FRAM

Non-Volatile Ferroelectric Random Access Memory (FRAM)

Overview

FRAM (Ferroelectric Random Access Memory) is a high-performance and low-power non-volatile memory that combines the benefits of conventional non-volatile memories (Flash and EEPROM) and high-speed RAM (SRAM and DRAM.)

This universal memory outperforms existing memories like EEPROM and Flash, consumes less power, is many times faster, and has greater endurance to multiple read-and-write operations.

The maximum number of read/write cycles for Flash and EEPROM is about 100,000 times. With more than 1 trillion (10^{13}) read/write cycles, the lifetime of a FRAM memory is essentially unlimited.

	SRAM/DRAM	FLASH EEPROM	FUJITSU FRAM
Fast Unlimited Read/Write Access	✓ Fast Unlimited R/W Access	✗ Slow Block Access ROM	✓ Fast Unlimited R/W Access
Non-Volatile	✗ Volatile – Power Required	✓ Non-Volatile	✓ Non-Volatile

FRAM combines the benefits of Flash/EEPROM and SRAM/DRAM.

Advantages of FRAM

- High-speed access: 30 times faster than EEPROM.
- High endurance: 1 billion times higher endurance (guaranteed 10^{12} times) over EEPROM.
- Low power consumption: 200 times less power consumption than EEPROM.
- Excellent tamper resistance: Data written in FRAM cannot be detected by physical analysis.
- Radiation resistance: FRAM is highly resistant to magnetic fields and radiation.
- Operating temperature range: -40°C to +85°C
- Data retention: 10 years without a battery.

Applications

Demand for FRAM is rapidly increasing in many applications that require high performance, low power and high endurance. FRAM is an excellent alternative to EEPROM for low-power, data-logging applications where it is essential to prevent any data loss, even in the event of a sudden power shutdown. Other applications include smart cards, RFID, security, industrial systems, factory automation and metering equipment. The ferroelectric material in FRAM is highly resistant to magnetic fields and radiation, making it well-suited for medical, aerospace and food applications.

Product Overview

Fujitsu provides standalone FRAMs and FRAM-based RFIDs as well as COT, foundry and custom design services.

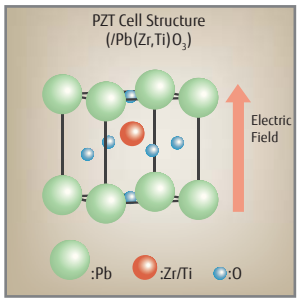
Standalone FRAM

Standalone FRAM can be integrated into any system that requires high-speed, non-volatile memory. FRAM does not require a battery to back up its data, saving significant cost and board space. FRAM can be used for storing parameters such as system settings, configuration and device-status information.

This information can be used later for activities such as resetting the devices, analyzing the status and activating recovery actions. Byte-wise random access makes memory management more efficient.

This high-speed, non-volatile memory runs like a RAM. This gives programmers the flexibility to assign ROM and RAM memory mapping, depending on their needs. End users can program FRAM at the ground level, to customize to their individual preferences. Standalone FRAM allows designers the freedom to explore and employ FRAM in a wide range of designs

FRAM Technology



FRAM stores information using the polarization of a ferroelectric film material placed between two electrodes. The FRAM cell structure, which is similar to the transistor and capacitor structure of a DRAM cell, does not require the same high programming voltages that Flash or EEPROM do to operate. As a result, FRAM offers non-volatile data storage, but is significantly more energy-efficient compared with other conventional non-volatile memories.

Specifically, FRAM uses ferroelectric film as a capacitor for storing data. The PZT (Pb {ZrTi}O3) material, which has a perovskite-type structure (ABO3), is commonly used. When an electric field is applied the Zr/Ti atom shifts up or down, and this polarization remains when the electric field is removed. It is this property that provides the non-volatility and keeps the power required for data storage very low.

Part Number	Memory Density	Power Supply Voltage	Operating Frequency (MAX)	Operating Temperature	Read/Write Cycles	Data Retention Guaranteed	Package
I²C Interface							
MB85RC1MT	1Mbit	1.8 to 3.6V	3.4MHz	-40 to +85°C	10^{13} (10 trillion) times	10 years (+85°C)	SOP-8
MB85RC512T	512Kbit	1.8 to 3.6V	3.4MHz		10^{13} (10 trillion) times		SOP-8
MB85RC256V	256Kbit	2.7 to 5.5V	1MHz		10^{12} (1 trillion) times		SOP-8
MB85RC128A	128Kbit	2.7 to 3.6V	1MHz		10^{12} (1 trillion) times		SOP-8
MB85RC64A	64Kbit	2.7 to 3.6V	1MHz		10^{12} (1 trillion) times		SOP-8
MB85RC64V	64Kbit	3.0 to 5.5V	1MHz		10^{12} (1 trillion) times		SOP-8
MB85RC16	16Kbit	2.7 to 3.6V	1MHz		10^{12} (1 trillion) times		SOP-8/SON-8
MB85RC16V	16Kbit	3.0 to 5.5V	1MHz		10^{12} (1 trillion) times		SOP-8
MB85RC04V	4Kbit	3.0 to 5.5V	1MHz		10^{12} (1 trillion) times		SOP-8
SPI Interface							
MB85RS2MT	2Mbit	1.8 - 2.7V	25MHz	-40 to +85°C	10^{13} (10 trillion) times	10 years (+85°C)	SOP-8
		2.7 - 3.6V	40MHz				DIP-8
MB85RS1MT	1Mbit	1.8 - 2.7V	25MHz		10^{13} (10 trillion) times		SOP-8/WL-CSP
		2.7 - 3.6V	30MHz				
MB85RS512T	512Kbit	1.8 - 2.7V	25MHz		10^{13} (10 trillion) times		SOP-8
		2.7 - 3.6V	30MHz				
MB85RS256B	256Kbit	2.7 to 3.6V	33MHz		10^{12} (1 trillion) times		SOP-8
MB85RS128B	128Kbit	2.7 to 3.6V	33MHz		10^{12} (1 trillion) times		SOP-8
MB85RS64	64Kbit	2.7 to 3.6V	20MHz		10^{12} (1 trillion) times		SOP-8
MB85RS64V	64Kbit	3.0 to 5.5V	20MHz		10^{12} (1 trillion) times		SOP-8
MB85RS16N	16Kbit	2.7 to 3.6V	20MHz		10^{12} (1 trillion) times		SOP-8/SON-8
MB85RS16	16Kbit	2.7 to 3.6V	20MHz		10^{12} (1 trillion) times		SOP-8
MB85RDP16LX	16Kbit binary counter	1.65 to 1.95V	15MHz	-40 to +105°C	10^{13} (1 trillion) times	10 years (+105°C)	SON-8
Parallel Interface							
MB85R4M2T	4Mbit (265Kx16)	1.8 to 3.6V	150ns	-40 to +85°C	10^{13} (10 trillion) times	10 years (+85°C)	TSOP-44
MB85R4001A	4Mbit (512K×8)	3.0 to 3.6V	150ns		10^{10} (10 billion) times	10 years (+55°C)	TSOP-48
MB85R4002A	4Mbit (256K×16)	3.0 to 3.6V	150ns		10^{10} (10 billion) times	10 years (+55°C)	TSOP-48
MB85R1001A	1Mbit (128K×8)	3.0 to 3.6V	150ns		10^{10} (10 billion) times	10 years (+55°C)	TSOP-48
MB85R1002A	1Mbit (64K×16)	3.0 to 3.6V	150ns		10^{10} (10 billion) times	10 years (+55°C)	TSOP-48
MB85R256F	256Kbit (32K×8)	2.7 to 3.6V	150ns		10^{12} (1 trillion) times	10 years (+85°C)	TSOP-28/SOP-28

FRAM-Based Radio Frequency Identity (RFID) Chips

The industry is no longer satisfied with the limited and insecure information available through magnetic strips or barcodes. Instead, companies are storing larger amounts of information (beyond simple historical and tracking records) within each individual product. Traceability at difference stages of the supply chain is essential to ensure quality products and services through monitoring from each process stage.

FRAM is ideal for use in RFID products, where high security and low power consumption are important. The Fujitsu family of high-density, FRAM-based RFID products enables robust tracking applications. Since FRAM has a high tolerance against radiation, these RFID chips are suitable for various medical and pharmaceutical applications where gamma sterilization and autoclave are often required.

Advantages of FRAM and RFID

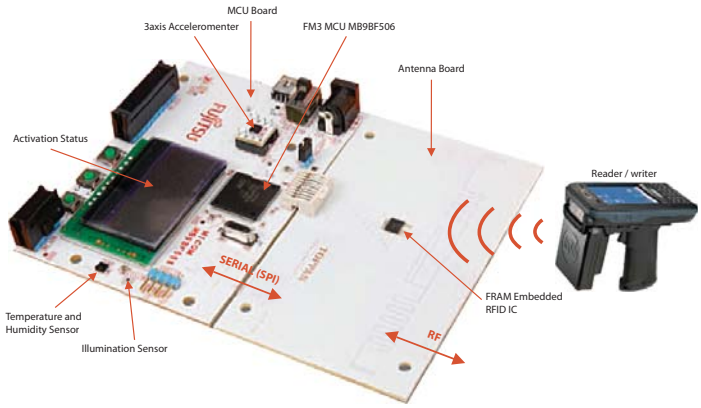
- **Speed and high capacity:** FRAM memories can be written as fast as they can be read. The high-speed access and low power consumption allow the design of high-capacity RFID chips suitable for data logging.
- **Almost unlimited read-write times:** With read-write endurance of 10^{12} cycles, FRAM is more durable and suitable for applications that require frequent rewriting.
- **Gamma radiation hardness:** Unlike EEPROM, FRAM does not lose its content due to radiation exposure. Therefore FRAM-based RFID tags are ideally suited for medical or food-industry applications where sterilization is performed by irradiation. FRAM data is protected against up to 50kGy gamma ray sterilization, double the dosage typically used.

Target Applications

- Logistic-tracking systems
- Data-logging devices
- Information displays
- Wireless tracking
- Environmental monitoring control

FRAM Memory Device with Wireless and Wired SPI Interfaces

The MB97R803A/B and MB89R112 are available with two interfaces: a conventional contactless RFID product and a contact-based SPI interface. This dual-interface device can be implemented as part of a microcontroller-based embedded system. Data captured by the sensors and the MCU can be stored in the FRAM memory. The user can easily access this data using the contact or contactless interface.

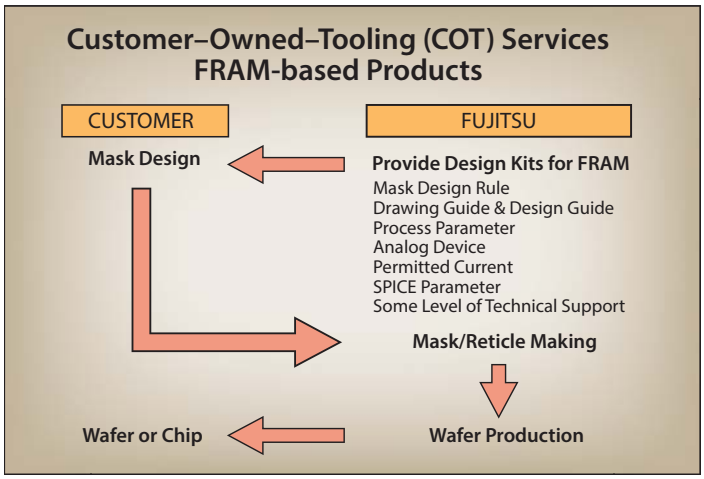


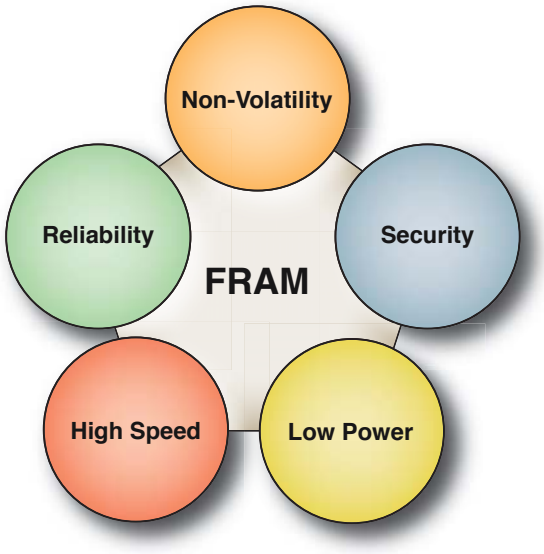
Product Lineup of LSI for FRAM RFID Tags						
Part Number	**Operating Frequency**	**Memory Density**	**Commands**	**Serial Interface**	**Data Retention Guaranteed**	**Read/Write Cycles**
MB97R803A/B	UHF 860-960MHz	4KBytes	ISO/IEC18000-6C EPC C1G2 Ver.1.2.0	–	10 years (+55°C)	10^{10} (10 billion) times
MB97R804A/B	UHF 860-960MHz	4KBytes	ISO/IEC18000-6C EPC C1G2 Ver.1.2.0	SPI	10 years (+55°C)	10^{10} (10 billion) times
MB97R8050	UHF 860-960MHz	128bits	ISO/IEC18000-6C EPC C1G2 Ver.1.2.0	–	10 years (+55°C)	10^{10} (10 billion) times
MB89R118C	HF 13.56MHz	2KBytes	ISO/IEC15693	–	10 years (+85°C)	10^{12} (1 trillion) times
MB89R119B	HF 13.56MHz	256Bytes	ISO/IEC15693	–	10 years (+85°C)	10^{12} (1 trillion) times
MB89R112	HF 13.56MHz	9KBytes	ISO/IEC15693	SPI	10 years (+85°C)	10^{12} (1 trillion) times

Customer-Owned-Tooling (COT) Foundry Services and Custom Design Services for FRAM-based Products

There is a growing demand for top-down design especially from fabless companies. Fujitsu actively supports a variety of third-party tools, and gives customers the opportunity to incorporate the next-generation FRAM technology into their products. In this scenario, customers design the logic and layout using their own tools, while adhering to Fujitsu's process rules. Fujitsu performs design rule checks, mask making and wafer fabrications.

Other technical and business support services are available. For more information and product listings, please go to http://us.fujitsu.com/semi/fram.





Comparison of FRAM with Other Memory Devices

	FRAM	EEPROM	Flash	SRAM
Type	Non-volatile	Non-volatile	Non-volatile	Volatile
Writing Method	Overwriting	Erase (byte) + write	Erase (sector) + write	Overwriting
Write Cycle Time	150ns	3ms	1s	55ns
Endurance	100K	1 million	1 million	Unlimited

Fujitsu FRAM Leadership

Fujitsu has a proven track record of designing and manufacturing high-quality, highly reliable FRAM products. Fujitsu was the first company to embed FRAM into CMOS logic in 1998 and to release production quantities in 1999. The industry's largest FRAM supplier, Fujitsu can control design, process technology, and production, ensuring a reliable and stable supply to meet the increasing demand for FRAM products.

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