Federal Systems

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DATE: September 20, 1996
TO: A. Garrison/310
FROM: K. Sahu/300.1 KS
SUBJECT: Radiation Report on: 16 MBit DRAMs, Q02L00JQ and P44016JK
Project: Parts and Packaging
Control #: 15054 and 15055
Job #: EE61915

PPM-96-009

- cc: M. Gates/735.1
G. Kramer/311
A. Sharma/311
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A radiation evaluation was performed on Q02L00JQ and P44016JK (16 MBit DRAMs, 5-volt and 3.3-volt, respectively) 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 Co^{60} gamma ray source. During the radiation testing, five parts of each type were irradiated under bias (see Figure 1 for bias configuration) and one part of each type was used as a control sample. The total dose radiation levels were 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krads*. The dose rate was between 0.08 and 1.25 krads/hour (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. The electrical tests included six functional tests. These were as follows: 1. SIMPLE FUNCTIONAL TEST (which consists of randomly accessing two addresses without using the algorithmic pattern generator), 2. COL_ADDRESS, 3. ALL_ONES, 4. ALL_ZEROS, 5. CHECKERBOARD & INVERSE CHECKERBOARD, 6. SURROUND.

Q02L00JQ (5-volt part type):

All irradiated parts passed all functional and electrical tests up to and including the 50 krad irradiation level. After the 75 krad irradiation, one of the five irradiated parts (S/N 64) exceeded the maximum specification limit of 10 μA for IIL, with a reading of >128 μA (this was the preset limit of the test equipment) and exceeded the maximum specification limit of 2 mA for ICC2, with a reading of 4.9 mA. All parts continued to pass all functional tests and all other irradiated parts continued to pass all other electrical parametric tests.

After the 100 krad irradiation, four of the five irradiated parts (S/N 62, 64, 65 and 66) exceeded the maximum specification limit for IIL, with readings of >128 μA and S/N 64, 65 and 66 exceeded the maximum specification limit for ICC2, with readings of 16.0, 5.4 and 6.6 mA, respectively. In addition, S/N 64 marginally exceeded the maximum specification limit of 75.0 mA for ICC1, with a reading of 75.2 mA, and marginally exceeded the maximum specification limit of 65.0 mA for ICC4, with a reading of 65.1 mA. All parts continued to pass all functional tests and all other irradiated parts continued to pass all other electrical parametric tests. After annealing for 168 hours at 25°C, all five of the irradiated parts showed the same degradation, but continued to pass all functional tests.

After annealing for 168 hours at 100°C, all parts except one recovered to within specification limits for all IIL and ICC tests. One part (S/N 64) continued to exceed specification limits for ICC2, with a reading of 2.2 mA. No rebound effects were observed.

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* The term rads, as used in this document, means rads(SiO_2). 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.

P44016JK (3.3-volt part type):

All parts passed initial electrical measurements. All parts passed all electrical parametric and functional tests up to and including the 20 krad level.

After the 30 krad irradiation, S/N 67 and 70 exceeded the maximum specification limit of 10 μA for IIL, with a reading of >128 μA (this was the preset limit of the test equipment). All parts continued to pass all functional tests and all other irradiated parts continued to pass all other electrical parametric tests.

After the 50 krad irradiation, all irradiated parts showed the same degradation in IIL. In addition, all irradiated parts exceeded the maximum specification limit of 2.0 mA for ICC2, with readings ranging from 2.2 to 16 mA and exceeded the maximum specification limit of 1.0 mA for ICC5, with readings ranging from 2.2 to 16 mA. All parts continued to pass all functional tests and all irradiated parts continued to pass all other electrical parametric tests.

After the 75 krad irradiation, all irradiated parts continued to show the same degradation in IIL, ICC2 and ICC5, with all parts reading approximately 16.0 mA for both ICC2 and ICC5. In addition, S/N 67 exceeded the maximum specification limit of 65.0 mA for ICC4, with a reading of 70.4 mA and S/N 67 exceeded the maximum specification limits for ICC1 through ICC6, with readings ranging from 16 to 97.1 mA. At this irradiation level, various timing measurement failures were also observed.

After the 100 krad irradiation, the following degradation was observed: S/N 67 and 68 failed all six functional tests, S/N 70 failed Functional Tests # 2-6 and S/N 69 and 72 failed Functional Tests # 2-5. All irradiated parts continued to show similar degradation in IIL and ICC1 through ICC6. In addition, S/N 67, 68, 69 and 72 fell below the minimum specification limit of 0.8 V for VIL_3.0V, with readings ranging from 0.7 to -0.1 V. S/N 67 and 68 also exceeded the maximum specification limit of 2.4 V for VIH_3.0V and VIH_3.3V, with readings of 3.1 V and 3.7 V, respectively. S/N 67 and 68 also fell below the minimum specification limit of 0.8 V for VIL_3.3V, with readings of -0.1 V. Timing measurement failures continued to be observed.

After annealing for 168 hours at 25°C, almost no recovery was seen in the functional failures (S/N 70 passed Functional Test # 6). S/N 69, 70 and 72 recovered to within specification limits for all VIH and VIL tests. Degradation in IIL and various ICC tests and timing measurements continued to be observed.

After annealing for 168 hours at 100°C, all irradiated parts passed all functional and electrical parametric tests. No rebound effects were observed.

Table IV provides a summary of the mean and standard deviation values for each parameter after each irradiation exposure and annealing step.

Comparison of 5-volt and 3.3-volt Part Types:

The 5-volt part type (Q02I00JQ) began to show degradation in ICC at the 50 krad level and in IIL at the 75 krad level. No functional failures were observed up to and including the 100 krad level.

The 3.3-volt part type (P44016JK) began to show degradation in IIL at the 30 krad level and in ICC at the 50 krad level. Numerous timing failures began to occur at the 75 krad level, and all irradiated parts failed at least four functional tests after the 100 krad irradiation.

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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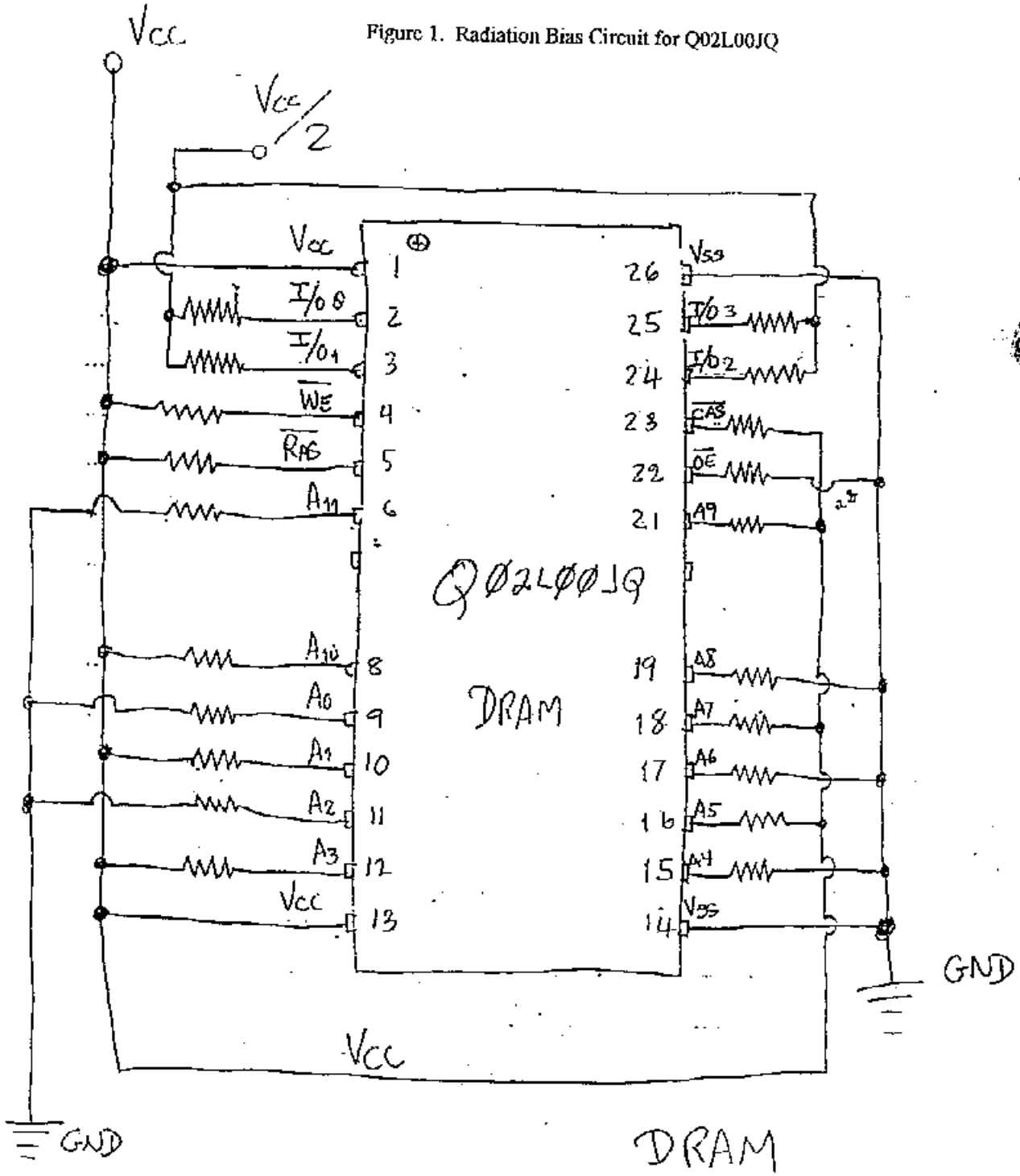
Figure 1. Radiation Bias Circuit for Q02L00JQ



DRAM

RADIATION BIAS CIRCUIT

$V_{CC} = +5.0V \pm 0.1V$

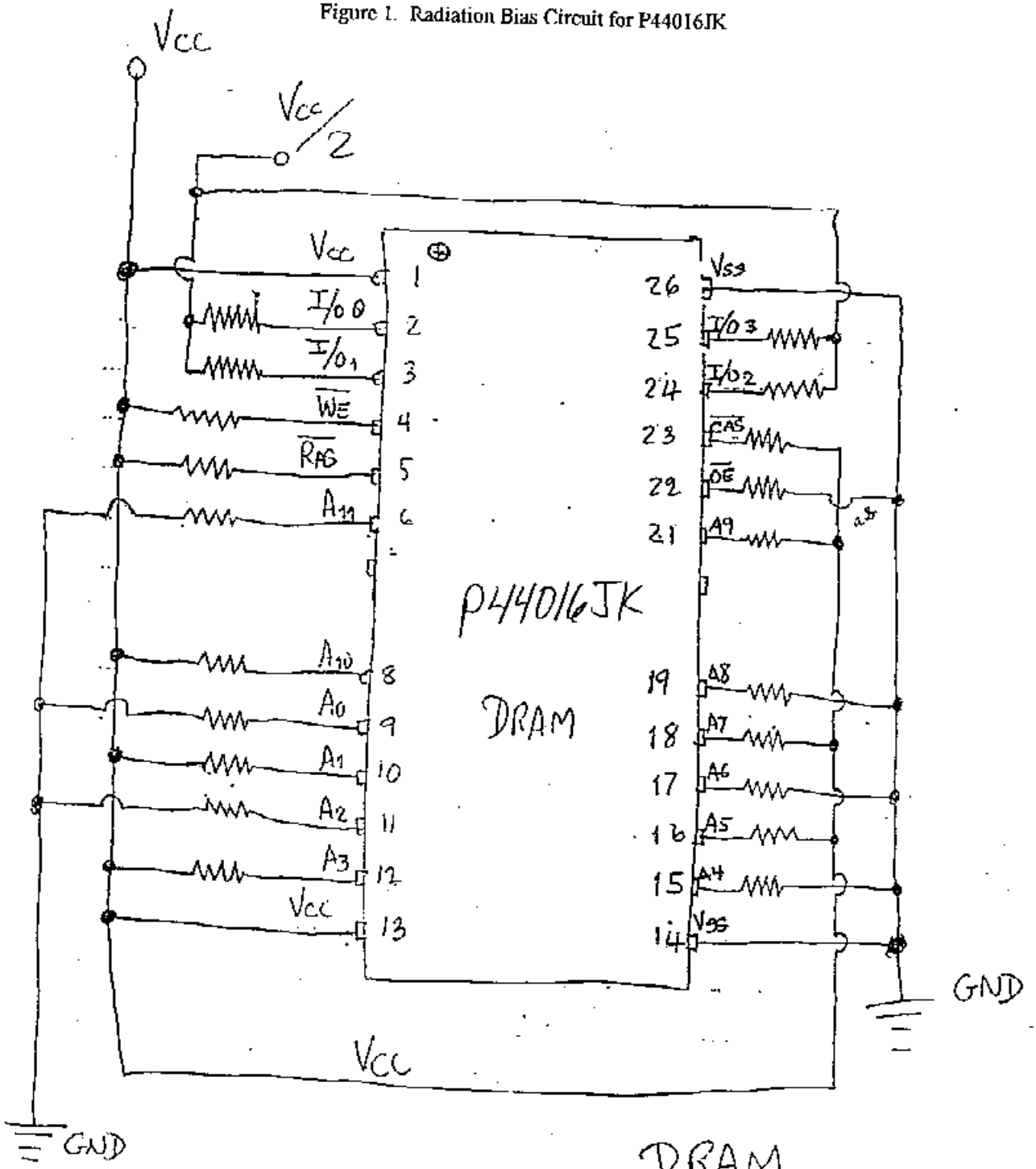
$V_{CC}/2 = +2.5V \pm 0.1V$

GND = 0V ± 0V

RL 2/11/95

R = 2KΩ ~~47KΩ~~ ± 10% 1/4W

Figure 1. Radiation Bias Circuit for P44016JK



DRAM
RADIATION BIAS CIRCUIT

$V_{CC} = +3.0V \pm 0.1V$, $GND = 0V \pm 0V$

$V_{CC}/2 = +1.5V \pm 0.1V$, $R = 2K\Omega$ ~~to 47KΩ~~ ± 10% 1/4 W

RAE 2/11/95

TABLE I. Part Information

Generic Part Numbers:	Q02L00JQ* P44016JK
Parts and Packaging Part Numbers	Q02L00JQ P44016JK
Parts and Packaging Control Number:	15054 15055
Charge Number:	EE61915
Manufacturer:	IBM
Lot Date Codes (LDC):	Q02L00JQ: 9314 P44016JK: 9352
Quantities Tested:	Q02L00JQ: 6 P44016JK: 6
Serial Numbers of Control Samples:	Q02L00JQ: 61 P44016JK: 67
Serial Numbers of Radiation Samples:	Q02L00JQ: 62, 63, 64, 65, 66 P44016JK: 68, 69, 70, 71, 72
Part Function:	16 MBit DRAM
Part Technology:	CMOS
Package Style:	24-pin SOJ (plastic)
Test Equipment:	S-50
Engineer:	C. Nguyen

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

TABLE II. Radiation Schedule for Q02L00JQ and P4401GJK

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS	06/18/96
2) 2.5 KRAD IRRADIATION* (0.16 KRADS/HOUR)	06/18/96
POST-2.5 KRAD ELECTRICAL MEASUREMENT	06/19/96
3) 5 KRAD IRRADIATION (0.16 KRADS/HOUR)	06/19/96
POST-5 KRAD ELECTRICAL MEASUREMENT	06/20/96
4) 10 KRAD IRRADIATION (0.30 KRADS/HOUR)	06/20/96
POST-10 KRAD ELECTRICAL MEASUREMENT	06/21/96
5) 15 KRAD IRRADIATION (0.08 KRADS/HOUR)	06/21/96
POST-15 KRAD ELECTRICAL MEASUREMENT	06/24/96
6) 20 KRAD IRRADIATION (0.18 KRADS/HOUR)	06/24/96
POST-20 KRAD ELECTRICAL MEASUREMENT	06/26/96
7) 30 KRAD IRRADIATION (0.67 KRADS/HOUR)	06/26/96
POST-30 KRAD ELECTRICAL MEASUREMENT	06/27/96
8) 50 KRAD IRRADIATION (1.25 KRADS/HOUR)	06/27/96
POST-50 KRAD ELECTRICAL MEASUREMENT	06/28/96
8) 75 KRAD IRRADIATION (0.23 KRADS/HOUR)	06/28/96
POST-75 KRAD ELECTRICAL MEASUREMENT	07/03/96
8) 100 KRAD IRRADIATION (0.71 KRADS/HOUR)	07/03/96
POST-100 KRAD ELECTRICAL MEASUREMENT	07/05/96
14) 168-HOUR ANNEALING @25°C	07/05/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/12/95
15) 168-HOUR ANNEALING @ 100°C	07/16/95
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	07/23/95

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

Table IIIa. Electrical Characteristics of Q02L00JQ

PART NO : Q02L00JQ	PART TYPE : 4MX4 16MBITS CMOS DYNAMIC RAM	PCN : SI10773A
LOCATION	TEST SPECIFICATIONS	
DIRECTORY : [LIBRARY.773]	IBM 1994 DATA SHEETS	

FUNCTIONAL TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C
FUNCT # 1	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V
FUNCT # 2	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V
FUNCT # 3	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V
FUNCT # 4	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V
FUNCT # 5	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V
FUNCT # 6	5.0V	0.0V	5.0V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V / VOH>2.0V

DC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C
VIH_4.5V	4.5V	N/A	N/A	FREQ= 5MHZ	INS	>+0.0V / <+2.4V
VIH_5.5V	5.5V	N/A	N/A	FREQ= 5MHZ	INS	>+0.0V / <+2.4V
VIL_4.5V	4.5V	N/A	N/A	FREQ= 5MHZ	INS	>+0.8V / <+4.5V
VIL_5.5V	5.5V	N/A	N/A	FREQ= 5MHZ	INS	>+0.8V / <+5.5V
IIH	5.5V	0.0V	5.5V	VIN = 5.5V	INS	>-10.0UA / <+10.0UA
IIL	5.5V	0.0V	5.5V	VIN = 0.0V	INS	>-10.0UA / <+10.0UA
IOZH	5.5V	0.0V	5.5V	VOUT= 5.5V	OUTS	>-10.0UA / <+10.0UA
IOZL	5.5V	0.0V	5.5V	VOUT= 0.0V	OUTS	>-10.0UA / <+10.0UA
ICC1	5.5V	0.0V	5.5V	FRQ=1/TRC MIN	VCC	> 0.0MA / <+75.0MA
ICC2	5.5V	0.0V	5.5V	STAND-BY	VCC	> 0.0MA / <+ 2.0MA
ICC3	5.5V	0.0V	5.5V	FRQ=1/TRC MIN	VCC	> 0.0MA / <+75.0MA
ICC5	5.5V	0.0V	5.5V	FRQ=1/TRC MIN	VCC	> 0.0MA / <+65.0MA
ICC6	5.5V	0.0V	5.5V	STAND-BY	VCC	> 0.0MA / <+ 1.0MA
				FRQ=1/TRC MIN	VCC	> 0.0MA / <+75.0MA

AC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	OUTPINS	LIMITS 25C
TAA_LH	4.5V	0.0V	3.0V	F=5.0MHZ/VCMP=1.5V	OUTS	> 0NS / < 35NS
TAA_HL	4.5V	0.0V	3.0V	F=5.0MHZ/VCMP=1.5V	OUTS	> 0NS / < 35NS

Table IIIb. Electrical Characteristics of P44016JK

PART NO : [redacted] P44016JK
PART TYPE : 4MX4 16NBITS CMOS DYNAMIC RAM
PCN : SI10774A

LOCATION
DIRECTORY : [LIBRARY.774]

TEST SPECIFICATIONS
IBM 1994 DATA SHEETS

FUNCTIONAL TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C
FUNCT # 1	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V
FUNCT # 2	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V
FUNCT # 3	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V
FUNCT # 4	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V
FUNCT # 5	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V
FUNCT # 6	3.3V	0.0V	3.3V	FREQ= 5.000MHZ	ALL I/O	VOL<1.0V , VOH>2.0V

DC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	PINS	LIMITS 25C
VIH_3.0V	3.0V	N/A	N/A	FREQ= 5MHZ	INS	>+0.0V , <+2.4V
VIH_3.6V	3.6V	N/A	N/A	FREQ= 5MHZ	INS	>+0.0V , <+2.4V
VIL_3.0V	3.0V	N/A	N/A	FREQ= 5MHZ	INS	>+0.8V , <+3.0V
VIL_3.6V	3.6V	N/A	N/A	FREQ= 5MHZ	INS	>+0.8V , <+3.6V
IIH	3.6V	0.0V	3.9V	VIN = 3.9V	INS	>-10.0UA , <+10.0UA
IIL	3.6V	0.0V	3.6V	VIN = 0.0V	INS	>-10.0UA , <+10.0UA
IOZH	3.6V	0.0V	3.6V	VOUT= 3.6V	OUTS	>-10.0UA , <+10.0UA
IOZL	3.6V	0.0V	3.6V	VOUT= 0.0V	OUTS	>-10.0UA , <+10.0UA
ICC1	3.6V	0.0V	3.6V	FRQ=1/TRC MIN	VCC	> 0.0MA , <+75.0MA
ICC2	3.6V	0.0V	3.6V	STAND-BY	VCC	> 0.0MA , <+ 2.0MA
ICC3	3.6V	0.0V	3.6V	FRQ=1/TRC MIN	VCC	> 0.0MA , <+75.0MA
ICC4	3.6V	0.0V	3.6V	FRQ=1/TPC MIN	VCC	> 0.0MA , <+65.0MA
ICC5	3.6V	0.0V	3.6V	STAND-BY	VCC	> 0.0MA , <+ 1.0MA
ICC6	3.6V	0.0V	3.6V	FRQ=1/TRC MIN	VCC	> 0.0MA , <+75.0MA

AC PARAMETRIC TESTS

PARAMETER	VCC	VIL	VIH	CONDITIONS	OUTPINS	LIMITS 25C
TAA_LH	3.0V	0.0V	3.0V	F=5.0MHZ, VCMP=1.5V	OUTS	> 0NS , < 35NS
TAA_HL	3.0V	0.0V	3.0V	F=5.0MHZ, VCMP=1.5V	OUTS	> 0NS , < 35NS

TABLE IVa: Summary of Functional Tests after Total Dose Exposures and Annealing for Q02L00JQ

#	Functional Tests /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
1	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P
2	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P
3	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P
4	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P
5	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P
6	Vcc=5.0V,Vil=0.0V,Vih=5.0V,Freq=5MHz	P	P	P	P	P	P	P	P	P	P	P	P

#	Parameters	Units	Spec. Lim./3 min	max	Initial mean	sd	2.5 mean	sd	5 mean	sd	10 mean	sd	15 mean	sd	20 mean	sd	30 mean	sd	50 mean	sd	75 mean	sd	100 mean	sd	168 hrs@25°C mean	sd	168 hrs@100°C mean	sd
1	VIH_4.5V	V	0	2.4	1.74	.05	1.70	0	1.72	.04	1.70	0	1.72	.04	1.70	0	1.70	0	1.62	.04	1.60	0	1.58	.04	1.60	0	1.68	.04
2	VIH_5.5V	V	0	2.4	1.78	.04	1.76	.05	1.74	.05	1.74	.05	1.72	.04	1.70	0	1.70	0	1.68	.04	1.64	.05	1.60	0	1.60	0	1.70	0
3	VIL_4.5V	V	0.8	4.5	1.30	0	1.16	.08	1.20	.06	1.20	.06	1.20	0	1.20	0	1.20	0	1.18	.04	1.06	.08	1.02	.12	1.10	0	1.12	.07
4	VIL_5.5V	V	0.8	5.5	0.92	.04	1.22	.04	1.08	.15	1.14	.12	1.20	0	1.20	0	1.04	.20	0.98	.15	1.10	0	0.98	.17	1.00	.15	0.92	.16
5	IIH	µA	-10	10	0	0	0	.01	0	0	0	.01	0	0	0	0	0	.01	0.02	.08	0.12	.06	0.03	.11	0.01	.06	0	0
6	IIL/4	µA	-10	10	-0.11	.21	-0.11	.21	-0.11	.21	-0.11	.21	-0.11	.20	-0.11	.20	-0.10	.17	-0.17	.18	4P1F		1P4F		1P4F		4P1F	
7	IOZH	µA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	.15	0.05	.11	0.11	.20	0.05	.09	0	0
8	IOZL	uA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.04	.05	-0.17	.11	-1.14	1.5	-0.66	.57	-0.01	.02
9	ICC1	mA	0	75	28.4	.36	28.4	.43	28.4	.42	28.4	.42	28.3	.37	28.1	.38	27.8	.29	27.7	.33	29.2	2.5	41.0	17	34.8	10	27.9	.64
10	ICC2	mA	0	2	0.04	.01	0.04	.02	0.03	.02	0.02	.01	0.02	.01	0.02	.02	0.03	.01	0.11	.09	1.27	1.8	6.08	5.4	4.25	5.9	0.50	.85
11	ICC3	mA	0	75	25.4	.37	25.4	.43	25.4	.41	25.4	.42	25.3	.43	25.1	.35	24.9	.32	24.7	.30	26.2	2.5	38.0	17	31.8	10	25.0	.61
12	ICC4	mA	0	65	4.53	.08	4.54	.10	4.36	.25	4.51	.10	4.48	.10	4.50	.08	4.39	.33	5.04	.67	7.93	4.0	23.1	21	15.7	14	4.34	.97
13	ICC5	mA	0	1	0.02	.02	0.03	.01	0.02	.02	0.02	.01	0.03	0	0.04	.02	0.03	.01	0.10	.10	1.26	1.8	6.12	5.4	4.27	5.9	0.48	.84
14	ICC6	mA	0	75	28.5	.44	28.5	.44	28.5	.45	28.4	.40	28.2	.36	28.2	.43	27.9	.35	27.9	.34	29.2	2.5	41.0	17	34.9	10	27.9	.61
16	TAA_LH	ns	0	35	18.4	.18	18.5	.18	18.5	.20	18.6	.20	18.5	.32	18.6	.16	18.6	.15	19.0	.75	18.9	.86	19.4	.73	18.9	.24	18.7	.25
16	TAA_HL	ns	0	35	15.3	3.1	15.3	3.2	15.4	3.1	15.3	3.1	15.4	3.2	15.4	3.3	15.4	3.3	15.6	3.4	15.7	3.4	16.4	3.2	16.2	3.2	15.5	3.3

Notes:

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

2/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.

3/ 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.

4/ After the 75 krad irradiation, some parts had readings exceeding the preset limits of the test equipment (128 µA). Test results are then indicated as Pass/Fail, as in note 2.

TABLE IVb: Summary of Functional Tests after Total Dose Exposures and Annealing for P44016JK

#	Functional Tests /2	Initial	2.5	5	10	15	20	30	50	75	100	Annealing 168 hrs@25°C	Annealing 168 hrs@100°C
1	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	3P2F	3P2F	P
2	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	F	F	P
3	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	F	F	P
4	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	F	F	P
5	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	F	F	P
6	Vcc=3.3V,Vil=0.0V,Vih=3.3V,Freq=5MHz	P	P	P	P	P	P	P	P	P	F	F	P

#	Parameters	Units	Spec. Lim./3 min	Spec. Lim./3 max	Initial mean	Initial sd	2.5 mean	2.5 sd	5 mean	5 sd	10 mean	10 sd	15 mean	15 sd	20 mean	20 sd	30 mean	30 sd	50 mean	50 sd	75 mean	75 sd	100 mean	100 sd	168 hrs@25°C mean	168 hrs@25°C sd	168 hrs@100°C mean	168 hrs@100°C sd
1	VIH_3.0V	V	0	2.4	1.52	.04	1.50	.06	1.44	.05	1.46	.05	1.44	.05	1.40	0	1.36	.05	1.34	.05	2.02	.88	2.02	.88	2.02	.88	1.38	.04
2	VIH_3.6V	V	0	2.4	1.82	.04	1.84	.05	1.74	.05	1.76	.05	1.74	.05	1.62	.04	1.60	0	1.60	0	1.96	.87	2.38	1.0	2.38	1.1	1.60	0
3	VIL_3.0V	V	0.8	3.0	0.90	0	0.92	.04	0.96	.05	0.94	.05	0.98	.04	1.02	.04	1.00	0	1.00	0	0.76	.43	0.40	.41	0.50	.49	0.98	.04
4	VIL_3.6V	V	0.8	3.6	1.04	.04	1.08	.04	1.14	.05	1.10	0	1.16	.05	1.24	.05	1.28	.04	1.26	.05	0.94	.52	0.58	.56	0.64	.61	1.20	0
5	IIH	µA	-10	10	0	.01	0	0	0	0	0	0	0	0	0	0	0.01	.03	0.15	.39	0.27	.76	0.37	1.1	0.28	.86	0.02	.09
6	IIL /4	µA	-10	10	0	0	0	0	0	0	0	0	0	0	-0.01	.03	3P2F		F		F		F		F		-0.17	.25
7	IOZH	µA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	0.04	.04	0.68	.51	1.28	1.2	1.77	1.7	1.34	1.4	0.08	.16
8	IOZL	µA	-10	10	0	0	0	0	0	0	0	0	0	0	0	0	-0.17	.11	-0.54	.29	-1.06	.49	-1.97	1.1	-0.95	.23	-0.03	.03
9	ICC1	mA	0	75	26.8	.54	26.6	.32	26.6	.29	26.6	.30	26.6	.26	27.1	.33	27.3	.50	35.5	6.1	64.4	19	117	14	70.7	11	26.8	.19
10	ICC2	mA	0	2	0.20	.38	0.01	.01	0.01	.01	0.03	.01	0.02	.02	0.02	.01	0.17	.14	7.28	5.8	16.0	.02	16.0	0	16.0	.01	0.05	.02
11	ICC3	mA	0	75	25.3	.56	25.1	.26	25.0	.29	25.1	.22	25.0	.27	25.4	.29	25.5	.46	35.7	6.1	62.8	19	115	14	69.8	11	25.0	.13
12	ICC4	mA	0	65	3.47	.53	3.22	.17	3.17	.16	3.18	.17	3.20	.18	3.08	.03	3.70	.12	12.8	5.8	49.2	20	121	14	73.9	15	3.52	.24
13	ICC5	mA	0	1	0.20	.38	0.02	.01	0.02	.02	0.01	.01	0.02	.01	0	.01	0.16	.14	7.27	5.8	16.0	.03	16.0	.01	16.0	.01	0.05	.03
14	ICC6	mA	0	75	27.0	.50	26.8	.27	26.8	.25	26.6	.21	26.7	.25	27.1	.37	27.3	.48	35.5	6.1	64.2	18	116	13	71.0	11	26.9	.18
15	TAA_LH	ns	0	35	18.5	3.6	19.1	1.6	18.9	1.9	19.2	2.6	19.7	.81	19.2	2.2	19.5	1.0	5.0E4	2.2E5	1.0E5	3.0E5	1.5E5	3.6E5	1.0E5	3.0E5	19.5	.93
16	TAA_HL	ns	0	35	12.5	6.4	9.11	4.9	9.28	6.9	6.7E4	2.5E4	8.70	5.8	10.2	6.3	10.8	5.7	4.0E5	4.9E5	6.7E4	2.5E5	1.3E5	3.4E5	6.7E4	2.5E5	7.56	6.3

Notes:

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

2/ "P" indicates that all parts passed this test at this irradiation or annealing level. "F" indicates that all parts failed this test at this irradiation or annealing level. "nPmF" indicates that n parts passed and m parts failed this test at this irradiation or annealing level.

3/ 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.

4/ After the 30 krad irradiation, some parts had readings exceeding the preset limits of the test equipment (128 µA). Test results are then indicated as Pass/Fail, as in note 2.