APM361 -

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Memorandum

PARAMAX
A Unisys Company

PPM-93-061

DATE: June 11, 1993

TO: A. Sharma/311.0

FROM: K. Sahu/300.1 KS

SUBJECT: Annealing Study on Part Nos. 54AC00, 54AC02, 54AC04, 54AC11, 54AC109, 54AC161, 54AC245 and 54ACT245

cc: Library/300.1

An annealing study was performed on eight different 54AC series parts[1/] (54AC00, 54AC02, 54AC04, 54AC11, 54AC109, 54AC161, 54AC245 and 54ACT245), previously irradiated to 300 krads total dose. The objective of this study was to determine the effects of long-term (approximately two years) annealing on these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through III.

For each part type, the previous total dose testing had been performed earlier (between 3/22 and 8/8/91, for the SMEX Project) using a cobalt-60 gamma ray source. During the radiation testing, eight parts were irradiated under bias and two parts were used as control samples. The total dose radiation steps were 10, 20, 30, 50, 75 and 100 krads[2/]. After 100 krads, parts were annealed at +25°C for 168 hours, and then the irradiation was continued to 200 and 300 krads (cumulative). The dose rate ranged from 0.06 to 5.7 krads/hour, depending on the total dose level. After each radiation exposure and annealing treatment, parts were electrically tested according to the test conditions and the specification limits[3/] established for each part type. These tests included DC tests (VOH, VOL, IIH, IIL, ICCH, ICCL, IOZH, IOZL and ICCZ), AC tests (propagation delay) and at least one functional test for each part type.

For all part types, significant increases in ICCH and ICCL measurements were observed after total dose levels ranging from 10 to 200 krads. After 300 krads, ICCH measurements ranged from 963 to 41000 μA and ICCL measurements ranged from 1000 to 34000 μA, against maximum specification limits of 80 or 160 μA. Two part types (54AC161 and 54ACT245) also showed functional failures. For further details, refer to the following radiation reports[4/]:

Part Type	Report No.	Part Type	Report No.
54AC00	PPM-91-440	54AC161	PPM-91-252
54AC02	PPM-91-508	54AC245	PPM-91-442
54AC04	PPM-91-376	54ACT245	PPM-91-191
54AC11	PPM-91-425		
54AC109	PPM-91-437		

1/ These are not radiation-hardened parts. No radiation tolerance was guaranteed by the manufacturer for these parts.

2/ The term rads, as used in this document, means rads(silicon).

3/ These were manufacturers' non-irradiated data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

4/ Copies of these reports are available to qualified users; please submit a written request through the cognizant GSFC Project Office or Branch Head to the Office of Flight Assurance Information Center, Code 300.

The irradiated parts used in this study were under storage at room temperature anneal (without bias) for approximately two years. At the end of this period, electrical measurements were made. The parts were then placed under bias and annealed for one week (168 hours) at 25°C, after which electrical measurements were performed. The parts were then placed back in annealing at 25°C for a total of 504 hours (cumulative), and electrical measurements were made at the end of this period. Finally, the parts were annealed for 168 hours at 100°C to test for rebound effects.

Tables I and II present the test results for ICCH and ICCL measurements, respectively, after various annealing steps. These parameters were the most sensitive to radiation. After annealing for one year without bias, seven part types showed decreases in ICCH and ICCL, ranging from 7% to 83%. One part type (54AC161), however, showed an increase in both ICCH and ICCL of over 600%, after annealing for one year. All part types were still over the maximum specification limits for both parameters. After annealing for 168 hours under bias at 25°C, five part types (54AC00, 54AC02, 54AC04, 54AC109 and 54AC245) showed some recovery, ranging from 2% to 23% (see Fig.1), while three part types (54AC11, 54AC161 and 54ACT245) showed an increase (2% to 24%) in the values of these parameters (see Fig.2). After annealing under the same conditions for 504 hours, only 54AC109 showed an increase of 9% in ICCH; all other part types showed continued decreases from 1% to 22% in both ICCH and ICCL.

Six part types (54AC00, 54AC02, 54AC04, 54AC11, 54AC109 and 54AC245) passed all functional tests throughout all irradiation and annealing steps. The 54AC161 device lot had 5 failures at 300 krads radiation exposure and throughout all subsequent annealing steps at 25°C. The 54ACT245 device lot had 4 failures at 300 krads radiation exposure, but all parts passed all functional tests during all subsequent annealing steps.

After annealing for 168 hours at 100°C, no rebound effects were observed.

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

TABLE I: Summary of Mean Values of ICCH Measurements After Total Dose Exposures and Annealing /1

Part type	Units	Spec. Lim. Min	Spec. Lim. Max	Total Dose Exposure: Initial	Total Dose Exposure: 300 krads	Anneal: One Year @25°C Unbiased	Anneal: 168 hrs. @25°C Biased	Anneal: 504 hrs. @25°C Biased	Anneal: 168 hrs. @100°C Biased
54AC00	µA	0.0	80	0.0	7174	4978	4902	4894	2126
54AC02	µA	0.0	80	0.0	10200	7561	7141	7048	1909
54AC04	µA	0.0	80	0.0	27000	16817	16353	16301	9614
54AC11	µA	0.0	80	0.0	9581	3314	3376	3304	202.9
54AC109	µA	0.0	80	0.0	41000	30198	29825	30079	16765
54AC161	µA	0.0	160	0.0	1000	7560	8389	8040	2701
54AC245	µA	0.0	160	0.0	963	636.5	524.1	471.1	65.7
54ACT245	µA	0.0	160	0.0	2000	353.8	438	342.5	36.0

TABLE II: Summary of Mean Values of ICCL Measurements After Total Dose Exposures and Annealing /1

Part type	Units	Spec. Lim. Min	Spec. Lim. Max	Total Dose Exposure: Initial	Total Dose Exposure: 300 krads	Anneal: One Year @25°C Unbiased	Anneal: 168 hrs. @25°C Biased	Anneal: 504 hrs. @25°C Biased	Anneal: 168 hrs. @100°C Biased
54AC00	µA	0.0	80	0.0	6194	5741	5655	5622	2522
54AC02	µA	0.0	80	0.0	10700	7942	7577	7484	2484
54AC04	µA	0.0	80	0.0	27000	22154	21642	21533	11794
54AC11	µA	0.0	80	0.0	1345	335	347.6	273.4	<80
54AC109	µA	0.0	80	0.0	34000	25051	24418	24424	13081
54AC161	µA	0.0	160	0.0	1000	7232	8130	7803	3157
54AC245	µA	0.0	160	0.0	3207	1034	801.3	718	64.6
54ACT245	µA	0.0	160	0.0	3000	505.4	593.5	570	42.5

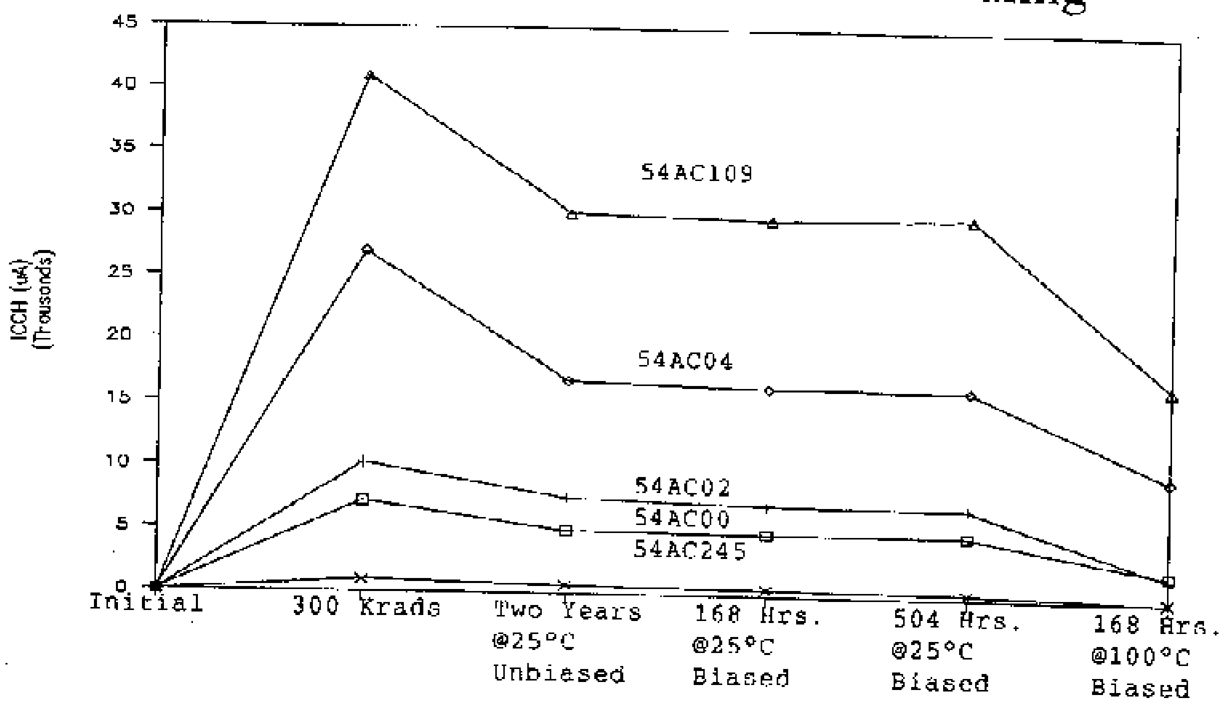
TABLE III: Summary of Functional Tests After Total Dose Exposures and Annealing /1

Part type	Total Dose Exposure: Initial	Total Dose Exposure: 300 krads	Anneal: One Year @25°C Unbiased	Anneal: 168 hrs. @25°C Biased	Anneal: 504 hrs. @25°C Biased	Anneal: 168 hrs. @100°C Biased
54AC00	P	P	P	P	P	P
54AC02	P	P	P	P	P	P
54AC04	P	P	P	P	P	P
54AC11	P	P	P	P	P	P
54AC109	P	P	P	P	P	P
54AC161	P	3P/5F	3P/5F*	2P/5F	2P/5F	3P/4F
54AC245	P	P	P	P	P	P
54ACT245	P	4P/4F	P	P	P	P

/1 Up to 300 krads, statistics are based on eight irradiated samples. For the 168- and 504-hour anneals at 25°C and the 168-hour anneal at 100°C, statistics are based on seven samples.
*One of the passing parts was removed from testing at the following annealing steps, reducing the sample size from 3P/5F to 2P/5F.

Figure 1

a) ICCH vs. Total Dose and Annealing



b) ICCL vs. Total Dose and Annealing

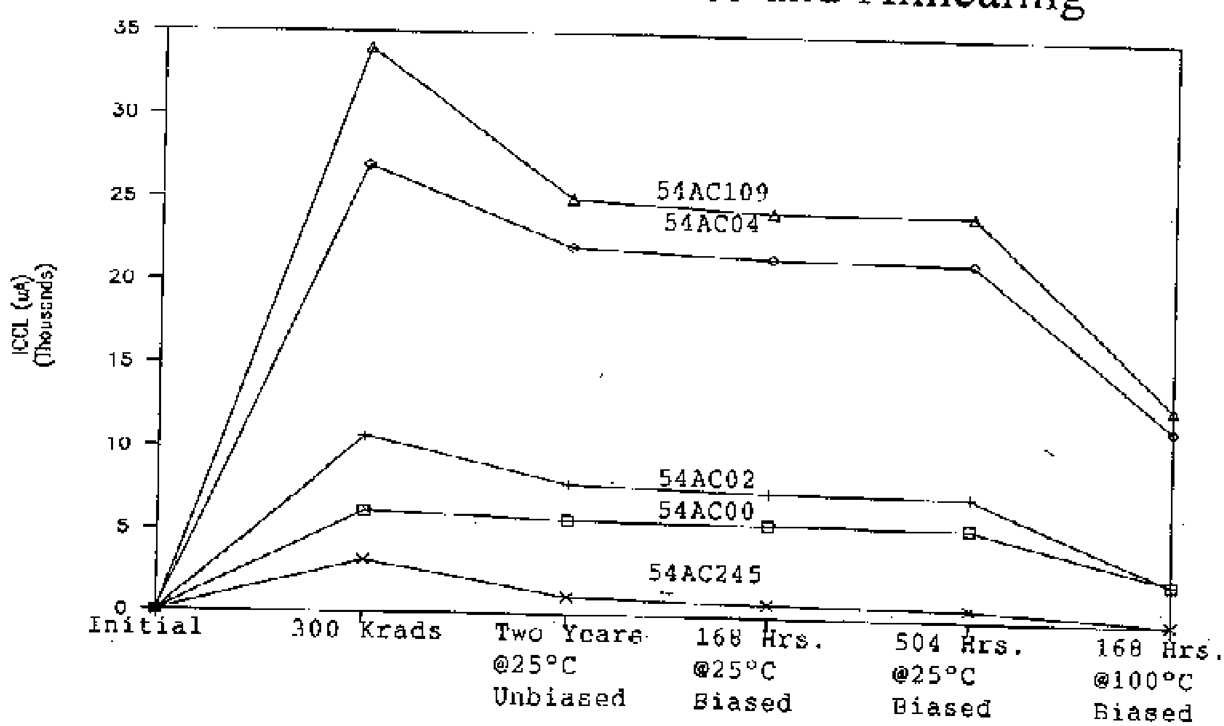
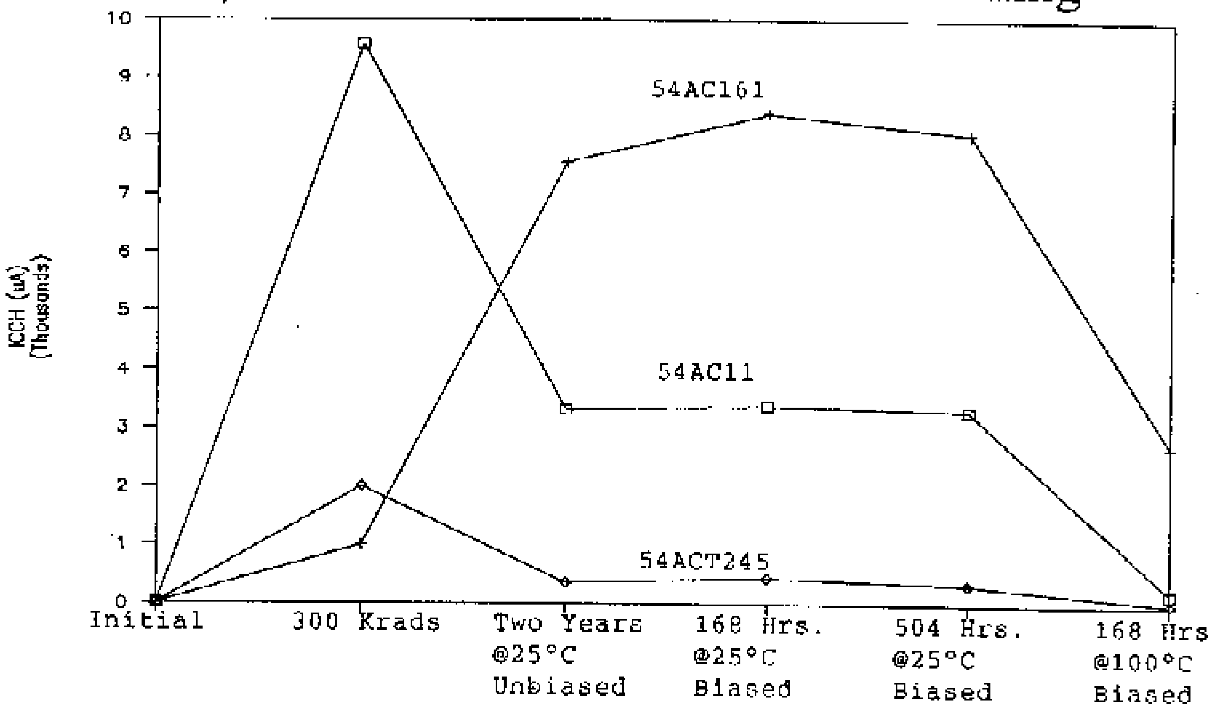


Figure 2

a) ICCH vs. Total Dose and Annealing



b) ICCL vs. Total Dose and Annealing