



6th D/TOS-QCA Final Presentation Day 2004

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) and AT17LV010 (Serial).

ESTEC Contract No. 13528/99/NL/MV, COO-14

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Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) and AT17LV010 (Serial).

Work performed under this contract:

Heavy ions testing of

AT17LV10

1M-bit serial EEPROM

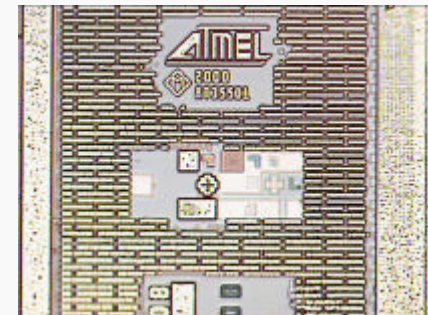
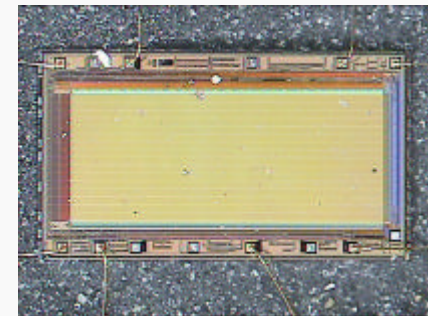
AT28C010E

1M-bit Paged Parallel EEPROM

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(1/8)

Part type: *AT17LV010*
Function: *EE Programmable 1 048 576 x 1-bit Serial
Memory Designed to Store Configuration
Programs for (FPGAs), 3.3V (-10%) Version*

Manufacturer: *ATMEL*
Package: *8-pin PDIP*
Quality Level: *Commercial*
Die Marking: *ATMEL 2000 M AT35501*
Die dimensions: *4.3 mm x 2.4 mm*



Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(2/8)

Supply Voltage : 3V3

Test Temperature : room temperature

Test samples were written prior to the test campaign

Bitstream is the concatenation of 8-bit data words as per the repetitive pattern shown

Address	Data
...	...
n	00000000
n+1	10101010
n+2	01010101
n+3	11111111
n+4	10011001
n+5	01100110
n+6	01010101
n+7	00000000
n+8	10101010
n+9	01010101
n+10	11111111
n+11	10011001
n+12	01100110
n+13	10101010
n+14	00000000
...	...

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(3/8)

Two different sets of test conditions were used:

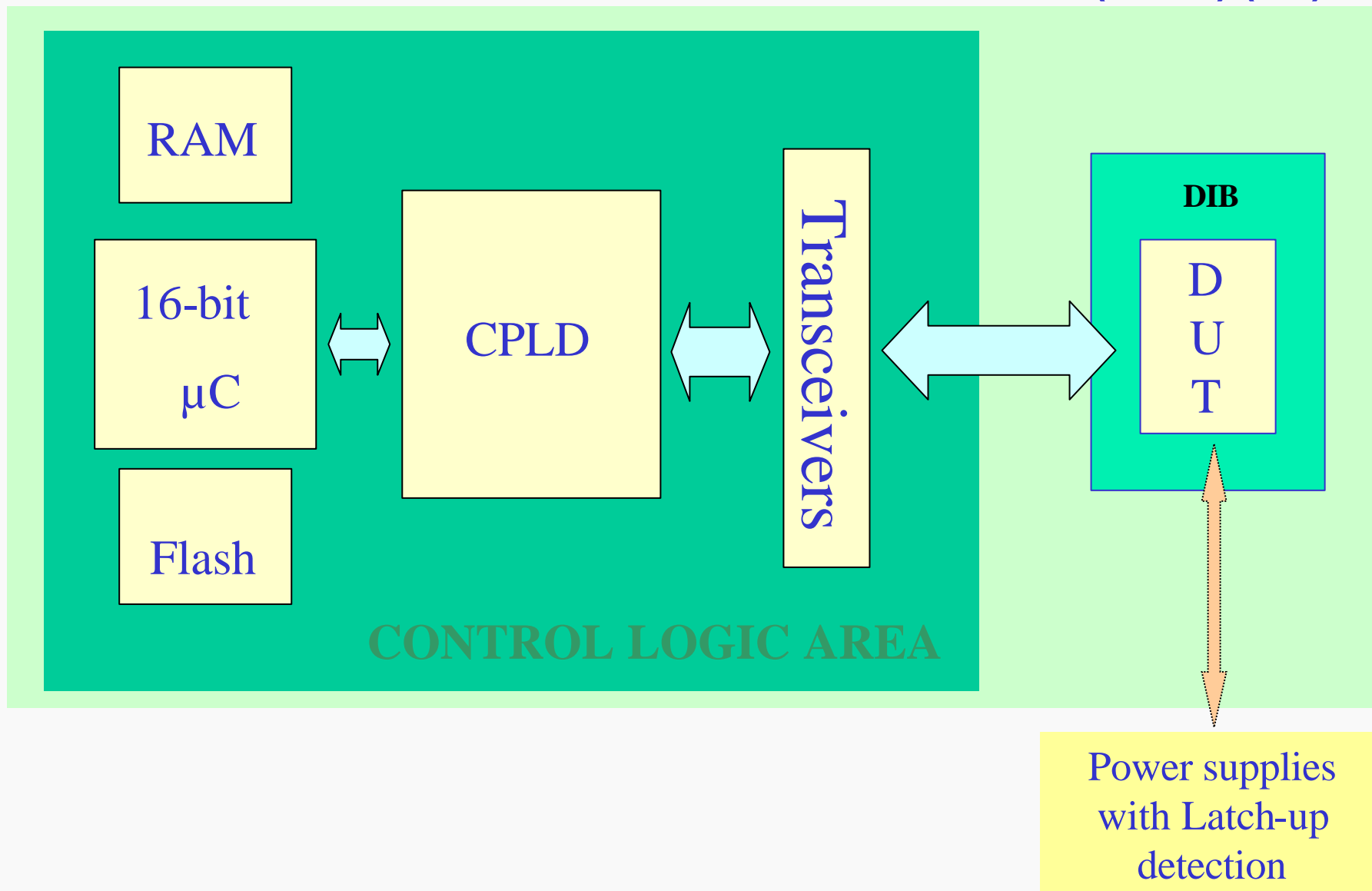
Static ON :

- Exposure
- After exposure, read the memory

Continuous Read :

- Read periodically the memory under beam exposure (cycle time is programmable)

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(4/8)



Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(5/8)

UCL Cyclotron accelerator

2002-07-05

Ion	Energy MeV	LET(Si) Mev/(mg/cm ²)	Range (Si) μm
N-15	62	2.97	64
Ne-20	78	5.85	45
Ar-40	150	14.1	42
Kr-84	316	34	43

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(6/8)

RESULTS

Static
c ON

S/N #	Ion	Tilt deg.	Eff. LET MeV/(mg/cm ²)	Fluence # /cm ²	Read after exposure
1	N	0	2.97	1 E+06	No error
	N	47	4.35	1 E+06	No error
	Ne	0	5.85	1 E+06	All Data to FF (*)
	Ar	0	14.1	1 E+06	All Data to FF (*)
	Kr	0	34	1 E+06	No error
2	N	47	4.35	1 E+06	No error
	Ne	0	5.85	1 E+06	No error
	Kr	0	34	1 E+06	No error

(*) Data integrity fully recovered after DUT power reset

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(7/8)

RESULTS

Continuous Read

S/N #	Ion	Tilt deg	Eff. LET MeV/(mg/cm ²)	Fluence # /cm ²	Read after exposure
1	N	0	2.97	1 E+06	No error
	N	47	4.35	1 E+06	1 read large error (at 1 cycle)
	Ne	0	5.85	1 E+06	No error
	Ar	0	14.1	1.7 E+05	Stop on functional error (*)
2	N	47	4.35	1 E+06	No error
	Ne	0	5.85	2.4 E+05	Stop on functional error (*)
	Ar	0	14.1	4.5 E+05	Stop on functional error (*)
	Kr	0	34	9.6 E+04	Stop on functional error (*)

(*) Error consist in an offset in the data pattern.
Data integrity fully recovered after DUT power reset

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM, AT17LV010 (Serial).(8/8)

JYFL Cyclotron accelerator

2003-01-28

Ion	Energy MeV	LET(Si) Mev/(mg/cm ²)	Range (Si) μm
XE-132	475	62	44

SEL Test
(Continuous
Read test
config.

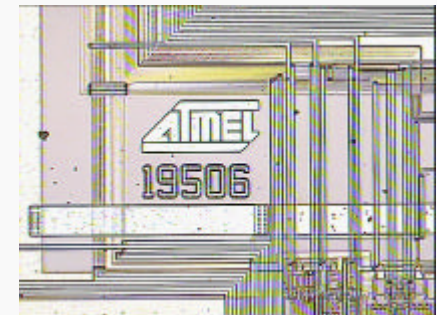
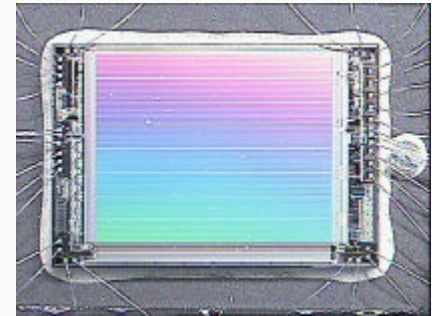
S/N #	Ion	Tilt deg.	Eff. LET MeV/(mg/cm ²)	Fluence # /cm ²	Result
2	Xe	0	62	1 E+07	No SEL

Upon run completion, memory presented stuck bits.
Data integrity fully recovered after DUT power reset

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) (1/6)

Part type: *AT28C010E*
Function: *High-performance Paged Parallel EEPROM. Its one megabit of memory is organized as 131,072 words by 8 bits. The device contains a 128-byte page register to allow writing of up to 128-bytes simultaneously.*

Manufacturer: *ATMEL*
Package: *32-pin CERDIP*
Quality Level: *Military*
Date Code: *0013*
Die marking: *ATMEL 19506*
Die dimensions: *9.3 mm x 6.2 mm*



Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) (2/6)

Supply Voltage : 5V

Test Temperature : room temperature

Memory organization: 1024 x 128 x 8

Data pattern as shown (pattern is offset at each write operation so bit cell is flipped)

Address	Data
...	...
n	00000000
n+1	10101010
n+2	01010101
n+3	11111111
n+4	10011001
n+5	01100110
n+6	01010101
n+7	00000000
n+8	10101010
n+9	01010101
n+10	11111111
n+11	10011001
n+12	01100110
n+13	10101010
n+14	00000000
...	...

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) (3/6)

Three different sets of test conditions were used:

Static ON :

- Exposure
- After exposure, read the memory

Continuous Read :

- Read periodically the memory under beam exposure (cycle time is programmable)

Read/Write :

- Prior to exposure, write the entire memory,
- During exposure, continuously read, erase and write 100 pages selected out of the 1024,
- After exposure, check the other pages for eventual data corruption.

Heavy Ion Characterization of ATMEL 1M-Bit EEPROM's, AT28C010 (Parallel) (4/6)

UCL Cyclotron accelerator

2002-07-05

Ion	Energy MeV	LET(Si) Mev/(mg/cm ²)	Range (Si) μm
N-15	62	2.97	64
Ne-20	78	5.85	45
Ar-40	150	14.1	42
Kr-84	316	34	43

RESULTS

With the three test conditions, occurrence of random word errors which are persistent.

Error LET threshold is 5.85 Mev/(mg/cm²) (Ne at 0 deg.).
Errors are Single Bit errors at low LET while MBUs are counted with Krypton (Let of 34)

Writing the memory does not cure these errors.
Time could anneal some of them.

In all cases, data integrity is fully recovered after DUT power reset

RESULTS

Continuous Read N, Ne, Ar, Kr

With Kr (LET 34): Stop on persistent functional error (> 30 000 words).
A DUT power reset allows for recovering data integrity.

Read/Write N, Ne, Ar

With Ar (LET 14.1): Stop on functional error (All 1024 pages erased)