

FRAM RFID LSI for UHF Tag Solutions and Embedded RF Solutions

MB97R803A/B

MB97R804A/B

New RFID LSI products “MB97R803A/B” and “MB97R804A/B” are lined-up in FUJITSU’s RFID products “FerVID Family™.” In addition to the large density memory feature as data carrier tag, the serial interface feature can create new value on RFID solutions with embedded MCU systems.

Introduction

FRAM (Ferroelectric Random Access Memory) embedded RFID LSI “FerVID family” has been used in the wide range of applications including industrial application, such as FA and maintenance, aviation, infrastructure, and asset management as data carrier tag, because of the large density memory and fast writing feature. In addition to the conventional RFID applications, recently RFID is expected to be an added value for embedded solutions by connecting with Microcontroller (hereafter referred to as MCU) through the serial interface equipped on the RFID LSI.

“MB97R803A/B” and “MB97R804A/B” are RFID LSI for UHF band (860 to 960MHz) with large density memory; 4Kbytes FRAM. The LSI is compliant with the industry standard EPCglobal Class 1 Generation 2 (hereafter referred to as C1G2), and the most important is that the serial interface is equipped, which enables RFID to apply on embedded solutions by connecting with MCU.

Advantages of FRAM RFID for the UHF band

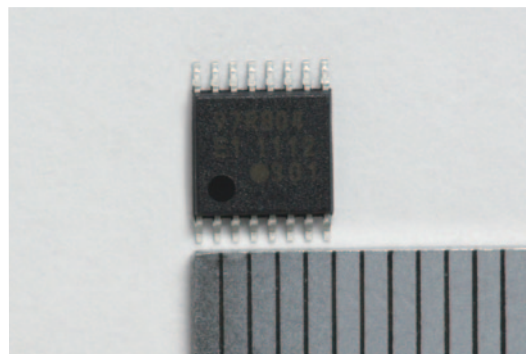
There are two key features of FRAM RFID for UHF applications. One is large density memory as data carrier and the other is stable

communication distance during read and write access.

■ Large density memory and high-speed writing

The conventional UHF RFID widely known is low cost tag, which is used for retail, logistics, baggage control, and so on, as an ID tracking instead of barcode. Among these applications, it is required that a large number of RFID tags in the fields are detected with long distance, and FRAM RFID could not show any advantages because the read operation is more focused in this case. However, an added value of RFID as data carrier has been recognized in the market recently, and the products embedded with user memory are getting increased. One of the

Photo 1 External View of MB97R804B



typical examples is the airplane tag provided by FUJITSU for maintenance record of airplane (history, parts information, and so forth), in which 64Kbytes FRAM is embedded.

Large density memory is one of the advantages of FRAM RFID, because of its fast writing feature that E²PROM cannot achieve. MB97R803A/B and MB97R804A/B have 4Kbytes FRAM, and they're promoted as data carrier RFID into aviation, FA, and maintenance for industrial application, construction, and facility management, etc..

The fast writing feature of FRAM RFID is quite beneficial for the customer to write data frequently into the memory, and it is getting critical especially for writing large amount of data.

The response time of FRAM UHF RFID to write command is few 10 microseconds which is 2digit faster than E²PROM UHF RFID. Theoretically the total writing time of 4Kbytes data into FRAM UHF RFID is approximately 0.4 seconds and reading time is approximately 0.1 seconds.

■ Stable communication distance during read and write access

The typical feature of UHF RFID is longer communication distance. Although it is passive RFID without battery, some of the E²PROM UHF RFID in the market enables to communicate approximately 10m in the maximum. However, it is not the writing distance but the reading distance, because the writing operation needs higher voltage to be pumped-up internally and as a result the writing distance becomes less than reading distance.

On the other hand, FRAM dose not require such an internal higher voltage for writing operation and the power consumption of writing is the same as that of reading. Therefore, the writing distance of FRAM UHF RFID is the same as reading distance.

This feature is important for the FA system for example, which requires the fixed range of reading and writing, because the RF communication of UHF RFID is easily affected by the environment of use, for example unexpected tag may happen to be read because of the longer reading distance and some reflection.

Advantages of FRAM RFID for Embedded Applications

The large density memory and fast writing feature of FRAM RFID is suitable for data loggers in embedded applications. By connecting with MCU via a serial interface, RFID can be connected to monitoring devices such as sensors and meters, which enables RFID to act as a memory to record the history of environment and the status monitoring when something bad happens. It is also possible to use them as memories to record the configuration of MCU, the switching information of the electronic paper beyond the MCU, and the parameter for sensors, which can

be changed by RFID.

The potential usage of RFID for embedded applications is expected to be huge. Some of the examples are introduced in the article "Evaluation Board for Embedded RFID Solution with FM3 Family Microcontroller" of Vol.29 No.1 FIND magazine. The evaluation board is planned to be released as software development kit in near future.

This product has 4Kbytes FRAM as large density memory and it is compliant with the industrial standard C1G2 as an RFID in the UHF band (860 to 960MHz). It also has a SPI (Serial Peripheral Interface) which can be connected with MCU.

Table 1 presents the main specifications of this product.

■ Memory configuration

The memory of this product is separated into four areas (USER, EPC, TID, and Reserved) with the minimum access unit of 2bytes (16-bit) word as specified in C1G2 specification.

Table 2 presents the memory configuration of this product.

It should be noted that the USER area has large density 3,434 bytes memory. This area can be read and written from both RF interface and serial interface. Although EPC and TID areas where ID information is recorded can also be accessed from both interfaces, they cannot be written from the serial interface. Furthermore, the Reserved area cannot be accessed from the serial interface.

The USER area consists of six area groups (00 to 06). Each area group consists of 16 areas, which contain 16 words each (11 areas for area group 06 only). Each unit of the area can be locked from writing and/or reading, and the lock information is recorded in

Table 1 Key specifications

RF interface	EPC global Class1 Gen2
RF frequency	UHF, 860 to 960MHz
R/W ⇒ tag communication	DSB-ASK, SSB-ASK, PR-ASK conversion PIE: 40 to 160kbps (data rate for All "0")
Tag ⇒ R/W communication	FM0, Miller Subcarrier (M=2, 4, 8) 40 to 640kbps
Read/Write sensitivity	-6dBm
Operating temperature range	-20 to 85°C
FRAM memory size	4Kbytes (user memory: 3,434bytes)
Read/Write endurance	10 ¹⁰ times
Data retention	10 years@55°C
Serial interface	SPI
Serial input frequency	2MHz (max.)
Serial input voltage	2.3 to 3.6V
Shipment form	Wafer, TSSOP16

the “Area Lock” and “Read Lock” areas of the table, respectively, and can be read from the serial interface.

In addition, the access arbitration function avoids the simultaneous memory access, if there is access from serial interface and RF interface at the same time. In this case the access from RF interface is prioritized. This feature enables to use this product for embedded applications, as described previously.

Command

This product supports the following commands:

Commands from the RF interface

Table 3 presents the supported commands.

This product supports the Mandatory commands and the Optional commands specified in CIG2 Ver.1.2.0. And as custom commands, there are Read Lock command, which enables to read-lock in the unit of areas (16 words), and ChgAreaGroupPwd command for read lock password setting.

Table 2 Memory Configuration

Area	Logical Address (RF communication)			Logical Address (SPI)	Data Description		Size (word)	Total (word)	Total (bit)
	bank	(bit)	(word)						
USER	11	00000 - 000FF	0000 - 000F	0000 - 000F	AreaGroup00	Area00	16	1,712	27,392
		00100 - 001FF	0010 - 001F	0010 - 001F		Area01	16		
		00200 - 00EFF	0020 - 00EF	0020 - 00EF		Area02-14	208		
		00F00 - 00FFF	00F0 - 00FF	00F0 - 00FF		Area15	16		
		01000 - 01FFF	0100 - 01FF	0100 - 01FF	AreaGroup01	Area00-15	256		
		02000 - 02FFF	0200 - 02FF	0200 - 02FF	AreaGroup02	Area00-15	256		
		03000 - 03FFF	0300 - 03FF	0300 - 03FF	AreaGroup03	Area00-15	256		
		04000 - 04FFF	0400 - 04FF	0400 - 04FF	AreaGroup04	Area00-15	256		
		05000 - 05FFF	0500 - 05FF	0500 - 05FF	AreaGroup05	Area00-15	256		
06000 - 06AFF	0600 - 06AF	0600 - 06AF	AreaGroup06	Area00-10	176				
EPC	01	00000 - 0000F	0000 - 0000	06C0 - 06C0	StoredCRC16 (PC to EPC)		1	35	560
		00010 - 0001F	0001 - 0001	06C1 - 06C1	StoredPC (Protocol Control)		1		
		00020 - 0002F	0002 - 0020	06C2 - 06E0	EPC		31		
		00210 - 0021F	0021 - 0021	06E1 - 06E1	XPC_W1		1		
		00220 - 0022F	0022 - 0022	06E2 - 06E2	XPC_W2		1		
TID	10	00000 - 000FF	0000 - 000F	06F0 - 06FF	TID		16	16	256
Reserved	00	00000 - 0000F	0000 - 0000	076C - 076C	KILL-Password [31:16]		1	4	64
		00010 - 0001F	0001 - 0001	076D - 076D	KILL-Password [15:0]		1		
		00020 - 0002F	0002 - 0002	076E - 076E	ACCESS-Password [31:16]		1		
		00030 - 0003F	0003 - 0003	076F - 076F	ACCESS-Password [15:0]		1		
Area Lock	—	—	—	0770 - 0770	AreaGroup00	Area00-15	1	7	112
				0771 - 0771	AreaGroup01	Area00-15	1		
				0772 - 0772	AreaGroup02	Area00-15	1		
				0773 - 0773	AreaGroup03	Area00-15	1		
				0774 - 0774	AreaGroup04	Area00-15	1		
				0775 - 0775	AreaGroup05	Area00-15	1		
				0776 - 0776	AreaGroup06	Area00-10	1		
Read Lock	—	—	—	0778 - 0778	AreaGroup00	Area00-15	1	7	112
				0779 - 0779	AreaGroup01	Area00-15	1		
				077A - 077A	AreaGroup02	Area00-15	1		
				077B - 077B	AreaGroup03	Area00-15	1		
				077C - 077C	AreaGroup04	Area00-15	1		
				077D - 077D	AreaGroup05	Area00-15	1		
				077E - 077E	AreaGroup06	Area00-10	1		

Commands from the serial interface

The serial interface of this product supports read command and write command, as specified by operation codes (**Table 4**).

■ Shipment form

This product is specified in the following two types of parts number depending on the application:

- MB97R803A/B: Only the antenna pads are enabled for pure RFID applications
- MB97R804A/B: Both antenna and SPI pads are enabled for embedded RFID applications

The shipment forms are either sawn wafers or TSSOP 16-pin package (**Photo 1**), and they are distinguished as A and B in the parts number.

Future Approach

With the unique feature of FRAM and wide range of MCU products, FUJITSU SEMICONDUCTOR intends to expand the FRAM RFID business not only for conventional RFID applications but also for the embedded RF solutions, and supports customer's development in order to create new value on the existing embedded applications. *

Table 3 Commands from the RF interface

Class	Command	Description	Command code	EPC
Select	Select	Selection of particular tag population	1010	Mandatory
Inventory	Query	Inventory round initialization and specifying	1000	Mandatory
	QueryAdjust	Q (slot number) adjustment	1001	Mandatory
	QueryRep	Slot counter decrementing	00	Mandatory
	ACK	Single tag acknowledgement (PC, EPC, CRC16 acquisition)	01	Mandatory
	NAK	Communication cancellation move (to Arbitrate status)	11000000	Mandatory
Access	Req_RN	Tag authentication (RN16 generation)	11000001	Mandatory
	Read	Memory reading	11000010	Mandatory
	Write	Memory writing. In word units (2bytes)	11000011	Mandatory
	Kill	Tag invalidation	11000100	Mandatory
	Lock	Memory lock	11000101	Mandatory
	Access	Transition to secured status	11000110	Optional
	Block Write	Memory writing. Several words (up to 16 words)	11000111	Optional
	Block Erase	Memory erase. Several words (up to 16 words)	11001000	Optional
	Block Permalock	Permanent memory lock (16 words unit)	11001001	Optional
	ChgAreaGroupPwd	Memory read lock password setting	1110000000000100	Custom
	Read Lock	Memory read lock (16 words unit)	1110000000000111	Custom

Table 4 Commands from the serial interface

Code name	Function	Operation code
READ	Memory read in word units (2bytes)	0000 0011
WRITE	Memory write in word units (2bytes)	0000 0010