FUJITSU

FUJITSU Semiconductor FRAM

shaping tomorrow with you

FUJITSU SEMICONDUCTOR LIMITED

“FRAM”, high quality and high reliability with matured manufacturing experien

Fujitsu Limited has offered a continuous stream of memory products for more than 47 years since 1969. Today Fujitsu Semiconductor Limited offers products based on Ferroelectric Random Access Memory (FRAM), a type of high quality, high reliability non-volatile memory.

Development of FRAM began in 1995, and Fujitsu has a track record of more than 18 years of mass production. Fujitsu has previously received inquiries from customers in 45 countries all over the world regarding a diverse range of more than 200 types of applications.

FRAM has been employed for smart cards and RFID tags (Radio Frequency IDentification tags, i.e., electronic tags) in the customer applications, and also for power meters, automation machinery, medical RFID tags in the industrial applications.

non-volatile memory

ces

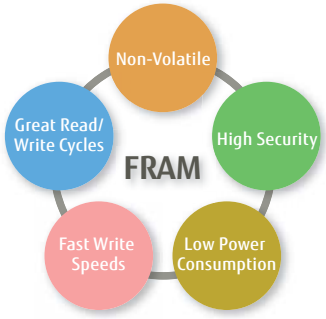
According to recent applications for IoT (internet of things), ultra-low power consumption, high speed and high read/write endurance non-volatile memory is needed. FRAM is most suitable memory for such demands and Fujitsu has been provided with our FRAM for wearable devices, industrial robots, and drones etc.

Through high quality and stable product supply backed up by our superior technical capabilities, Fujitsu has offered our FRAM to customers who need memory reliability.

Fujitsu continues developing memory products that are suitable for customer applications while striving to lower power consumption, extend the operating temperature range, and increase density.

FRAM Features

Because FRAM has both features of a random accessibility and non-volatility, it works as working memory and also can store data even when power is turned off. As compared with conventional types of non-volatile memory, such as EEPROM (Electrically Erasable and Programmable Read-Only Memory) and Flash memory, FRAM exhibits superior performance through faster write speeds, greater read/write cycle endurance and lower power consumption.

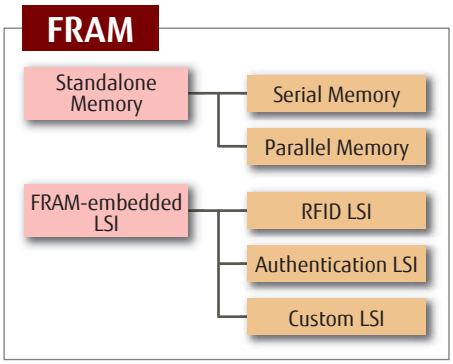


Comparison between FRAM and other memories

	FRAM	EEPROM	FLASH	SRAM
Memory Type	Non-volatile	Non-volatile	Non-volatile	Volatile
Write Method	Overwrite	Erase + Write	Erase + Write	Overwrite
Write Cycle Time	150ns	5ms	10µs	55ns
Read/Write Cycles	10^{13}	10^{6}	10^{5}	Unlimited
Booster Circuit	No	Yes	Yes	No
Data Backup Battery	No	No	No	Yes

FRAM Product Families

Fujitsu has two categorized FRAM products. One is "Standalone Memory," for general implementation usages. Another is "FRAM-embedded LSIs," which is customer designed used, such as RFID LSIs and authentication LSIs.
Fujitsu has also developed FRAM-embedded LSIs which can give the maximum superiority and performance according to customer requirements.



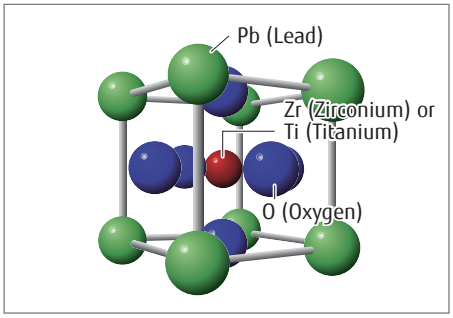
FRAM Structure

Fujitsu uses PZT (lead zirconate titanate) as a ferroelectric material in our FRAM. The crystalline structure of PZT is shown in the figure on the right.

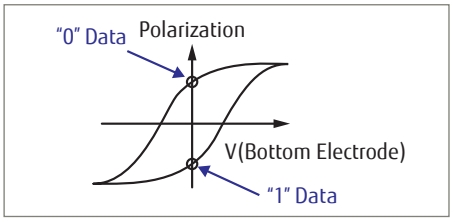
The zirconium or titanium positive ion occupies two stable positions in the lattice, and can be moved between the positions by applying an external electric field. Since the two stable positions are slightly displaced from the charge center, electric polarization with two opposite direction, up or down in the figure, appears in the ferroelectric material. Either up or down polarization can be stored even if the electric field is removed and can be switched between each other if the opposite field is applied.

Fujitsu can define the data "0" and "1" as "up polarization" and "down polarization" of the ferroelectric film, respectively. When an electric field is applied to a ferroelectric capacitor which is comprised of two electrodes sandwiched a ferroelectric film, a non-linear polarization-electric field (P-E) relation is obtained, which is called "P-E hysteresis curve".

Switching the polarization direction by applying an electric field to rewrite the data is generally much faster than the rewriting speed of floating gate memories, such as EEPRAM and Flash memory, which use electron tunneling through silicon dioxide film by applying high voltage for data rewriting.



Crystal structure of PZT

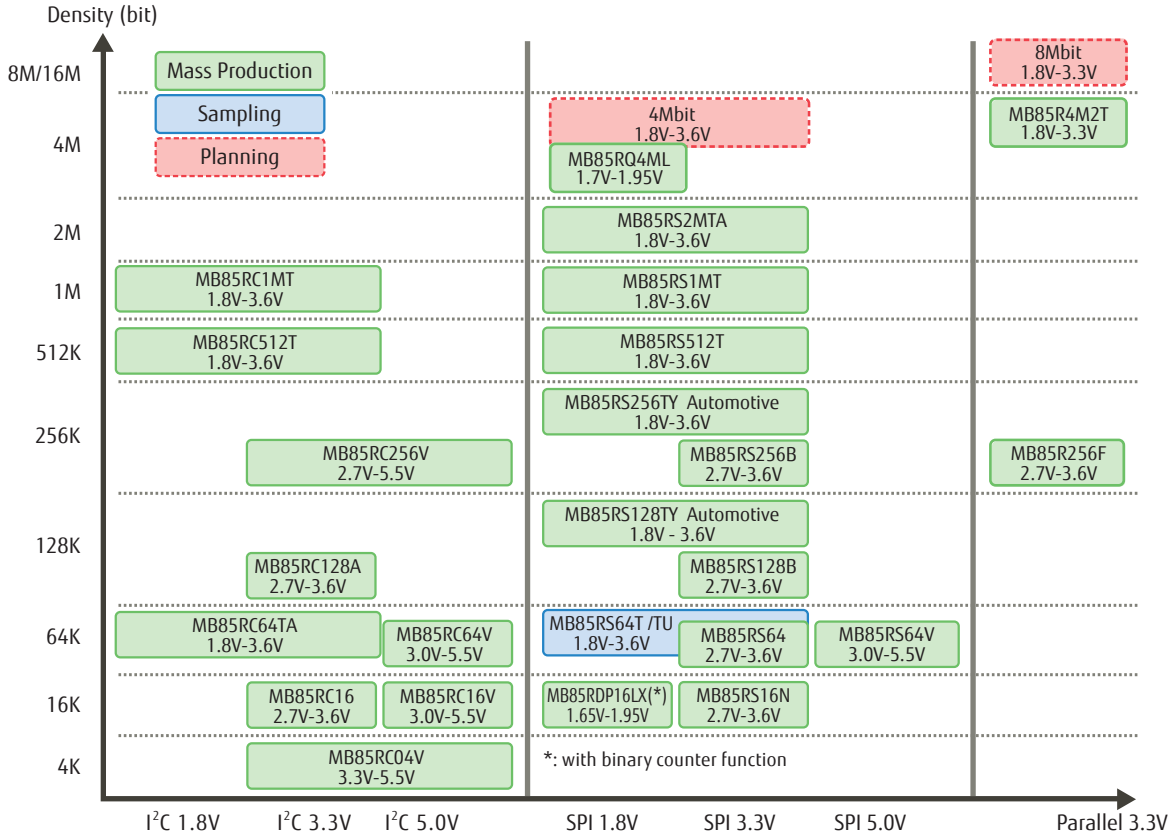


Hysteresis Loop of PZT

Product Lineup

Fujitsu provides with FRAM from 16Kbit to 4Mbit for the SPI interface and from 4Kbit to 1Mbit for the I²C interface. Operating voltage of all those products is 3.3V now, and Fujitsu has been developing 1.8V-operation FRAMs. Fujitsu can offer serial I/O FRAMs with 8-pin SOP packages for replacement of EEPROM, and also with SON (Small Outline Non-leaded package) and WL-CSP (Wafer Level Chip Size Package) for equipping in the wearable devices.

For parallel interface FRAM, 256Kbit and 4Mbit are available with TSOP packages. 256Kbit FRAM with SOP package is also available. These products are suited for replacement of battery back-upped SRAM and applications of low power consumption devices.



Application

Since FRAM has strong features of fast write and 10 trillion read/write cycles guaranteed, FRAM is used in applications required continuous rewriting, real-time recording, and data robustness.

Fujitsu offers solutions to meet customer requirements, such as "elimination of data retention batteries", "memory that allows for innumerable data read/write", "retain of data immediately before the power is switched off".

Flight Recorders/ Drive Recorders

- Drones
- Car Navigation Systems

Wearable Devices

- Smart Watches
- Hearing Aids

Robots

- Industrial Robots
- Consumer Robots

Lighting

- Lighting Equipment
- Traffic Lights

Networking

- Routers
- RAID Controllers

Metering

- Power Meters
- Gas, Water Meters

Medical

- Disposable products
- Medical Monitors

Industry Machines

- Motors, Rotary Encoders
- CNC, Control Units

IC Cards

- Security ID Cards
- IC Cards for Transportation

Remarkable Products

New AEC-Q100 compliant FRAM with guaranteed operation at 125°C

There is a demand for electronic components that are guaranteed to operate even in higher temperature environments involved in motor-related applications, as such machinery generates large amounts of heat.

In response to the customer's demands looking for memory guaranteed to operate in high temperature environment, Fujitsu Semiconductor has launched two products, MB85RS128TY and MB85RS256TY, that can operate up to 125°C.

These new products feature not only a maximum operating temperature of 125°C, but also improved reliability that has been achieved by reviewing the existing circuit design in order to meet the high quality levels for automotive applications.
Our automotive FRAM products comply with the AEC-Q100 (*1) reliability test criteria and also is in compliance with PPAP (*2).

Fujitsu responds to the requirements for future automotive applications with our FRAM, which is non-volatile memory with high reliability and high performance.

*1 : AEC (Automotive Electronic Council)
*2 : PPAP (Production Part Approval Process)

Part number	Memory density	Power supply voltage	Operating frequency	Operating temperature	Read/Write cycles	Data retention (*3)	Package
MB85RS256TY	256Kbit	1.8 to 3.6 V	33MHz	-40 to +125°C	10 trillion	10 years (+85°C) 1 year (+125°C) (*4)	SOP-8
MB85RS128TY	128Kbit	1.8 to 3.6 V	33MHz	-40 to +125°C	10 trillion	10 years (+85°C) 1 year (+125°C) (*4)	SOP-8

*3 : When operating temperature is lower than +85°C, data retention period can be extended.
*4 : Data retention performance at 125°C is under evaluation for more than 1 year.

Topics

High-density 8 Mbit parallel FRAM for industrial applications is under development

Fujitsu has been developing an 8 Mbit parallel FRAM that has the highest density in our lineup. This product is used for applications such as networks, routers, industrial computers, storage and RAID controllers, and meets the requirements of customers who want high density FRAM.

The 8 Mbit parallel FRAM is suitable for a replacement of SRAM, because it has the same package, pin assignment, and functions as asynchronous SRAM. As one of FRAM's advantages is its low power consumption, the product can also eliminate a backup battery, which is essential when using SRAM.

Accordingly, the 8 Mbit parallel FRAM can achieve batteryless solutions, which reduce the workload for battery replacement and minimize the issues caused by battery disconnections.

What FRAM can do

FRAM, non-volatile memory, does not require a battery for data retention, and does not consume power for data retention.
It also has an advantage that power consumption for write is small compared with standard EEPROM and Flash memory. Therefore, data can be written to FRAM with only very little power generated by energy harvesting, without battery power.

Fujitsu has actually verified that our demonstration device equipped with FRAM can write data without a battery.

In short, FRAM provides a batteryless solution by achieving low power consumption with its non-volatility and fast write speed.

- Batteryless Smart Shoes

Fujitsu Semiconductor developed a sensor device combined FRAM with energy harvesting using piezoelectric element. The power is generated by running with the shoes mounting insole made of piezoelectric element.
FRAM and Microcontroller are operated by this power, and step count is logged by using the data from acceleration sensor. This data is also sent to a smartphone through BLE (Bluetooth Low Energy) module, and user can monitor this data.
On our website, you can watch the demonstration video.

Batteryless Smart Shoes

- Recording rotation count by only dialing

iC-Haus GmbH, our business partner, developed a demonstrate device of rotary encoder with FRAM and Wiegand wire Technology. This demonstrate device is able to record rotation count data to FRAM with small power generated by dialing.
On our website, you can watch the demonstration video.


Rotary encoder demo

How to Buy FRAM via Online

In response to requests from our customers to get a small number of FRAM samples for evaluation, our FRAM website has set up the "Buy via Online" button on our FRAM website. The button is linked to online shopping sites for electronic devices handling Fujitsu Semiconductor's FRAM products, where you can purchase FRAM products in SOP or TSOP packages via the Internet. (When you purchase FRAM products from external online shopping sites, please confirm and follow the policy and terms and conditions of each site.) If you are unable to find the FRAM products you are looking for from online shopping sites, please contact our sales company or us directly. Please visit Fujitsu Semiconductor's website to find the contact information for our sales companies and the inquiry form.

FRAM

Serial Memory

● I²C Interface

Part number	Memory density	Power supply voltage	Operating frequency	Operating temperature	Read/Write cycles	Data retention (*1)	Package
MB85RC1MT	1Mbit	1.8 to 3.6V	3.4MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8
MB85RC512T	512Kbit	1.8 to 3.6V	3.4MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8
MB85RC256V	256Kbit	2.7 to 5.5V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RC128A	128Kbit	2.7 to 3.6V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RC64TA	64Kbit	1.8 to 3.6V	3.4MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8 / SON-8
MB85RC64V	64Kbit	3.0 to 5.5V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RC16	16Kbit	2.7 to 3.6V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8 / SON-8
MB85RC16V	16Kbit	3.0 to 5.5V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RC04V	4Kbit	3.0 to 5.5 V	1MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8

● SPI Interface

Part number	Memory density	Power supply voltage	Operating frequency	Operating temperature	Read/Write cycles	Data retention (*1)	Package
MB85RQ4ML (*2)	4Mbit	1.7 to 1.95V	108MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-16
MB85RS2MTA	2Mbit	1.8 to 3.6V	40MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8 / DIP-8
MB85RS1MT	1Mbit	1.8 to 3.6V	30MHz/40MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8 / WL-CSP
MB85RS512T	512Kbit	1.8 to 3.6V	30MHz/40MHz	-40 to +85°C	10 trillion	10 years (+85°C)	SOP-8
MB85RS256TY (*3)	256Kbit	1.8 to 3.6V	33MHz	-40 to +125°C	10 trillion	10 years (+85°C) 1 year (+125°C)	SOP-8
MB85RS256B	256Kbit	2.7 to 3.6V	33MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RS128TY (*3)	128Kbit	1.8 to 3.6V	33MHz	-40 to +125°C	10 trillion	10 years (+85°C) 1 year (+125°C)	SOP-8
MB85RS128B	128Kbit	2.7 to 3.6V	33MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RS64V	64Kbit	3.0 to 5.5V	20MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RS64	64Kbit	2.7 to 3.6V	20MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8
MB85RS64T	64Kbit	1.8 to 3.6V	10MHz	-40 to +85°C	1 trillion	10 years (+85°C)	SOP-8 / SON-8
MB85RS64TU	64Kbit	1.8 to 3.6V	10MHz	-55 to +85°C	1 trillion	10 years (+85°C)	SOP-8 / SON-8
MB85RS16N	16Kbit	2.7 to 3.6V	20MHz	-40 to +95°C	1 trillion	10 years (+95°C)	SOP-8 / SON-8
MB85RDP16LX (*4)	16Kbit	1.65 to 1.95V	15MHz (*5)	-40 to +105°C	10 trillion	10 years (+105°C)	SON-8

*1 : When operating temperature is lower than +85°C, data retention period can be extended. Please refer to datasheet.
*2 : Both SPI and Quad SPI interfaces are available.
*3 : AEC-Q100 compliant. Data retention performance at 125°C is under evaluation for more than 1 year.
*4 : With binary counter function
*5 : Maximum 7.5MHz operation is available at Dual SPI mode.

Parallel Memory

Parallel interface FRAM is available as 256Kbit and 4Mbit with TSOP and SOP package. Two parallel FRAM products operate at wide voltage range; 1.8V to 3.6V for MB85R4M2T, 2.7V to 3.6V for MB85R256F. And all packages are compatible with SRAM. So these products are suitable for the replacement of battery backed-up SRAM and applications of low power device.

Part number	Memory density (configuration)	Power supply voltage	Cycle time	Operating temperature	Read/Write cycles	Data retention (*1)	Package
MB85R4M2T	4Mbit (256K×16)	1.8 to 3.6V	150ns	-40 to +85°C	10 trillion	10 years (+85°C)	TSOP-44
MB85R256F	256Kbit (32K×8)	2.7 to 3.6V	150ns	-40 to +85°C	1 trillion	10 years (+85°C)	TSOP-28 / SOP-28

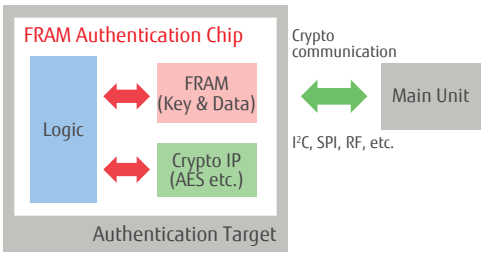
*1: When operating temperature is lower than +85°C, data retention period can be extended. Please refer to datasheet.

FRAM-embedded Authentication LSI

FRAM products have rich experiences in using for security applications such as IC cards. Fujitsu Semiconductor provides FRAM-embedded Authentication LSI and MB94R330 is one of standard product as the authentication LSI.

Part number	Power supply voltage	Interface	Communication frequency	Operating temperature	Read/Write cycles	Package
MB94R330	3.0 to 3.6V	I^2C	400kHz	-20 to +85°C	1 trillion	SON-8

Through the Challenge and Response authentication between the electric equipment and the peripheral, the MB94R330's sequence identifies between authorized and unauthorized parts.
MB94R330 is suitable for detecting cloned peripherals and accessories (cartridges, toners, etc.) that are used in electronic equipment such as printers, multifunction printers, etc.
For security applications, Fujitsu provides custom LSIs in addition to MB94R330 of standard authentication LSI to meet the specific individual specification requirements of each customer.



Example of using authentication LSI

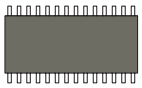
Package Size

● Serial Memory

Package	Top view	Width × Length (mm)	Height (mm)
WL-CSP-8		(*1)	0.33
SON-8		3.0 x 2.0	0.7
SOP-8		3.9 x 5.1	1.75
SOP-16		7.5 x 10.3	2.7

*1 : Regarding detailed package size, please refer to datasheet.

● Parallel Memory

Package	Top view	Width × Length (mm)	Height (mm)
SOP-28		7.6 x 17.8	2.8
TSOP-28		11.8 x 8.0	1.2
TSOP-44		10.2 x 18.4	1.2

RFID

Fujitsu Semiconductor offers FRAM-embedded LSIs, such as RFID and authentication LSIs, which utilize the strengths of FRAM, such as fast write speeds, high read/write endurance and low power consumption.

FRAM-embedded RFID LSI

By using the features of FRAM, Fujitsu provides FRAM-embedded RFID LSI. Our products are not simply read-oriented RFID tags. They are being increasingly adopted for use in data carrier RFID tags in the fields of factory automation (FA) in which needs to often rewrite production and maintenance records. These products are attracting attention as LSI to support the sensor networking society whose future depends on wireless communication of data acquired by sensors.

Features

- Improves throughput with faster write speeds
- Due to the low power consumption, there is no degradation due to communication distance.
- Larger memory density allows for data storage on the tag
- Up to 1 trillion read/write cycles allowing frequent data logging and long term use
- Conforms to International Standards: ISO15693, ISO18000-3 (mode 1), 6

Lineup

I/F	Operating frequency	Communication distance	Part number (User memory density) (*1)	
			0 ~ 256Byte	2KByte ~ 8KByte
SPI	UHF band : 860 – 960MHz	3m		MB97R8130 (8KB)
	HF band : 13.56MHz	50cm		MB89R112A/B (8KB)
Non SPI	UHF band : 860 – 960MHz	3m	MB97R8050 (0B) (EPC memory : 128bit)	MB97R8120 (8KB)
	HF band : 13.56MHz	50cm	MB89R119B (256B)	MB89R118C (2KB)

*1: We are flexible about memory density.

RFID LSI for batteryless applications

Part number	Operating frequency	User memory density (*1)	Commands	I/F	Data retention	Read/Write cycles
MB97R8110	UHF band : 860 - 960MHz	8KB	ISO/IEC18000-63 EPC C1G2 Ver.1.2.0	SPI Master SPI Slave GPIO Key Matrix Scan	10 years (+85°C)	1 trillion

*1: We are flexible about memory density.

Applications suited for RFID LSI

Factory
- Process record
- Data-log

Medical
- Use history record
- Information check

Logistics
- Transportation record
- Product control

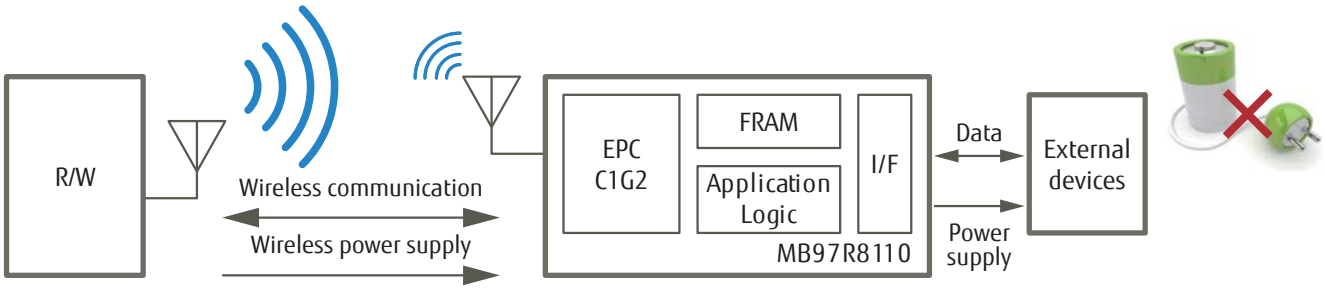
Transportation
- Maintenance record

Authenticity determination
- True/false determination
- Counterfeit determination

Authentication
- Security lock

Application in batteryless applications

● Example applications of the MB97R8110



Sales Company for FRAM & RFID

Fujitsu Semiconductor's sales companies are Fujitsu Electronics Inc. and its contracting distributors. Please contact Fujitsu Electronics or its sales office near you for any requests or inquiries regarding FRAM products.
Fujitsu Electronics also has sales offices overseas, allowing it to provide seamless support to customers expanding their operations overseas. You can also find contact information on the sales offices of Fujitsu Electronics in Japan and overseas from the link provided on Fujitsu Semiconductor's website.

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AD05-00033-10E August 2017
Edited: System Memory Company