APPLICATION NOTE

SELECTING BETWEEN ROM, FASTROM AND FLASH FOR A MICROCONTROLLER

by Microcontroller Division Applications

INTRODUCTION

A customer who develops an MCU-based application needs various levels of flexibility in order to perform code modifications at different times in the life cycle of the product (these levels are explained on the next page). To satisfy these requirements, STMicroelectronics supports several device types within two main groups of microcontroller product families:

– EPROM, OTP, FASTROM and ROM microcontroller families

– Flash, FASTROM and ROM microcontroller families

This Application Note discusses the second group of families. For information on the first group, refer to Application Note AN886.

DEFINITION OF TERMS

Flash: Flash devices are electrically programmable and erasable. Device programming is typically performed by the customer, so changes to the program code can be made quickly and easily. Flexibility is further enhanced for the customer by the use of In-Circuit Programming, In Application Programming, and In-Circuit Testing.

- In-Circuit Programming (ICP) allows the customer to program or erase the device after it has been soldered on the application board.
- In Application Programming (IAP) allows the user to program or erase part of the Flash memory while the application is running.
- ICT allows the customer to program test routines in Flash memory to be executed during the board manufacturing phase and subsequently replaced by the final application code.

FASTROM (Factory Advanced Service Technique Read Only Memory): this type of MCU is a Flash device pre-programmed by STMicroelectronics with the customer's code and selected options. The advantage of FASTROM, compared to Flash, is improved programming efficiency for large quantities (10,000+) and compared to ROM, it has the advantage of a shorter leadtime and the devices can be reprogrammed.

ROM (Read Only Memory): ROM devices are programmed by STMicroelectronics at the fabrication step using a special mask containing the customer code. Therefore, the code cannot be modified afterwards.

Costs are highly dependent on the **flexibility** given to the device (ability to be easily erased or programmed). ROM is the cheapest technology but provides little flexibility whereas Flash is more flexible but its manufacturing cost is higher.

1 TYPICAL APPLICATION DEVELOPMENT FLOW

	Design Phase	Validation Phase	Pre-production Phase	Production Phase	
ST Solution	Flash	Flash	Flash	Flash	ROM
Code Updates	••••	•••	••	•	None
Number of Units	•	••	•••	••••	•••••

When a new application is developed, different device versions will be used at each step of the development, depending on the required **programming flexibility**.

During the **design and validation phases**, a high flexibility is required and only a small number of parts are necessary, therefore the use of Flash is recommended.

The next step is **pre-production phase**: only a few code updates are needed at a reasonable device cost. Again, the best choice is to use Flash memory. Finally, when the **mass production phase** begins, there is no more need for corrections since the product has been fully optimized, so ROM is the most suitable if very high volumes are needed. Otherwise (low to medium volumes) the most effective solution is to continue using STMicroelectronics' competitively priced Flash.

The following table summarizes the main benefits and drawbacks of using ROM or Flash MCU devices.

	ROM	Flash
+	**Cheaper than Flash** (simpler process and testing) **Lower failure rate** (less handling, no programming)	Ability to be programmed **directly** by the **final user** Depending on the silicon technology used, 100 or 10,000 write/erase cycle endurance at 25°C ambient temperature
-	**Limited flexibility** (customer code implemented at masking stage) Higher inventory risks	Higher failure rate compared to ROM due to customer handling and programming Expensive silicon manufacturing process

2 FLASH WRITE/ERASE CYCLE ENDURANCE

During the product and process qualification phase, STMicroelectronics performs three times the minimum number of write/erase cyclesat room temperature (300 cycles to qualify a min. spec of 100 cycles at 25°C). In addition, 100 cycles are performed over the whole operating temperature range (-40 -125°C) during pruduct qualification.

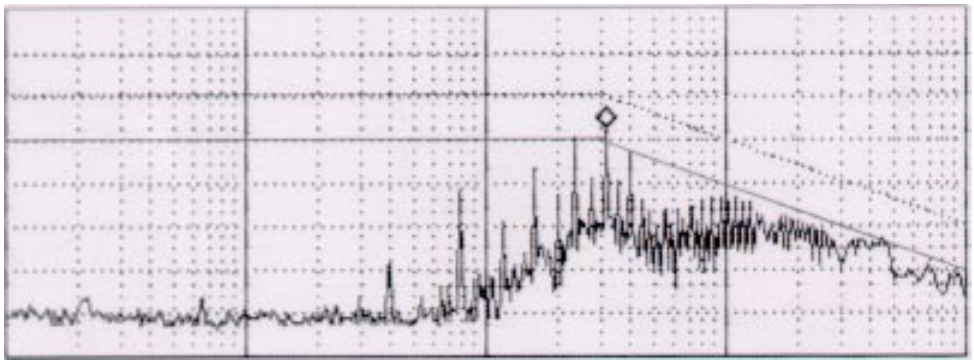
Due to process differences, some microcontrollers (all ST9 MCUs and ST7 devices with more that 8 Kbytes of Flash memory, are specified with a min. endurance of 10,000 write/erase cycles.To reduce chip size and cost smaller ST7 devices use a process that guarantees 100-cycle endurance for Flash memory.

Data retention tests are performed at high temperature to guarantee 20 data retention.

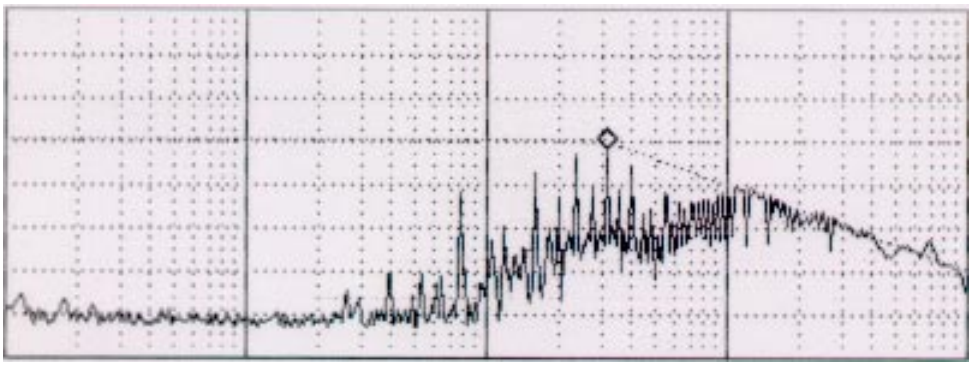
3 COMPARISON OF ROM AND FLASH

ROM and Flash devices have almost the same functional and electrical behaviour in an application because STMicroelectronics designs the two products with the same methodology. ROM and Flash devices are qualified using the same procedures. They are tested using the **same test flows** (except for the Flash-specific programming tests) and with the **same parameter limits**. A good indication of device similarity is EMC (electromagnetic noise immunity) measurements performed on both versions (ROM and Flash) for the same MCU device.

ST72334 (ROM version)



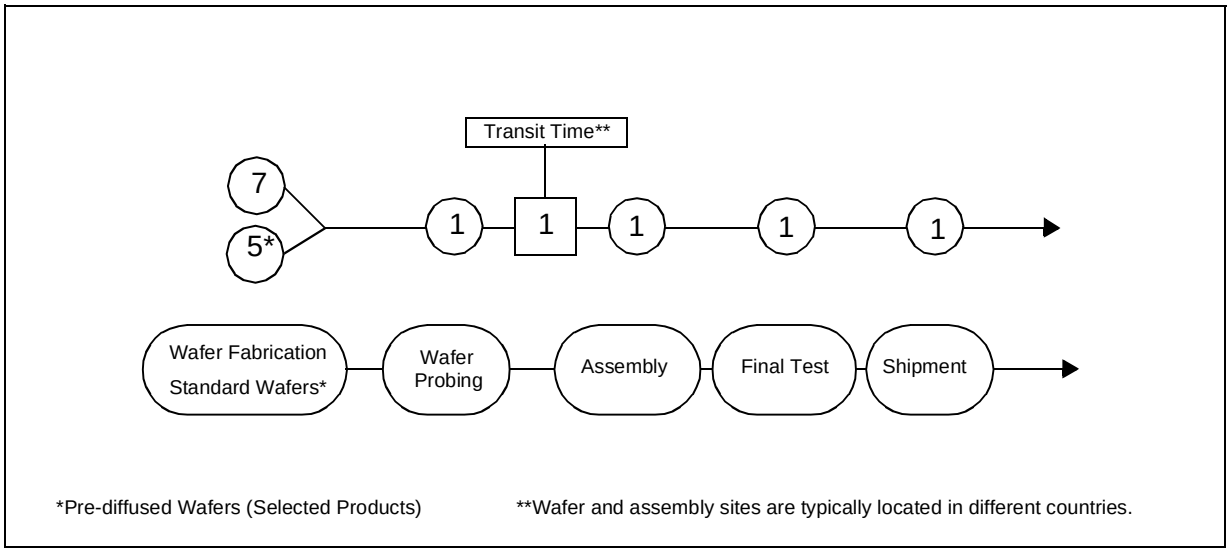
ST72C334 (Flash version)



4 TYPICAL MANUFACTURING LEAD TIME FOR ROM AND FLASH

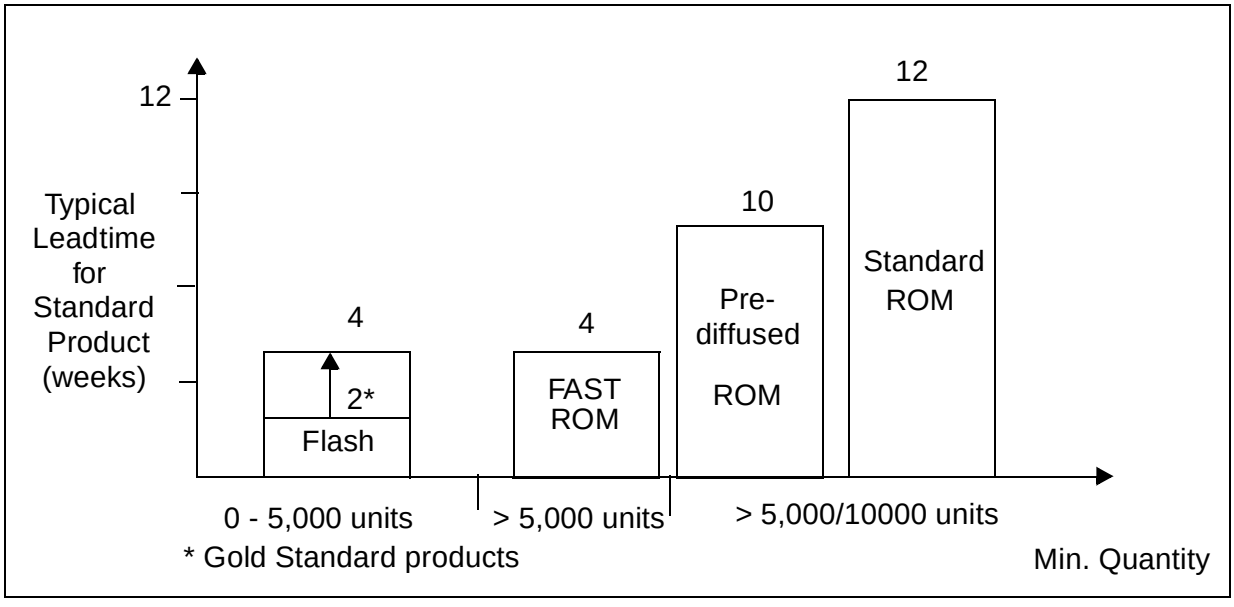
The complexity of all the operations needed to manufacture a component implies a certain time period. Understanding STMicroelectronics MCU manufacturing cycle is important in order to establish good relationships with customers. The numbers given here are typical and subject to change in the future

Figure 1. Typical Fabrication Leadtime.



In order to limit lead time on ROM products, STMicroelectronics has introduced pre-diffusion technology on selected products. This allows a two-week reduction in total cycle time. Also notice that MCU devices have to be ordered in specified minimum quantities for ROM versions.

Figure 2. Typical Leadtime for Standard Products



5 MINIMUM ORDER QUANTITIES FOR ROM AND FASTROM

The following minimum order quantities apply to ROM and FASTROM microcontroller devices:.

	ROM			FASTROM
	Minimum quantity per year	**Minimum order quantity**	**Minimum quantity per line item**	**Minimum quantity per year and per line item**
ST6 Family	100000	50000	10000	5000
ST7 and ST9 Families	50000	25000	5000	5000

6 FLASH RELIABILITY

Why do ROM devices have very low failure rates?

For ROM parts, the customer program is included at a **specific mask level** of the wafer fabrication. Therefore, the complete product functionality is present in both the die and the assembled product. This functionality can be fully evaluated at both **wafer probing** and **final electrical test**, thus ensuring a **low reject rate** at customer manufacturing stage.

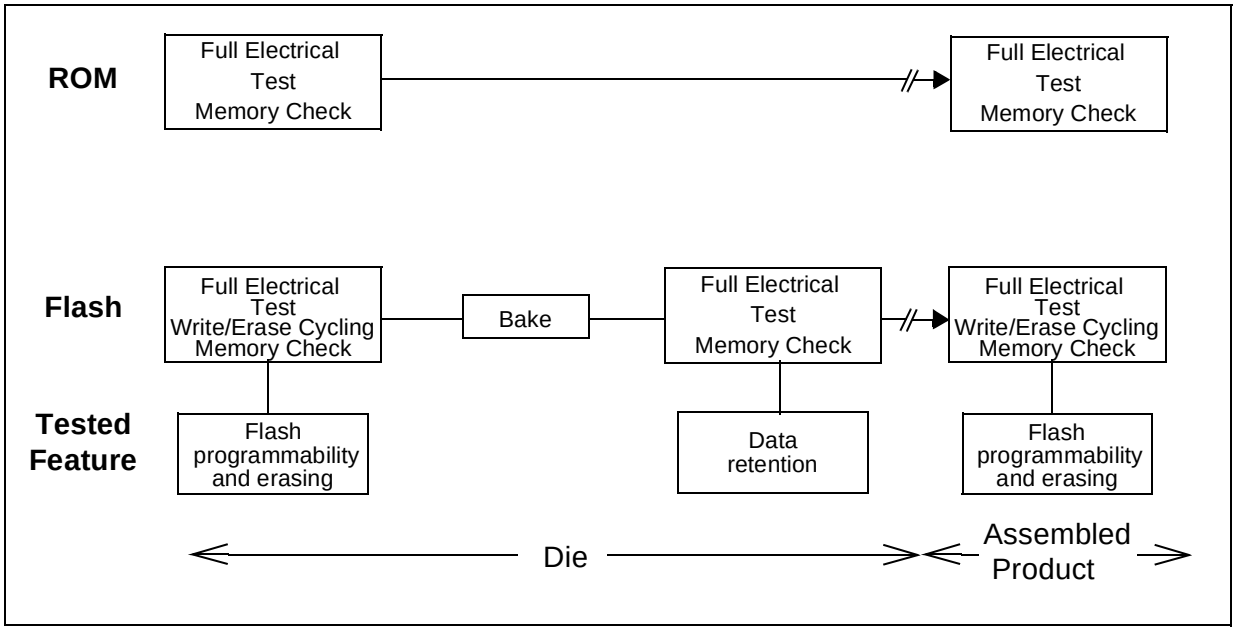
Testing Cycling Endurance and Data Retention for Flash devices

To ensure optimal Flash quality, STMicroelectronics tests two important device characteristics: **write/erase cycling endurance** and **data retention**. The program memory of a Flash MCU should be seen as a number of cells that will be activated during programming and deactivated during erasing.

During the various test phases, the dice are electrically tested and the memory is programmed and erased to verify **cycling endurance**. They are placed in high temperature **bake** to accelerate any possible memory retention defects. The dice are then tested again to check **data retention**.

Description of Flash cycling endurance test

Figure 3. Comparison of the electrical tests performed on Flash and ROM



Although the write/erase cycling endurance of the Flash die is verified as fully functional at probe test, the assembly process can **affect this parameter** in the finished product (for example by damaging some cells). It is therefore necessary to make a **final test** again to check **cycling endurance**.

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