1k-bit (SLIC) / 2k-bit (SLIX) R/W Memory ISO/IEC15693 Standard Compliant Device

General Description

The EM4237/SLIX is a long range passive CMOS integrated circuit intended for use in applications requiring a contactless read/write memory and offering optionally a certain level of security based on a 32-bit password authentication.

The SLIC 1k-bit / SLIX 2k-bit R/W NV memory are organized in 32/64 blocks of 4-bytes. The EM4237SLIC/SLIX offers a high level of flexibility in terms of memory management and access conditions. A memory block can be read/write protected and/or locked separately.
This latest generation of NV memory offers data retention of 60-years enabling solutions for long-term asset management applications.

Chip application privacy and NV memory access conditions are optionally protected by a 32-bit password, good trade-off for most part of anti-theft applications. To ensure a good level of privacy, the chip can be personalized to remain silent to any command received from the RFID interrogator or be programmed to return a random ID number value.

The EM4237SLIC/X features are enriched with a Smart Electronic Article Surveillance (EAS) mainly used in library applications. The EAS is configurable and programmable providing the maximum of efficiency and optionally protected by the IC password.
The IC supports all the ISO/IEC 15963-3 mandatory commands and many of the optional commands. The chip command set is completed by custom commands providing a higher degree of differentiation in terms of security, flexibility and data protection.

Features

- ISO/IEC15693 & ISO/IEC18000-3 compliant
- Long range, low power vicinity transponder IC
- 64-bit ISO/IEC 15963-3 Unique Identifier
- 1024-bit / 2048-bit user's free data memory
- Security features based on a 32-bit password
- Optional Random ID for enhanced security and privacy
- Advanced NVM management access conditions
- Smart EAS for advanced library management systems
- Data Storage Format Identifier (DSFID)
- Application Field Identifier (AFI)
- Memory blocks/pages Locking mechanism
- Lock mechanism for AFI, DSFIS and EAS
- Password protected EAS and AFI functionality
- Destroy function to deactivate the chip forever
- Support all mandatory, most of optional ISO/IEC15693-3 commands and an enriched set of custom commands
- 53kbps baud rate for read multiple block command
- On-chip and accurate resonant capacitor: 23.5pF
- -40°C to +85°C temperature range
- Bonding pads optimized for flip-chip assembly
- 60-years NVM data retention
- Wafer delivery 3 mils thickness, suitable solution for ticketing applications
- Package option: ultra-thin DFN403 package

Applications

- Library management
- Access Control
- Industrial laundries
- Ticketing
- Casino and Gaming
- Supply Chain Management

Block Diagram

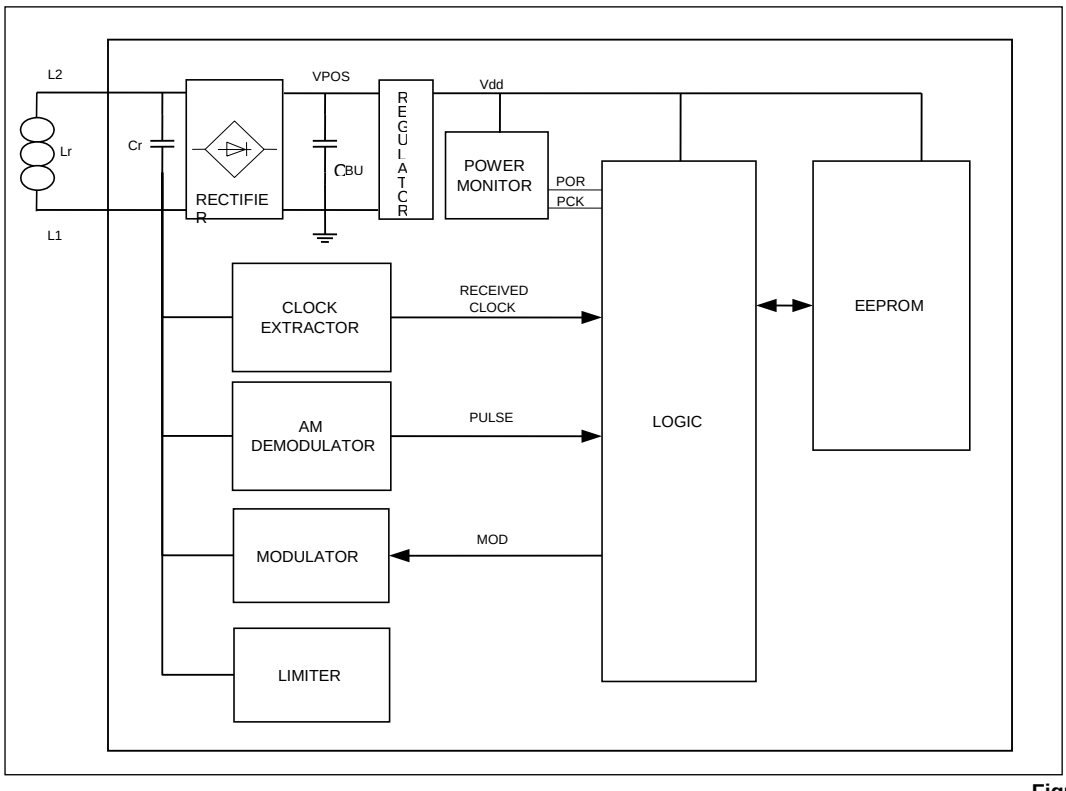


Figure 1

Table of Contents

1. Definitions, abbreviations and symbols

Terms and definitions

downlink
tag to reader communication link

uplink
reader to tag communication link

modulation index
index equal to [a-b]/[a+b] where a and b are the peak and minimum signal amplitude respectively.
Note 1: The value of the index may be expressed as a percentage.

subcarrier
a signal of frequency fs used to modulate the carrier of frequency fc

byte
a byte consists of 8 bits of data designated b1 to b8, from the most significant bit (MSB,b8) to the least significant bit (LSB,b1)

Anticollision loop
Algorithm used to prepare for and handle a dialogue between a VCD and one or more VICCs in its energizing field.

Abbreviations

AFE	Analog Front-End
AFI	Application family identifier
ASK	Amplitude shift keying
CID	Card IDentifier
CRC	Cyclic redundancy check
DSFID	Data storage format identifier
EOF	End of frame
LSB	Least significant bit
MSB	Most significant bit
RF	Radio Frequency
RFU	Reserved for future use
SOF	Start of frame
UID	Unique identifier
VCD	Vicinity Coupling Device (reader)
VICC	Vicinity Integrated Circuit Card (tag)

Symbols

fc	Frequency of operating field (carrier frequency)

2. Absolute Maximum Ratings

Parameter	Symbol	Conditions
Supply Voltage	V_{POS}	-0.3 to 7V
Voltage at any other pin except L1,L2	V_{pin}	VSS-0.3 to 1.98V
Storage temperature	T_{store}	-55 to +125°C
Maximum AC current induced on L1, L2	I_{coil_RMS}	50mA
Electrostatic discharge[1)]	V_{ESD}	2000V

Table 1

Note 2: Human Body Model (HBM; 100pF, 1.5k Ohms) between L1 and L2 terminals.

Stresses above these listed maximum ratings may cause permanent damages to the device. Exposure beyond specified operating conditions may affect device reliability or cause malfunction.

3. Handling Procedures

This device has built-in protection against high static voltages or electric fields; however, anti-static precautions must be taken as for any other CMOS component. Unless otherwise stated, proper operation can only occur when all terminal voltages are kept within the specified voltage range. Unused inputs must always be tied to a defined logic voltage level.

4. Operating Conditions

Parameter	Symbol	Min	Max	Unit
AC peak current induced on L1, L2 in operating conditions	I_{coilop}		30	mA
Operating temperature	T_{op}	-40	85	°C

Table 2

5. Electrical Characteristics

Operating conditions (unless otherwise specified):
V_{coil} = 4Vpp V_{SS} = 0V fc = 13.56MHz Sine Wave T_{op}=25°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resonance Capacitor	C_{r23}	fc = 13.56 MHz, U = 2Vrms	22.3	23.5	24.6	pF
Coil limiting voltage	V_{CLIM}	Icoil = 10mA		6		V
Modulator voltage drop-in	$V_{Modiso1}$	Icoil = 100uA	0.8	0.95	1.1	V
Modulator voltage drop-in	$V_{Modiso2}$	Icoil = 5mA	1.4	1.6	1.8	V
NVM Cycling Endurance	N_{cy}	erase all/ write all	10^5			cycle
NVM Retention	T_{ret}	Top=55°C after 10^5 cycles	60			year

Table 3

6. VICC to VCD timings

Timings in the table below represent minimum execution time in case of commands writing to NVM.
A VICC answer is sent in the appropriate following time slot specified by ISO/IEC 15693 (option_flag is not set) or after EOF reception (option_flag is set).

Parameter	Symbol	(1 of 4 mode) Execution time	(1 of 256 mode) Execution time	Unit
Write Single Block	$T_{WRBLOCK}$	4.66	4.7	ms
Lock Block	Tlock	6.67	6.7	ms
Write AFI	Twafi	6.67	6.7	ms
Lock AFI	Tlafi	6.67	6.7	ms
Write DSFID	Twdsfid	6.67	6.7	ms
Lock DSFID	Tldsfid	6.67	6.7	ms
Protect Memory Page	$T_{PROTECT}$	6.67	6.7	ms
Enable Privacy	$T_{TRANSPEN}$	6.67	6.7	ms
Disable Privacy	$T_{TRANSPDIS}$	6.67	6.7	ms
Change Key (32 bits)	T_{KEY}	4.66	4.7	ms
Enable Random ID	$T_{RANDOMEN}$	6.67	6.7	ms
Disable Random ID	$T_{RANDOMDIS}$	6.67	6.7	ms
Set EAS	Tseas	6.67	6.7	ms
Reset EAS	Treas	6.67	6.7	ms
Lock EAS	Tleas	6.67	6.7	ms
Protect EAS	Tpeas	6.67	6.7	ms
Write EAS ID	Teasid	6.67	6.7	ms
Write EAS CFG	Teascfg	6.67	6.7	ms

Table 4

In case of commands writing to NVM **if option_flag is not set** then downlink communication timings (VICC to VCD answer) are defined according to ISO/IEC15693 are specified by the formulae:

$t1_{nom}$ + a multiple of 4096/f_C with a total tolerance of ±32/ **f_C** upon detection of the rising edge of the EOF of the VCD request

Where

$t1_{nom}$ = 4352/ **f_C** (320, 9 us)

Fast Read Multiple Block command mode

The Fast Read Multiple Block mode enables a double speed downlink data rate which corresponds to a two times faster data rate defined by the ISO/IEC15693-3. The Fast mode allows communication speeds of 53 kbit/s or 13 kbit/s depending on the selected Low / High data rate.

The table below describes all timing combinations when the answer is sent in Fast mode.

			Fast mode timing *[values are in number of clocks at the carrier frequency or defined in microseconds]*		
High data rate	**Single subcarrier**	**SOF**	28.32us	12 (fc/32)	DATA1
		DATA=0	4 (fc/32)		9.44us
		DATA=1	9.44us		4 (fc/32)
		EOF	DATA0	12 (fc/32)	28.32us
	Dual subcarrier	**SOF**	14 (fc/28)	12 (fc/32)	DATA1
		DATA=0	4 (fc/32)		5 (fc/28)
		DATA=1	5 (fc/28)		4 (fc/32)
		EOF	DATA0	12 (fc/32)	14 (fc/28)
Low data rate	**Single subcarrier**	**SOF**	113.28us	48 (fc/32)	DATA1
		DATA=0	16 (fc/32)		37.76us
		DATA=1	37.76us		16 (fc/32)
		EOF	DATA0	48 (fc/32)	113.28us
	Dual subcarrier	**SOF**	56 (fc/28)	48 (fc/32)	DATA1
		DATA=0	16 (fc/32)		20 (fc/28)
		DATA=1	20 (fc/28)		16 (fc/32)
		EOF	DATA0	48 (fc/32)	56 (fc/28)

Table 5

Fast mode timing example - (high data rate, single subcarrier

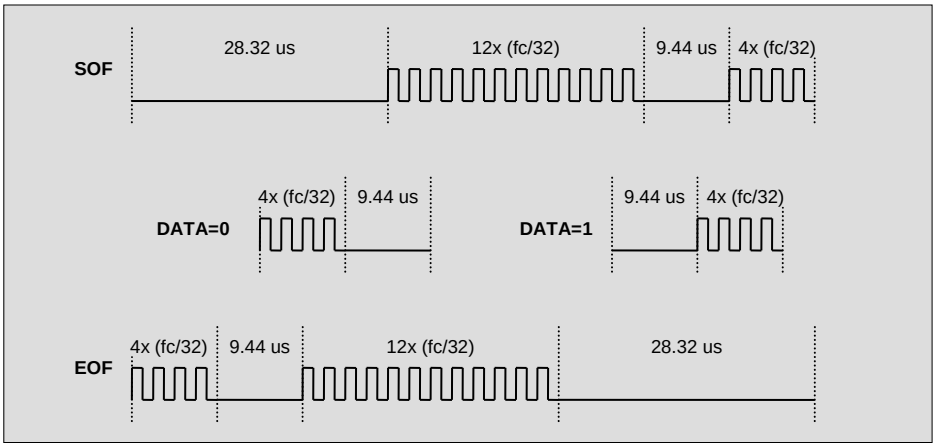


Figure 2

7. Memory Organization

A memory block is composed of 4 bytes (32 bits).

A memory page is composed of 4 blocks.

The 1k bit user's data NVM memory is organized in 32 blocks of 32 bits.

Bit31 Bit0	Block	Page	
User Block 0	0	0	User's Data Memory
User Block 1	1		
User Block 2	2		
User Block 3	3		
.....	.....	.....	
User Block 24 / EAS	24	6	
User Block 25 / EAS	25		
User Block 26 / EAS	26		
User Block 27 / EAS	27	7	
User Block 28 / EAS	28		
User Block 29 / EAS	29		
User Block 30 / EAS	30	---	
User Block 31 / EAS	31	---	

Table 6-1

The 2k-bit user's data NVM memory is organized in 64 blocks of 32 bits.

Bit31 Bit0	Block	Page	
User Block 0	0	0	User's Data Memory
User Block 1	1		
User Block 2	2		
User Block 3	3		
----------	----------	----------	
User Block 24 / EAS	24	6	
User Block 25 / EAS	25		
User Block 26 / EAS	26		
User Block 27 / EAS	27	7	
User Block 28 / EAS	28		
User Block 29 / EAS	29		
User Block 30 / EAS	30	---------	
User Block 31 / EAS	31	---------	
…	…	…	
User Block 56	56	14	
User Block 57	57		
User Block 58	58		
User Block 59	59		
User Block 60	60	15	
User Block 61	61		
User Block 62	62		
User Block 63	63		
User Block 64	64	16	
User Block 65	65		

Table 6-2

8. NVM Memory Map description

8.1 User's data Memory

At delivery, the user's data memory is access free and the default memory content is set to 0. No protection in Read or Write access is activated.

8.2 Memory Configuration area

This memory area contains chip configuration parameters and serial number and cannot be accessed by the VCD.

8.2.1 Unique Identifier (UID)

64-bit length according to ISO/IEC15693-3 and used to guaranty the uniqueness of each device. It is programmed at wafer test level and cannot be changed afterwards
The UID is defined in accordance with the figure below:

UID format

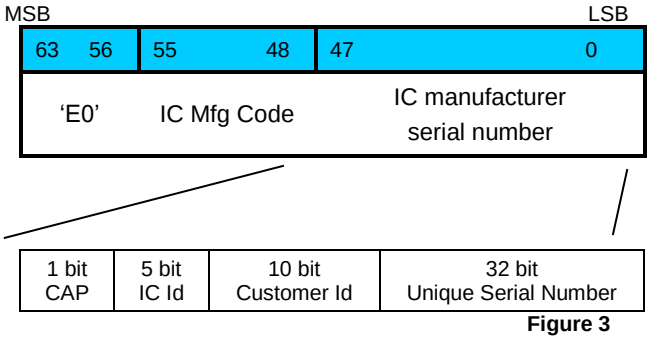


Figure 3

EM4237SLIC/X UID number comprises:

- ❑ 8 MSB's indicates the Allocation Class number 'E0' as defined by ISO/IEC15963-3 standard.
- ❑ 8 bit IC manufacturer code as defined in ISO/IEC 15963-3. In accordance with ISO/IEC7816-6:1996/Amd.1, EM-Microelectronic is identified by hexadecimal code **0x16**.
- ❑ 48 bit IC manufacturer serial number as defined in ISO/IEC 15963 and assigned by the IC manufacturer. EM manufacturer serial number consists of the following information, MSB to LSB:
  - 1 bit capacitor value
  - 5 bit IC Id (different for each member of the EM ISO 15693 / ISO18000-3 family)
  - 10 bit Customer Id
  - 32 bit unique serial number
- ❑ IC Id: **"0x0D"** corresponds to EM4237SLIC
- ❑ IC Id: **"0x17"** corresponds to EM4237SLIX
- ❑ CAP value is **'0'** for 23.5pF version

8.2.2 Random Serial Number

To insure a good level of customer privacy, the EM4237SLIC/X offers an option to use random number instead of fixed 32 bits of Unique Serial Number.

47	46 42	41 32	31 0
CAP	**IC Id**	**Customer ID**	**Random Serial Number**

Table 7

The random part of UID is generated always after power up and it is kept until next power down of the device.

UID with Random Serial Number is used during anti-collision scheme and in address mode.

Real Unique ID programmed in the memory is returned to ISO/IEC15693-3 command Get System Information in secure mode.

In normal mode, Get System Information returns Random ID number.

This feature can be enabled in secure mode by Enable Random ID and disabled by Disable Random ID commands.

At chip delivery, chip random serial number feature is disabled.

9. Features and Modes

9.1 Error Code

EM4237SLIC/X supports only error code 0x0F.

If there is an error situation, the VICC answers with error message only in case a command was sent directly to this device. I.e.:

- ❑ device is in select mode and command was sent with select bit
- ❑ command was sent in address mode with UID of this device

In other cases, if there is an error situation, the device remains silent not to disturb transmission of addressed VICC.

	Normal mode		Secure mode	
	Non - addressed	**Addressed / Select**	**Non addressed**	**Addressed / Select**
Unknown command	No response	No response	No response	No response
Correct command opcode but format error (RFU bits)	No response	Error code	No response	Error code
Incorrect parameters (out of range, incorrect password)	No response	Error code	No response	Error code
Commands not supported in current mode	No response	No response	No response	No response

Table 8

9.2 Privacy mode

The IC Privacy feature can be used in some label situations for privacy reasons.

When Privacy mode is enabled, the VICC remains silent to all commands except commands which are related to entering secure mode.

As soon as device enters secure mode, it accepts all commands as usually. At chip delivery, the Privacy mode feature is disabled.

9.3 Security

EM4237SLIC/X implements the following security features:
- ❑ Unique 64-bit serial number
- ❑ 32-bit password
- ❑ Lock mechanism for each user memory block
- ❑ Lock mechanism for DSFID, AFI and EAS
- ❑ Optional 32-bit password protected Destroy feature
- ❑ Optional 32-bit password protected Random ID number
- ❑ Optional 32-bit password protected Privacy mode
- ❑ Optional 32-bit password protected EAS
- ❑ Optional 32-bit password protected AFI

EM4237SLIC/X can be in two different access modes:
- ❑ Normal mode
- ❑ Secure mode

9.3.1 Normal mode

EM4237SLIC/X is in normal mode after every power up or when a secure mode is lost. In normal mode, a read and write access to user memory is restricted by Page Protection or Lock bits. Some commands aren't accepted in normal mode.

9.3.2 Secure Mode

Secure mode is intended to be used to access protected memory blocks.

If device enters the secure mode, it is allowed to:
- ❑ Read/write to all user memory even to blocks which are protected by Page Protection. The write access to the user data is restricted only by active Lock block bits
- ❑ Change access rights to User Memory by changing corresponding Page Protection bits
- ❑ Access chip UID number in case Random ID feature is enabled
- ❑ Access to device functionalities in case that Privacy mode is enabled
- ❑ Change Key command in order to update the 32-bit password
- ❑ Enable or Disable Privacy Mode
- ❑ Enable or Disable Random ID
- ❑ Reset or Set the Electronic Article Surveillance feature (EAS)
- ❑ Activate Destroy feature

At chip delivery, the 32-bit password value is programmed to 0x00000000h.

9.3.3 Login Procedure

Login command is used to enter the IC secure mode.

Exit Secure mode

Secure mode is lost when:
- ❑ Power on reset occurs
- ❑ Login done with wrong password value.

In all other cases, secure mode is kept. Even if an error occurs, secure mode is not lost.

9.3.4 Message Integrity Checks

CRC

In normal and in Secure mode, when Authentication level 0 or Authentication Level 1 is selected a standard CRC according to ISO/IEC15693 is used in all commands.

9.3.5 User data Memory protection

In normal mode, the access to the user data memory is controlled by Lock bits and Page Protection bits.

In a secure mode, the access to user memory is restricted only by Lock bits. Pages restricted by Page Protection are accessible (read and write).

At delivery, the user data memory is fully accessible in normal mode. There is neither protection of Read nor Write access activated.

9.3.6 Page Protection Bits

The read/write access rights to user memory pages in normal mode are defined by appropriate Page Protection bits.

Page Protection bits for every memory page can be set to:

- ❑ Reading as well as writing is allowed
- ❑ Writing is protected. Reading is allowed
- ❑ Reading is protected. Writing is allowed
- ❑ Reading as well as writing is protected

In normal mode, if a memory page is read protected, the device masks data with all zeros in case of any read command.

In normal mode, if a memory page is protected against write the device answers with an error response if reader attempts to write any block from the page.

In a secure mode, Page Protection bits are ignored and whole user memory can be accessed without Page Protection restrictions. Page protection bits can be changed by Protect Memory Page command which is accepted only in a secure mode.

At chip delivery, page protection bits are reset, memory blocks and pages are access free.

9.3.7 Lock Block Mechanism

Lock block command is defined by ISO/IEC15693-3 standard. It defines which user's data memory blocks are permanently locked against programming.

If a memory page is protected by Write page protection, Lock block command to any block of this page is accepted only in secure mode.

In normal mode, in case that a lock block command attempts to lock a block from a memory page which is protected by Write protection, the chip returns an error code 0x0F.

In normal mode, in case that a lock block command attempts to lock a block from a memory page which is not protected by Write protection, the chip executes normally the command and locks for ever the corresponding memory block.

9.4 Application Field identifier (AFI)

The EM4237SLIC/X supports the AFI feature defined by the ISO/IEC15693-3 standard.
For security aspects, required in some applications, the AFI can be optionally password protected. In secure mode, AFI can be rewritten if it was previously locked. At chip delivery, the default AFI value is set to 00h.

10. Electronic Article Surveillance (EAS)

The EM4237SLIC/X offers an Electronic Article Surveillance (EAS) feature for applications requiring a secure anti-theft protection.

The EAS feature can be activated, disabled, locked or password protected via a complete set of custom commands.

The feature offers also a high level of flexibility by giving the possibility to set the EAS telegram value and set its length.

A complete EAS feature description is given at the corresponding command chapter.

11. EM4237SLIC/X ISO/IEC15693 Command Set

Four sets of commands are defined by the ISO/IEC15693-3 standard: Mandatory, Optional, Custom and Proprietary.

Command Code	Function	Request Mode					Option flag	Secure Mode required
		Inventory	Addressed	Non addressed	Select	AFI		
'01'	**Inventory**	■	-	-	-	■	-	
'02'	**Stay Quiet**	-	■	-	-	-	-	
'20'	**Read single block**	-	■	■	■	-	■	
'21'	**Write single block**	-	■	■	■	-	■	
'22'	**Lock block**	-	■	■	■	-	■	
'23'	**Read multiple blocks**	-	■	■	■	-	■	
'25'	**Select**	-	■	-	-	-	-	
'26'	**Reset to ready**	-	■	■	■	-	-	
'27'	**Write AFI**	-	■	■	■	-	■	
'28'	**Lock AFI**	-	■	■	■	-	■	
'29'	**Write DSFID**	-	■	■	■	-	■	
'2A'	**Lock DSFID**	-	■	■	■	-	■	
'2B'	**Get System Information**	-	■	■	■	-	-	
'2C'	**Get Multiple block security status**	-	■	■	■	-	-	
'A2'	**Set EAS**	-	■	■	■	-	■	■
'A3'	**Reset EAS**	-	■	■	■	-	■	■
'A4'	**Lock EAS**	-	■	■	■	-	■	■
'A5'	**Active EAS**	-	■	■	■	-	■	■
'A6'	**Protect EAS**	-	■	■	■	-	■	■
'A7'	**Write EAS ID**	-	■	■	■	-	■	■
'A8'	**Write EAS CFG**	-	■	■	■	-	■	■
'B0'	**Inventory Block Read**	-	■	■	■	-	■	
'B4'	**Change Key**	-	■	-	■	-	■	■
'B6'	**Protect Memory Page**	-	■	■	■	-	■	■
'B8'	**Get Multiple block protection status**	-	■	■	■	-	-	
'B9'	**Destroy**	-	■	■	■	-	■	■
'BA'	**Enable Privacy**	-	■	■	■	-	■	■
'BB'	**Disable Privacy**	-	■	■	■	-	■	■
'BE'	**Enable Random ID**	-	■	-	■	-	■	■
BF'	**Disable Random ID**	-	■	-	■	-	■	■
'C3'	**Fast Read Multiple Blocks**	-	■	■	■	-	■	
'E4'	**Login**	-	■	■	■	-	-	■

■: Implemented - : Not applicable

-: Command is not executed in Normal mode.

11.1 Command format

11.1.1 VCD request

The reader request is always composed of

- Start of frame (SOF)
- Data field composed of:
  - Flags
  - Command Opcode
  - Parameters according to command
- Checksum fields
  - CRC – in normal mode or secure mode

SOF	Flags	Command opcode	Parameters (optional)	CRC	EOF
	8 bits	8 bits	n bits	16 bits	

Figure 4

Only data fields are described in further chapters. Only data fields which contain parameters are explicitly described. The other simple commands without any parameters are described in ISO standard.

11.1.2 VICC answer format

VICC answer format is composed of:

- Start of frame
- Data field composed of
  - Flags
  - Parameters according to command
- Checksum fields
  - CRC – in normal mode or secure mode

SOF	Flags	Parameters (optional)	CRC	EOF
	8 bits	n bits	16 bits	

Figure 5

Only data fields are described in further chapters.

The device answers to most of commands with standard ISO/IEC15693-3 answer format. If command was accepted and executed error_flag is zero. If command wasn't accepted or correctly executed error_flag is set and field with error code is included in frame

Only answers different to standard answer formats are described in further chapters.

11.2 Mandatory and Optional commands

See ISO/IEC15693-3 standard for detailed information about Mandatory and Optional commands.

Only ISO/IEC15693-3 Mandatory and Optional commands writing to the configuration memory area or do have a complement of functionality are described below.

Device is not verifying results of the execution of commands. The user have to perform a read command to validate any write action or a new communication exchange in order to validate any change of security parameter

11.2.1 Inventory

This command is intended to be used in any mode (normal and secure).

11.2.2 Write single block

Supported Option Flag 0 – if operation is successful the VICC answers when it has completed the write operation after time given by Twr and formula specified in chapter 6.

Supported Option Flag 1 - The VCD must wait minimum Twr time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

If VCD tries to write a block locked against writing then the Error_flag is set.

If VCD in normal mode tries to write a block inside the page protected area protected against writing then the Error_flag is set.

11.2.3 Lock block

Supported Option Flag 0 – if operation is successful the VICC answers when it has completed the write operation after time given by Tlock and formula specified in chapter 6.

Supported Option Flag 1 - The VCD must wait minimum Tlock time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.2.4 Write AFI

Supported Option Flag 0 - if operation is successful the VICC answers when it has completed the write operation after time given by Twafi.

Supported Option Flag 1 - The VCD must wait minimum Twafi time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.2.5 Lock AFI

Supported Option Flag 0 - if operation is successful the VICC answers when it has completed the write operation after time given by Tlafi.

Supported Option Flag 1 - The VCD must wait minimum Tlafi time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.2.6 Write DSFID

Supported Option Flag 0 - if operation is successful the VICC answers when it has completed the write operation after time given by Twdsfid.

Supported Option Flag 1 - The VCD must wait minimum Twdsfid time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.2.7 Lock DSFID

Supported Option Flag 0 - if operation is successful the VICC answers when it has completed the write operation after time given by Tldsfid.

Supported Option Flag 1 - The VCD must wait minimum Tldsfid time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.3 Custom commands

All custom commands send by VCD shall contain IC Mfg Code field as it defined by ISO/IEC15693-3.
At delivery the EAS mode is in a reset state.

11.3.1 Set EAS (Command code 'A2')

Set EAS command activates the EAS feature if the EAS feature is not locked. If EAS feature is locked then the Error_flag is set.

If the EAS feature is protected by a password then the command can only be executed in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Tseas.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Set EAS request format

Flags	Set EAS	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 6

Set EAS response format when Error_flag is set

Flags	Error Code
8 bits	8 bits

Figure 7

Set EAS response format when Error_flag is NOT set

Flags
8 bits

Figure 8

11.3.2 Reset EAS (Command code 'A3')

Reset EAS command deactivates the EAS features if the EAS feature is not locked. If EAS feature is locked then the Error_flag is set.

If the EAS feature is protected by a password then the command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Treas.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Reset EAS request format

Flags	Reset EAS	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 9

Reset EAS response format when Error_flag is set

Flags	Error Code
8 bits	8 bits

Figure 10

Reset EAS response format when Error_flag is NOT set

Flags
8 bits

Figure 11

11.3.3 Lock EAS (Command code 'A4')

Lock EAS command locks the current state of EAS mode (reset / set) and EAS ID.

If the EAS mode is protected by a password, then the command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Tleas.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Lock EAS request format

Flags	Lock EAS	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 12

Lock EAS response format when Error_flag is set:

Flags	Error Code
8 bits	8 bits

Figure 13

Lock EAS response format when Error_flag is NOT set:

Flags
8 bits

Figure 14

11.3.4 Active EAS (Command code 'A5')

VICC answers to this command only if EAS state is set. If EAS is reset then VICC ignores this command and remains silent.

The EAS feature presents a high level of flexibility and permits a general or a selective EAS detection. To allow such operating mode, two types of configuration have been implemented in the device.

If the Option Flag of the VCD request is set to 0:

Active EAS request format

Flags	Active EAS	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 15

Active EAS response format when Error_flag is NOT set

Flags	EAS Telegram
8 bits	See Note 4

Figure 16

Note 4: If the EAS mode is in set state, the VICC return an EAS Telegram which length depends of the EASCfg option bit settings. EAS Telegram length could be comprised between 32 up to 256 bits.
In case of an error, the device remains silent.

If the Option Flag of the VCD request is set to 1:

Active EAS request format

Flags	Active EAS	IC Mfg code	UID (optional)	EAS ID Mask Length	EAS ID Value (optional)
8 bits	8 bits	8 bits	64 bit	8 bits	0, 8 or 16 bits

Figure 17

Request parameter:

- EAS Mask Length to identify how many bits of the EAS ID value are valid (multiple of 8 bits). Only those VICC will respond with the EAS telegram which have stored the corresponding data in the EAS ID configuration (selective EAS) and if the EAS mode is set. If the EAS ID Mask length is set to 0, the VICC answers with it EAS ID.
- EAS ID value (optional)

Only the device which has the corresponding EAS ID and the EAS feature activated responds to the VCD command. In this mode, the VCD performs a selective EAS.
In case of an error, the VICC remains silent.

Active EAS response format when Error_flag is NOT set and the EAS Mask length is not equal to 0

Flags	EAS Telegram
8 bits	See Note 7

Figure 18

Note 7: At delivery, the EAS Telegram value is 00h and its length is set to 256 bits (memory blocks 24 to 31).
The EAS Telegram length depends on the EAScfg parameter settings thus could be comprised between 32 up to 256 bits.
When the VICC send its EAS Telegram to the VCD, it starts to read memory block content defined by EAScfg (see table 11) up to the last memory block (block 31). .

The EAS Telegram value is defined by the contents of user's memory block 24 up to 31.
The EAS Telegram value can be updated by writing previously blocks 24 to 31 using the Write single block command defined by ISO15693 standard.

Active EAS response format when Error_flag is NOT set and the EAS Mask length is equal to 0

Flags	EAS ID
8 bits	16 bits

Figure 19

In case of an error or if the EAS mode is disabled, the device remains silent.

11.3.5 Protect EAS (Command code 'A6')

Protect EAS command activates the EAS password protection.

The command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Tpeas.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Protect EAS request format

Flags	Protect EAS	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 20

Protect EAS response format when Error_flag is set

Flags	Error code
8 bits	8 bits

Figure 21

Protect EAS response format when Error_flag is NOT set

Flags
8 bits

Figure 22

11.3.6 Write EAS ID (Command code 'A7')

Write EAS ID command writes a new EAS Identifier Number.

If the EAS parameters are protected by a password then the command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Teasid.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Write EAS ID request format

Flags	Write EAS ID	IC Mfg code	UID (optional)	EAS ID value
8 bits	8 bits	8 bits	64 bits	16 bits

Figure 23

Write EAS ID response format when Error_flag is set

Flags	Error code
8 bits	8 bits

Figure 24

Write EAS ID response format when Error_flag is NOT set

Flags
8 bits

Figure 25

11.3.7 Write EAScfg (Command code 'A8')

Write EAScfg command configures the EAS telegram data length (EAScfg).

If the EAS feature is password protected then the command can only be executed in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Teascfg.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Write EAScfg request format

Flags	Write EAScfg	IC Mfg code	UID (optional)	EAScfg value
8 bits	8 bits	8 bits	64 bits	8 bits

Figure 26

Note 8: only two LSB bits of EAScfg are used.

EAScfg option bits		
bit 1	**bit 0**	**EAS message length**
0	0	256 bit EAS message (user block 24 to 31)
0	1	128 bit EAS message (user block 28 to 31)
1	0	64 bit EAS message (user block 30 to 31)
1	1	32 bit EAS message (user block 31)

Table 9

Write EAScfg response format when Error_flag is set

Flags	Error code
8 bits	8 bits

Figure 27

Write EAScfg response format when Error_flag is NOT set

Flags
8 bits

Figure 28

11.3.8 Inventory block Read (Command code 'B0')

When receiving an Inventory block Read command, the VICC performs the same as in the anti-collision sequence, except that instead UID number and DSFID, the VICC returns requested memory content.

If an error is detected, the VICC remains silent.

If the Option_flag is not set, the VICC returns n blocks of data.

If the Option_flag is set to 1, the VICC returns n blocks of data, part of the UID number which is not part of the mask and DSFID number.

Inventory Block Read request format

Flags	Inventory Read Block	IC Mfg code	Optional AFI	Mask length	Mask value	First block Number	Number of blocks
8 bits	8 bits	8 bits	8 bits	8 bits	0 to 64 bits	8 bits	8 bits

Figure 29

Inventory flag must be set to 1.

Meaning of flags 5 to 8 is according to table 5 in ISO/IEC15693-3.
The number of blocks in the request is one less than the number of blocks that the VICC returns in its response.

Inventory Block Read response if the Option Flag in the request is set to 0

Flags	data Repeated as needed
8 bits	

Figure 30

The EM4237SLIC/X reads the requested blocks and sends back their value in the response.
The mechanism and timing of the Inventory Read Block commands performs the same as at the ISO/IEC15693-3 Inventory command (Clause 8).

Inventory Block Read response if the Option Flag in the request is set to 1

Flags	DSFID	Rest of UID which is not part of the mask and slot number	Data
8 bits	8 bits	0 to 64 bits	Data
	8 bits	Multiple of 8 bits	Repeated as needed

Figure 31

The VICC reads the requested blocks and sends back their value in the response.

Additionally the bytes of the UID, which are not part of the mask and the slot number in case of 16 slots, are returned. Instead of a padding with zeros up to the next byte boundary the corresponding bits of the UID are returned.

The mechanism and timing of the Inventory Block Read command perform the same as the ISO/IEC15693-3 Inventory command (Clause 8).

If the sum of first block number and number of block exceeds the total available number of user blocks the number of transmitted blocks is less than the requested number of blocks, which means that the last returned block is the highest available user block followed by the 16-bit CRC and the EOF.

11.3.9 Change Key (Command code ‘B4’)

Change Key command updates the current password or key value by a new value. The command contains a data field (Key identifier) which indicates which item will be modified.

The Change Key command can be executed only in secure mode and only in an addressed or selected mode.
If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by T_{KEY}.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum T_{KEY} time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

Change Key Request Format

Flags	Change Key	IC Mfg code	UID (optional)	Key Identifier	Password
8 bits	8 bits	8 bits	64 bits	8 bits	32 bits

Figure 32

Key Identifier description

Key identifier	32-bit Password to be changed
00h	Password
01h – FFh	RFU

Table 10

11.3.10 Protect Memory Page (Command code 'B6')

The Protect Memory Page command defines the protection condition of a user's data memory page.

The command can be executed only in secure mode.

If there is error response the operation is not executed.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by $T_{PROTECT}$.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum $T_{PROTECT}$ time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

Protect Memory Page request format

Flags	Protect Memory Page	IC Mfg code	UID (optional)	Page Nb	Protect Status
8 bits	8 bits	8 bits	64 bits	8 bits	8 bits

Figure 33

Protect Status definition

Protect Status	Description
00h	Memory page is readable and writable
01h	Memory page is Read protected
10h	Memory page is Write protected
11h	Memory page is Read and Write protected

Table 11

11.3.11 Get multiple block protection status (Command code 'B8')

When receiving the Get multiple block protection status command, the VICC sends back the block protection status.
The number of blocks in the request is one less than the number of block protection status that the VICC returns in its response.

Get Multiple Block Protection Status request format

Flags	Get Multiple Block Protection Status	IC Mfg code	UID (optional)	First Block Number	Number of blocks
8 bits	8 bits	8 bits	64 bits	8 bits	8 bits

Figure 34

Get Multiple Block Protection Status response when Error flag = 0

Flags	Block protection status
8 bits	8 bits
	Repeated as needed

Figure 35

Block Protection Status description

bit	Description
0	if '1' then locked by Lock bit
1	if '1' then blocked against reading
2	if '1' then blocked against writing
7-3	not used (always '0')

Table 12

11.3.12 Destroy (Command code 'B9')

This command deactivates forever the device after next chip POR. The Destroy bit is set and the device will no longer react to any command from a VCD.

The command is password/secret Key protected thus it can only be executed in secure mode and when the device is in an addressed or selected mode.
If an error response is received by VCD, this means that the destroy operation was not executed.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time Tdestroy.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response.

Destroy request format

Flags	Destroy	IC Mfg code	UID (optional)
8 bits	8 bits	8 bits	64 bits

Figure 36

Destroy response format when Error_flag is set

Flags	Error Code
8 bits	8 bits

Figure 37

Destroy response format when Error_flag is NOT set

Flags
8 bits

Figure 38

11.3.13 Enable Privacy (Command code 'BA')

The Enable Privacy command activates the Chip Privacy mode.

The command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by Ttranspen.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum Tptranspen time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.3.14 Disable Privacy (Command code 'BB')

The Disable Privacy command disables Chip Privacy mode.

The command can be executed only in secure mode.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by Ttranspdis.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum Ttranspdis time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.3.15 Enable RandomID (Command code 'BE')

This command enables RandomID feature. The change takes effect immediately when command is executed.
When enabled, a part of device's UID is randomly generated after each power up. After each power up the device will have different UID to avoid traceability of the VICC.

Random ID is used in all commands like Inventory and in commands where UID is used (address mode). Get System Information returns Random ID in normal mode.
The programmed (fix) Unique ID is returned to Get System Information command in Secure mode.

Random ID is used for command addressing even in these modes.
The command can only be executed in secure mode in Addressed and Selected mode.
If there is error response the operation is not executed.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by $T_{RANDOMEN}$.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum $T_{RANDOMEN}$ time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.3.16 Disable RandomID (Command code 'BF')

This command disables RandomID feature. The change takes effect immediately when command is executed.

The command can only be executed in secure mode in Addressed and Selected mode.

If there is error response the operation is not executed.

If the Option_flag is not set, the VICC returns its response when it has completed the write operation starting after time given by $T_{RANDOMDIS}$.

If Option_flag is set, the VICC waits for the reception of an EOF from the VCD and upon such reception returns its response. The VCD must wait minimum $T_{RANDOMDIS}$ time before sending EOF in order to ensure proper energy condition to VICC during NVM programming.

11.3.17 Fast Read Multiple blocks (Command code 'C3')

The command request format and framing are similar to the ISO/IEC15693 optional Read Multiple blocks command.

Command request format:

Flags	Fast Read Multiple blocks	IC Mfg code	UID (optional)	First Block number	Number of blocks
8 bits	8 bits	8 bits	64 bits	8 bits	8 bits

Figure 39

Request parameters:
- First block number
- Number of blocks

The command answer format and framing are the same as in the case of Read Multiple blocks command. However the command answer data rate is realized in Fast mode as described in Table 5.

11.4 Proprietary command

11.4.1 Login (Command code 'E4')

Login command enters secure mode. Login command has to include the 32-bit password. Login command is not successful if the password value is incorrect. In that case an error code is returned. After a successful Login, the VICC enters secure mode

In all other cases, the secure mode is kept. Even if an error occurs secure mode is not lost.

Login request format

Flags	Login	IC Mfg code	UID (optional)	Password
8 bits	8 bits	8 bits	64 bits	32 bits

Figure 40

12. VICC state transition diagram

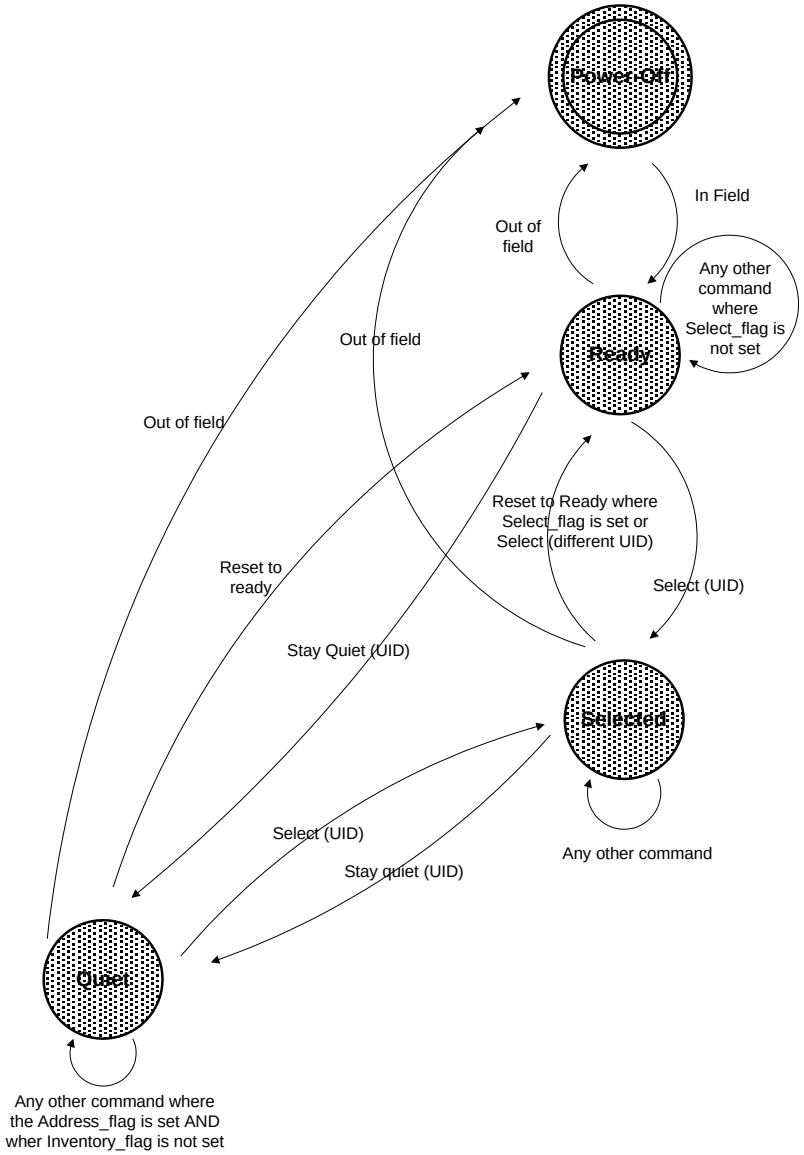


Figure 41

Note 10: The VICC state transition diagram shows only valid transitions. In all other cases the current VICC state remains unchanged. When the VICC cannot process a VCD request (e.g. CRC error, etc.), it stays in its current state.

Note 11: The intention of the state transition method is that only one VICC should be in the selected state at a time.

13. EM4237SLIC/SLIX Chip Floorplan

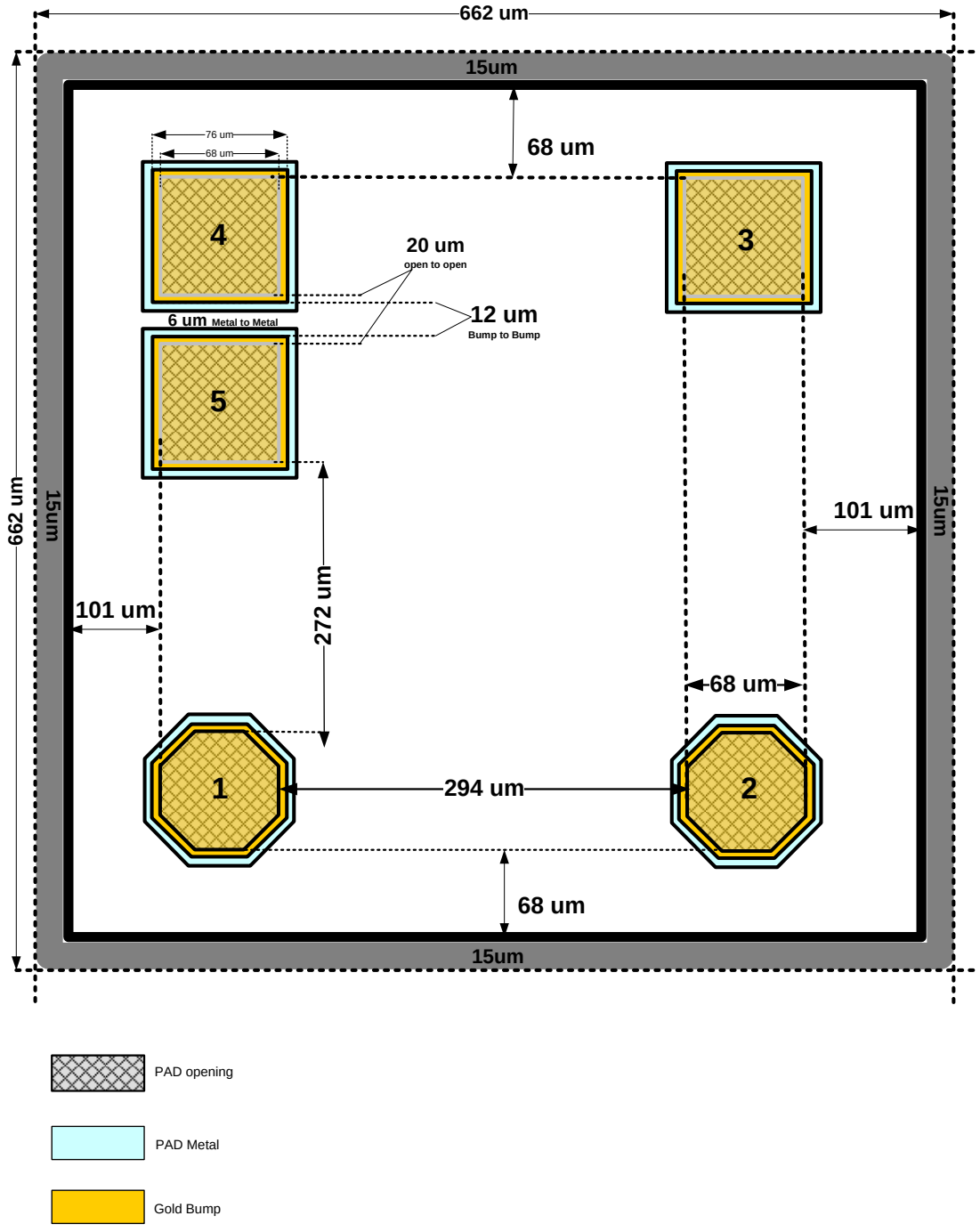


Figure 42

Pin description

Pin	Name	I/O	Description
1	COIL1	ANA	Antenna terminal
2	COIL2	ANA	Antenna terminal
3	TEST_IO	I/O	Test purposes – non-active pad
4	TEST_IO	I/O	Test purposes – non-active pad
5	TEST_IO	I/O	Test purposes – non-active pad

Table 13

14. Ordering Information

From wafer from delivery, please refer to EM4237SLIC/SLIX wafer specification document.

14.1 DIE Form:

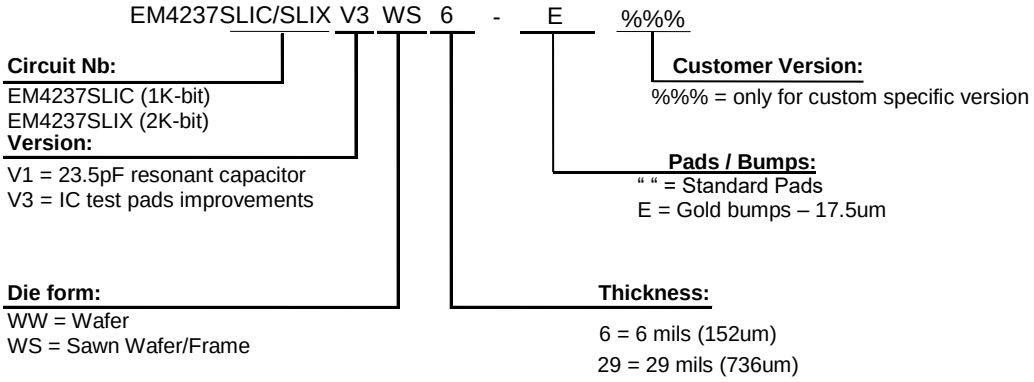


Figure 43

* Refer to PCN 19-005 and Appendix 1, resonant capacitor remains 23.5pF.
V1 is no longer available from Oct 1st, 2019.

14.2 Standard Versions:

The versions below are considered standards and should be readily available. For the other delivery form, please contact EM Microelectronic-Marin S.A. Please make sure to give the complete part number when ordering.

Part Number	Package / Die Form	Delivery form / Bumping
EM4237SLICV3WS6E	Sawn wafer, 6 mils thickness	Gold bump
EM4237SLIXV3WW29	Wafer, 29 mils thickness	Standard Aluminium Pads

Table 14

15. Package information

2 leads Plastic extremely thin small outline package; body 1.1 x 1.4 x 0.46 mm: EMDFN403

15.1 Package mechanical dimensions:

All dimensions in inches [mm].

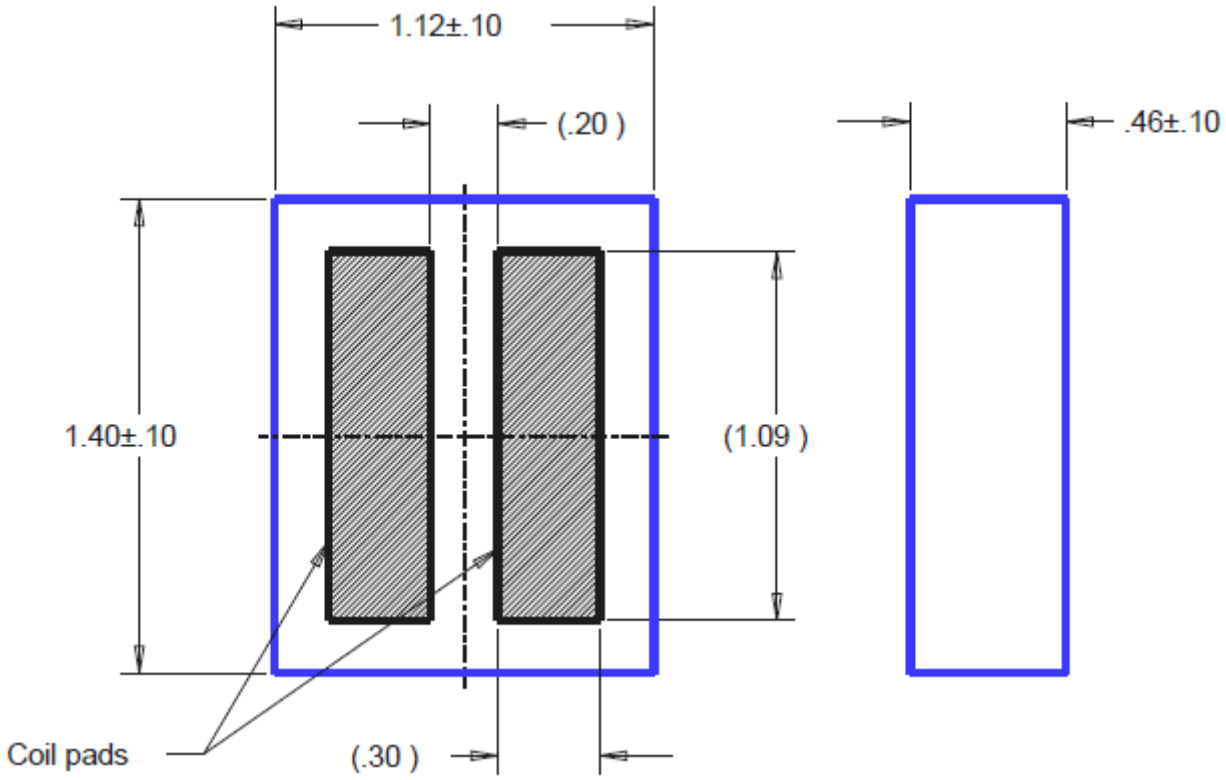


Figure 44

15.2 Packing method

Following packing method is available:

- ❑ Loose form (Aluminum canisters)
- ❑ Tape & Reel

15.3 Ordering Information – Package IC

Part Number	IC Reference	IC Resonant capacitor	Delivery format	Remarks
EM4237SLICV3DF403B+	EM4237SLIC	23.5pF	Tape & Reel	1 kbit version

Table 15

15.4 EMDFN-02 Package information

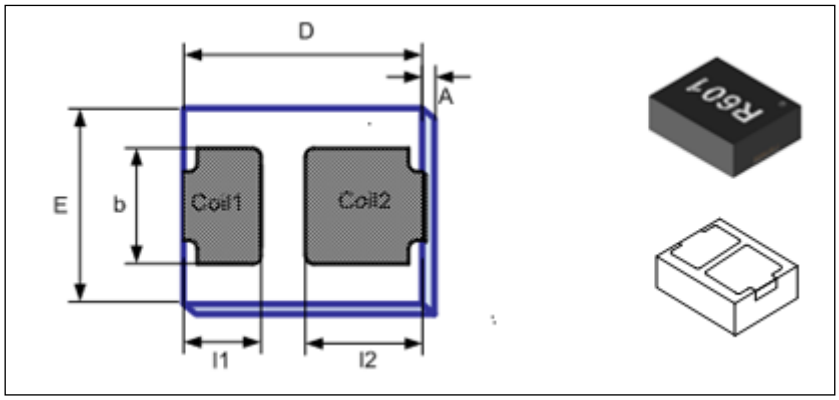


Figure 45

15.5 Package mechanical dimensions:

	A	D	E	B	l1	l2
Size	0.76	2.20	1.78	1.07	0.71	1.08
Tolerance	0.10	0. 15	0.15	0.05	0.05	0.05

Table 16

Note: all dimensions in mm.

15.6 Packing method

The following packing method is available:

- ❑ Loose form (Aluminum canisters)

15.7 Ordering Information – Package IC

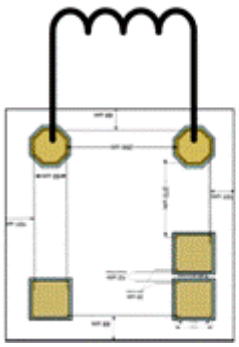
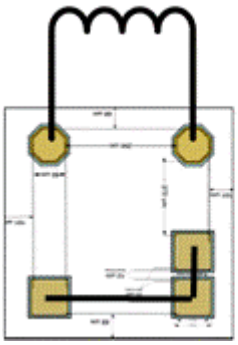
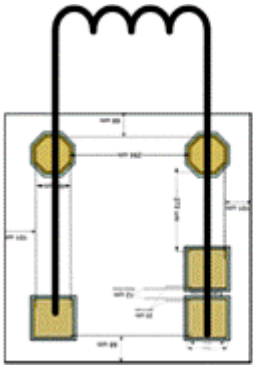
Part Number	IC Reference	IC Resonant capacitor	Delivery format	Remarks
EM4237SLICV3DF02C+	EM4237SLIC	23.5pF	Loose form	1k-bit version

Table 17

16. Appendix

16.1 Description of change PCN 19-005

IC layout changes of metal interconnect layers around 3 test pads.
Reduction of parasitic coupling between the residual test pad connection and circuitry adjacent to pad.
No change to the 2 coil pads connected to antenna.
No change to product specification or functionality.
No change to product parametric performance.

IC CONNECTION SCHEME	V1	V3
1. 	**OK**	**OK**
2. 	**ESD risk during IC assembly**	**OK**
3. 	**ESD risk during IC assembly**	**OK**

Product support

Check our web site under Products/RF Identification section. Questions can be sent to info@emmicroelectronic.com.