

ASSP

EPCglobal Class1 Generation2 Compliant

FeRAM Embedded UHF Band RFID LSI

MB97R8120

■ 1. OVERVIEW

This document provides LSI specifications for the passive RFID Tag LSI "MB97R8120" (USER bank 8kBytes) based on "EPCglobal Class 1 Generation 2 Ver.1.2.0".

In this specification, the term "interrogator" used in EPCglobal standard is described as R/W (reader/writer). The term "Tag" is used as is.

■ 1.1 FEATURES

- Compliant with EPCglobal Class 1 Generation 2 (C1G2)
 - Carrier frequency: 860 to 960 MHz
 - Data rate
 - R/W → Tag: 26.7 kbps to 128 kbps (assuming equiprobable data)
 - Tag → R/W: 40 kbps to 640 kbps
- FeRAM: Non-volatile memory with High speed read and write
 - USER bank size: 61,440 bits
 - EPC length: up to 480bits
 - BlockPermalock: 8 Areas of USER bank to be write-protected in units of 512 words (=8,192bits).
 - Read/Write Endurance: 10^{13} times
 - Memory data retention: 10 years (+85 °C)

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■ 1.2 BLOCK DIAGRAM

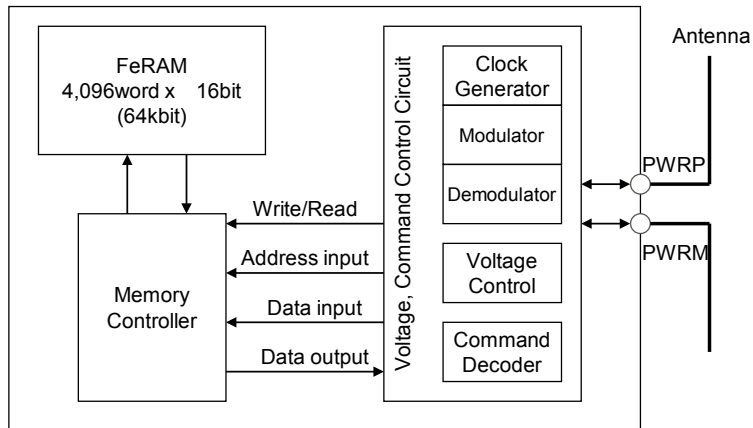


Figure 1.2 - BLOCK DIAGRAM

■ 1.3 PAD CONFIGURATION

Figure.1.3 shows the pad layout, and Table 1.3 shows the pad information.

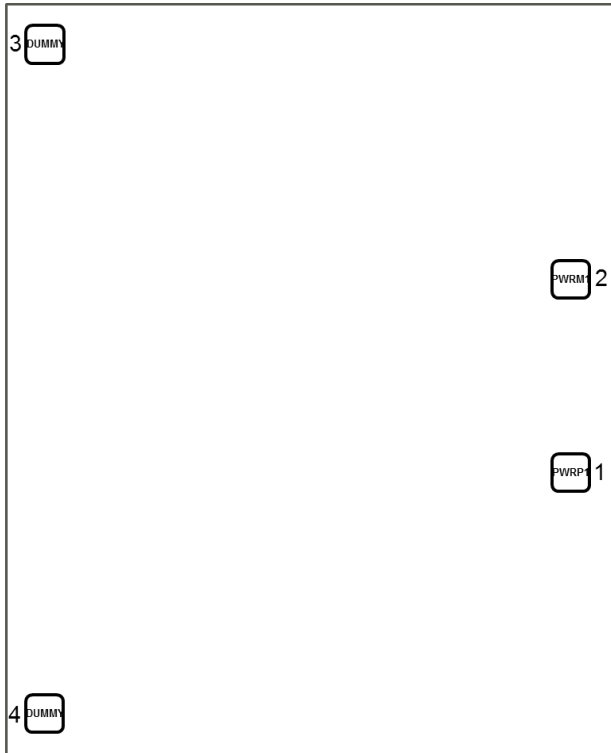


Figure 1.3 Pad Layout

Table 1.3 Pad Information

No.	Pad	Function
1	PWRP	Antenna pad for RF communication
2	PWRM	Antenna pad for RF communication
3	Dummy	*
4	Dummy	*

*. Dummy pads (No.3, 4) shall be electrically isolated from antenna pads (No.1,2) when they are connected to the antenna pattern on a tag/or an inlay. Because the dummy pad is used as power input for probing test stage, it may cause something harm for RF communication if they are connected with antenna.

■ 2 RF INTERFACE

RF signal interface is compliant with EPCglobal Class 1 Generation 2 Ver.1.2.0.

■ 2.1 Modulation type, communications timing

Compliant with EPCglobal Class 1 Generation 2 Ver.1.2.0

■ 2.2 Inventory, Tag selection

Compliant with EPCglobal Class 1 Generation 2 Ver.1.2.0

■ 2.3 Tag state-transition

Compliant with EPCglobal Class 1 Generation 2 Ver.1.2.0

■ 2.4 RF communication Error code

This LSI replies error code if it encounters an error when executing a handle-based command under Open state or Secured state. Error code is shown in Table 2.4, which is compliant with EPCglobal Class 1 Generation 2 Ver.1.2.0 (AnnexI).

Table 2.4 Error code

Error code	Error code name	Error description
00h	Other errors	Other errors not covered by the following errors
03h	Memory overrun	The specified memory location does not exist.
04h	Memory locked	The specified memory location is locked or permalocked
0Bh	Insufficient power	Insufficient power to perform the operation

■ 3 MEMORY

■ 3.1 Memory address

■ 3.1.1 Address description

The memory address is allocated in the units of 16bits (=1word). The logical address in each memory bank is described as WordAdr in this document. WordPtr is the address specified by RF command access, which is described in EBV(Extensible bit vectors) format conforming to EPCglobal Class 1 Generation 2 standard (AnnexA). EBV format is shown in Table3.1.1. The address description in this document is shown in Table3.1.2. And the practical examples of the comparison between WordPtr and WordAdr are shown in Table3.1.3.

Table 3.1.1 EBV format (Excerpt from EPCglobal standard)

0	0	0000000				
1	0	0000001				
$2^7 - 1$	127	0	1111111			
2^7	128	1	0000001	0	0000000	
$2^{14} - 1$	16383	1	1111111	0	1111111	
2^{14}	16384	1	0000001	1	0000000	0 0000000

Table 3.1.2 Address description in this document

Address range	WordAdr[13:0]	WordPtr[7:0] or WordPtr[15:8]	Comparison between WordPtr and WordAdr
0000h to 007Fh	0000h to 007Fh	00h to 7Fh	WordPtr={ <u>0</u> , WordAdr[6:0]} *
0080h to 0EFFh	0080h to 0EFFh	8100h to 9D7Fh	WordPtr={ <u>1</u> , WordAdr[13:7], <u>0</u> , WordAdr[6:0]} *

* Underlined 0,1 is defined by EBV format.

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Table 3.1.3 Comparison between WordPtr and WordAdr

WordAdr = 0000h

WordAdr[13:0]															
0000h															
WordPtr[7:0]															
00h															

WordAdr = 007Fh

WordAdr[13:0]															
007Fh															
WordPtr[7:0]															
7Fh															

WordAdr = 0080h

WordAdr[13:0]															
0080h															
WordPtr[15:0]															
8100h															

WordAdr = 0EFFh

WordAdr[13:0]															
0EFFh															
WordPtr[15:0]															
9D7Fh															

* The data stored in bit15, bit7 of WordPtr is defined by EBV format.

■ 3.2 Memory Map

■ 3.2.1 Memory bank

The Non-volatile memory (FeRAM) of this LSI is divided into the following four banks.

Table 3.2.1 Memory map

Bank		Address		Command Accessibility					
MemBank [1:0]	Definition	WordAdr[13:0]	WordPtr[15:8] WordPtr[7:0]	RF					
				Read	Write	BlockWrite	BlockErase	BlockPermalock	Select
11	USER	0000h to 0EFFh	00h to 9D7Fh	✓	✓	✓	✓	✓	✓
10	TID	0000h to 000Ch	00h to 0Ch	✓	—	—	—	—	✓
01	EPC	0000h to 001Fh	00h to 1Fh	✓	✓	✓	✓	—	✓
00	RESERVED	0000h to 003Fh	00h to 3Fh	✓	✓	—	—	—	—

USER, TID, EPC, and RESERVED memory banks contain the data in the format defined by EPCglobal C1G2 specification (Chapter 6.3.2.1). In each memory bank, the WordAdr and the WordPtr start from zero (00h).

■ 3.2.2 TID bank

The memory map of TID bank is shown in Table 3.2.2. TID bank can only be read, and the setting values cannot be changed. For details, please refer to EPCglobal Class 1 Generation 2 standard.

Table 3.2.2 TID bank memory map

WordAdr	WordPtr	MSB														LSB	Setting Value
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
00h	00h	Allocation Class							Designer							E281h	
01h	01h	Designer				Product ID				Version				0081h			
02h	02h	XTID header														3C00h	
03h	03h	Serial Number														<i>unique</i>	
04h	04h	Serial Number														<i>unique</i>	
05h	05h	Serial Number														<i>unique</i>	
06h	06h	optional command support														1DDEh	
07h	07h	BlockErase parameter														0002h	
08h	08h	BlockErase parameter														0310h	
09h	09h	BlockWrite parameter														0002h	
0Ah	0Ah	BlockWrite parameter														0310h	
0Bh	0Bh	Permalock Block size														0200h	
0Ch	0Ch	User memory size														0F00h	

■ 3.2.3 EPC bank

The memory map of EPC bank is shown in Table 3.2.3.

Table 3.2.3 EPC bank memory map

WordAdr	WordPtr	MSB															LSB	Default Value
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
00h	00h	Stored CRC																
01h	01h	Stored PC																3400h
02h	02h	EPC data																0000h
03h	03h	EPC data(Serial Number *)																<i>unique</i>
04h	04h	EPC data(Serial Number *)																<i>unique</i>
05h	05h	EPC data(Serial Number *)																<i>unique</i>
06h	06h	EPC data																0000h
07h	07h	EPC data																0000h
08h	08h	EPC data																0000h
09h	09h	EPC data																0000h
0Ah	0Ah	EPC data																0000h
0Bh	0Bh	EPC data																0000h
0Ch	0Ch	EPC data																0000h
0Dh	0Dh	EPC data																0000h
0Eh	0Eh	EPC data																0000h
0Fh	0Fh	EPC data																0000h
10h	10h	EPC data																0000h
.	EPC data																0000h
1Fh	1Fh	EPC data																0000h

*. As default value, the same serial number is stored in WordAdr=03h to 05h of EPC bank as the number stored in WordAdr=03h to 05h of TID bank.

The length of EPC is specified by EPC length field of Stored PC. The length is preprogrammed to 6 (words) as default value, which indicates 6words of EPC (WordAdr 02h to 07h). It is possible to expand the length up to 30words (WordAdr 02h to 1Fh) by programming the data of EPC length field

This LSI does not support XPC_W1 and XPC_W2. Stored CRC is not preprogrammed, because it is reflected after the response to ACK command.

■ 3.2.4 USER bank

The memory map of USER is divided into 8 Area groups as shown in Table 3.2.4

Table 3.2.4 USER bank memory map

WordAdr	WordPtr	MSB														LSB	Default Value
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
000h to 1FFh	00h to 837Fh	User data (Area0)														0000h	0000h
200h to 3FFh	8400h to 877Fh	User data (Area1)														0000h	0000h
400h to 5FFh	8800h to 8B7Fh	User data (Area2)														0000h	0000h
600h to 7FFh	8C00h to 8F7Fh	User data (Area3)														0000h	0000h
800h to 9FFh	9000h to 937Fh	User data (Area4)														0000h	0000h
A00h to BFFh	9400h to 977Fh	User data (Area5)														0000h	0000h
C00h to DFFh	9800h to 9B7Fh	User data (Area6)														0000h	0000h
E00h to EFFh	9C00h to 9D7Fh	User data (Area7)														0000h	0000h

Each area can be protected by Area Password (refer to Chapter5.2). And the same area is allocated for PermalockBlock (refer to Chapter4.1.3).

Regarding the memory access from RF communication (BlockWrite, BlockErase, and Read command), when the address reaches to WordPtr=8F7Fh (WordAdr=7FFh) among the range specified by WordCount, the address to be followed will be WordPtr=9000h (WordAdr=800h).

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■ 3.2.5 RESERVED bank

RESERVED bank is used for Password data management.

32bits Password can be set by 2steps of 16bits writing, 1st for [31:16] and 2nd for [15:0] by Req_RN and Write command as a set of sequence respectively without any other command between the steps.

Table 3.2.5 RESERVED bank memory map

WordAdr	WordPtr	MSB															LSB	Default Value
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
00h	00h	Kill password															[31:16]	0000h
01h	01h	Kill password															[15:0]	0000h
02h	02h	Access password															[31:16]	0000h
03h	03h	Access password															[15:0]	0000h
04h	04h	Reserved																0000h
.																	0000h
1Fh	1Fh	Reserved																0000h
20h	20h	Area password (Setting) (Area0)															[31:16]	0000h
21h	21h	Area password (Setting) (Area0)															[15:0]	0000h
22h	22h	Area password (Setting) (Area1)															[31:16]	0000h
23h	23h	Area password (Setting) (Area1)															[15:0]	0000h
24h	24h	Area password (Setting) (Area2)															[31:16]	0000h
25h	25h	Area password (Setting) (Area2)															[15:0]	0000h
26h	26h	Area password (Setting) (Area3)															[31:16]	0000h
27h	27h	Area password (Setting) (Area3)															[15:0]	0000h
28h	28h	Area password (Setting) (Area4)															[31:16]	0000h
29h	29h	Area password (Setting) (Area4)															[15:0]	0000h
2Ah	2Ah	Area password (Setting) (Area5)															[31:16]	0000h
2Bh	2Bh	Area password (Setting) (Area5)															[15:0]	0000h
2Ch	2Ch	Area password (Setting) (Area6)															[31:16]	0000h
2Dh	2Dh	Area password (Setting) (Area6)															[15:0]	0000h
2Eh	2Eh	Area password (Setting) (Area7)															[31:16]	0000h
2Fh	2Fh	Area password (Setting) (Area7)															[15:0]	0000h
30h	30h	Area password (Authentication) (Area0)															[31:16]	0000h
31h	31h	Area password (Authentication) (Area0)															[15:0]	0000h
32h	32h	Area password (Authentication) (Area1)															[31:16]	0000h
33h	33h	Area password (Authentication) (Area1)															[15:0]	0000h
34h	34h	Area password (Authentication) (Area2)															[31:16]	0000h
35h	35h	Area password (Authentication) (Area2)															[15:0]	0000h
36h	36h	Area password (Authentication) (Area3)															[31:16]	0000h
37h	37h	Area password (Authentication) (Area3)															[15:0]	0000h
38h	38h	Area password (Authentication) (Area4)															[31:16]	0000h
39h	39h	Area password (Authentication) (Area4)															[15:0]	0000h
3Ah	3Ah	Area password (Authentication) (Area5)															[31:16]	0000h
3Bh	3Bh	Area password (Authentication) (Area5)															[15:0]	0000h
3Ch	3Ch	Area password (Authentication) (Area6)															[31:16]	0000h
3Dh	3Dh	Area password (Authentication) (Area6)															[15:0]	0000h
3Eh	3Eh	Area password (Authentication) (Area7)															[31:16]	0000h
3Fh	3Fh	Area password (Authentication) (Area7)															[15:0]	0000h

■ 4 COMMAND

All mandatory commands and optional commands specified in EPCglobal C1G2 Ver.1.2.0. (Chapter 6.3.2.11) are supported as described in Table 4.

However, Parts of the specification of BlockWrite, BlockErase, BlockPermalock command (Optional command), and Read command (Mandatory command) are different from EPC C1G2 standard as described in Chapter 4.1, 4.2, 4.3, and 4.4.

Table 4 – RF mode command

Type	Command name	Command code
Mandatory	QueryRep	00
	ACK	01
	Query	1000
	QueryAdjust	1001
	Select	1010
	NAK	1100 0000
	Req_RN	1100 0001
	Read	1100 0010
	Write	1100 0011
	Kill	1100 0100
Optional	Lock	1100 0101
	Access	1100 0110
	BlockWrite	1100 0111
	BlockErase	1100 1000
BlockPermalock	1100 1001	

※Differences from EPCglobal C1G2 Ver. 1.2.0

(1) Stored CRC-16

If Stored PC and/or EPC data stored in EPC bank are renewed, StoredCRC-16 will not be updated when the power is turned on, but it is updated on the response to ACK command without truncation.

(2) UMI

UMI is fixed to “1” on this LSI. According to EPCglobal C1G2 Ver. 1.2.0, UMI stored in bit[10] of StoredPC in EPC bank shall be calculated by OR of bit[12:8] of WordAdr=00h in USER bank.

(3) Response to Read command when the WordCount is specified to 00h

According to EPCglobal C1G2 Ver. 1.2.0, the tag shall reply the whole data from the specified WordPtr to the last address of the bank, when the WordCount is specified to 00h.

USER bank of this LSI consists of 8 areas and can be protected by Area Password. Therefore, if parts of the data to be read is protected by Area Password, any data cannot be read and error code “04h” (indicating Memory locked) will be replied.

(4) Area Password

Area Password for data protection is stored in WordPtr=20h to 3Fh (WordAdr=20h to 3Fh) of RESERVED bank. As described in Chapter 5, Write command is used for Area Password setting and authentication when the command accesses to the specific address.

■ 4.1 BlockWrite (Optional command)

BlockWrite command format is shown in Table4.1. Part of the function are different from what is specified in EPCglobal C1G2 Ver.1.2.0 as following.

- MemBank specifies only EPC and USER bank. If BlockWrite command is executed on RESERVED and TID bank, error code “03h” (indicating Memory overrun) is replied. In this case, the data will not be written into the specified address.

- WordCount specifies the number of words to be written. If 00h is specified, the command will be ignored.

When the specified address is located in EPC bank or some address located in WordPtr=00h to 8F7Fh (WordAdr=000h to 7FFh) of USER bank, WordCount shall be 16(10h) or less. If it is 17(11h) or more, error code “03h” (indicating Memory overrun) will be replied. When the specified address is located in WordPtr=9000h to 9D7Fh (WordAdr=800h to EFFh), WordCount shall be specified up to 255(FFh). In this case, the data up to 16words is to be written into the specified address after CRC verification, but the data over 16words is to be written continuously without CRC verification. Therefore if the communication is terminated without any response because of low power detection, some data may have been written before the termination. When the specified address is all or partially locked by the BlockPermalock command or protected by Area Password, any data will not be written and error code “04h” (indicating Memory locked) is replied.

Table 4.1 — BlockWrite command

	Command	MemBank	WordPtr	WordCount	Data	RN	CRC
Number of bits	8	2	EBV	8	WordCount *16	16	16
Description	1100 0111	01:EPC 11:USER	Starting Address Pointer	Number of words to write	Data to be written	handle	CRC-16

When the address reaches WordPtr=8F7Fh (WordAdr=7FFh) among the range specified by WordCount, the address to be followed will be WordPtr=9000h (WordAdr=800h).

* In SPI slave communication, the address counter rollovers from WordAdr=7FFh to 000h.

■ 4.2 BlockErase (Optional command)

BlockErase command format is shown in Table4.2. Parts of the function are different from what is specified in EPCglobal C1G2 Ver.1.2.0 as described as follows.

- MemBank specifies only EPC and USER bank. If BlockErase command is executed on RESERVED and TID bank, error code “03h” (indicating Memory overrun) is replied. In this case, the data will not be erased.

- WordCount specifies the number of data to be erased. If 00h is specified, the command will be ignored. 01h to 10h shall be specified. When the specified address is all or partially locked by the BlockPermalock command or protected by Area Password, any data will not be erased and error code “04h” (indicating Memory locked) is replied.

Table 4.2 - BlockErase Command

	Command	MemBank	WordPtr	WordCount	RN	CRC
Number of bits	8	2	EBV	8	16	16
Description	1100 1000	01:EPC 11:USER	Starting Address Pointer	Number of words to erase	handle	CRC-16

■ 4.3 BlockPermalock (Optional command)

The unit of Block to be locked is defined as 512 words for this LSI. The BlockPermalock command can be executed to the 8 blocks of USER bank which is 7 areas of 8k bits and 1 area of 4k bits.

■ 4.3.1 BlockPermalock (Setting)

The format of the BlockPermalock command for Permalock setting is shown in Table 4.3.1. The Read/Lock value is set to “1”, and the specified block will be locked permanently. Lock data field is described in Chapter 4.3.3.

Table 4.3.1 – BlockPermalock command (Permalock)

	Command	RFU	Read /Lock	Mem Bank	BlockPtr	Block Range	LockData	RN	CRC
Number of bits	8	8	1	2	8	8	16	16	16
Description	1100 1001	0000 0000	1:Perma Lock	11:USER	0000 0000	0000 0001	0:Retain current permalock setting 1:Assert permalock	handle	CRC -16

There is a limitation as follows. If any other value is set, error code “03h” (indicating Memory overrun) will be replied and permalock operation is terminated.

- MemBank: Only executed for USER bank.
- BlockPtr: Only 00h is supported.
- BlockRange: Only 01h is supported.

■ 4.3.2 BlockPermalock (Read)

The format of the BlockPermalock command for reading permalock status is shown in Table 4.3.2.1. The Read/Lock value is set to “0”, and the permalock status of 8blocks of UER bank can be read. The response is shown in Table 4.3.2.2.

Table 4.3.2.1 – BlockPermalock command (Read)

	Command	RFU	Read /Lock	MemBank	BlockPtr	Block Range	RN	CRC
Number of bits	8	8	1	2	8	8	16	16
Description	1100 1001	0000 0000	0:Read	11:USER	0000 0000	0000 0001	handle	CRC-16

Table 4.3.2.2 – Response to BlockPermalock command (Read)

	Header	LockData	RN	CRC
Number of bits	1	16	16	16
Description	0	Permalock bits	handle	CRC-16

There is a limitation as follows. If any other value is set, error code “03h” (indicating Memory overrun) will be replied and reading operation is terminated.

- MemBank: Only executed for USER bank.
- BlockPtr: Only 00h is supported.
- BlockRange: Only 01h is supported.

■ 4.3.3 BlockPermalock and Permalocked Block

16bits of Lock data and corresponded block is shown in Table 4.3.3.

Table 4.3.3 – BlockPermalock data

Bit	Area	WordAdr	WordPtr
15	0	000h to 1FFh	00h to 837Fh
14	1	200h to 3FFh	8400h to 877Fh
13	2	400h to 5FFh	8800h to 8B7Fh
12	3	600h to 7FFh	8C00h to 8F7Fh
11	4	800h to 9FFh	9000h to 937Fh
10	5	A00h to BFFh	9400h to 977Fh
9	6	C00h to DFFh	9800h to 9B7Fh
8	7	E00h to EFFh	9C00h to 9D7Fh
7	—	—	—
6	—	—	—
5	—	—	—
4	—	—	—
3	—	—	—
2	—	—	—
1	—	—	—
0	—	—	—

When Lock data is set by BlockPermalock command (refer to Chapter 4.3.1), Bit[7:0] shall be set to “0” because of no target block.

■ 4.4 Read (Mandatory)

The command format is shown in Table 4.4.1

Table 4.4.1– Read command

	Command	MemBank	WordPtr	WordCount	RN	CRC
Number of bits	8	2	EBV	8	16	16
Description	1100 0010	00:RESERVED 01:EPC 10:TID 11:USER	Starting Address Pointer	Number of Words to read	handle	CRC-16

When the address reaches WordPtr=8F7Fh (WordAdr=7FFh) among the range specified by WordCount, the address to be followed will be WordPtr=9000h (WordAdr=800h).

When WordCount is set to “00h”, the response will be as shown in Table 4.4.2.

Table 4.4.2– Response to Read command with WordCount “00h”

MemBank	Area Password	Response
11:USER	Zero Password (All Area)	The data from the specified WordPtr (Table 4.4.1) to 9D7Fh (WordAdr=EFFh) are replied as normal response.
	Non zero Password (Some Area)	No data is read. Error code “04h” (indicating Memory locked) is replied. (refer to Chapter 2.4)
10:TID	—	The data from the specified WordPtr (Table 4.4.1) to 0Fh are replied as normal response.
01:EPC	—	The data from the specified WordPtr (Table 4.4.1) to the WordPtr corresponding to the length of EPC are replied as normal response.
00:RESERVED	—	The data from the specified WordPtr (Table 4.4.1) to 3Fh are replied as normal response.

■ 4.5 Lock (Mandatory)

The command format is shown in Table 4.5. When the Access Password(WordAdr=02h to 03h (WordPtr=02h to 03h)) is locked by setting Payload bit [17,16] and [7,6], Area Passwords(WordAdr=20h to 3Fh (WordPtr=20h to 3Fh)) are also locked automatically.

Regardless whether the password is locked or not, Area Password authentication can be executed by Write command. The detail of the command is specified in EPCglobal C1G2 Ver.1.2.0 (Chapter 6.3.2.11.3.5).

Table 4.5– Lock command

	Command	Payload	RN	CRC
Number of bits	8	20	16	16
Description	1100 0101	Mask and Action Fields	handle	CRC-16

■ 5 DATA PROTECTION

■ 5.1 LOCK Command, BlockPermalock Command, and Data protection area

This chapter describes the access control (hereinafter referred to as “Data protection”) for writing and reading memory. LOCK command can protect data in units of Bank except RESERVED Bank. And Kill Password and Access Password stored in RESERVED bank is protected. Area Password (refer to Chapter 5.2) stored in WordPtr=20h to 2Fh (WordAdr=20h to 2Fh) of RESERVED bank are also protected by the same payload [7:6] of Lock command as Access Password protection.

Table 5.1.1 Memory bank and Lock/BlockPermalock

MemBank	LOCK	WordAdr	WordPtr	BlockPermalock	Remarks
00:RESERVED	payload[9:8]	00h to 01h	00h to 01h	—	Kill Password
	payload[7:6]	02h to 03h	02h to 03h	—	Access Password
		20h to 2Fh	20h to 2Fh	—	Area Password
01:EPC	payload[5:4]	all	All	—	
10:TID	payload[3:2]	all	All	—	
11:USER	payload[1:0]	000h to 1FFh	00h to 837Fh	Mask[15]	Area0
		200h to 3FFh	8400h to 877Fh	Mask[14]	Area1
		400h to 5FFh	8800h to 8B7Fh	Mask[13]	Area2
		600h to 7FFh	8C00h to 8F7Fh	Mask[12]	Area3
		800h to 9FFh	9000h to 937Fh	Mask[11]	Area4
		A00h to BFFh	9400h to 977Fh	Mask[10]	Area5
		C00h to DFFh	9800h to 9B7Fh	Mask[9]	Area6
		E00h to EFFh	9C00h to 9D7Fh	Mask[8]	Area7

Please refer to EPCglobal C1G2 Ver.1.2.0 6.3.2.11.3.9) for the behavior to the combination of Lock command and BlockPermalock command.

■ 5.2 Data Protection for USER bank

USER bank is divided into 8 areas and each area can be access-controlled by Password Authentication.

■ 5.2.1 Area Password setting

Area Password can be set to the WordPtr=20h to 2Fh (WordAdr=20h to 2Fh) of RESERVED bank (refer to Table 3.2.5) by Write command as described in Table 5.2.1. This command is executed only in Secured state.

Table 5.2.1 Write command (Area Password setting)

	Command	MemBank	WordPtr	Data	RN	CRC
Number of bits	8	2	EBV	16	16	16
Description	1100 0011	00:RESERVED	Starting Address Pointer (20h-2Fh)	RN16 × Password to be set	handle	CRC-16

■ 5.2.2 Area Password Authentication

Area Password authentication can be set to the WordPtr=30h to 3Fh (WordAdr=30h to 3Fh) of RESERVED bank (refer to Table 3.2.5) by Write command as described in Table 5.2.2. 16bits of Password data will be sent twice for authentication as well as Access command. This command is executed only in Secured state.

Table 5.2.2 Write command (Area Password authentication)

	Command	MemBank	WordPtr	Data	RN	CRC
Number of bits	8	2	EBV	16	16	16
Description	1100 0011	00:RESERVED	Starting Address Pointer (30h-3Fh)	RN16 × (1/2 Password)	handle	CRC-16

When the authentication is failed, LSI will not reply, which is the same as failure case in the authentication of Access command. When the authentication is succeeded, the state of LSI will be transferred into AreaSecured state, and the area becomes be readable and writeable.

If the Password is set to 0, the state returns to Secured state regardless whether it was AreaSecured state or not. Because the authentication shall be applied to area by area, it is necessary to execute additional Area Password Authentication to the target area under Secured state.

■ 6 ELECTRICAL CHARACTERISTICS

■ 6.1 Absolute Maximum Rating

Table 6.1 - Absolute Maximum Rating

Parameter	Symbol	Value			Unit	Conditions/Remarks
		MIN	TYP	MAX		
Maximum input voltage	Vmax	—	—	4.0	V	PWRP1-PWRM1,PWRP3-PWRM3
Power supply voltage	VDD	-0.5	—	+4.0	V	
Input voltage	VIN	-0.5	—	VDD+0.5	V	
Output voltage	VOUT	-0.5	—	VDD+0.5	V	
ESD voltage immunity	VESD	-	—	±1200	V	Human Body Model
Storage temperature	Tstg	-40	—	+85	°C	

■ 6.2 Recommended Operation Conditions

Table 6.2 - Recommended Operation Conditions

Parameter	Symbol	Value			Unit	Conditions/Remarks
		MIN	TYP	MAX		
Operating ambient temperature	Ta	-40	—	+85	°C	
Retention guaranteed temperature	Trtn1	-40	—	+85	°C	Retention guaranteed period: 10years
RF communication						
Antenna input frequency	Fclk	860	—	960	MHz	
Receiving modulation depth	(A-B)/A	80	90	100	%	
Receiving bit rate	F_fwd	26.7	—	128	kbps	PIE code: mark rate =1/2
Receiving waveform rise time	Tr	1	—	500	µs	
Receiving waveform settling time	Ts	—	—	1500	µs	
Receiving waveform fall time	Tf	1	—	500	µs	

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■ 6.3 RF Communication Characteristics

Table 6.3 - RF Communication Characteristics (Bare die)

Parameter	Symbol	Value			Unit	Conditions/Remarks	
		MIN	TYP	MAX			
Minimum operating power when reading	PR_MIN	—	-12	—	dBm	920MHz	Measured with bare die Tari=25us,RTcal=2.5Tari,TRcal=3.0RTcal, DR=8,FM0,BLF=43kbps, DSB-ASK, Modulation depth=90% memory access length ≤ 6Word (※1)
		—	-12	—		866MHz	
Minimum operating power when writing	PW_MIN	—	-12	—	dBm	920MHz	
		—	-12	—		866MHz	
Maximum operating power	PMAX		+20		dBm		
Equivalent input capacitance (PWRP-PWRM)	CP	—	0.8	—		pF	920MHz
		—	0.8	—	pF	866MHz	Input power= -12dBm, parallel model
Equivalent input resistance (PWRP-PWRM)	RP	—	4.1	—	KΩ	920MHz	Input power= -12dBm, parallel model
		—	4.9	—		866MHz	Input power= -12dBm, parallel model
Returning bit rate	F_rtn	40	—	640	kbps		

■ 7 ORDERING INFORMATION

Part Number	Die / Package	Shipping form	Minimum Shipping Quantity
MB97R8120-DIAB15	Die 150±22.54μm thick	Sawn wafer with Frame Ring	-*

*. Please contact our sales office about minimum shipping quantity.

■ 8 OTHERS

■ 8.1 Note items

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■ 9 MAJOR CHANGES IN THIS EDITION

A change on a page is indicated by a vertical line drawn on the left side of that page.

Page	Section	Change Results
—	Overall	Following technical word is revised to more commonly used one. FRAM to FeRAM

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