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DATE: September 8, 1994 PPM-94-023

TO: A. Mecum/311.0
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on FUSE
Part No. 26C31
Control No. 10900

cc: A. Sharma/311
Library/300.1

A radiation evaluation was performed on 26C31 (Quad Op Amp) 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, 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, 10, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.04 and 1.3 krads/hour, depending on the total dose level (see Table II for radiation schedule). After the 100 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. All irradiated parts passed all electrical tests up to the 2.5 krad level.

At the 5 krad level, S/N 83, 84, 85, 86, 87, 88 and 90 fell below the minimum specification limit of -100 μA for Aout1_iofh - Dout1_ioffh and Aout2_ioffl - Dout2_ioffl, with readings in the range of -172 to -201 μA. In addition, S/N 90 exceeded the maximum specification limit of 14.0 ns for tr_Bou1, with a reading of 560.2 ns.

At the 10 krad level, S/N 84 exceeded the maximum specification limit of 14.0 ns for tr_Cou1, with a reading of 1000.7 ns and S/N 88 exceeded the maximum specification limit of 14.0 ns for tr_Bou1, with a reading of 552.1 ns. The same failures continued for Aout1_ioffh - Dout1_ioffh and Aout2_ioffl - Dout2_ioffl, with readings around -200 μA. In addition, S/N 83, 84, 85 and 88 exceeded the maximum specification limit of 3.0 ns for at least one of the parameters A_Skew_lh, B_Skew_lh and C_Skew_lh, with readings in the range of 3.3 to 7.3 ns. In addition, S/N 86 fell below the minimum specification limit of 2.50 V for A2_voh, with a reading of 0.98 V.

At the 15 krad level, S/N 83, 85, 88, 89 and 90 fell below the minimum specification limit of 2.50 V for A2_voh with readings in the range 0.91 to 1.11 V and S/N 89 and 90 fell below the minimum specification limit of 2.50 V for B2_voh with readings of 1.27 and 1.07 V, respectively. The same failures continued in all irradiated parts for Aout1_ioffh - Dout1_ioffh and Aout2_ioffl - Dout2_ioffl, with readings around -200 μA, for A_Skew_lh, B_Skew_lh and C_Skew_lh, with readings in the same range as at the 10 krad level, and for tr_Aou1 and tr_Bou1, with readings in the range of 1000 to 5000 ns.

*The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.
**These are manufacturer's non-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed. No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

At the 20 and 30 krad levels, the same failures continued, in the same range, along with additional similar failures in C2_voh and marginal failures in some propagation delay tests.

At the 50 krad level, the failures noted above continued, in approximately the same range of values. In addition, all irradiated parts exceeded the maximum specification limit of 0.50 V for A1_vol - D1_vol, with readings of approximately 1.0 V. and fell below the minimum specification limit of 2.50 V for A2_voh - D2_voh, with readings in the range of 0 - 1.2 V. All parts exceeded the maximum specification limit of 2100 μA for ICC_Vih, with readings in the range of 2450 to 3264 μA and S/N 84, 85, 86, 88 and 90 exceeded the maximum specification limit of 2100 μA for ICC_Vil, with readings in the range of 2438 to 2688 μA. At this level, all irradiated parts also exceeded the maximum specification limit of 5.00 μA for various iout_leak tests (Tests 45 - 59), with readings in the range of 7 to 18 μA, each part failing about 8 of the 15 tests, and S/N 84, 85, 86, 88 and 90 fell below the minimum specification limit of -1.000 μA for Din_iil, with readings in the range of -1.1.2 to -1.5 μA. In addition, all irradiated parts also marginally failed various propagation delay and rise and fall time tests.

At the 75 krad level, the same failures continued, with approximately the same readings. At this level, all irradiated parts also fell below the minimum specification limit of -100.00 μA for Aout_ioff1 - Dout2_ioff1 (Tests 69 - 76), with readings of approximately -200 μA.

At the 100 krad radiation level, all irradiated parts exceeded the maximum specification limit of 500.00 μA for ICC_gnd and ICC_vcc, with readings in the range of 2045 - 3547 μA. Readings for ICC_vil and ICC_vih increased to a range of 6375 to 10^5 μA. All other failures continued, with increasing readings.

After annealing for 168 hours at 25°C, some reduction in ICC current was seen but readings were still outside specification limits. No other recovery was observed.

After annealing for 168 hours at 100°C, some rebound effects were observed: The mean value for tplh_Aout1 went from 12.7 ns, which is within the maximum specification limit of 14 ns, to 17 ns; the mean value for A_Skew_lh went from 2.87 ns, which is within the maximum specification limit of 3 ns, to 5.44 ns; the mean value for A_Skew_hl went from 1.96 ns, which is within the maximum specification limit of 3 ns, to 5.66 ns; the mean value for tr_Aou1 went from 11.9 ns, which is within the maximum specification limit of 14 ns, to 1001 ns; the mean value for tr_Aou2, whose maximum specification limit is 14 ns, went from 1036 to 1501 ns; the mean value for tf_Aou2 went from 10.2 ns, which is within the maximum specification limit of 14 ns, to 16 ns; and the mean value for tpzh_Aou1, tpzl_Aou2 and tpzl_Aou2 increased between 10 and 100%, but remained within specification limits.

Table IV provides a summary of the mean and standard deviation values for each parameter after different irradiation exposures and annealing steps.

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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TABLE I. Part Information

Generic Part Number:	26C31
FUSE Part Number:	26C31*
FUSE Control Number:	10900
Charge Number:	C44370
Manufacturer:	National Semiconductor
Lot Date Code:	9317A
Quantity Tested:	10
Serial Number of Control Samples:	81, 82
Serial Numbers of Radiation Sample:	83, 84, 85, 86, 87, 88, 89, 90
Part Function:	Quad Op Amp
Part Technology:	Bipolar
Package Style:	TO-8 can
Test Equipment:	A540
Test Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for 26C31

EVENTS	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	07/08/94
2) 2.5 KRAD IRRADIATION (0.034 KRADS/HOUR)	07/08/94
POST-2.5 KRAD ELECTRICAL MEASUREMENT	07/11/94
3) 5 KRAD IRRADIATION (0.13 KRADS/HOUR)	07/11/94
POST-5 KRAD ELECTRICAL MEASUREMENT	07/12/94
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	07/12/94
POST-10 KRAD ELECTRICAL MEASUREMENT	07/13/94
5) 15 KRAD IRRADIATION (0.26 KRADS/HOUR)	07/13/94
POST-15 KRAD ELECTRICAL MEASUREMENT	07/14/94
6) 20 KRAD IRRADIATION (0.25* KRADS/HOUR)	07/14/94
POST-20 KRAD ELECTRICAL MEASUREMENT	07/15/94
7) 30 KRAD IRRADIATION (0.15 KRADS/HOUR)	07/15/94
POST-30 KRAD ELECTRICAL MEASUREMENT	07/18/94
8) 50 KRAD IRRADIATION (1.11 KRADS/HOUR)	07/19/94
POST-50 KRAD ELECTRICAL MEASUREMENT	07/20/94
9) 75 KRAD IRRADIATION (1.32 KRADS/HOUR)	07/20/94
POST-75 KRAD ELECTRICAL MEASUREMENT	07/21/94
10) 100 KRAD IRRADIATION (1.32 KRADS/HOUR)	07/21/94
POST-100 KRAD ELECTRICAL MEASUREMENT	07/22/94
11) 168-HOUR ANNEALING @25°C	07/22/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/29/94
12) 168-HOUR ANNEALING @100°C*	08/01/94
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	08/12/94

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

*A power outage interrupted irradiation after 3 hours at 0.25 krads/hr. The parts remained under bias at 25°C for 16 hours, after which irradiation was continued for 3.5 hours at 1.16 krads/hr for a total accumulated dose of 20 krads.

**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 26C31

Vcc = 5.5 V unless specified otherwise.

test#	Test name	Min	Max	Test conditions
1	ICC_gnd	0.0 ua	500.0 ua	Vin = 0v
2	ICC_vcc	0.0 ua	500.0 ua	Vin = 5.5v
3	ICC_vil	0.0 ua	2100.0 ua	Vin = 0.5v
4	ICC_vih	0.0 ua	2100.0 ua	Vin = 2.4vv
5	A1_voh	2.50 v		Vcc= 4.5v iout =-20ma
6	B1_voh	2.50 v		Vcc= 4.5v iout =-20ma
7	C1_voh	2.50 v		Vcc= 4.5v iout =-20ma
8	D1_voh	2.50 v		Vcc= 4.5v iout =-20ma
9	A2_voh	2.50 v		Vcc= 4.5v iout =-20ma
10	B2_voh	2.50 v		Vcc= 4.5v iout =-20ma
11	C2_voh	2.50 v		Vcc= 4.5v iout =-20ma
12	D2_voh	2.50 v		Vcc= 4.5v iout =-20ma
13	A1_vol		0.50 v	Vcc= 4.5v iout = 20ma
14	B1_vol		0.50 v	Vcc= 4.5v iout = 20ma
15	C1_vol		0.50 v	Vcc= 4.5v iout = 20ma
16	D1_vol		0.50 v	Vcc= 4.5v iout = 20ma
17	A2_vol		0.50 v	Vcc= 4.5v iout = 20ma
18	B2_vol		0.50 v	Vcc= 4.5v iout = 20ma
19	C2_vol		0.50 v	Vcc= 4.5v iout = 20ma
20	D2_vol		0.50 v	Vcc= 4.5v iout = 20ma
21	ENH_iih	-1.000 ua	1.000 ua	Vin = 5.5v
22	ENL_iih	-1.000 ua	1.000 ua	Vin = 5.5v
23	Ain_iih	-1.000 ua	1.000 ua	Vin = 5.5v
24	Bin_iih	-1.000 ua	1.000 ua	Vin = 5.5v
25	Cin_iih	-1.000 ua	1.000 ua	Vin = 5.5v
26	Din_iih	-1.000 ua	1.000 ua	Vin = 5.5v
27	ENH_iil	-1.000 ua	1.000 ua	Vin = 0.0v
28	ENL_iil	-1.000 ua	1.000 ua	Vin = 0.0v
29	Ain_iil	-1.000 ua	1.000 ua	Vin = 0.0v
30	Bin_iil	-1.000 ua	1.000 ua	Vin = 0.0v
31	Cin_iil	-1.000 ua	1.000 ua	Vin = 0.0v
32	Din_iil	-1.000 ua	1.000 ua	Vin = 0.0v
33	ENH_iih	-1.000 ua	1.000 ua	Vin = 2.0v
34	ENL_iih	-1.000 ua	1.000 ua	Vin = 2.0v
35	Ain_iih	-1.000 ua	1.000 ua	Vin = 2.0v
36	Bin_iih	-1.000 ua	1.000 ua	Vin = 2.0v
37	Cin_iih	-1.000 ua	1.000 ua	Vin = 2.0v
38	Din_iih	-1.000 ua	1.000 ua	Vin = 2.0v
39	ENH_iil	-1.000 ua	1.000 ua	Vin = 0.8v
40	ENL_iil	-1.000 ua	1.000 ua	Vin = 0.8v
41	Ain_iil	-1.000 ua	1.000 ua	Vin = 0.8v
42	Bin_iil	-1.000 ua	1.000 ua	Vin = 0.8v
43	Cin_iil	-1.000 ua	1.000 ua	Vin = 0.8v
44	Din_iil	-1.000 ua	1.000 ua	Vin = 0.8v

Table III (cont.). Electrical Characteristics of 26C31

test#	Test name	Min	Max	Test conditions
45	Aout1_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
46	Bout1_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
47	Cout1_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
48	Dout1_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
49	Aout2_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
50	Bout2_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
51	Cout2_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
52	Dout2_iozh	-5.00 ua	5.00 ua	Vout = 5.5v
53	Aout1_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
54	Bout1_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
55	Cout1_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
56	Dout1_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
57	Aout2_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
58	Bout2_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
59	Cout2_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
60	Dout2_iozl	-5.00 ua	5.00 ua	Vout = 0.0v
61	Aout1_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
62	Bout1_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
63	Cout1_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
64	Dout1_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
65	Aout2_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
66	Bout2_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
67	Cout2_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
68	Dout2_ioffh		100.0 ua	Vcc =0.0v, Vout = 6.0v
69	Aout1_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
70	Bout1_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
71	Cout1_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
72	Dout1_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
73	Aout2_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
74	Bout2_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
75	Cout2_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
76	Dout2_ioffl	-100.0 ua		Vcc =0.0v, Vout = 0.0v
77	Aout1_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
78	Bout1_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
79	Cout1_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
80	Dout1_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
81	Aout2_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
82	Bout2_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
83	Cout2_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
84	Dout2_isc	-150.0 ma	-30.0 ma	Vin = 0.0v
85	A1_vt	2.00 v		Vcc = 4.5v
86	B1_vt	2.00 v		Vcc = 4.5v
87	C1_vt	2.00 v		Vcc = 4.5v
88	D1_vt	2.00 v		Vcc = 4.5v
89	A2_vt	2.00 v		Vcc = 4.5v
90	B2_vt	2.00 v		Vcc = 4.5v
91	C2_vt	2.00 v		Vcc = 4.5v
92	D2_vt	2.00 v		Vcc = 4.5v
93	v_diff1		0.400 v	Vcc = 4.5v
94	v_diff2		0.400 v	Vcc = 4.5v
95	v_diff3		0.400 v	Vcc = 4.5v
96	v_diff4		0.400 v	Vcc = 4.5v

Table III (cont.). Electrical Characteristics of 26C31

test#	Test name	Min	Max	Test conditions
97	tplh_Aout1		14.0 ns	Vcc = 5.0v
98	tplh_Bout1		14.0 ns	
99	tplh_Cout1		14.0 ns	
100	tplh_Dout1		14.0 ns	
101	tplh_Aout2		14.0 ns	
102	tplh_Bout2		14.0 ns	
103	tplh_Cout2		14.0 ns	
104	tplh_Dout2		14.0 ns	
105	tphl_Aout1		14.0 ns	Vcc = 5.0v
106	tphl_Bout1		14.0 ns	
107	tphl_Cout1		14.0 ns	
108	tphl_Dout1		14.0 ns	
109	tphl_Aout2		14.0 ns	
110	tphl_Bout2		14.0 ns	
111	tphl_Cout2		14.0 ns	
112	tphl_Dout2		14.0 ns	
113	A_Skew_lh		3.0 ns	
114	B_Skew_lh		3.0 ns	
115	C_Skew_lh		3.0 ns	
116	D_Skew_lh		3.0 ns	
117	A_Skew_hl		3.0 ns	
118	B_Skew_hl		3.0 ns	
119	C_Skew_hl		3.0 ns	
120	D_Skew_hl		3.0 ns	
121	tr_Aou1		14.0 ns	
122	tr_Bou1		14.0 ns	
123	tr_Cou1		14.0 ns	
124	tr_Dou1		14.0 ns	
125	tr_Aou2		14.0 ns	
126	tr_Bou2		14.0 ns	
127	tr_Cou2		14.0 ns	
128	tr_Dou2		14.0 ns	
129	tf_Aou1		14.0 ns	
130	tf_Bou1		14.0 ns	
131	tf_Cou1		14.0 ns	
132	tf_Dou1		14.0 ns	
133	tf_Aou2		14.0 ns	
134	tf_Bou2		14.0 ns	
135	tf_Cou2		14.0 ns	
136	tf_Dou2		14.0 ns	
137	tpzh_Aou1		22.0 ns	
138	tpzh_Bou1		22.0 ns	
139	tpzh_Cou1		22.0 ns	
140	tpzh_Dou1		22.0 ns	
141	tpzl_Aou2		28.0 ns	
142	tpzl_Bou2		28.0 ns	
143	tpzl_Cou2		28.0 ns	
144	tpzl_Dou2		28.0 ns	

Table III (cont.). Electrical Characteristics of 26C31

test#	Test name	Min	Max	Test conditions
145	tplz_Aou2		14.0 ns	
146	tplz_Bou2		14.0 ns	
147	tplz_Cou2		14.0 ns	
148	tplz_Dou2		14.0 ns	

performed Go / No Go at 25oC :

- Vil , Vih, and Fucntional test.

TABLE IV: Summary of Electrical Measurements after Total Dose Exposures and Annealing for 26C31 /1

Test			Spec. Lim./2		Initial		Total Dose Exposure (krads)																		Annealing			
							2.5		5		10		15		20		30		50		75		100		168 hrs @25°C		168 hrs @100°C	
#/3	Parameter	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
1	ICC_gnd	µA	0	500	219	5.8	227	6.1	244	9.9	259	11	275	15	315	31	361	42	378	48	393	53	2868	534	951	91	169	6.5
2	ICC_vcc	µA	0	500	216	0	231	0	259	7.1	267	12	281	19	322	29	353	39	375	45	391	52	2751	502	906	175	169	6.5
3	ICC_vil	µA	0	2100	223	6.5	279	9.9	312	30	376	47	414	59	632	105	845	293	2325	312	2928	353	2.7E4	3.5E4	1.3E4	2.7E4	473	49
4	ICC_vih	µA	0	2100	1175	37	1198	41	1229	53	1251	66	1284	78	1399	111	1672	156	2885	307	3406	357	2.9E4	3.8E4	1.3E4	2.6E4	970	66
5	A1_voh	V	2.5	-	3.92	.03	3.91	.03	3.92	.03	3.86	.02	3.85	.01	3.87	.01	3.99	.01	4.09	.02	4.17	.02	4.24	.02	4.17	.01	3.95	.05
9	A2_voh	V	2.5	-	3.69	.02	3.55	.04	3.03	.31	2.72	.91	2.08	1.4	1.85	.70	1.07	.06	0.28	.30	0.31	.11	0.65	.06	0.39	.32	3.94	.01
13	A1_vol	V	-	0.5	0.25	.01	0.25	.01	0.25	.01	0.25	.01	0.25	.01	0.99	.01	2.02	0	1.02	0	1.02	0	1.02	0	1.02	0	0.27	.01
17	A2_vol	V	-	0.5	0.25	.01	0.25	.01	0.25	.01	0.25	.01	0.24	.01	0.29	.01	0.23	.01	0.23	.01	0.23	.01	0.23	.01	0.24	0	0.31	.02
21	ENH_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	ENL_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Ain_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	ENH_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.05	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.05	0	-0.05	0
28	ENL_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0
29	Ain_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0
33	ENH_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0
34	ENL_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Ain_iih	µA	-1.0	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	ENH_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0
40	ENL_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0
41	Ain_iil	µA	-1.0	1.0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-0.06	0	-7.00	.44	-0.06	0
45	Aout1_iozh	µA	-5.0	5.0	0	0	0	0	0.01	0	0.79	.56	1.24	.72	3.11	.73	6.56	.79	12.9	3.9	31.1	4.2	41.0	0	41.0	0	0.02	0
49	Aout2_iozh	µA	-5.0	5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	.01	0.86	.09	1.15	.17	0.43	.07	0.04	0
53	Aout1_iozl	µA	-5.0	5.0	0	0	0	0	0.02	0	0.32	.19	1.03	.59	1.99	.60	4.12	1.1	9.21	2.8	15.4	3.1	41.0	0	41.0	0	0.02	.01
57	Aout2_iozl	µA	-5.0	5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	.01	0.61	.09	0.24	.04	0.02	.01

TABLE IV (cont'd.): Summary of Electrical Measurements after Total Dose Exposures and Annealing for 26C31 /1

Test			Spec. Lim./2		Initial		Total Dose Exposure (krads) 2.5		5		10		15		20		30		50		75		100		Annealing 168 hrs @25°C		168 hrs @100°C	
#/3	Parameter	Units	min	max	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
61	Aout1_ioff	µA	-	100	-0.74	.62	0.55	.49	0.16	.65	0.33	.67	0.19	.44	0.06	.45	0.06	.53	-0.02	.35	0.78	.69	0.15	.26	0.31	.14	0.56	.52
65	Aout2_ioff	µA	-	100	0.18	.09	0.20	.11	0.21	.10	0.29	.21	0.31	.29	0.39	.28	0.41	.29	0.44	.30	0.46	.10	0.46	.07	0.36	.33	0.36	.28
69	Aout1_ioff	µA	-100	-	-24.1	12	-76.7	21	-173	45	-200	.22	-200	.23	-200	.21	-200	.23	-200	.24	-200	.17	-200	.14	-200	.14	-200	.31
73	Aout2_ioff	µA	-100	-	-20.1	9.8	-71.4	22	-165	47	-200	.12	-200	.12	-200	.17	-200	.17	-200	.18	-200	.18	-200	.16	-200	.16	-200	.29
77	Aout1_isc	mA	-150	-30	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4	-122	1.4
81	Aout2_isc	mA	-150	-30	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.3	-122	1.4	-122	1.3	-122	1.3
85	A1_vt	V	2.0	-	3.49	.02	3.50	.01	3.51	.02	3.55	.02	3.58	.02	3.60	.01	3.69	.02	3.75	.02	3.71	.01	3.81	.01	3.81	.01	3.67	.01
89	A2_vt	V	2.0	-	3.47	.02	3.49	.01	3.50	.01	3.53	.02	3.60	.02	3.63	.01	3.72	.02	3.86	.02	3.75	.02	4.00	.01	3.93	.01	3.56	.01
93	v_diff1	V	-	0.4	0	0	0	0	0	0	0	0	0.02	0	0.04	0	0.09	.01	0.11	.01	0.17	.01	0.19	.01	0.13	.01	0.11	.01
97	tplh_Aout1	ns	-	14	12.9	.39	12.8	.37	12.8	.30	12.7	.29	12.1	.24	12.0	.25	13.1	.17	13.2	.10	14.9	.17	15.0	.20	14.1	.01	7.45	.24
101	tplh_Aout2	ns	-	14	11.9	.17	11.9	.17	12.0	0.18	11.7	.15	11.5	.14	11.3	.15	11.2	.16	11.1	.16	11.1	.15	11.0	.13	11.2	.14	12.8	.26
105	tphl_Aout1	ns	-	14	13.4	.17	13.3	.18	13.1	.60	12.9	.77	12.7	.78	12.6	.63	12.5	.21	12.6	.10	12.4	.12	12.4	.18	12.7	.10	17.0	.70
109	tphl_Aout2	ns	-	14	12.8	.22	12.6	.22	12.6	.23	12.7	.19	12.9	.17	13.0	.15	13.1	.11	13.9	.09	14.1	.10	14.9	.12	14.6	.18	11.3	1.6
113	A_Skew_lh	ns	-	3.0	0.99	.24	0.80	.18	0.71	.19	0.67	.10	0.63	.14	1.10	.13	1.95	.12	2.06	.11	2.99	.10	4.03	.13	2.87	.10	5.44	.19
117	A_Skew_hl	ns	-	3.0	0.79	.15	0.80	.16	0.77	.14	0.45	.18	0.28	.19	0.98	.17	1.17	.09	1.25	.05	1.79	.10	2.53	.15	1.96	.13	5.66	1.8
121	tr_Aou1	ns	-	14	9.23	.20	9.24	.21	9.55	.30	9.69	.41	9.81	.45	10.2	.30	10.9	.11	11.3	.07	11.6	.14	249	437	11.9	.16	1001	.08
122	tr_Bou1	ns	-	14	8.53	.26	8.50	.11	77.5	195	228	396	1253	1579	1445	1445	2001	1852	1501	1414	1001	.06	1501	1414	2501	2070	10.6	.16
125	tr_Aou2	ns	-	14	10.6	.09	10.6	.09	10.6	.10	10.5	.17	10.5	.16	9.98	.15	9.46	.12	1000	.05	51.5	125	604	97	1036	1373	1501	1414
129	tf_Aou1	ns	-	14	10.5	.31	10.4	.33	10.2	.29	10.2	.25	10.1	.24	11.1	.21	10.4	1.5	12.4	3.2	10.9	1.0	554	1531	12.9	1.3	11.2	.29
133	tf_Aou2	ns	-	14	11.7	.15	11.6	.15	11.6	.15	11.5	.16	11.4	.16	11.0	.15	10.9	.10	10.2	.12	10.0	.19	9.64	.23	10.2	.15	16.0	3.1
137	tpzh_Aou1	ns	-	22	8.34	.27	8.33	.28	8.32	.29	8.30	.31	8.31	.33	8.49	.31	8.50	.33	8.59	.30	9.00	.29	9.11	.24	9.20	.28	9.95	.35
141	tpzl_Aou2	ns	-	28	6.49	.38	6.50	.40	6.51	.42	6.51	.39	6.52	.32	6.52	.32	6.54	.31	6.56	.31	6.77	.28	6.99	.24	7.02	.20	8.05	.56
145	tpzl_Aou2	ns	-	14	4.34	.16	4.55	.17	4.51	.09	5.56	.10	9.38	.09	9.34	.10	9.29	.10	9.26	.12	9.21	.13	9.20	.17	4.26	.14	9.54	.16

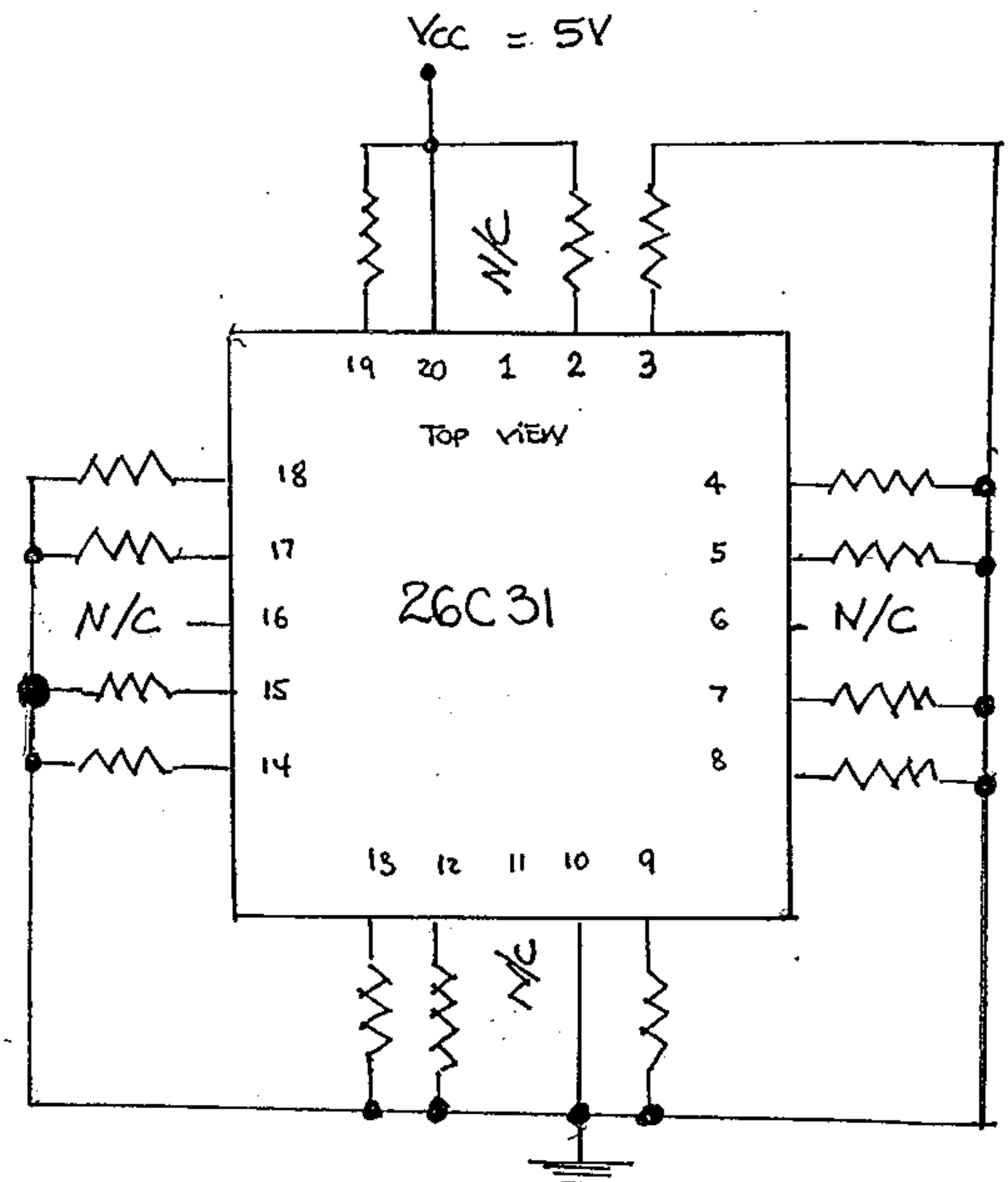
1/ The mean and standard deviation values were calculated over the eight parts irradiated in this testing. The control samples remained constant throughout the testing and is not included in this table.

2/ These are manufacturer's non-irradiated data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time the tests were performed.

3/ With the exception of tr_Boul (Test #122), in which major failures occurred, only the data for section A of the part are presented here. Data for other sections are available on request.

4/ The radiation sensitive parameters were ICC, voh, vol, iil, iozh, iozl, ioff1, propagation delay and rise time.

Figure 1. Radiation Bias Circuit for 26C31



* ALL Rs = 2KΩ ±10% 1/4 W