XMC1000 EEPROM emulation and data retention

XMC1000

About this document

Scope and purpose

This document provides a brief introduction to the use of the XMC1000 Microcontroller family with emulated EEPROM.

Intended audience

This document is intended for engineers who wish to develop an emulated EEPROM application with the XMC1000 Microcontroller family.

Applicable products

- XMC1100 series
- XMC1200 series
- XMC1300 series
- XMC1400 series

References

- Infineon: DAVE™ **http://www.infineon.com/DAVE**
- Infineon: XMC™ Family **http://www.infineon.com/XMC1000**

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1 XMC1000 EEPROM emulation

In an application with emulated EEPROM the same flash type is used in two different modes:

- One part is used for program flash.
- One part is used for EEPROM emulation.

The difference between both modes is the number of erase cycles.

In this document program flash and EEPROM flash are defined as:

Table 1 Erase/write cycles per flash usage[1]

	Program flash [cycles]	EEPROM flash [cycles]
Erase/write cycles [2]	100	10 000

Flash structure

The flash is structured in blocks, pages and sectors:

- Block = 16 Byte
  - A block represents the smallest data portion that can be written.
- Page = 16 Blocks = 256Byte
  - A page represents the smallest data portion that can be erased.
- Sector = 16 pages = 4kByte

Page and Sector erases

In this Application the page erase is limited to 10 000 times for each page.

A page can be erased by a page erase or by a sector erase when the page is in this sector. Either method counts as one erase.

The complete flash can have up to 2 000 000 erases in total. Independently, if one page is erased multiple times or different pages are erased by a page erase, each page erase counts as one erase.

A sector erase which erases 16 pages counts as one erase. Therefore, it is recommended to erase 16 pages by 1 sector erase instead of 16 page erases, to not exceed the 2 000 000 erase limit.

[1] See References and Notes

2 Example use-case

The use-case is valid for a program flash usage of up to 64kByte and an EEPROM usage of up to 4kByte.

The program flash and the EEPROM flash support data retention of up to 20 years. This means that after the last write cycle the flash content from the last write operation is valid for 20 years.

Frequent cycling stresses the flash. To ensure the high reliability the EEPROM size is limited.

The following table shows the Program flash data retention and the emulated EEPROM data retention with 5k cycles or 10k cycles.

Note: The total EEPROM size must not exceed 4kByte.

Table 2 Program flash and emulated EEPROM data retention[1]

	T_J [°C] [1]	Data retention [years]	Flash size [kByte]
Program flash [2]	-40 to 85	20	≤ 64
EEPROM with 5k cycle [2]	-40 to 85	7.5	≤ 4
EEPROM with 10k cycle [2]	-40 to 85	4.5	≤ 4

A block (16Byte) represents the smallest data portion that can be written.

A page (256Byte) represents the smallest data portion that can be erased.

The 4 096Byte emulated EEPROM is represented by 256 blocks, or 16 pages, or 1 sector. The erase cycles are limited to 10 000 for each page.

A cycle consists of one or many writes and one erase. The number of writes can be calculated by:

- (EEPROM_size / Byte_per_write) * write_erase_cycles = writes cycles.

The maximum numbers of writes for EEPROM @10k cycles is:

- (4 096Byte / 16Byte) * 10 000 cycles = 2 560 000 writes cycles.

The maximum numbers of writes for EEPROM @5k cycles is:

- (4 096Byte / 16Byte) * 5 000 cycles = 1 280 000 writes cycles.

[1] See References and Notes

3 Temperature dependency

The flash data retention depends strongly on the junction temperature of the Flash memory.

The temperature dependency of the data retention for the XMC1000 flash can be seen in the following table:

Table 3 Temperature dependency[1]

	T_J [°C] [1]	Data retention [years]	Flash size [kByte]
Program flash [2]	-40 to 85	20	≤ 64
	-40 to 100	8	≤ 64
	-40 to 115	4	≤ 64
EEPROM with 5k cycle [2]	-40 to 85	7.5	≤ 4
	-40 to 100	4	≤ 4
	-40 to 115	2	≤ 4
EEPROM with 10k cycle [2]	-40 to 85	4.5	≤ 4
	-40 to 100	2	≤ 4
	-40 to 115	1	≤ 4

The following calculation is for the data retention time for a program flash with a size up to 64kByte. This is the temperature profile:

- 115°C (T_J) 0.3425 years (3000h)
- 100°C (T_J) 0.5708 years (5000h)
- 85°C (T_J) To be calculated

The percentage of time used in 115°C (T_J) and 100°C (T_J) is calculated:

- 115°C (T_J): 0.3425 years / 4.0 years = 8.56%
- 100°C (T_J): 0.5708 years / 8.0 years = 7.13%

Both percentages are summarized and the time for 85°C (T_J) is reduced:

- 8.56% + 7.13%= 15.70%
- 85°C (T_J): 20 years * (100%-15.70%) = 16.86 years

In the last step the total data retention is calculated.

- 0.3425 years + 0.5708 years + 16.86 years = 17.77 years

[1] See References and Notes

4 References and Notes

Note: The Data retention time describes flash behavior. This is independent of whether the microcontroller is powered or not.

[1] The ambient temperature T_A can be calculated out of T_J in combination with the Package thermal resistance, the current consumption, and the Voltage. For example:

TSSOP38 R_{thja} = 70.3 K/W, I = 12 mA, U = 5.5 V, P = 5.5V * 12 mA = 66 mW

$T_{j/a}$ = 70.3K *66mW = 4.64°K

[2] Cycles are equally distributed over the life-time.

Revision history

Major changes since the last revision

Page or Reference	Description of change
All	First release.

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