

Unisys

DATE: June 30, 1997
 TO: A. Sharma/311
 FROM: K. Sahu/300.1
 SUBJECT: Radiation Report on: AM29F016
 Project: New Technology Evaluations
 Job #: C71064 (C78033)
 Project part #: AM29F016

PPM-97-011

cc: G. Kramer/311
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A radiation evaluation was performed on AM29F016 (16Mbit Flash Memory) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Figures 1 and 2, and Tables I through IV.

The total dose testing was performed using a Co⁶⁰ gamma ray source. During the radiation testing, four parts (SN's 71, 72, 73, and 74) were irradiated without pretreatment, four parts (SN's 75, 76, 77, and 78) were given an 85/85 test before irradiation and four parts (SN's 79, 80, 81, and 82) were given a 1000-hour life test before irradiation. All parts were irradiated under bias (see Figure 1 for bias configuration) and three parts (SN's 70, 83 and 84) were used as control samples for each batch respectively. The total dose radiation levels were 5.0, 7.5, and 10 kRads* for the standard radiation parts, 5.0, 7.5, 10, and 15 kRads for the 85/85 parts, and 5.0, 10, and 15 kRads for the 1000-hour life parts. The dose rate was 0.125 kRads/hour for all parts (see Table II for radiation schedule). After the last irradiation, the parts were annealed under bias. The standard radiation parts were annealed for 144 and 168 hours at 25°C, 336 hours at 25°C for the 85/85 parts, and 96 hours at 25°C for the 1000-hour life test parts. After each radiation exposure and the annealing step, the parts were electrically tested according to the test conditions and the specification limits** listed in Table III. The electrical tests included nine functional tests as follows: 1. Read Checkerboard, 2. Sector Erase (all 32 sectors), 3. Read Logic 1 on all locations – 2 Megs, 4. Write/Read Logic 0 First Half), 5. Write/Read Logic 0 (Second Half), 6. Sector Erase (all 32 sectors), 7. Read Logic 1 on all locations – 2 Megs, 8. Write/Read Checkerboard (First Half), 9. Write/Read Checkerboard (Second Half).

AM29F016 (16Mbit Flash Memory), No Pretreatment Before Irradiation

All parts passed all functional tests initially and up to 7.5 kRads. At 10 kRads, all parts failed 4 functional tests. After annealing, all parts failed 5 functional tests.

All parts passed all DC/AC electrical tests initially and on irradiation up to 5.0 kRads. No significant degradation was observed in any DC or AC parameter.

After the 7.5 kRad irradiation, all parts exceeded the specification limit of 450mV for VOL with readings of 4.5V for all. Most parts exceeded the specification limit for several timing parameters.

After the 10 kRad irradiation, all parts fell below the specification limit of 2.4V for VOH with readings of 0V for all. All parts continued to degrade in VOL as before. All parts exceeded the specification limit of 1000µA for ICC3 with readings in the range of 1100 to 1200µA. All parts failed all timing parameters.

* The term Rads, as used in this document, means Rads (SiO₂). All radiation levels cited are cumulative.

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

The parts were annealed at 25°C for 144 hours and showed no recovery in any DC/AC parameter. The parts were annealed at 100°C for 168 hours and showed no rebound effects.

AM29F016 (16Mbit Flash Memory), Pretreated at 85°C/85%RH for 168 Hours

All parts passed all functional tests initially and on irradiation up to 10 kRads. After the 15 kRad irradiation, three parts failed four functional tests and after 336 hours of annealing at 25°C, three parts failed five functional tests.

All parts passed all electrical tests up to 10 kRads. No significant degradation was observed in any DC or AC parameter.

After the 15 kRad irradiation, all parts catastrophically failed VOH, VOL, and all timing parameters.

The parts were annealed for 336 hours @ 25°C and showed no recovery.

AM29F016 (16Mbit Flash Memory) Pretreated with 1000 Hours Life Testing

All parts passed all functional tests initially and on irradiation up to 10 kRads. After the 15 kRad irradiation, three parts failed four functional tests and after 96 hours of annealing at 25°C, three parts failed five functional tests.

All parts passed all electrical tests initially and up to 10 kRads. No significant degradation was observed in any DC or AC parameter.

After the 15 kRad irradiation, all parts catastrophically failed VOH, VOL, and all timing parameters.

The parts were annealed for 96 hours @ 25°C and showed no recovery.

Summary

These parts showed very low radiation tolerance. The functional failure level varied from 10 to 15 kRads, depending on the pretreatment given.

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

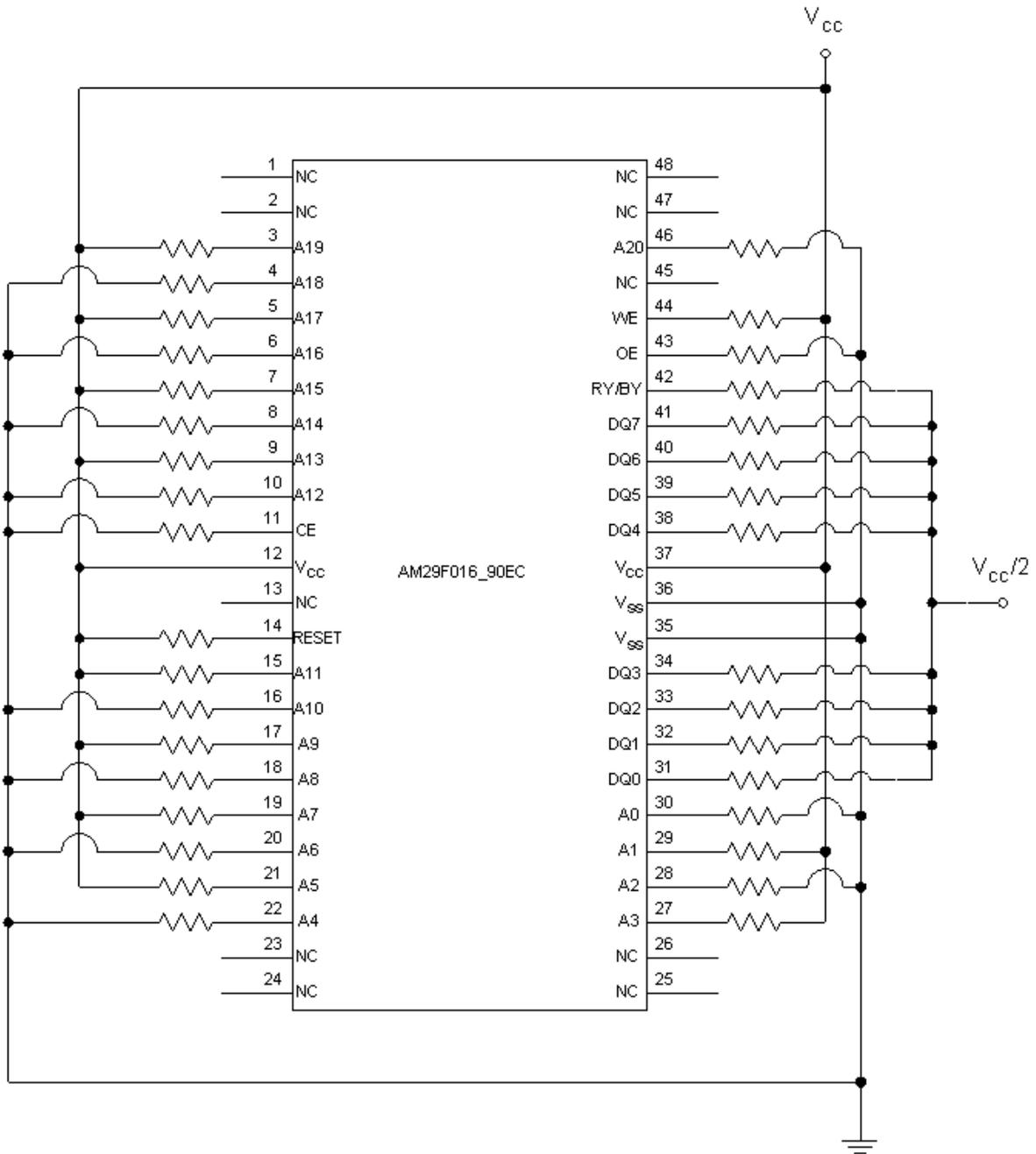
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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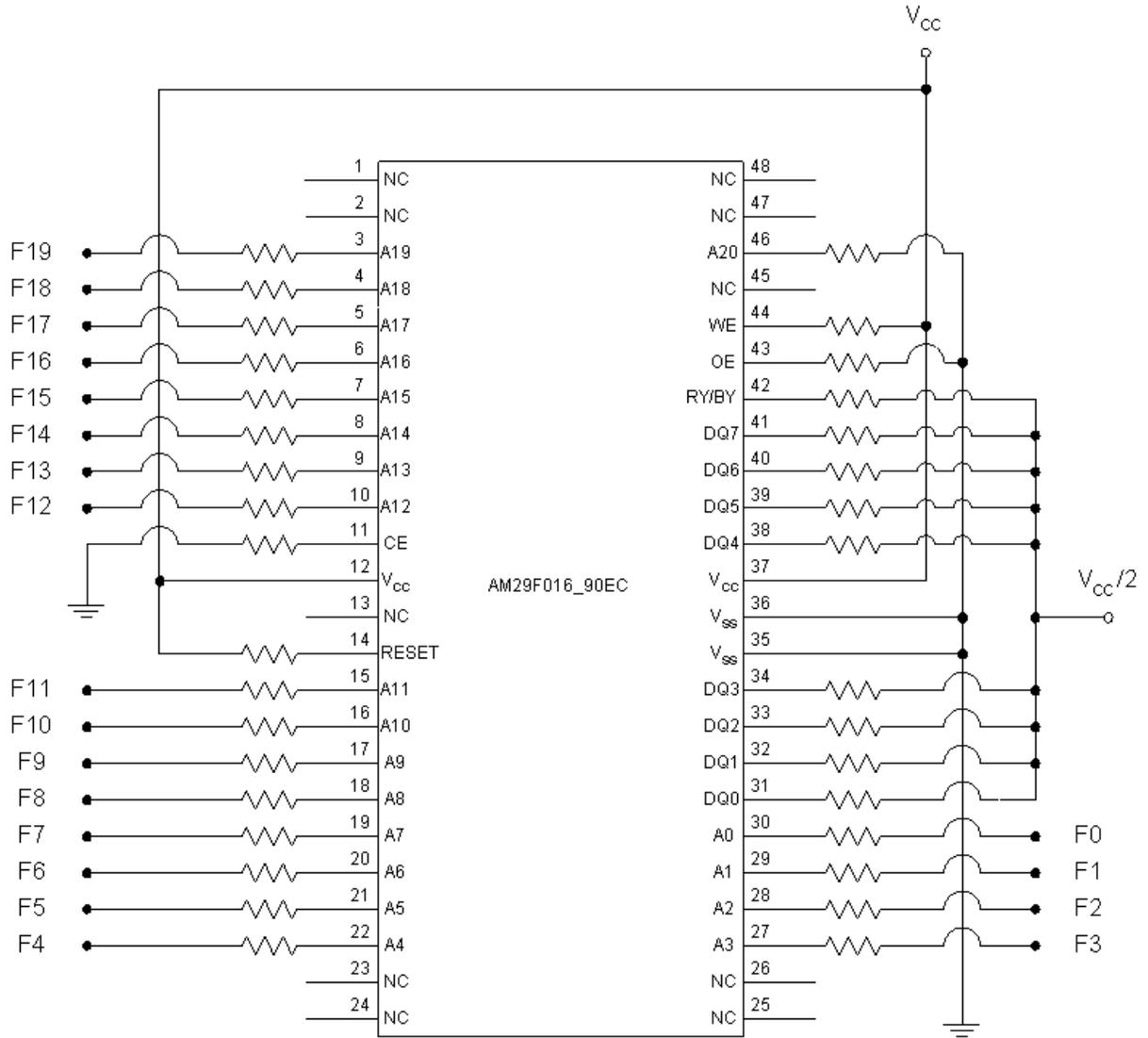
Figure 1 (a). Radiation Bias Circuit for AM29F016 (16Mbit Flash Memory)



Notes:

1. All resistors are 1kΩ ±5%, ¼W.
2. V_{CC} = 5.0V ±0.5VDC
3. V_{CC}/2 = 2.5V ±0.5VDC

Figure 1 (b). Life Test Circuit for AM29F016 (16 Mbit Flash Memory)



Notes:

1. All resistors are 1kΩ ±5%, ¼W.
2. V_{cc} = 5.0V ±0.5VDC
3. V_{cc}/2 = 2.5V ±0.5VDC
4. Frequencies: F0 - F1 = 1MHz, F2 - F3 = 500kHz, F4 - F6 = 250kHz, F7 - F8 = 125kHz, F9 - F10 = 62.5kHz, F11 - F12 = 31.25kHz, F13 - F14 = 15.62kHz, F15 - F16 = 7.82kHz, F17 - F18 = 3.91kHz, F19 = 1.95kHz
5. All frequencies are ±0.5%.

TABLE I. Part Information

Generic Part Numbers:	AM29F016
New Technology Evaluations Part Numbers:	AM29F016_90EC
Charge Number:	C71064 (C78033)
Manufacturer:	Advanced Micro Devices
Lot Date Codes (LDC):	None Given
Quantities Tested:	5 (Std.), 5 (85/85), 5 (1000 Hr.)
Serial Numbers of Control Samples:	70 (Std.), 83 (85/85), 84 (1000 Hr.)
Serial Numbers of Radiation Samples:	71, 72, 73, 74 (Std.); 75, 76, 77, 78 (85/85); 79, 80, 81, 82 (1000 Hr.)
Part Function:	16 Mbit Selector Erase Flash Memory
Part Technology:	CMOS
Package Style:	48 PIN TSOP
Test Equipment:	S-50
Engineer:	A. Duvalsaint

* The manufacturer for this part guaranteed no radiation tolerance/hardness.

TABLE II (a). Radiation Schedule for AM29F016 (Standard Parts)

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	01/08/97
2) 5.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	01/13/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT	01/15/97
3) 7.5 KRAD IRRADIATION (0.06 KRADS/HOUR)	01/15/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT	01/17/97
4) 10.0 KRAD IRRADIATION (0.12 KRADS/HOUR)	01/17/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT	01/21/97
5) 144-HOUR ANNEALING @25°C	01/21/97
POST-144 HOUR ANNEAL ELECTRICAL MEASUREMENT	01/27/97
6) 168-HOUR ANNEALING @100°C	01/27/97
POST-168 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/03/97

Effective dose rate = 10,000 RADS/9 DAYS = 46.3 RADS/HOUR = 0.0129 RADS/SEC.

 All parts were irradiated and annealed under bias. See Figure 1

TABLE II (b). Radiation Schedule for AM29F016 (85/85 Parts)

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	01/08/97
2) 168-HOUR 85% RH @85°C.....	01/13/97
POST-168 HOUR 85/85 ELECTRICAL MEASUREMENT.....	01/22/97
3) 5.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	02/04/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT.....	02/06/97
4) 7.5 KRAD IRRADIATION (0.06 KRADS/HOUR)	02/06/97
POST-7.5 KRAD ELECTRICAL MEASUREMENT.....	02/10/97
5) 10.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	02/10/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT.....	02/12/97
6) 15.0 KRAD IRRADIATION (0.12 KRADS/HOUR)	02/12/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT.....	02/14/97
7) 336-HOUR ANNEALING @25°C	02/14/97
POST-336 HOUR ANNEAL ELECTRICAL MEASUREMENT	02/28/97

Effective dose rate = 15,000 RADS/11 DAYS = 56.8 RADS/HOUR = 0.0158 RADS/SEC.

 All parts were irradiated and annealed under bias. See Figure 1

TABLE II(c). Radiation Schedule for AM29F016 (1000 Hour Life Test Parts)

EVENT	DATE
1) INITIAL ELECTRICAL MEASUREMENTS.....	01/08/97
2) 500-HOUR LIFE TEST @25°C.....	01/08/97
POST-500 HOUR LIFE TEST ELECTRICAL MEASUREMENT.....	02/07/97
3) 1000-HOUR LIFE TEST @25°C.....	02/07/97
POST-1000 HOUR LIFE TEST ELECTRICAL MEASUREMENT.....	02/28/97
4) 5.0 KRAD IRRADIATION (0.06 KRADS/HOUR)	04/22/97
POST-5.0 KRAD ELECTRICAL MEASUREMENT.....	04/24/97
5) 10.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	04/24/97
POST-10.0 KRAD ELECTRICAL MEASUREMENT.....	04/28/97
6) 15.0 KRAD IRRADIATION (0.125 KRADS/HOUR)	04/28/97
POST-15.0 KRAD ELECTRICAL MEASUREMENT.....	04/30/97
7) 96-HOUR ANNEALING @25°C	04/30/97
POST-96 HOUR ANNEAL ELECTRICAL MEASUREMENT	05/05/97

Effective dose rate = 15,000 RADS/9 DAYS = 69.4 RADS/HOUR = 0.0193 RADS/SEC.

 All parts were irradiated and annealed under bias. See Figure 1

Table III: Electrical Characteristics of AM29F016

Test #	Functional Test	Test Conditions
1	Read Checkerboard Previously Written	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
2	Sector Erase – All 32 Sectors	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
3	Read Logic 1 – All locations (2 Megs)	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
4	Write/Read Logic 0 – First Half	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
5	Write/Read Logic 0 – Second Half	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
6	Sector Erase – All 32 Sectors	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
7	Read Logic 1 – All locations (2 Megs)	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
8	Write/Read Checkerboard – First Half	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz
9	Write/Read Checkerboard – Second Half	V _{CC} =5.0V, V _{IL} =0.0V, V _{IH} =5.0V, Freq=2MHz

Test #	Parameters	Units	Test Conditions	Spec. Lim.	
				min	max
1	VOH	V	I _{OH} = -2.5mA, V _{CC} = V _{CC} min	2.4	5.5
2	VOL	mV	I _{OL} = 12mA, V _{CC} = V _{CC} min	0	450
3	IIL	μA		-10.0	10.0
4	IIH	μA		-10.0	10.0
5	IOZL	μA		-10.0	10.0
6	IOZH	μA		-10.0	10.0
7	ICC1	mA	CE = V _{IL} , OE = V _{IH}	0.0	40.0
8	ICC2	mA	CE = V _{IL} , OE = V _{IH}	0.0	60.0
9	ICC3	mA	V _{CC} = V _{CC} max, CE = V _{CC} ±0.3V, RESET = V _{CC} ±0.3V	0.0	1.0
10	ICC4	mA	V _{CC} = V _{CC} max, RESET = V _{SS} ±0.3V	0.0	1.0
11	TAVQV_LH	ns	CE = V _{IL} , OE = V _{IL}	0.0	90.0
12	TAVQV_HL	ns	CE = V _{IL} , OE = V _{IL}	0.0	90.0
13	TGLQV_ZH	ns		0.0	40.0
14	TGLQV_ZL	ns		0.0	40.0
15	TELQV_ZH	ns	OE = V _{IL}	0.0	90.0
16	TELQV_ZL	ns	OE = V _{IL}	0.0	90.0

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for AM29F016 (See Notes 1-4)

Functional Tests /2 /3		Total Dose Exposure (kRads)										Annealing			
		Initial		5		7.5		10		144 hrs @ 25°C		168hrs @ 100°C			
1	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4F		4F	
2	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P	
3	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4F		4F		4F	
4	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P	
5	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P	
6	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P	
7	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4F		4F		4F	
8	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4F		4F		4F	
9	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz	4P		4P		4P		4P		4F		4F		4F	
Spec. Lim. /4															
Parameters	Units	min	max	Initial		5		7.5		10		144 hrs @ 25°C		168 hrs @ 100°C	
VOH	V	2.4	5.5	4.4	0.003	4.3	0.004	4.3	0.005	4F		4F		4F	
VOL	mV	0	450	270	5.85	278	10.23	4F		4F		4F		4F	
IIL	μA	-10.0	10.0	-1.1	6.31	-0.14	1.13	-0.007	0.047	-0.008	0.045	-0.009	0.05	-0.003	0.01
IIH	μA	-10.0	10.0	0	0	0	0	0	0	0.0002	0.001	0	0	0	0
IOZL	μA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0	0
IOZH	μA	-10.0	10.0	0	0	0	0	0	0	0	0	0	0	0.0006	0.003
ICC1	mA	0	40.0	15.5	0.085	15.3	0.052	15.3	0.097	17.1	0.15	17.2	0.20	16.6	0.14
ICC2	mA	0	60.0	17.2	1.01	18.1	1.40	20.2	2.10	14.3	0.24	14.8	1.10	14.8	0.67
ICC3	μA	0	1000	294	3.9	294	3.9	358	12.3	1167	77.2	1143	76.8	527	87.1
ICC4	μA	0	1000	0	0	0	0	66.6	11.97	884	73.2	854	81.2	235	85.0
TAVQV_LH	ns	0	90.0	37.0	1.90	37.0	1.98	3P/1F		4F		4F		4F	
TAVQV_HL	ns	0	90.0	36.1	1.70	36.0	1.75	36.6	1.72	4F		4F		4F	
TGLQV_ZH	ns	0	40.0	21.9	0.79	21.9	0.80	3P/1F		4F		4F		4F	
TGLQV_ZL	ns	0	40.0	20.1	0.36	20.0	0.33	20.2	0.23	4F		4F		4F	
TELQV_ZH	ns	0	90.0	53.2	2.50	54.1	3.19	3P/1F		4F		4F		4F	
TELQV_ZL	ns	0	90.0	48.3	0.12	48.6	0.27	48.5	0.25	4F		4F		4F	

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing.

2/ The control samples remained constant throughout the testing are are not included in this table.

3/"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.

4/ 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.

Radiation sensitive parameters: VOH, VOL, ICC3, TAVQV, TGLQV, TELQV.

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for AM29F016 After 168 Hrs of 85%RH/85°C (See Notes 1-4)

Functional Tests /2 /3				Total Dose Exposure (kRads)												Annealing	
				Initial		Post Humidity		5		7.5		10		15		336hrs @ 25°C	
1	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P		1P3F	
2	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P		4P	
3	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		1P3F		1P3F	
4	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P		4P	
5	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P		4P	
6	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		4P		4P	
7	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		1P3F		1P3F	
8	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		1P3F		1P3F	
9	V _{cc} =5.0V, V _{il} =0.0V, V _{ih} =5.0V, Freq=2MHz	4P		4P		4P		4P		4P		4P		1P3F		1P3F	
Parameters				Spec. Lim. /4													
Units	min	max	Initial		Post Humidity		5		7.5		10		15		96hrs @ 25°C		
VOH1	V	2.4	5.5	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4F		4F	
VOH2	mV	0	450	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4F		4F	
VOL1	V	-1.0	2.0	0.26	0.03	0.26	0.03	0.26	0.03	0.26	0.03	0.26	0.03	4F		4F	
VOL2	V	-1.0	2.0	0.25	0.02	0.25	0.02	0.25	0.02	0.25	0.02	0.25	0.02	4F		4F	
IIL	µA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IIH	µA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IOZL	µA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IOZH	µA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ICC1	mA	0	40	15.2	0.2	15.4	0.2	15.8	0.7	16.5	1.5	15.5	1.3	17.3	1.3	16.2	1.1
ICC2	mA	0	60	17.3	0.4	17.5	1.5	17.9	1.8	17.4	2.1	19.4	1.5	17.2	1.1	16.3	1.2
ICC3	mA	0	1.0	0.28	0.5	0.29	0.07	0.29	0.01	0.29	0.01	0.29	0.01	1.4	0.93	1.1	0.8
ICC4	mA	0	1.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.8	1.4	0.6
TAVQV_LH	ns	0	90	37.0	1.8	41.3	1.4	41.7	1.6	42.1	2.5	38.4	1.6	4F		4F	
TAVQV_HL	ns	0	90	36.1	1.7	35.2	1.3	35.4	2.0	36.0	2.7	36.1	2.0	4F		4F	
TGLQV_ZH	ns	0	40	21.9	2.2	22.8	2.1	22.5	2.8	22.9	3.1	22.1	2.8	4F		4F	
TGLQV_ZL	ns	0	40	20.1	1.5	20.6	1.4	20.5	0.7	20.5	1.7	19.9	0.7	4F		4F	
TELQV_ZH	ns	0	90	53.2	1.3	60.3	1.1	55.6	0.9	51.7	2.8	52.1	0.9	4F		4F	
TELQV_ZL	ns	0	90	48.3	1.2	48.4	0.9	48.5	1.1	48.6	1.9	49.6	1.1	4F		4F	

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing.

2/ The control samples remained constant throughout the testing are not included in this table.

3/ "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.

4/ 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.

Radiation sensitive parameters: VOH, VOL, ICC3, ICC4, TAVQV, TGLQV, TELQV.

TABLE IV: Summary of Electrical Measurements After Total Dose Exposures and Annealing for AM29F016 After 1000 Hour Life Test (See Notes 1-4)

Functional Tests /2 /3				Total Dose Exposure (kRads)									Annealing		
				Initial		Post Life Test		5		10		15		96 hrs @ 25°C	
1	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		4P		1P3F	
2	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		4P		4P	
3	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		1P3F		1P3F	
4	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		4P		4P	
5	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		4P		4P	
6	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		4P		4P	
7	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		1P3F		1P3F	
8	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		1P3F		1P3F	
9	Vcc=5.0V, Vil=0.0V, Vih=5.0V, Freq=2MHz			4P		4P		4P		4P		1P3F		1P3F	
				Spec. Lim. /4											
Parameters	Units	min	max	Initial		Post Life Test		5		10		15		96hrs@25°C	
VOH1	V	2.4	5.5	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4F		4F	
VOH2	mV	0	450	4.34	0.01	4.34	0.01	4.34	0.01	4.34	0.01	4F		4F	
VOL1	V	-1.0	2.0	0.26	0.03	0.26	0.03	0.26	0.03	0.26	0.03	4F		4F	
VOL2	V	-1.0	2.0	0.25	0.02	0.25	0.02	0.25	0.02	0.25	0.02	4F		4F	
IIL	μA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IHH	μA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IOZL	μA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IOZH	μA	-10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ICC1	mA	0	40	15.2	0.2	15.4	0.2	15.8	0.7	17.2	1.3	18.1	1.1	18.9	1.3
ICC2	mA	0	60	17.3	0.4	17.5	1.5	18.9	1.8	19.4	1.5	14.5	1.2	14.2	1.1
ICC3	mA	0	1.0	0.28	0.5	0.29	0.07	0.29	0.06	0.41	0.01	3.3	0.3	3.2	0.4
ICC4	mA	0	1.0	0.0	0.01	0.0	0.0	0.0	0.0	0.12	0.01	3.2	0.3	3.1	0.5
TAVQV_LH	ns	0	90	37.0	1.8	41.3	1.4	41.7	1.6	38.4	1.6	4F		4F	
TAVQV_HL	ns	0	90	36.1	1.7	35.2	1.3	35.4	2.0	36.1	2.0	4F		4F	
TGLQV_ZH	ns	0	40	21.9	2.2	22.8	2.1	22.5	2.8	22.1	2.8	4F		4F	
TGLQV_ZL	ns	0	40	20.1	1.5	20.6	1.4	20.5	0.7	19.9	0.7	4F		4F	
TELQV_ZH	ns	0	90	53.2	1.3	60.3	1.1	55.6	0.9	52.1	0.9	4F		4F	
TELQV_ZL	ns	0	90	48.3	1.2	48.4	0.9	48.5	1.1	49.6	1.1	4F		4F	

Notes:

1/ The mean and standard deviation values were calculated over the four parts irradiated in this testing.

2/ The control samples remained constant throughout the testing are not included in this table.

3/ "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.

4/ 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.

Radiation sensitive parameters: VOH, VOL, ICC3, ICC4, TAVQV, TGLQV, TELQV.