



Hybrid Memory Products Ltd

Data Retention Performance

PUMA2F16006MB-12

The product is built using 4 X HMP MFM8516WM-90 4Mb Flash LCC's.

Non-Volatile Screening

The specification of Retention is a way of specifying the life expectancy of the data stored in a memory device. The concern of retention is with failures occurring in three phases of the devices life cycle a) early life; b) random failure rate during normal use and c) the intrinsic failures near the end of life (i.e. bathtub curve). Infant mortality cases are screened out by a combination of endurance cycling and retention bake. Intrinsic retention failures at the end of device life are determined by structural design, technology and processing of the memory cells (and is generally determined to be many orders of magnitude greater than equipment life times). This leaves the random failure rate during normal use as the most practical measurement of data integrity. The actual retention failure rate is determined by storing devices unpowered at high temperature with a preset data pattern. Devices in plastic packages are stored at 150°C and ceramic packages at 250°C and are then read from time to time. From the die manufacturers reliability data (section 2 below) it is possible to calculate the Retention failure rate under certain condition as follows:

- I. After 10,000 Write/Erase Cycles = 78 FITS
($E_A=0.6\text{eV}$, $T_f=55^\circ\text{c}$, 60% Confidence level, MTBF = 1,603 Device Years)
- II. From Data Retention Test @ 250°C = 1.40 FITS
($E_A=0.6\text{eV}$, $T_f=55^\circ\text{c}$, 60% Confidence level, MTBF = 89,290 Device Years)

Another way of expressing this is as a failure rate for a specified retention time. For 10 year retention time the failure rate for the die after 10,000 cycles is 0.63% (and for the module = 2.5%). Clearly the basic data retention performance of the module is several magnitudes better than this.

HMP evaluate each new non-volatile memory to possible effects of our processing and to establish appropriate screening - refer to later section for details. Hence a basic data retention performance is established and monitored by the die

manufacturer. HMP further screen the part to remove early life failures resulting from the further processing. The device performance is monitored continually as screening data is accumulated.

Die Manufacturers Reliability Data (4Mb Flash Memory)

- I. Data Retention Bake @ 150°C for 1000 Hours, 403 parts tested, 0 fails.
- II. Data Retention Bake @ 250°C for 500 Hours, 478 parts tested with, 0 fails
- III. 10,000 Write/Erase Cycles followed by Data Retention Bake @ 150°C for 1000 Hours, 100 parts, 0 fails
- IV. 1000 Cycles followed by Data Retention Bake @ 150°C for 36 Hours, 20,876 parts tested, 0 fails
- V. 10,000 Cycles followed by Data Retention Bake @ 150°C for 36 Hours, 1116 parts tested, 0 fails
- VI. 100,000 Cycles followed by Data Retention Bake @ 150°C for 36 Hours, 636 parts tested, 0 fails

HMP Evaluation

Parts have been tested after assembly by HMP as follows:

19314-1 (Die lot 145922)

- ◆ Qty 26 Gang Cycled 10,000 cycles with no fails
- ◆ Qty 26 DRB, 0 fail
- ◆ Qty 26 passed -55/125°C

19314-2 (Die lot 145922)

- ◆ Qty 26 Gang Cycled 10,000 cycles with no fails
- ◆ Qty 26 DRB, 1 fail
- ◆ Qty 25 passed -55/125°C

19167-1 (Die lot 145922)

- ◆ Qty 12 Gang Cycled 10,000 cycles with no fails
- ◆ Qty 12 DRB, 0 fail
- ◆ Qty 12 passed -55/125°C

In total 64 parts submitted to 10,000 cycles, 1 part failed DRB after 72 Hours @ 150°C.

- ◆ Qty 12 (Batch 19167-1) submitted to 110,000 Cycles, 1 fail after 63,500 Cycles
- ◆ Qty 11 good after 110,000 cycles passed 72 Hour DRB @ 150°C

HMP Screening:

1000 Write/Read Cycles as per MIL-STD-883 Method 1033

Followed by Data Retention Bake - 72 Hours @ 150°C.

HMP Reliability Testing:

The parts that have completed 100,000 Write/Erase Cycles are to proceed to Extended Data Retention bake (1000 hours @ 150°C).

Re-qualification is performed in-house at a significant change in the die or the HMP process. Periodic testing would only be performed if specified by the customer (i.e. per customer specification.).

Bill Robson 3/12/97