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To
Department Sharma.
From Code 311
Department Sahu
Subject 7809
Radiation Report on ZQ04031
GPEP/PPL Part No. ZQ04031/62832H
(32k x 8 SRAM)

Date PPM-91-702
Location Nov. 7, 1991
Telephone GSFC
Location 731-8954
cc Lanham

S. Archer-Davies
T. Perry

A radiation evaluation was performed on ZQ04031 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 on twelve parts using a Cobalt-60 gamma-ray source, while three parts were used as control samples. The twelve irradiated parts were separated into three test groups of four parts each, in order to test the effect of different biasing conditions on the parts during irradiation. Test Groups 1 and 2 (TG1 and TG2) were biased during irradiation using the circuit in Figure 1 with SW1 in the Static 1 and Static 2 positions, respectively. Test Group 3 (TG3) was left unbiased during irradiation. The total dose radiation steps for each group were 5, 10, 20, 40 and 80 krad*. The dose rate was between 0.25 and 1 krad/hour, depending on the total dose level (see Table II for radiation schedule). After 80 krad, parts were annealed for 48 and 168 hours at +25°C. After each radiation exposure and annealing treatment, parts were electrically tested at +25°C, according to the test conditions and the specification limits listed in Table III. After the final annealing treatment, electrical measurements were also made at high and low temperature (+125°C and -55°C).

six functional tests were also performed on all parts after each radiation exposure and annealing treatment. Functional tests #1, #3 and #5 (at 10 MHz, 5 MHz and 2 MHz, respectively) consisted of writing and reading the following patterns: all ones, all zeros, checkerboard and inverse checkerboard. Functional tests #2 and #4, at frequencies of 10 MHz and 5 MHz, respectively, consisted of eight different test patterns: "1 On" march, row address, column address, sliding diagonally,, ping-pong, surround, row galpat and column galpat. Functional test #6 consisted of writing a checkerboard pattern to the parts, reducing the VCC voltage from 5V to 2V for 55ns and then reading the pattern from the parts at 1 MHz., for a data retention test. For details of functional tests, see Table III.

All parts passed all electrical and functional tests from initial (pre-rad) up to and including 10 krad. After the 20-krad irradiation, all parts from TG1 and TG2 exhibited functional failures for some tests and one part from TG3 showed failure in one functional test (#6). After 40 krad, all parts from TG1 and TG2 failed some functional tests and one part from TG3 failed all functional tests. After 80 krad, a similar failure pattern was observed. For details, see Table IV.

Parts from TG3 passed all parametric tests throughout the radiation testing, however, parts from TG2 exceeded maximum specification limits for VIH, ISBL_CMS and timing tests at 80 krad, and parts from TG1 exceeded maximum specification limits for ICCDR at 40 krad. Other than in ISBL_CMS for parts in TG3, very little recovery was observed during annealing for 168 hours at +25°C. Parts in TG3 exhibited a reversal in recovery of timing measurements during high temperature measurements at +125°C after 168 hours annealing.

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

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

*In this report, the term "rads" is used as an abbreviation for rads(Si).

TABLE I. Part Information

Generic Part Number:	ZQ04031
GPEP/PPL Part Number:	ZQ04031/62832H
GPEP/PPL Control Number:	4101
Charge Number:	C14082
Manufacturer:	Elmo/Hitachi
Lot Date Code:	9107, 9101
Quantity Tested:	15
Serial Numbers of Radiation Samples:	6, 11, 12, 14-16, 18, 19, 21-24
Serial Numbers of Control Samples:	8, 9, 164
Part Function:	32k x 8-bit SRAM
Part Technology:	CMOS
Package Style:	DIP
Test Engineer:	J. Lander

TABLE II. Radiation Schedule for ZQ04031

EVENTS	DATE
1) Initial Electrical Measurements	08/08/91
2) 5-KRAD IRRADIATION (0.25 KRADS/HOUR)	08/19/91
POST-5-KRAD ELECTRICAL MEASUREMENT	08/20/91
3) 10-KRAD IRRADIATION (0.25 KRADS/HOUR)	08/20/91
POST-10-KRAD ELECTRICAL MEASUREMENT	08/21/91
4) 20-KRAD IRRADIATION (0.5 KRADS/HOUR)	08/21/91
POST-20-KRAD ELECTRICAL MEASUREMENT	08/22/91
5) 40-KRAD IRRADIATION (1.0 KRADS/HOUR)	08/22/91
POST-40-KRAD ELECTRICAL MEASUREMENT	08/23/91
6) 80-KRAD IRRADIATION (0.59 KRADS/HOUR)	08/23/91
POST-80-KRAD ELECTRICAL MEASUREMENT	08/26/91
7) 48-HOUR ANNEALING	08/26/91
POST-48-HOUR ANNEAL ELECTRICAL MEASUREMENT	08/28/91
8) 168-HOUR ANNEALING	08/28/91
POST-168-HOUR ANNEAL ELECTRICAL MEASUREMENT (+25°C)	09/03/91
POST-168-HOUR ANNEAL ELECTRICAL MEASUREMENT (-55°C)	09/04/91
POST-168-HOUR ANNEAL ELECTRICAL MEASUREMENT (+125°C)	09/05/91

Table III. Electrical Characteristics of ZQ04031

PART NO : ZQ04031 62B32H		PART TYPE : (32K x 8) Bits RAD-HARDENED CMOS Static RAM.		PCN : S110423A		
LOCATION			TEST SPECIFICATIONS			
DISK LABEL : LIR_20 DIRECTORY : DQAL\PROGRAMS.4231			HITACHI IC MEMORY DATA BOOK JANUARY 1990.			
FUNCTIONAL TESTS						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C, -55C & 125C
FUNCT # 1	5.0V	0.0V	5.0V	FREQ = 10 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT # 2	5.0V	0.0V	5.0V	FREQ = 10 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT # 3	5.0V	0.0V	5.0V	FREQ = 5 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT # 4	5.0V	0.0V	5.0V	FREQ = 5 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT # 5	5.0V	0.0V	5.0V	FREQ = 2 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
FUNCT # 6	5.0V	0.0V	5.0V	FREQ = 1 MHz	ALL I/O	VOL<1.5V , VOH>1.5V
DC PARAMETRIC TESTS						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C, -55C & 125C
VIH_4.5V	4.5V	0.0V	0.8V	FREQ= 1MHZ	INS	>+0.0V , <+2.2V
VIH_5.5V	5.5V	0.0V	0.8V	FREQ= 1MHZ	INS	>+0.0V , <+2.2V
VIL_4.5V	4.5V	2.2V	4.5V	FREQ= 1MHZ	INS	>+0.8V , <+5.5V
VIL_5.5V	5.5V	2.2V	5.5V	FREQ= 1MHZ	INS	>+0.8V , <+5.5V
VOH1	4.5V	0.8V	2.2V	LOAD= -4MA	OUTS	>+2.4V , <+5.5V
VOH2	4.5V	0.0V	4.5V	LOAD= -4MA	OUTS	>+2.4V , <+5.5V
VOL1	4.5V	0.8V	2.2V	LOAD= +8MA	OUTS	>+0.0V , <+0.4V
VOL2	4.5V	0.0V	4.5V	LOAD= +8MA	OUTS	>+0.0V , <+0.4V
I IH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	>-0.00A , <+100A
I IL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-100A , <+0.00A
I LOH	5.5V	0.0V	5.5V	VOUT= 5.5V	OUTS	>-100A , <+100A
I LOL	5.5V	0.0V	5.5V	VOUT= 0.0V	OUTS	>-100A , <+100A
ISBL TTL	5.5V	0.8V	2.2V	CS+OE=2.2V	VCC	>+0.0MA , <+30MA
ISBH TTL	5.5V	0.8V	2.2V	CS+OE=2.2V	VCC	>+0.0MA , <+30MA
ISBL CMS	5.5V	0.0V	5.3V	CS+OE=2.2V	VCC	>+0.0MA , <+2MA
ISBH CMS	5.5V	0.0V	5.3V	CS+OE=2.2V	VCC	>+0.0MA , <+2MA
ICCDR	3.0V	0.2V	2.8V	CS+OE+WE=2.8V	VCC	>+0.00A , <+500A
ICCX	5.5V	0.0V	5.5V	F=1MHZ, 1K BLK	VCC	>+0.0MA , <+2MA
ICCD	5.5V	0.0V	5.5V	FRQ=18.2MHZ	VCC	>+0.0MA , <+120MA
AC PARAMETRIC TESTS						
PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C, -55C & 125C
TAA1_LH	4.5V	0.0V	3.0V	F=1.0MHZ, VCMP=1.5V	OUTPUTS	> 0ns , < 55ns
TAA1_HL	4.5V	0.0V	3.0V	F=1.0MHZ, VCMP=1.5V	OUTPUTS	> 0ns , < 55ns
TAA2_LH	5.5V	0.0V	3.0V	F=1.0MHZ, VCMP=1.5V	OUTPUTS	> 0ns , < 55ns
TAA2_HL	5.5V	0.0V	3.0V	F=1.0MHZ, VCMP=1.5V	OUTPUTS	> 0ns , < 55ns

Table III (cont.)

COMMENTS/EXCEPTIONS	
(1) FUNCTIONAL TESTS ARE PERFORMED AT VCC=5.0V ONLY.	
(2) FUNCTIONAL TESTS #1, #3 & #5 CONSISTS OF THE FOLLOWING PATTERNS :	
1 - ALL ONES	2 - ALL ZEROS
3 - CHECKERBOARD	4 - INVERSED CHECKERBOARD
(3) FUNCTIONAL TESTS #2 & #4 CONSISTS OF THE FOLLOWING APG PATTERNS :	
1 - "10N" MARCH	2 - ROW_ADDRESS
3 - COL_ADDRESS	4 - SLIDING_DIAGONALLY
5 - PING_PONG	6 - SURROUND
7 - ROW_GALPAT	8 - COL_GALPAT
(4) FUNCTIONAL TESTS #6 CONSISTS OF THE FOLLOWING :	
- WRITE CHECKERBOARD (ALL ADDRESSES)	
- REDUCE VCC TO 2.0V TO PERFORM DATA RETENTION TEST.	
- WAIT 55ns AT VCC = 2.0V	
- INCREASE VCC BACK TO 5.0V	
- READ CHECKERBOARD (ALL ADDRESSES)	
(5) VIL & VIH WERE TESTED DYNAMICALLY @ 1MHZ FUNCTIONAL AND GO/NOGO DURING VOL & VOH DC TESTS.	
(6) ICCX : STAND BY QUIESCENT CURRENT MEASUREMENT FOR EVERY 1024 ADDRESS LOCATIONS. CONSIST OF THE FOLLOWING PROCEDURE :	
(a) - WRITE ZEROES (ALL ADDRESSES).	
(b) - WRITE ONES TO THE FIRST 1024 ADDRESSES.	
(c) - PERFORM AN ICCSB MEASUREMENTS.	
(d) - WRITE ZEROES TO THE FIRST 1024 ADDRESSES.	
(e) - REPEAT STEPS (b)-(d) FOR THE NEXT 1024 ADDRESSES AND SO ON, FOR A TOTAL OF 32 READINGS (32K ADDRESSES).	
(7) TESTS NOT PERFORMED :	
- CIN , CCLKL & COUT TEST.	
- WRITE/READ CYCLE TIMING PERFORMED GO/NOGO @ 10.0MHz (FUNCT #1 & #2).	
- ONLY ADDRESS ACCESS TIME PROP. DELAYS WERE PERFORMED (TAA TESTS).	
- ALL OTHER AC TESTS ARE NOT BEING PERFORMED WITHIN THIS PROGRAM.	
(8) THIS PROGRAM TESTS FOR CONTINUITY AND ORIENTATION TESTS. ALSO THIS PROGRAM WILL PERFORM AN OPPOSITE STATE VOL & VOH TEST.	
HARDWARE REQUIREMENTS	TEST TEMPERATURES
DEVICE CONFIGURATION : 28-PIN DIP (0.300")	+25 DEG. C. [X]
S-50 LOAD BOARD #17 : SWITCH/JUMP PIN 14 TO GND.	-55 DEG. C. [X]
	+125 DEG. C. [X]
PROGRAMMER : JUAN R. LANDER	DATE : 06-24-91

TABLE IVa: Summary of Elec. Measurements After
Total Dose Exposures and Annealing for ZQ04031 Group 1 (Static I, biased) 1/2/

Parameters	Spec. Limi min max	Total Dose Exposure (TDE) (krads)										Annealing											
		0 (Pre-Rad)		5		10		20		40		80		48 hours +25°C		168 hour +25°C		168 hour -55°C		168 hour +125°C			
		mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd		
FUNC1		4/0		4/0		4/0		3/1		0/4		0/4		0/4		0/4		4/0		0/4			
FUNC2		4/0		4/0		4/0		1/3		0/4		0/4		0/4		0/4		2/2		0/4			
FUNC3		4/0		4/0		4/0		1/3		0/4		0/4		0/4		0/4		3/1		0/4			
FUNC4		4/0		4/0		4/0		1/3		0/4		0/4		0/4		0/4		0/4		0/4			
FUNC5		4/0		4/0		4/0		1/3		0/4		0/4		0/4		0/4		3/1		0/4			
FUNC6		4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4			
V _{IH} 4.5V	V	0	2.2	1.51	.01	1.50	0	1.31	.02	1.48	.01	1.55	.03	1.53	.02	1.56	0	1.58	.01	1.58	.04	1.18	.02
V _{IH} 5.5V	V	0	2.2	1.50	.01	1.51	.02	1.50	.01	1.50	.02	1.55	.04	1.54	.02	1.57	.01	1.58	.01	1.56	.03	1.37	.02
V _{IL} 4.5V	V	0.8	5.5	1.22	.01	1.23	.02	1.22	.03	1.22	.03	1.22	.01	1.19	.01	1.20	.01	1.21	.02	1.31	.04	1.06	.01
V _{IL} 5.5V	V	0.8	5.5	1.24	.01	1.23	.03	1.22	.02	1.20	.01	1.21	.01	1.19	.01	1.20	.01	1.20	.01	1.29	.03	1.08	.05
V _{OH1}	V	2.4	5.5	3.02	.02	3.02	.01	3.02	.01	3.02	.01	3.02	.02	3.01	.01	3.02	.02	3.02	.02	2.97	.02	3.07	.02
V _{OH2}	V	2.4	5.5	3.02	.02	3.02	.01	3.02	.02	3.02	.02	3.02	.02	3.01	.01	3.02	.02	3.02	.02	2.97	.02	3.07	.02
V _{OL1}	V	0	0.4	0.19	.01	0.20	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.12	.01	0.30	.02
V _{OL2}	V	0	0.4	0.19	.01	0.20	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.12	.01	0.30	.02
I _{IH}	uA	0	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.86	5	0.02	.01
I _{IL}	uA	-10	0	0	-	0	-	0	-	0	-	0	-	-6.2	-	-0.05	0.1	-0.1	0.1	-0.07	0.1	-0.43	0.4
I _{LOH}	uA	-10	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.22	0.4	0.02	.01
I _{LOL}	uA	0	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.01	.04	0.03	0
I _{SBL TTL}	mA	0	30	2.13	.03	2.13	.04	2.13	.02	2.14	.03	2.13	.07	2.30	0.2	2.18	0.2	2.17	0.3	2.68	.04	2.63	0.1
I _{SBH TTL}	mA	0	30	12.2	.08	12.2	.08	12.2	.07	12.2	.08	12.2	0.3	12.6	0.9	12.0	0.9	12.0	0.9	15.1	.08	9.58	.03
I _{SBL CMS}	mA	0	2	0	-	0	-	0	-	0.03	.06	0.26	0.4	0	-	0	-	0	-	0	-	0.45	.06
I _{SBH CMS}	mA	0	2	0	-	0	-	0	-	0.13	0.2	0.56	0.8	0	-	0	-	0	-	0	-	0.45	.06
I _{CCDR}	uA	0	50	0	-	0	-	0	-	98.0	170	445	656	0	-	0	-	0	-	0	-	296	43
I _{CCX}	uA	0	2	0	-	0	-	0	-	0.03	.06	0.26	.36	0	.01	0	-	0	-	0	.01	0.47	.05
I _{CCD}	mA	0	120	33.2	0.3	34.2	0.1	34.5	0.3	34.6	0.1	34.1	0.5	34.7	1.0	34.2	0.2	33.8	0.3	40.6	0.2	31.3	0.2
TAA1 LH	ns	0	55	22.4	0.8	22.5	0.8	22.6	0.8	22.3	0.8	22.6	0.8	22.6	0.8	22.3	0.8	22.3	0.8	19.8	0.6	27.8	1.2
TAA1 HL	ns	0	55	21.6	0.8	22.8	0.9	22.7	0.9	22.6	0.9	22.6	0.9	23.0	0.9	22.6	0.9	22.7	0.9	18.4	0.6	28.3	1.1
TAA2 LH	ns	0	55	19.2	0.8	18.8	0.8	19.5	0.8	19.7	0.8	19.7	0.8	18.6	1.1	18.7	0.9	18.7	0.9	16.6	0.7	23.2	1.4
TAA2 HL	ns	0	55	20.2	0.7	21.3	0.7	23.0	0.7	21.8	0.7	21.0	0.7	21.1	0.7	21.1	0.7	21.0	0.7	17.2	0.7	25.0	0.8

Notes:

- 1/ The mean and standard deviation values were calculated over the twelve parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ #/# in the functional test column means number passed/number failed.

TABLE IVb: Summary of Elec I Measurements After
Total Dose Exposures and Annealing for ZQ04031 Group 2 (Static II, biased) 1/2/

Parameters	Spec. Limit	min	max	Total Dose Exposure (TDE) (krads)												Annealing							
				0 (Pre-Rad)		5		10		20		40		80		48 hours +25°C		168 hour +25°C		168 hour -55°C		168 hour +125°C	
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		3/3		0/4	
FUNC2				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4	
FUNC3				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4	
FUNC4				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4	
FUNC5				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4	
FUNC6				4/0		4/0		4/0		0/4		0/4		0/4		0/4		0/4		0/4		0/4	
VIE 4.5V	V	0	2.2	1.49	.01	1.50	0	1.49	.01	1.46	.01	1.47	.01	2.24	1.3	1.49	.01	1.48	.02	1.56	.03	2.19	1.3
VIE 5.5V	V	0	2.2	1.49	.01	1.50	.01	1.49	.01	1.48	.01	1.46	.01	2.49	1.7	1.49	.01	1.48	.02	1.58	.04	2.42	1.8
VIL 4.5V	V	0.8	5.5	1.23	.01	1.24	.01	1.20	.01	1.22	.01	1.20	.02	0.89	0.5	1.19	.01	1.21	.01	1.20	.02	0.84	0.5
VIL 5.5V	V	0.8	5.5	1.22	.02	1.25	.02	1.22	.03	1.22	.01	1.20	.02	0.90	0.5	1.20	.01	1.21	.01	1.28	.03	0.83	0.5
VOH1	V	2.4	5.5	3.02	.01	3.03	.01	3.03	.01	3.02	.01	3.02	.01	3.02	.02	3.03	.01	3.03	.01	2.97	.01	3.09	.01
VOH2	V	2.4	5.5	3.03	.01	3.03	.01	3.03	.01	3.02	.02	3.02	.01	3.02	.02	3.03	.07	3.03	.01	2.97	.01	3.09	.01
VOL1	V	0	0.4	0.19	.01	0.20	.01	0.19	.01	0.19	.01	0.19	.01	0.28	0.5	0.19	.01	0.19	.01	0.12	.01	0.30	.01
VOL2	V	0	0.4	0.19	.01	0.20	.01	0.19	.01	0.19	.01	0.19	.01	0.28	0.5	0.20	0.5	0.19	.01	0.12	.01	0.30	.01
IIR	uA	0	10	0	-	0	-	0	-	0.88	.01	3.62	.02	10.2	94.7	0.18	1.6	.01	.01	0.97	5.3	0.44	0.3
IIL	uA	-10	0	0	-	0	-	0	-	1.08	0.3	16	17.6	7	100	44	61	.01	.01	2.26	0.9	2.3	2.5
ILOH	uA	-10	10	0	-	0	-	0	-	0.02	.01	11.7	36.0	33.0	169	0.53	2.9	0	0	0.16	0.4	0.34	0.4
ILOL	uA	0	10	0	-	0	-	0	-	2.22	0.5	13	23.4	17	44.8	5.7	17	-.24	0.5	.02	.06	0.4	0.6
ISBL TTL	mA	0	30	2.12	.03	2.13	.04	2.12	.03	2.12	.03	2.15	-	2.21	.09	2.45	0.6	2.12	.03	2.66	.02	2.63	.05
ISBH TTL	mA	0	30	12.3	.01	12.0	.01	12.0	.09	11.9	.09	11.8	.06	11.6	.04	11.6	0.2	11.5	.01	15.6	.14	9.29	.05
ISBL CMS	mA	0	2	0	-	0	-	0	-	0.42	.07	11.9	0.9	1.43	0.7	0.18	.13	0	-	0	-	0.57	.07
ISBH CMS	mA	0	2	0	-	0	-	0	-	0	-	0.25	.04	0.05	.14	0	-	0	-	0	-	0.51	.06
ICCDR	uA	0	50	0	-	0	-	0	-	0	-	8.25	14.3	23.4	41	0	-	0	-	0	-	3.2	27
ICCX	mA	0	2	0	-	0	-	0	-	0.20	.04	1.59	0.8	1.39	0.8	0.17	.12	0	-	0	-	0.60	.06
ICCD	mA	0	120	33.5	0.5	34.5	0.3	34.8	0.2	34.8	0.3	34.6	0.2	35.4	0.2	36.4	2.7	34.1	0.2	41.2	0.2	31.4	0.1
TAA1 LH	ns	0	55	22.7	0.8	22.5	0.8	22.4	0.8	22.4	0.8	22.5	0.8	3E5	4E5	22.5	0.8	22.5	0.8	19.7	0.6	3E4	2E5
TAA1 HL	ns	0	55	21.8	0.9	22.9	0.9	22.8	0.9	22.7	0.9	22.7	1.0	5E4	2E5	29.6	15.9	22.9	0.9	18.3	0.6	5E4	2E5
TAA2 LE	ns	0	55	19.1	0.9	18.2	0.8	18.0	0.8	18.7	0.8	18.8	0.8	2E5	4E5	18.8	0.8	18.9	0.8	16.6	0.6	2E4	4E4
TAA2 HL	ns	0	55	20.2	0.7	21.1	0.7	21.1	0.7	21.0	0.7	21.0	0.7	6E4	2E5	21.0	1.2	21.1	0.7	17.0	0.7	3E4	2E4

Notes:

- 1/ The mean and standard deviation values were calculated over the twelve parts irradiated in this testing. The control samples remained constant throughout the testing and are not included in this table.
- 2/ #/# in the functional test column means number passed/number failed.

TABLE IVc: Summary of Electrical Measurements After
Total Dose Exposures and Annealing for ZQ04031 Group 3 (unbiased) 1/2/

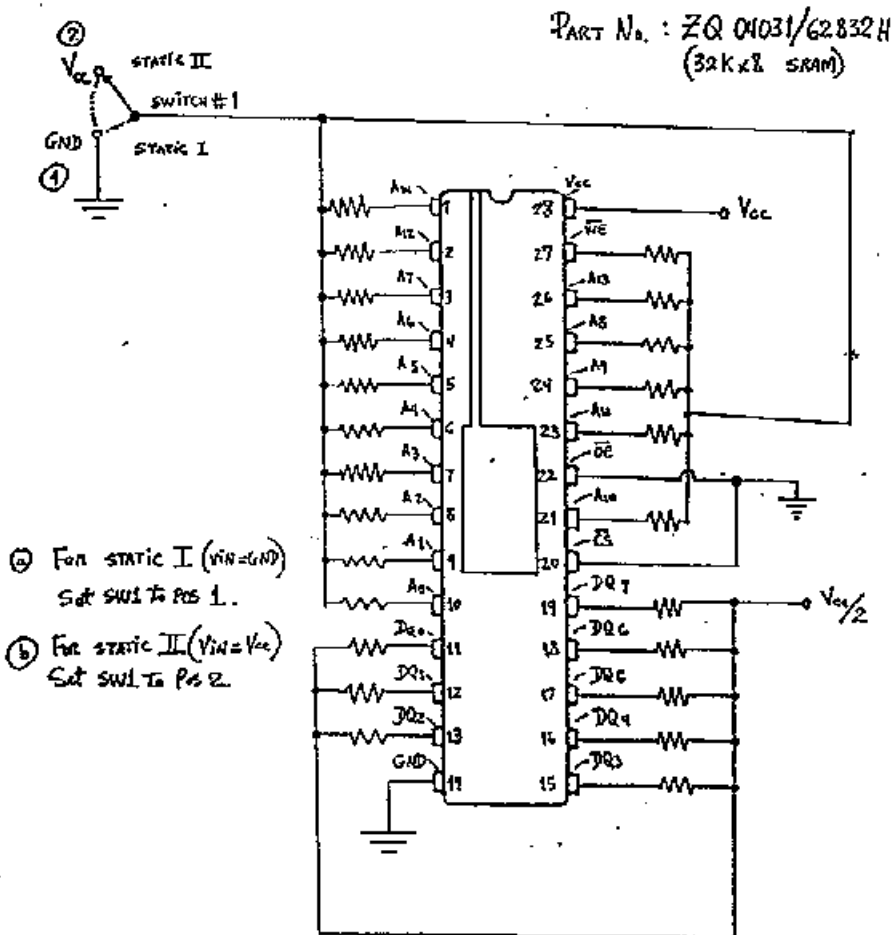
Parameters	Spec. Limit	min	max	Total Dose Exposure (TDE) (krads)												Annealing							
				0 (Pre-Rad)		5		10		20		40		80		48 hours +25°C		168 hour +25°C		168 hour -55°C		168 hour +125°C	
				mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
FUNC1				4/0		4/0		4/0		4/0		4/0		4/0		4/0		4/0		4/0		3/1	
FUNC2				4/0		4/0		4/0		4/0		4/0		1/3		1/3		1/3		4/0		3/1	
FUNC3				4/0		4/0		4/0		4/0		4/5		4/0		4/0		4/0		4/0		3/1	
FUNC4				4/0		4/0		4/0		4/0		3/1		1/3		1/3		1/3		4/0		3/1	
FUNC5				4/0		4/0		4/0		4/0		4/5		1/3		2/2		3/1		4/0		3/1	
FUNC6				4/0		4/0		4/0		3/1		3/1		1/3		1/3		1/3		4/0		3/1	
V _{IH} 4.5V	V	0	2.2	1.49	.02	1.50	.02	1.50	.02	1.49	.02	1.48	.02	1.46	.01	1.46	.02	1.48	.01	1.58	.03	1.40	.02
V _{IH} 5.5V	V	0	2.2	1.49	.02	1.51	.01	1.50	.02	1.49	.02	1.48	.01	1.47	.01	1.47	.01	1.47	.02	1.57	.03	1.40	.03
V _{IL} 4.5V	V	0.8	5.5	1.24	.02	1.25	.02	1.22	.02	1.24	.04	1.22	.02	1.19	.01	1.19	.02	1.19	.01	1.27	.01	1.09	.04
V _{IL} 5.5V	V	0.8	5.5	1.24	.03	1.24	.03	1.22	.02	1.23	.02	1.22	.02	1.20	.02	1.20	.03	1.20	.02	1.29	.04	1.09	.03
V _{OH1}	V	2.4	5.5	3.0	.02	3.0	.02	3.0	.02	3.0	.02	3.0	.02	3.01	.02	3.01	.02	3.01	.02	2.95	.02	3.06	.03
V _{OH2}	V	2.4	5.5	3.0	.02	3.0	.02	3.0	.02	3.0	.02	3.0	.02	3.01	.02	3.01	.02	3.01	.02	2.95	.02	3.06	.02
V _{OL1}	V	0	0.4	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.12	.01	0.29	.01
V _{OL2}	V	0	0.4	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.19	.01	0.12	.01	0.29	.01
I _{IH}	uA	0	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.04	0.2	0	.01
I _{IL}	uA	-10	0	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.02	0.1	0	.01
I _{LOH}	uA	-10	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.01	.03	0.04	.06
I _{LOL}	uA	0	10	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.01	.02	0.01	.01
I _{SBL TTL}	mA	0	30	2.09	.04	2.08	.03	2.09	.03	2.09	.04	2.08	.04	2.08	.04	2.07	.04	2.08	0.1	2.57	0.1	2.30	0.1
I _{SBH TTL}	mA	0	30	12.1	0.1	12.0	0.1	12.0	0.1	11.9	0.2	11.8	0.2	11.6	0.2	11.6	0.2	11.6	0.2	15.6	0.3	9.30	0.2
I _{SBL CMS}	mA	0	2	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.23	0.1
I _{SBH CMS}	mA	0	2	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.23	0.1
I _{CCDR}	uA	0	50	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	134	60
I _{CCX}	mA	0	2	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0.23	0.1
I _{CCD}	mA	0	120	33.1	0.3	33.6	.09	33.1	0.2	33.6	0.2	33.8	0.3	33.7	0.3	33.9	0.3	33.3	0.2	40.5	0.3	30.9	0.2
TAA1 LH	ns	0	55	22.8	0.9	22.4	0.9	22.4	0.9	22.3	0.9	22.3	0.9	22.5	0.9	22.3	0.9	22.4	0.9	19.7	0.7	28.4	1.5
TAA1 HL	ns	0	55	21.7	1.0	22.6	1.0	22.6	1.0	22.6	1.0	22.6	1.0	23.0	1.1	22.7	1.0	22.7	1.0	18.3	0.7	29.4	1.7
TAA2 LH	ns	0	55	19.2	0.9	18.8	0.9	18.8	0.9	18.8	0.9	18.8	0.9	18.6	1.1	18.7	0.9	18.8	0.9	16.5	0.7	23.9	1.7
TAA2 HL	ns	0	55	20.2	0.7	21.0	0.7	21.0	0.8	20.9	0.7	21.0	0.8	21.1	0.8	21.0	0.8	21.0	0.8	17.1	0.7	27.1	1.5

Notes:

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

2/ #/# in the functional test column means number passed/number failed.

Figure 1. Radiation Bias Circuit for ZQ04031



- NOTES:
1. ALL RESISTORS ARE $2K\Omega \pm 5\%$
 2. $V_{CC} = 6V \pm 0.25V$
 3. $V_{CC}/2 = 2.5V \pm 3.0V$
 4. $T_A = +125^{\circ}C \pm 0.5^{\circ}C$ During Burn-In or Live Test.
 $T_A = +25^{\circ}C$ During Radiation.

DESIGNED BY: JL 05/07/91
APPROVAL BY: KK 5/7/91

FIGURE 1. STATIC I & II CIRCUIT,
AND RADIATION BIAS CIRCUIT.