.89
BUSY vol	mV		400	66	67	66	66	61	62	58	59	54	53	50	54	42	43	42	42	43	51
CLK vol	mV		400	122	135	130	134	127	129	128	128	139	131	164	169	2050	2050	2050	2050	2050	2050
DB0-11 iol***	µA	-10	10	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	5P7F	8P4F	10P2F	7P5F	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
DB0-11 ioh***	µA	-10	10	PASS	PASS	PASS	PASS	PASS	PASS	5P7F	8P4F	5P7F	8P4F	5P7F	7P5F	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
Unipolar_il	mA		3.5	-0.85	0.156	0.153	0.155	0.153	0.155	0.151	0.156	0.158	0.155	0.150	0.155	0.150	0.155	0.151	0.156	0.150	0.155
Unipolar_ih	mA		3.5	1.856	1.896	1.858	1.896	1.858	1.898	1.859	1.899	1.861	1.898	1.859	1.899	1.858	1.898	1.859	1.898	1.863	1.902
Bipolar_il	mA	-1.75	1.75	-0.85	0.86	0.85	0.86	0.85	0.86	0.85	0.86	0.84	0.87	0.85	0.86	0.85	0.85	0.85	0.87	0.85	0.87
Bipolar_ih	mA	-1.75	1.75	0.856	0.873	0.855	0.874	0.856	0.874	0.856	0.876	0.860	0.875	0.858	0.875	0.855	0.875	0.858	0.876	0.858	0.876
Missing Codes			0	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
DNL	sb	-900	900	.41	.37	.39	.39	.42	.41	.42	.39	.72	.56	124	124	124	124	124	124	124	124
INL	sb	-500	500	.59	.58	.61	.58	.57	.58	.56	.55	.75	.72	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1
Conv. time	µs	4.8	5.2	5.044	5.046	5.043	5.045	5.605	5.054	5.604	5.599	5.601	5.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
RD_BUSY delay	ns	0	230	165.4	173.8	170.6	173.5	163.2	161.3	152.3	160.1	141.1	141.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*Failures are indicated by shaded cells.
**These are manufacturers' non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.
***"PASS" in this column means that the part passed all tests in this series. "FAIL" means that the part failed all tests in the series. "nPmF" means that the part passed n tests and failed m tests in the series. Data for individual tests in each series are available on request.

Figure 1. Radiation Bias Circuit for AD7672



R_L = 2 KΩ, ±10%, 1/4W
C = 0.1 uF