1k bit Read/Write ISO15693 Standard Compliant Smart Contactless Device

General Description

The EM4233SLIC is a long range passive CMOS integrated circuit intended for use in applications requiring a contactless read/write memory offering unsurpassed read range performance.

The configurable 1k bit EEPROM memory included in the chip is organized as 32 blocks of 32 bits.

The enhanced 32 bit password security feature permits a flexible administration of the memory access rights which makes it the right solution for advanced theft protection.

This latest generation of EEPROM memory offers data retention of 60 years enabling solutions for long-term asset management applications like archives or long life books.

The on-chip Electronic Article Surveillance (EAS) and the Application Field Identifier (AFI) features make the device compliant with all world wide library standards and infrastructures.

The IC supports all the ISO15693 mandatory commands and many of the optional commands. Its command set is completed by unique custom commands which provide a higher degree of differentiation in terms of security, flexibility and data protection.

Each EM4233SLIC contains a 64 bit unique serial number programmed at factory level which cannot be altered and guaranties the uniqueness of each device.

Features

- ISO15693 / ISO18000-3 standard compliant
- Long range, low power vicinity transponder IC
- 64-bit ISO15693 Unique Identifier (UID)
- 1k bit user's free EEPROM (32 blocks of 32 bits)
- 60 years memory data retention
- 32 bit password security to protect chip memory data and functionality
- Optional Password Protected Application Field Identifier
- Smart and flexible Electronic Article Surveillance feature
- Password protected Destroy function to deactivate the label forever
- Password Protected Privacy mode
- Data Storage Format Identifier (DSFID)
- EEPROM blocks/pages Locking mechanisms
- Support all mandatory and most optional ISO/IEC 15693 commands and a complete set of custom commands
- Fast read command for long data transactions using a double speed data rate
- On-chip resonant capacitor options: 23.5pF and 97pF
- -40 to +85°C temperature range
- Bonding pads optimized for flip-chip assembly

Applications

- Library management
- Archives and collections
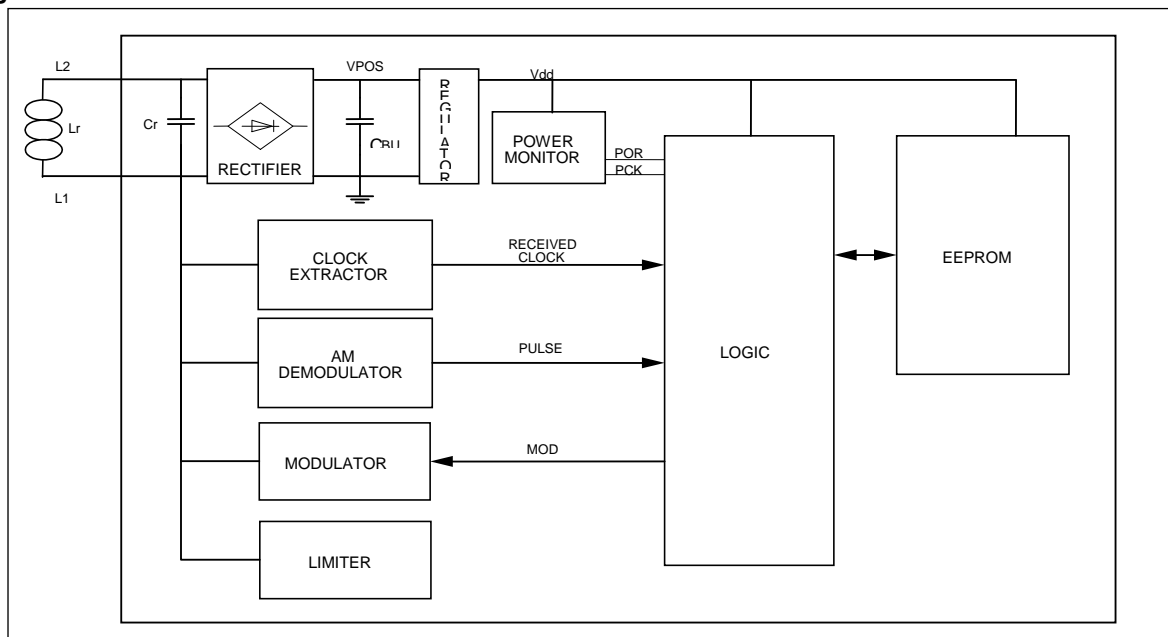- Long-term asset management
- Pharmaceutical

Block Diagram

Figure 1

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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: 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
SDB	Segment Definition Block
SOF	Start of frame
UID	Unique identifier
VCD	Vicinity Coupling Device (reader)
VICC	Vicinity Integrated Circuit Card (tag)

Symbols

a	Carrier amplitude without modulation
b	Carrier amplitude when modulated
fc	Frequency of operating field (carrier frequency)
fs	Frequency of subcarrier

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 3.6V
Storage temperature	T_{store}	-55 to +125V
Maximum AC current induced on L1, L2	I_{coil_RMS}	50mA
Electrostatic discharge[1]	V_{ESD}	2000V

Table 1

Note 1: Human Body Model (HBM; 100pF, 1.5kohm) with reference to substrate VSS

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

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.

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

Electrical Characteristics

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

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Resonance Capacitor	C_{r23}	f = 13.56 MHz, U = 2Vrms	22.3	23.5	24.7	pF
Resonance Capacitor	C_{r97}	f = 13.56 MHz, U = 2Vrms	92.1	97	101.8	pF
Coil limiting voltage	V_{CLIM}	Icoil=10mA	4.5	5.5	6.5	V
EEPROM Cycling Endurance	N_{cy}	erase all/ write all	10^5			Cycles
EEPROM Retention	T_{ret}	Top=55°C after 10^5 cycles	60			Years

Table 3

EM4233SLIC

1. VICC to VCD timings

All timings are derived from the field frequency (f_c = 13.56MHz).

Initialization (startup time)	T_{init}	400 µs

Table 4

Timings in the table below represent minimum execution time in case of commands writing to EEPROM.
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).

Command	Symbol	(1 of 4 mode) Execution time [ms]	(1 of 16 mode) Execution time [ms]
Write Single Block	T_{wr}	4.6	4.7
Lock Block	T_{lock}	3.6	3.7
AFI Write	T_{wafi}	6.2	6.3
AFI Lock	T_{lafi}	3.6	3.7
DSFID write	T_{wdsfid}	6.2	6.3
DSFID Lock	T_{ldsfid}	3.6	3.7
Set EAS	T_{seas}	2.2	2.3
Reset EAS	T_{reas}	4.2	4.3
Lock EAS	T_{leas}	2.2	2.3
Protect EAS	T_{peas}	3.6	3.7
Write EAS ID	T_{weasid}	4.9	5.0
Write EAScfg	$T_{weascfg}$	4.9	5.0
Write password	$T_{password}$	4.6	4.7
Protect Page	$T_{protect}$	4.9	5.0
Destroy	$T_{destroy}$	3.6	3.7
Enable Privacy	$T_{privacyen}$	6.2	6.3
Disable Privacy	$T_{privacydis}$	6.2	6.3

Table 5

In case of commands writing to EEPROM **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 and latest after 20 ms upon detection of the rising edge of the EOF of the VCD request

where

t1$_{nom}$ = 4352/ f_C (320,9 us)

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2. 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/IEC 15693-3. This 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 6
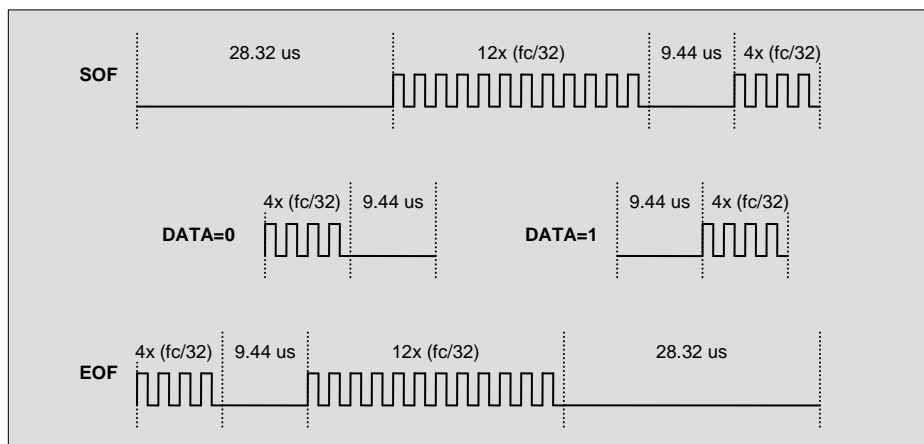
Figure 2: Fast mode timing example - (high data rate, single subcarrier)

3. Memory organization

The chip memory is composed of 2 areas:

- ❑ User's data memory from Block 0 up to Block 31
- ❑ Configuration area

The 1k bit EEPROM user's data memory is organized in 32 blocks of 32 bits. User's free memory area starts at memory block 0.

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

A memory page is composed of 4 blocks.

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

Figure 3

4. EEPROM Memory Map description

4.1 User's data Memory

At delivery, the user's data memory is access free. No protection in Read or Write access is activated.

In normal mode, the access to the user's data memory depends on both Lock bits and Page protection bits.

In Secure mode, the write access to the user's data memory depends on Lock bits only.

4.2 Memory Configuration area

This memory area is accessible only by custom commands in accordance with the following description.

4.2.1 Unique Identifier (UID)

64 bit length according to ISO/IEC 15693-3 and used to guaranty the uniqueness of each device. It is programmed by EM Microelectronic-Marin SA at wafer test level and cannot be changed afterwards.

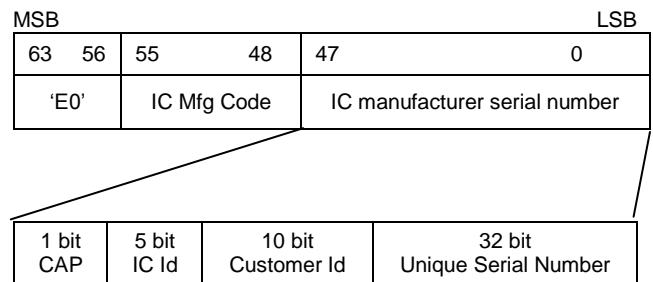The UID is set by the IC manufacturer in accordance with the figure below:

UID format

Figure 4

The UID comprises:
- ❑ The 8 MSB's indicate the Allocation Class is 'E0' as defined in ISO/IEC 15963.

- ❑ The 8 bit IC manufacturer code as defined in ISO/IEC 15963. In accordance with ISO/IEC 7816-6:1996/Amd.1, EM-Microelectronic is identified by hexadecimal code **0x16**.

- ❑ The 48 bit IC manufacturer serial number as defined in ISO/IEC 15963 and assigned by the IC manufacturer. The 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 / ISO 18000-3 family)
  - 10 bit Customer Id
  - 32 bit unique serial number

- ❑ IC Id: "0x0A" corresponds to EM4233SLIC

- ❑ CAP value is '0' for 23.5pF version

- ❑ CAP value is '1' for 97pF version

4.2.2 Lock Block Bits

❑ Defines which user's data memory blocks are permanently locked against programming
❑ Lock block bits can be set by Lock Block command

4.2.3 32 bit Password

❑ Changeable by Write Password command only in Secure Mode.

4.2.4 EAS

❑ Defined by custom commands
(Set EAS, Reset EAS) if LockEAS bit is not set

4.2.5 EAS ID

❑ Changeable by Write EAS ID command when LockEAS bit is not set

4.2.6 EAS CFG

❑ Changeable by Write EAScfg command when LockEAS bit is not set

4.2.7 Page Protection bits

❑ A pair of bits define the protection status of the corresponding user's data memory page against reading and/or writing
❑ Protection bit status is not taken in account in secure mode
❑ Changeable in Secure mode by Protect Page command

Protection status of a page is defined according to the table below:

Bit (n+1)	Bit (n)	Protection status
0	0	Memory page always readable and writable.
0	1	Memory page is Read protected. Writing is possible.
1	0	Memory page is Write protected. Reading is possible.
1	1	Memory page is Read and Write protected.

Table 7

Note: n = 2 x page number

5. Features and modes

5.1 Secure mode

If the VICC is in the secure mode, the content of the Memory Configuration area and user memory area can be changed by using the commands executable in this mode.

The VICC enters into Secure mode after a successful login command transaction using the valid 32 bit password.

5.2 Privacy mode

When the privacy mode is enabled and after power-up occurs, the IC remains silent to any command received from the VCD except the Login command. As soon as device enters Secure mode, it accepts all commands as usual.

5.3 Electronic Article Surveillance (EAS) feature

The EM4233SLIC integrates an EAS function for anti-theft purposes. It is activated by Set EAS command, deactivated by Reset EAS command, locked by Lock EAS command and can be securely protected by Protect EAS command.

If the EAS function is active, then the VICC answers to Active EAS command as follows:
❑ An EAS Telegram stored in User free memory ranging from User Block 24 to User Block 31 is sent to VCD.
❑ The data is always sent ending with User Block 31.
❑ The length of the EAS Telegram is programmable by Write EAScfg command.

5.4 Application Field identifier (AFI)

The EM4233SLIC supports the AFI feature defined by the ISO/IEC15693 standard.

For security aspects, required by some applications, the AFI can be optionally password protected.

The optional AFI sub-families of a family (including proprietary sub-families) defined by ISO15693-3 are not supported by the IC.

The application can program an AFI value using the Write AFI command. The AFI value can also be locked using the Lock AFI command.

After an AFI locking operation, it is still possible to change the AFI value by:
o Sending a Login command using the 32 bit password in order to access the chip in secure mode
o Writing a new AFI value.

When the EM4233SLIC exits the secure mode, the new AFI value is locked in the chip memory. This feature can be used in applications requiring security for check-in and check-out operations.

6. ISO15693 Commands (Contactless interface)

For detailed information concerning protocol timings, modulation, bit-coding, data rates, transactions, anticollision process, device states etc. please refer to **ISO15693-2 and ISO15693-3 standards**.

EM4233SLIC supports only error code 0x0Fh.

6.1 Command types

Four sets of commands are defined: Mandatory, Optional, Custom and Proprietary.

6.2 Command codes

Command Code	Type	Function	Active Flags							
			b1	b2	b3	b4	b5	b6	b7	b8
'01'	Mandatory	**Inventory**	x	x	1	0	x	x	0	0
'02'	Mandatory	**Stay Quiet**	x	x	0	0	0	1	0	0
'20'	Optional	**Read single block**	x	x	0	0	x	x	x	0
'21'	Optional	**Write single block**	x	x	0	0	x	x	x	0
'22'	Optional	**Lock block**	x	x	0	0	x	x	x	0
'23'	Optional	**Read multiple blocks**	x	x	0	0	x	x	x	0
'25'	Optional	**Select**	x	x	0	0	0	1	0	0
'26'	Optional	**Reset to ready**	x	x	0	0	x	x	0	0
'27'	Optional	**Write AFI**	x	x	0	0	x	x	x	0
'28'	Optional	**Lock AFI**	x	x	0	0	x	x	x	0
'29'	Optional	**Write DSFID**	x	x	0	0	x	x	x	0
'2A'	Optional	**Lock DSFID**	x	x	0	0	x	x	x	0
'2B'	Optional	**Get System Information**	x	x	0	0	x	x	0	0
'2C'	Optional	**Get Multiple block security status**	x	x	0	0	x	x	0	0
'A2'	Custom	**Set EAS**	x	x	0	0	x	x	x	0
'A3'	Custom	**Reset EAS**	x	x	0	0	x	x	x	0
'A4'	Custom	**Lock EAS**	x	x	0	0	x	x	x	0
'A5'	Custom	**Active EAS**	x	x	0	0	x	x	x	0
'A6'	Custom	**Protect EAS**	x	x	0	0	x	x	x	0
'A7'	Custom	**Write EAS ID**	x	x	0	0	x	x	x	0
'A8'	Custom	**Write EAScfg**	x	x	0	0	x	x	x	0
'B4'	Custom	**Write Password**	x	x	0	0	x1 10		x	0
'B6'	Custom	**Protect Memory Page**	x	x	0	0	x	x	x	0
'B8'	Custom	**Get Multiple block protection status**	x	x	0	0	x	x	0	0
'B9'	Custom	**Destroy**	x	x	0	0	0	1	x	0
'BA'	Custom	**Enable Privacy**	x	x	0	0	x	x	x	0
'BB'	Custom	**Disable Privacy**	x	x	0	0	x	x	x	0
'C3'	Custom	**Fast Read multiple blocks**	x	x	0	0	x	x	x	0
'E4'	Proprietary	**Login**	x	x	0	0	x	x	0	0
			Sub-carrier	Data rate	Inventory	Protocol ext.	Select	Addressed	Option	RFU

Table 8

x means used flag, can be 0 or 1.

6.3 Mandatory commands

Command Code	Type	Function	Active Flags							
			b1	b2	b3	b4	b5	b6	b7	b8
'01'	Mandatory	**Inventory**	x	x	1	0	x	x	0	0
'02'	Mandatory	**Stay Quiet**	x	x	0	0	0	1	0	0
			Sub-carrier	Data rate	Inventory	Protocol ext.	Select	Addressed	Option	RFU

Table 9

6.3.1 Inventory

Command code = '01'

See ISO/IEC 15693-3 standard for detailed information.

6.3.2 Stay quiet

Command code = '02'

See ISO/IEC 15693-3 standard for detailed information.

6.4   Optional Commands

Command Code	Type	Function	Active Flags							
			b1	b2	b3	b4	b5	b6	b7	b8
'20'	Optional	Read single block	x	x	0	0	x	x	x	0
'21'	Optional	Write single block	x	x	0	0	x	x	x	0
'22'	Optional	Lock block	x	x	0	0	x	x	x	0
'23'	Optional	Read multiple blocks	x	x	0	0	x	x	x	0
'25'	Optional	Select	x	x	0	0	0	1	0	0
'26'	Optional	Reset to ready	x	x	0	0	x	x	0	0
'27'	Optional	Write AFI	x	x	0	0	x	x	x	0
'28'	Optional	Lock AFI	x	x	0	0	x	x	x	0
'29'	Optional	Write DSFID	x	x	0	0	x	x	x	0
'2A'	Optional	Lock DSFID	x	x	0	0	x	x	x	0
'2B'	Optional	Get System Information	x	x	0	0	x	x	0	0
'2C'	Optional	Get Multiple block security status	x	x	0	0	x	x	0	0

Columns: Sub-carrier, Data rate, Inventory, Protocol ext., Select, Addressed, Option, RFU

Table 10

6.4.1   Read single block

Command code = '20'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0 and Option Flag 1.

If VCD in normal mode tries to read a read protected memory block, the VICC returns back a 0 data value.

6.4.2   Write single block

Command code = '21'

See ISO/IEC 15693-3 standard for detailed information. Supported Option Flag 0 and Option Flag 1.

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 and it is protected against writing, then the Error_flag is set.

Note: The internal VICC powercheck function guaranties the correct writing operation and detects any error that could occur.

6.4.3   Lock block

Command code = '22'

See ISO/IEC 15693-3 standard for detailed information. Supported Option Flag 0 and Option Flag 1.

6.4.4   Read multiple blocks

Command code = '23'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0.

Supported Option Flag 1.

If VCD in normal mode tries to read a block inside the page protected area and it is protected against reading. then the appropriate data will be masked by 0 values.

6.4.5   Select

Command code = '25'

See ISO/IEC 15693-3 standard for detailed information.

6.4.6   Reset to ready

Command code = '26'

See ISO/IEC 15693-3 standard for detailed information.

6.4.7   Write AFI

Command code = '27'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0.

Supported Option Flag 1.

Note: It's optional to allow rewriting of AFI value in the Secure mode if AFI is locked.

6.4.8   Lock AFI

Command code = '28'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0.

Supported Option Flag 1.

6.4.9   Write DSFID

Command code = '29'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0.

Supported Option Flag 1.

6.4.10 Lock DSFID

Command code = '2A'

See ISO/IEC 15693-3 standard for detailed information.

Supported Option Flag 0.

Supported Option Flag 1.

6.4.11 Get system information

Command code = '2B'

See ISO/IEC 15693-3 standard for detailed information.

Response parameters description:
- Info flags field value is 0Fh
- UID code field on 64 bits
- DSFID value is present
- AFI value is present
- VICC memory size - the device provides 32 blocks (1Fh) of 4 bytes (03h) user's data memory
- IC Reference value is 02h

6.4.12 Get multiple block security status

Command code = '2C'

See ISO/IEC 15693-3 standard for detailed information.

6.5 Custom commands

Command Code	Type	Function	Active Flags							
			b1	b2	b3	b4	b5	b6	b7	b8
'A2'	Custom	**Set EAS**	x	x	0	0	x	x	x	0
'A3'	Custom	**Reset EAS**	x	x	0	0	x	x	x	0
'A4'	Custom	**Lock EAS**	x	x	0	0	x	x	x	0
'A5'	Custom	**Active EAS**	x	x	0	0	x	x	x	0
'A6'	Custom	**Protect EAS**	x	x	0	0	x	x	x	0
'A7'	Custom	**Write EAS ID**	x	x	0	0	x	x	x	0
'A8'	Custom	**Write EAScfg**	x	x	0	0	x	x	x	0
'B4'	Custom	**Write Password**	x	x	0	0	x1 10		x	0
'B6'	Custom	**Protect Memory Page**	x	x	0	0	x	x	x	0
'B8'	Custom	**Get Multiple block protection status**	x	x	0	0	x	x	0	0
'B9'	Custom	**Destroy**	x	x	0	0	0	1	x	0
'BA'	Custom	**Enable Privacy**	x	x	0	0	x	x	x	0
'BB'	Custom	**Disable Privacy**	x	x	0	0	x	x	x	0
'C3'	Custom	**Fast Read multiple blocks**	x	x	0	0	x	x	x	0
			Sub-carrier	Data rate	Inventory	Protocol ext.	Select	Addressed	Option	RFU

Table 11

If IC Mfg Code is not correct VICC remains silent and the operation is not executed.

6.5.1 Set EAS

Command Code = 'A2'

This command activates the EAS features if the EAS feature is not locked. If EAS bit is locked then the Error_flag is set.

If the EAS parameters are protected by a password (SecureEAS = '1') 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 and specified in Table 4.

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

SOF	Flags	Set EAS	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 5

Set EAS response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 6

Set EAS response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 7

6.5.2 Reset EAS

Command Code = 'A3'

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

If the EAS parameters are protected by a password (SecureEAS = '1') 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 and specified in Table 4.

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

SOF	Flags	Reset EAS	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 8

Reset EAS response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 9

Reset EAS response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 10

6.5.3 Lock EAS

Command Code = 'A4'

This command locks the current state of EAS parameters.

If the EAS parameters are protected by a password (SecureEAS = '1') 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 and specified in Table 4.

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

SOF	Flags	Lock EAS	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 11

Lock EAS response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 12

Lock EAS response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 13

6.5.4 Active EAS

Command Code = 'A5'

VICC answers to this command only if EAS is activated. If EAS is deactivated 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

SOF	Flags	Active EAS	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 14

Active EAS response format when Error_flag is NOT set

SOF	Flags	EAS Telegram	CRC16	EOF
	8 bits	See Note	16 bits	

Figure 15

Note: the EAS Telegram length depends on the EASCfg option bit settings. The EAS Telegram length could be comprised between 32 up to 256 bits, see **Table 12**.

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

S O F	Flags	Active EAS	IC Mfg code	UID (optional)	EAS Mask length	EAS ID	CRC16	E O F
	8 bits	8 bits	8 bits	64 bit	8 bits (Note1)	See Note2	16 bits	

Figure 16

Note 1: Only EAS Mask length values 0, 8 and 16 are supported.
Note 2: 0, 8 or 16 bits (optional).

Request parameter:
❑ EAS Mask Length to identify how many bits of the EAS ID are valid (optional)
❑ EAS ID (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

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

SOF	Flags	EAS Telegram	CRC16	EOF
	8 bits	See Note	16 bits	

Figure 17

Note: The EAS Telegram length depends on the EASCfg option parameter settings. The EAS Telegram length could be comprised between 32 up to 256 bits.

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

SOF	Flags	EAS ID	CRC16	EOF
	8 bits	16 bits	16 bits	

Figure 18

In case of an error, the device remains silent.

6.5.5 Protect EAS

Command Code = 'A6'

This command protects the EAS parameters. It sets SecureEAS to '1'.

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 and specified in Table 4.

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

SOF	Flags	Protect EAS	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 19

Protect EAS response format when Error_flag is set

SOF	Flags	Error code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 20

Protect EAS response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 21

6.5.6 Write EAS ID

Command Code = 'A7'

This command writes a new EAS Identifier Number.

If the EAS parameters are protected by a password (SecureEAS = '1') 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 and specified in Table 4.

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

S O F	Flags	Write EAS ID	IC Mfg code	UID (optional)	EAS ID value	CRC16	E O F
	8 bits	8 bits	8 bits	64 bits	16 bits	16 bit	

Figure 22

Write EAS ID response format when Error_flag is set

SOF	Flags	Error code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 23

Write EAS ID response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 24

6.5.7 Write EAScfg

Command Code = 'A8'

This command writes a new EAScfg.

If the EAS parameters are protected by a password (SecureEAS = '1') 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 and specified in Table 4.

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

S O F	Flags	Write EAScfg	IC Mfg code	UID (optional)	EAScfg value	CRC16	E O F
	8 bits	8 bits	8 bits	64 bits	8 bits	16 bit	

Figure 25

Note: 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 12

Write EAScfg response format when Error_flag is set

SOF	Flags	Error code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 26

Write EAScfg response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 27

6.5.8 Write Password

Command Code = 'B4'

This command changes the current Password value to a new one.

The command contains a data field (Password identifier) which indicates which item will be modified.

The Write Password command can only be executed in Secured mode and when the device is 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 Tpassword and specified in Table 4.

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 Password request format

S O F	F l a g s	Write Pass word	IC Mfg code	UID (optional)	Pass word Identif ier	New Password	C R C 1 6	E O F
	8 bits	8 bits	8 bits	64 bits	8 bits	32 bits		

Figure 28

Password identifier	Password
00h	Login Password

Table 13

Write Password response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 29

Write Password response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 30

6.5.9 Protect Page

Command Code = 'B6'

The Protect Page command defines the protection condition of a user's data memory page (1 page = 4 blocks = 128 bits).

The command is password protected thus it 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 Tprotect and specified in Table 4.

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 Page request format

S O F	Flags	Protect Page	IC Mfg code	UID (optional)	Page Nb	Protect Status	C R C 1 6	E O F
	8 bits	8 bits	8 bits	64	8 bits	8 bits	16 bits	

Figure 31

For the Protect Status definition, please, refer to the Page Protection bits in table below.

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 14

Protect Page response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 32

Protect Page response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 33

6.5.10 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:

S O F	Flags	Get multiple block protection status	IC Mfg code	UID (optional)	First Block number	Number of block	CRC16	E O F
	8 bits	8 bits	8 bits	64 bits	8 bits	8 bits	16 bits	

Figure 34

Request parameter:
- First block number
- Number of blocks

Get multiple block protection status response when Error_Flag is set:

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 35

Get multiple block protection status response format when Error_Flag is NOT set:

SOF	Flags	Block protection status	CRC 16	EOF
	8 bits	8 bits	16 bits	
		Repeated as needed		

Figure 36

Block protection status byte description

bit	Description
0	if '1' then locked by Lock bit
1	if '1' then protected against reading by Read Page protection bit
2	if '1' then protected against writing by Write Page protection bit
7-3	not used (always '0')

Table 15

6.5.11 Destroy

Command Code = 'B9'

This command destroys the device. The Destroy bit is set and the device will no longer react to any command from a VCD.

The command is password 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, 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 and specified in Table4.

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

S O F	Flags	Destroy	IC Mfg code	UID (optional)	CRC 16	E O F
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 37

Destroy response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 38

Destroy response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 39

6.5.12 Enable Privacy

Command Code = 'BA'

The Enable Privacy command sets Privacy bit to '1' and puts the device into a silent mode. Then, after power-On, the device always waits for a successful Login command.

The Enable Privacy command is password protected thus it is only 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 Tprivacyen and specified in Table 4.

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

Enable Privacy request format

SOF	Flags	Enable Privacy	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 40

Enable Privacy response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 41

Enable Privacy response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 42

6.5.13 Disable Privacy

Command Code = 'BB'

This command sets Privacy bit to '0'.

The command is password protected thus it is only 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 Tprivacydis and specified in Table 4.

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

Disable Privacy request format

SOF	Flags	Disable Privacy	IC Mfg code	UID (optional)	CRC 16	EOF
	8 bits	8 bits	8 bits	64 bits	16 bits	

Figure 43

Disable Privacy response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 44

Disable Privacy response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 45

6.5.14 Fast Read Multiple blocks

Command code = 'C3'

The command request format and framing are similar to the Read Multiple blocks command.

Command request format:

S O F	Flags	Fast Read Multiple blocks	IC Mfg code	UID (optional)	First Block number	Number of blocks	CRC16	E O F
8 bits	8 bits	8 bits	8 bits	64 bits	8 bits	8 bits	16 bits	

Figure 46

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 4**.

6.6   Proprietary commands

Command Code	Type	Function	Active Flags							
			b1	b2	b3	b4	b5	b6	b7	b8
'E4'	Proprietary	**Login**	x	x	0	0	x	x	0	0
			Sub-carrier	Data rate	Inventory	Protocol ext.	Select	Addressed	Option	RFU

Table 16

If IC Mfg Code is not correct VICC remains silent and the operation is not executed.

6.6.1   Login

Command Code = 'E4'

The Login command enables Secure mode of EM4233SLIC if the correct password is used.

The Login command is not successful if the password is incorrect, then the Error_flag is set and VICC returns to normal mode.

After a successful Login, the VICC enters Secure mode and user has special rights defined in the specification.

Secure mode is lost in case of:
❑ power on reset
❑ Login with wrong password value

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

Login request format

S O F	Flags	Login	IC Mfg code	UID (optional)	Password	CRC 16	E O F
	8 bits	8 bits	8 bits	64 bits	32 bits	16 bits	

Figure 47

Login response format when Error_flag is set

SOF	Flags	Error Code	CRC16	EOF
	8 bits	8 bits	16 bits	

Figure 48

Login response format when Error_flag is NOT set

SOF	Flags	CRC16	EOF
	8 bits	16 bits	

Figure 49

7. EM4233SLIC Chip Floorplan – 23.5pF Cres version

Pad Opening : 86um X 86um

All dimensions in μm
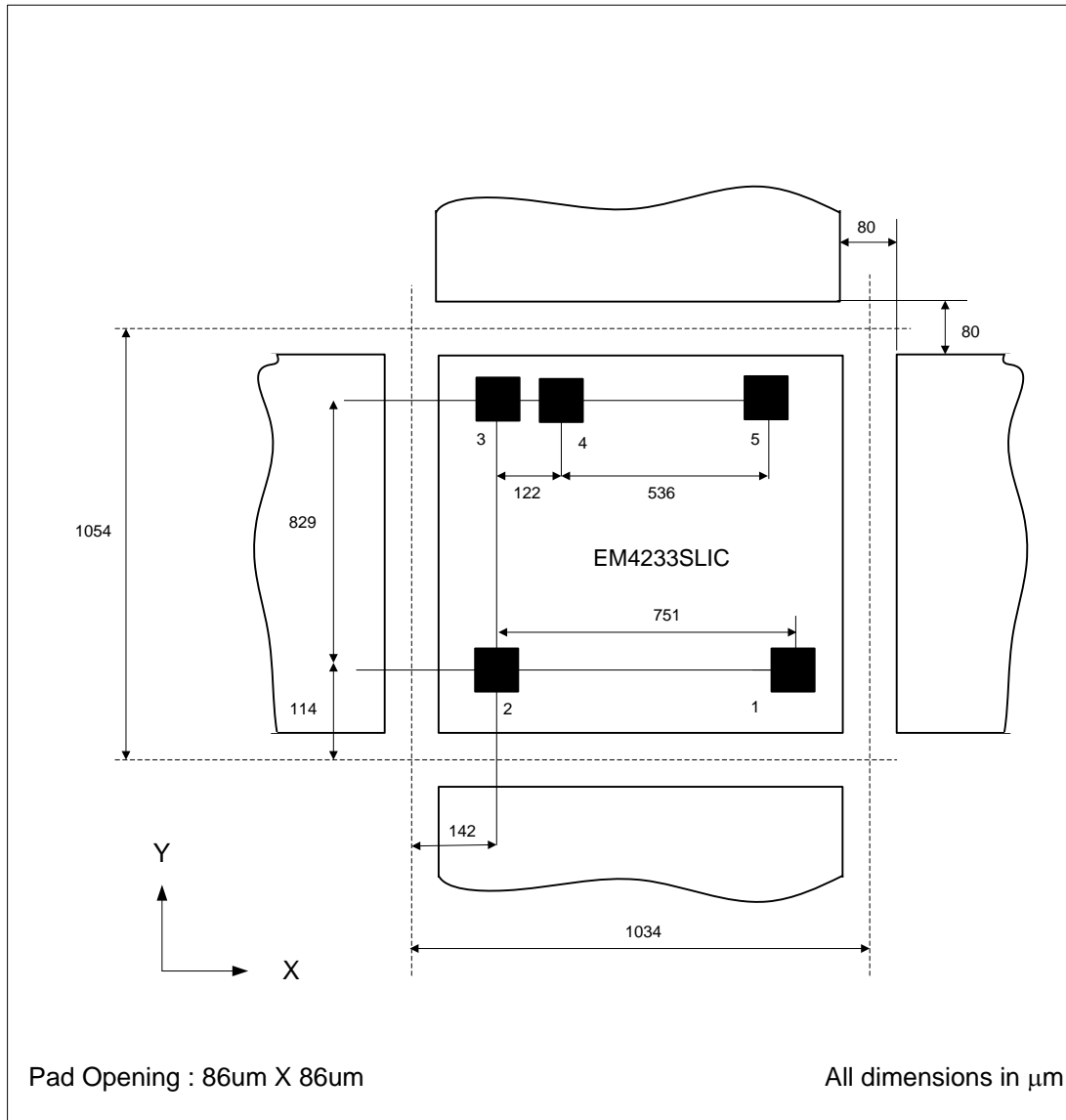
Figure 50

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 17

8. EM4233 Floorplan – 97pF Cres version
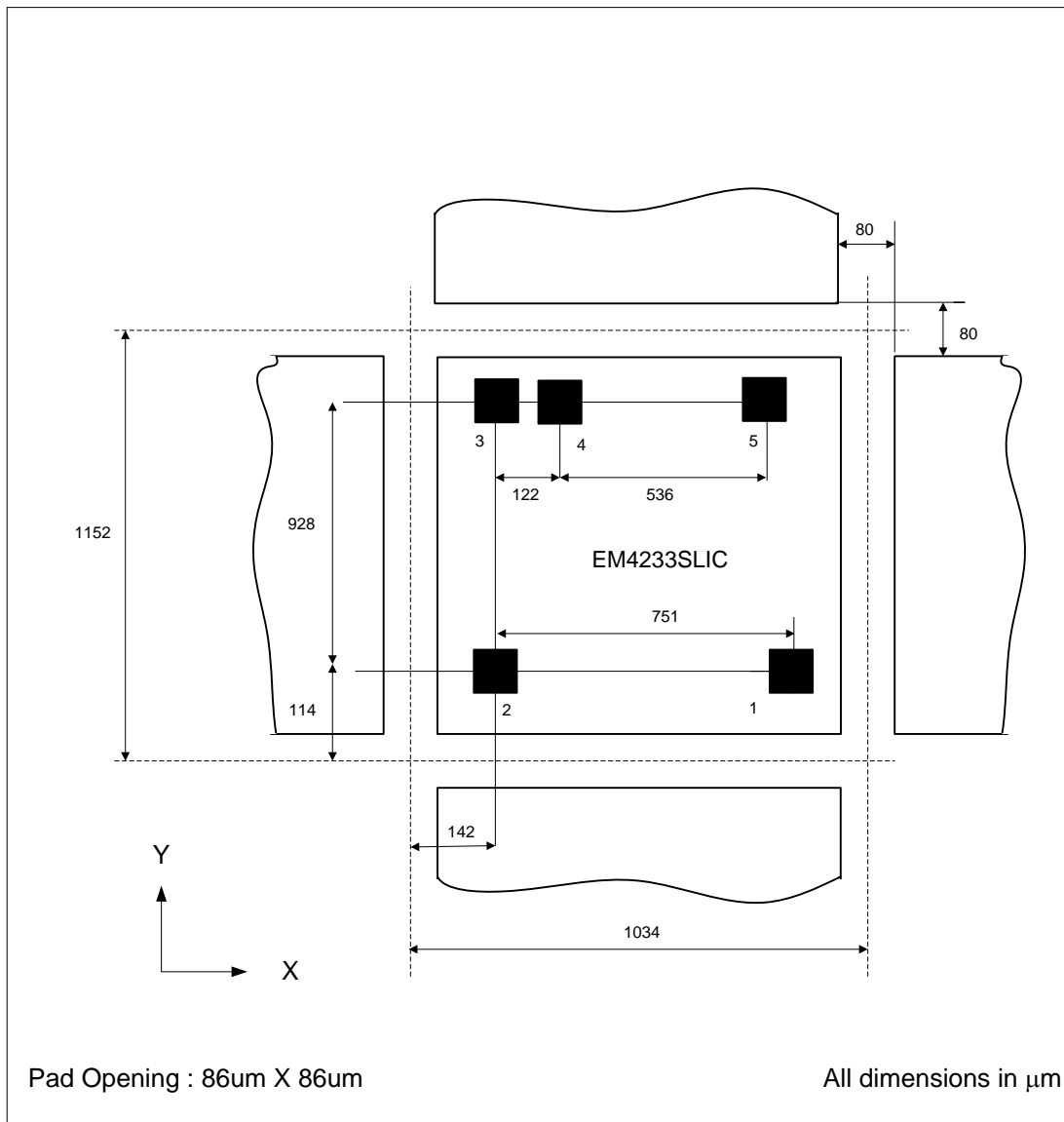
Figure 51

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 18

9.   Ordering Information

From wafer from delivery, please refer to EM4233SLIC wafer specification document.

9.1   DIE Form:

EM4233SLICVx WS 11 - %%%

Circuit Nb:
EM4233SLIC

Version:
V1 = 23.5pF resonant capacitor
V2 = 97pF resonant capacitor

Die form:
WW = Wafer
WS = Sawn Wafer/Frame

Customer Version:
%%% = only for custom specific version

Thickness:
6 = 6 mils (152um)
7 = 7 mils (178um)
11 = 11 mils (280um)
29 = 29 mils (725um)
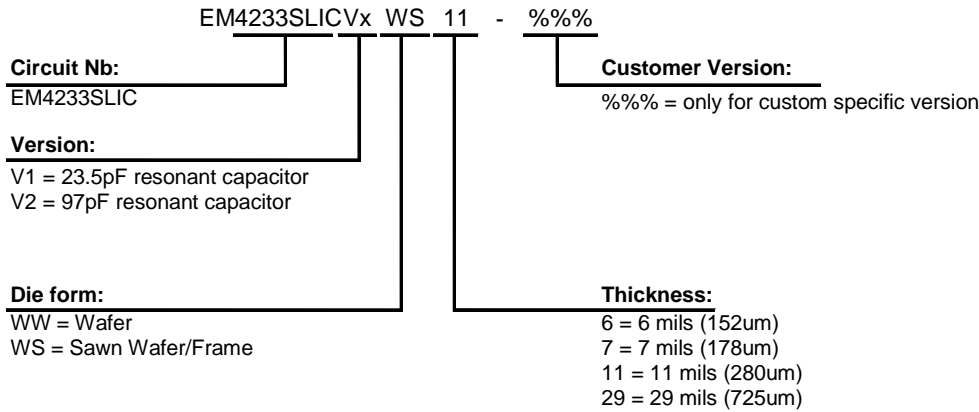
Figure 52

9.2   Standard Versions:

The versions below are considered standards and should be readily available. For other versions, 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
EM4233SLICV1WW6E	Unsawn wafer, 6 mils thickness	Gold bump
EM4233SLICV1WS6E	Sawn wafer, 6 mils thickness	Gold bump
EM4233SLICV2WW6E	Unsawn wafer, 6 mils thickness	Gold bump
EM4233SLICV2WS6E	Sawn wafer, 6 mils thickness	Gold bump

Table 19