

UNISYS

DATE: December 15, 1996
 TO: J. Lohr/311.1
 FROM: K. Sahu/300.1 *KS*
 SUBJECT: Radiation Report on: DG201
 Project: ASTRO-E/XDS
 Control #: 15404
 Job #: EF62006

PPM-97-003

cc: A. Sharma/311
 OFA Library/300.1

A radiation evaluation was performed on DG201 (Quad Analog Switch) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Figure 1 and Tables I through IV.

The total dose testing was performed using a Co⁶⁰ gamma ray source. During the radiation testing, four 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 1, 3, 5, 10, 20, 50 and 100 krad^s. The dose rate was between 60 and 1760 rads/hour, depending on the total dose level (see Table II for radiation schedule). After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits^{**} listed in Table III.

All parts passed all initial electrical tests. All parts passed all electrical tests after the 1 krad irradiation.

After the 3 krad irradiation, S/N 196 exceeded the maximum specification limit of 500 ns for D1_{toff}, D2_{toff}, D3_{toff} and D4_{toff}, with readings of 537.0, 550.7, 556.1 and 554.1 ns, respectively. All irradiated parts continued to pass all other electrical tests at this level.

After the 5 krad irradiation, the same degradation continued to be observed in S/N 196, with readings ranging from 703.7 to 741.5 ns. All irradiated parts continued to pass all other electrical tests at this level.

After the 10 krad irradiation, the same degradation continued to be observed in S/N 196, with readings ranging from 1230.9 to 1347.7 ns. In addition, S/N 197 also exceeded the maximum specification limit for D1_{toff}, D2_{toff}, D3_{toff} and D4_{toff}, with readings of 598.1, 592.5, 575.0 and 576.3 ns, respectively. All irradiated parts continued to pass all other electrical tests at this level.

After the 10 krad irradiation, the parts were annealed for 96 hours at 25°C. After this anneal, no significant recovery was found in any of the irradiated parts.

After the 20 krad irradiation, all parts showed very significant increase in degradation for the all switching time parameters. The readings for switching times varied from 500 to 8000 ns. All irradiated parts continued to pass all other electrical tests at this level.

On continued irradiation to 50 and 100 krad^s, parts failed to switch on and off appropriately, indicating functional failures of the parts. Parts also showed significant increases in Rds.

* The term rads, as used in this document, means rads(SiO₂). All consecutive annealing times at the same temperature and all radiation levels cited are cumulative.

** These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

On annealing the parts at 25°C for 336 hours, parts showed some recovery but most parts continued to fail most of the timing parameters very significantly.

No rebounds effects were observed on annealing the parts for 168 hours at 100°C.

No significant degradation was observed in any other parameter throughout all irradiation steps.

Table IV provides mean and standard deviation values for each parameter initially and after each irradiation exposure.

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

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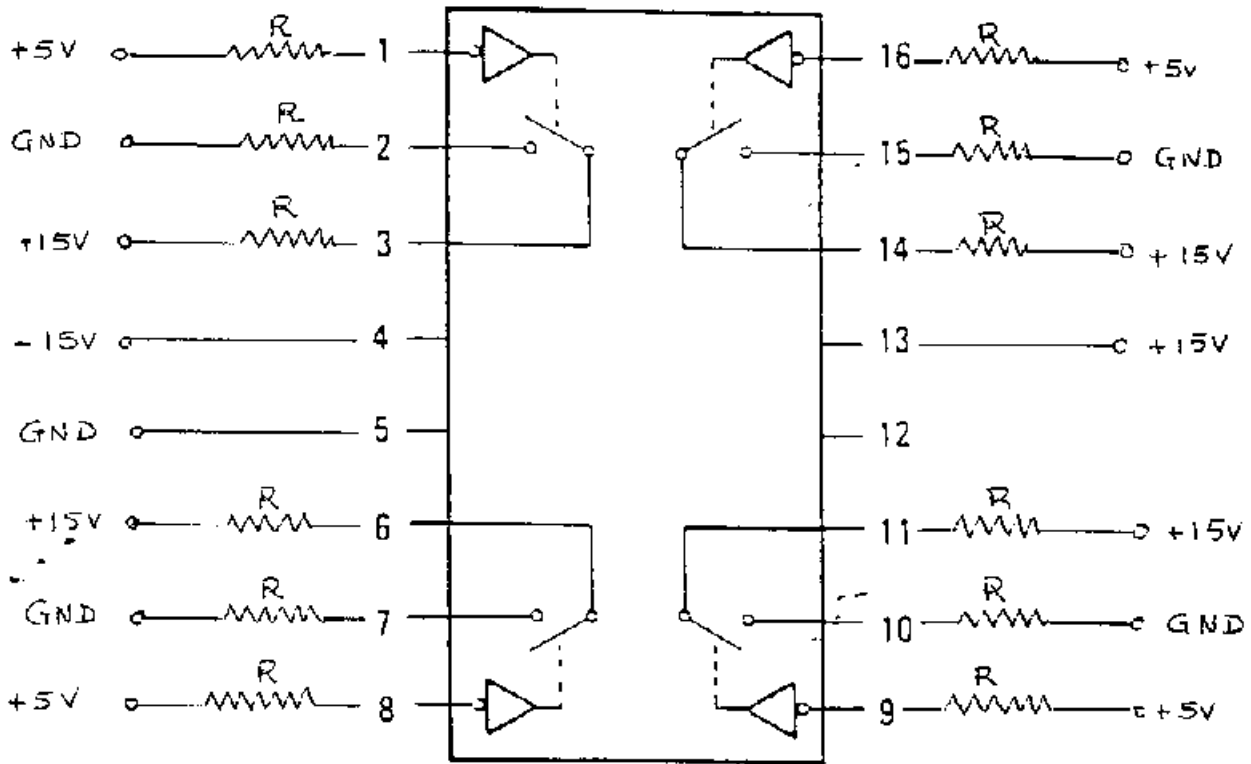
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Figure 1. Radiation Bias Circuit for DG201

PART NO: DG201AAL

HI1-201-X
TOP VIEW



$R = 10K \Omega$

FIGURE 1.. RADIATION BIAS CIRCUIT

TABLE 1. Part Information

Generic Part Numbers:	DG201
ASTRO-E/XDS Part Number	5962-7705301FA
ASTRO-E/XDS Control Number:	15404
Charge Number:	EE62006
Manufacturer:	Phillips
Lot Date Code (I.D.C):	9514
Quantity Tested:	6
Serial Number of Control Sample:	195
Serial Numbers of Radiation Samples:	196, 197, 198, 199
Part Function:	Quad Analog Switch
Part Technology:	Bipolar
Package Style:	16-pin DIP
Test Equipment:	A540
Engineer:	A. Duvalsaint

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

TABLE II. Radiation Schedule for DG201

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	11/02/96
2) 1 KRAD IRRADIATION* (0.06 KRADS/HOUR).....	11/04/96
POST-1 KRAD ELECTRICAL MEASUREMENT	11/05/96
3) 3 KRAD IRRADIATION (0.12 KRADS/HOUR).....	11/05/96
POST-3 KRAD ELECTRICAL MEASUREMENT.....	11/06/96
4) 5 KRAD IRRADIATION (0.12 KRADS/HOUR).....	11/06/96
POST-5 KRAD ELECTRICAL MEASUREMENT.....	11/07/96
5) 10 KRAD IRRADIATION (0.29 KRADS/HOUR).....	11/07/96
POST-10 KRAD ELECTRICAL MEASUREMENT.....	11/08/96
6) 96-HOUR ANNEALING @25°C.....	11/08/96
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT.....	11/12/96
7) 20 KRAD IRRADIATION (0.59 KRADS/HOUR).....	11/12/96
POST-20 KRAD ELECTRICAL MEASUREMENT.....	11/13/96
8) 50 KRAD IRRADIATION (1.76 KRADS/HOUR).....	11/13/96
POST-50 KRAD ELECTRICAL MEASUREMENT.....	11/14/96
9) 100 KRAD IRRADIATION (0.56 KRADS/HOUR).....	11/14/96
POST-100 KRAD ELECTRICAL MEASUREMENT.....	11/18/96
10) 336 HOURS ANNEALING @25°C.....	11/19/96
POST 336 HOURS ANNEALING ELECTRICAL MEASUREMENT	12/03/96
11) 168 HOURS ANNEALING @100°C.....	12/03/96
POST 168 HOURS ANNEALING ELECTRICAL MEASUREMENT	12/10/96

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

Table III. Electrical Characteristics of DG201

#	Electrical Parameters	Units	Spec. Lim.	
			min	max
1	IDD_vil	mA	0	4
2	IDD_vih	mA	0	3
3	ISS_vil	mA	-4	0
4	ISS_vih	mA	-3	0
5	A1_iih /2	μ A	-1	1
13	S1_isoff1 /3	nA	-2	2
21	D1_idoff1 /3	nA	-1	1
29	D1_idon1 /3	nA	-1	1
37	Rds_1p	Ω	-	175
38	Rds_2p	Ω	-	175
39	Rds_3p	Ω	-	175
40	Rds_4p	Ω	-	175
41	Rds_1n	Ω	-	175
42	Rds_2n	Ω	-	175
43	Rds_3n	Ω	-	175
44	Rds_4n	Ω	-	175
45	D1_ton	ns	-	1000
46	D2_ton	ns	-	1000
47	D3_ton	ns	-	1000
48	D4_ton	ns	-	1000
49	D1_toff	ns	-	500
50	D2_toff	ns	-	500
51	D3_toff	ns	-	500
52	D4_toff	ns	-	500

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for DG201

#	Electrical Parameters	Units	Spec. Lim./		Total Dose Exposure (krads)								Annealing		Total Dose Exposure (krads)								Annealing		Annealing	
					Initial				3		5		10		24 hrs. @ 25°C		20		50		100		24 hrs. @ 25°C		100 hrs. @ 100°C	
					mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	IDD_vil	mA	0	4	0.79	.01	.67	.05	.66	.03	.63	.04	.62	.05	0.58	.07	0.58	.08	.57	.15	.48	.03	.51	.02		
2	IDD_vih	mA	0	3	0.79	.02	.67	.05	.66	.03	.62	.03	.61	.05	0.65	.17	1.01	2.0	.82	.36	.67	.24	.68	.24		
3	ISS_vil	mA	-4	0	-0.28	0	-.20	.04	-.21	.02	-.16	.04	-.13	.05	-0.11	.06	-0.11	.07	-.11	.11	-.21	.22	-.57	.21		
4	ISS_vih	mA	-3	0	-0.28	.01	-.20	.04	-.20	.02	-.16	.04	-.13	.04	-0.21	.21	-1.67	1.9	-.96	.47	-.28	.23	-.24	.25		
5	A1_iih /2	µA	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
13	S1_isoff /3	nA	-2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
21	D1_idoff /	nA	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
29	D1_idon /3	nA	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
37	Rds_1p	Ω	-	175	118	1.3	114	2.5	112	1.1	119	1.8	121	1.0	130	2.4	1413	2141	1490	2444	205	5.1	205	5.1		
38	Rds_3p	Ω	-	175	115	.98	107	2.1	110	1.5	118	.11	118	.9	130	3.0	1399	2123	1449	2050	203	4.2	203	4.2		
39	Rds_3p	Ω	-	175	115	.88	106	1.9	109	1.4	114	.22	117	1.2	131	3.5	1382	2094	1436	1987	205	4.6	205	4.6		
40	Rds_4p	Ω	-	175	111	1.3	101	2.0	108	1.3	110	.33	115	.7	126	3.3	1365	2072	1401	2000	208	5.6	208	5.6		
41	Rds_1n	Ω	-	175	123	.50	135	1.5	140	.26	149	.34	141	1.3	148	2.7	1450	2181	1500	2107	212	7.1	212	7.1		
42	Rds_2n	Ω	-	175	125	.26	138	1.0	142	.24	151	.33	143	1.5	155	2.2	1461	2196	1520	1908	209	6	209	6		
43	Rds_3n	Ω	-	175	124	.58	139	1.7	143	.35	153	.43	145	1.4	159	2.9	1480	2215	1580	1605	209	6.5	209	6.5		
44	Rds_4n	Ω	-	175	123	.68	141	1.6	143	.33	153	.53	146	1.9	160	3.3	1492	2227	1581	2551	213	8.2	213	8.2		
45	D1_ton 4/	ns	-	1000	371	6.0	452	59.7	495	40	718	113	688	173	1108	510	4F		4F		4F		4F			
46	D2_ton 4/	ns	-	1000	370	7.8	451	48.6	491	38	682	110	678	167	1069	488	4F		4F		4F		4F			
47	D3_ton 4/	ns	-	1000	366	5.7	443	48.4	492	39	682	105	685	155	2188	2352	1P3F		4F		4F		4F			
48	D4_ton 4/	ns	-	1000	369	6.6	437	39.2	485	31	730	90	601	174	2504	2898	1P3F		4F		4F		4F			
49	D1_toff 4/	ns	-	500	347	7.8	460	78.3	490	150	916	360	858	553	1344	1340	1P3F		4F		4F		4F			
50	D2_toff 4/	ns	-	500	351	7.7	471	75.2	512	116	928	355	880	315	1377	1374	1P3F		4F		4F		4F			
51	D3_toff 4/	ns	-	500	348	5.3	478	81.3	501	152	962	423	902	602	4438	6684	1P3F		4F		4F		4F			
52	D4_toff 4/	ns	-	500	346	7.4	480	85.2	503	163	960	443	900	636	2440	3220	1P3F		4F		4F		4F			

Notes:

- 1/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.
- 1a/ All parts passed all test after 1krad exposures. That data is available on request.
- 2/ Readings for all iih and iil measurements were zero throughout all irradiation and annealing steps.
- 3/ Readings for all isoff, idoff and idon measurements were never greater than -0.16 nA throughout all irradiation and annealing steps.
- 4/ After radiation exposures to 50 and 100 Krads, The switch on /off timings could not be measured as the parts had degraded so much that they were failing these tests functionally. On annealing at 25 c and 100 c, parts showed some recovery, but most parts continued to fail.