SIC614D

LF HDX immobilizer tag with 40/80-bit encryption

REV 1.0

Features Summary

Highlight Features

- Single-chip security transponder ideal for access control applications
- Low-frequency HDX technology at 134 kHz field frequency
- Best-in-class read and write sensitivity
- Encrypted security with built-in 40/80-bit classical encryption
- Mutual authentication
- Fast authentication

Memory

- 32-bit unique device identification
- 40/80-bit secret key for authentication
- 40/80-bit secret key for mutual authentication
- 24-bit transponder configuration
- 336-bit user memory
- Memory erase/write cycle up to 100,000 cycles
- Memory retention up to 20 years

Supported Protocol

- ASK downlink data transmission
- FSK uplink at 134kHz/123kHz with RF/16 data rate
- Fully compatible with D80 command sets and protocol
- ID4D transponder family replacement

Package

- Wedge

Revision History

Revision	Date	Description	Change/Update Comment
1.0	3 Jan 2024	Release	1st Initial product factsheet

Ordering information

Part No.	Description	Package	Mark
PADAW203EP0SU4D63C3	SIC614D-63, Immobilizer LF HDX with 40/80bit encryption Wedge 134kHz, Canister, RFID TAG	Wedge	-

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0. Notation

0.1 Styles and Fonts for key words

This part defines styles and fonts used for the key words throughout this document. The key words are names of signal, register, pin, state of operation and command. The styles, fonts, and their indications are shown in Table 0-1.

Table 0-1: Style and Fonts key word

Symbol	Indication
Signal	Signal name
Register	Register name or Bit name
pin RX	Pin name
"State of Operation"	State of operation
Command	Command name for RF interface
"Flag"	Flag name in response state

- To refer to a register address and a value in a register, a hexadecimal number proceeding with letter "0x" is used, for example 0x0A.
- To refer to a bit located in a register address, a symbol "." following by a number reflecting the bit location starting from 0 to 7 is used. For example, 0x0A.0 refers to bit 0, least significant bit, in the register 0x0A.
- To refer to a set of consecutive bits located in a register address, a format ".[msb:lsb]" is used after a register value. For example, a value of 0x0A.[3:0] refers to bit 3 ,2, 1, and 0 in the register 0x0A.
- To refer to a binary value in some registers, the letter "b" is placed at the end of the binary number, for example "1010b".
- To refer to logic level, the number in single quote '1' and '0' are used to refer to binary logic level.

0.2 Abbreviation

Table 0-2: Abbreviation

Abbreviation	Term
AFE	Analog-Front-End
CRC	Cyclic redundancy check
EEPROM	Electrically Erasable Programmable Read-Only Memory
EOB	End of burst
fc	Carrier frequency
FSK	Frequency Shift Keying
HDX	Half duplex
HV	High-voltage supply
LF	Low frequency
OTP	One-time program
POR	Power-on-reset
PWD	Pre-defined password
RFID	Radio frequency identification
SIC	Silicon Craft Technology

1. Functional Overview

SIC614D is a low-frequency half-duplex RFID tag with built-in encryption module which enables the tag to process authentication and mutual authentication operations required for automotive immobilizer applications. It can be configured to work with either 40-bit or 80-bit key. The tag operation is compatible with 40 or 80 bits classic immobilizer tags in the market.

1.1 Block Diagram

Error! Reference source not found. depicts a conceptual block diagram of SIC614D, w hich mainly consists of two parts as listed below:

- RF Analog Front End (RF-AFE)
- Digital Controller and Memory

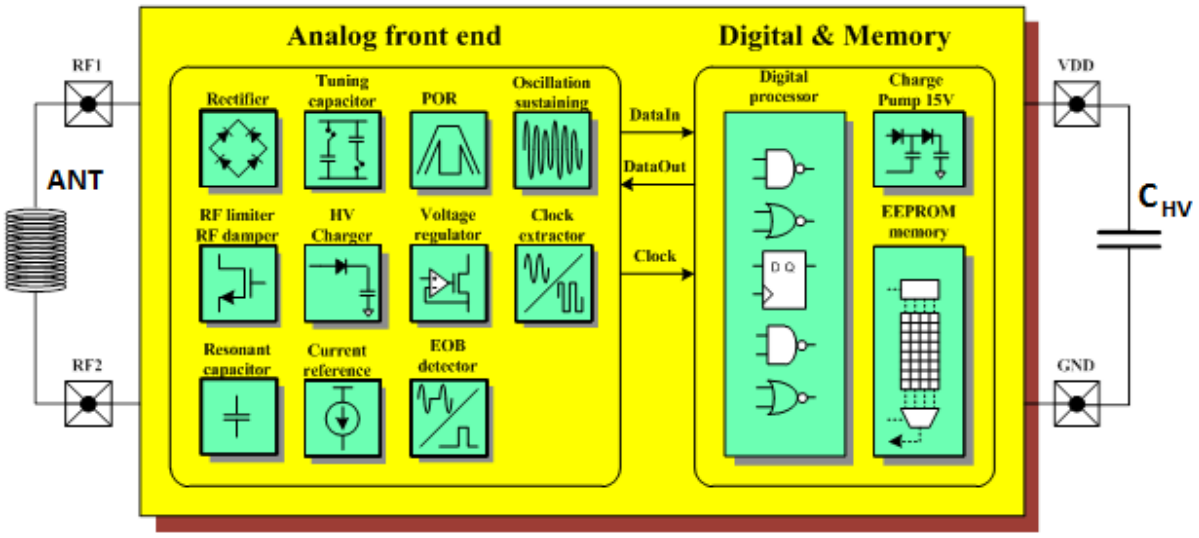

Figure 1-1: SIC614D block diagram

1.1.1 Analog Front End (AFE)

The RF Analog-Front-End (AFE) has RF1 and RF2 terminals for connecting to an external antenna, VDD and GND terminals for connecting to the external storage capacitor (CHV). It harvests energy from the induced RF signal in the antenna and stores the energy in CHV to supply the internal circuit. The AFE also provides facilities for RF communication such as a modulator for uplink data communication, a demodulator for downlink data communication, a power-on-reset module, and a clock extractor for data synchronization.

1.1.2 Digital Controller

The digital controller controls data transaction between the AFE and the EEPROM. The digital controller handles the following operations:

- Decoding incoming RF downlink commands and encoding RF uplink data/response
- Reading and programming data from/to the EEPROM
- Process authentication using an encryption module

2. Specification

2.1 Absolute Maximum Rating

Conditions above the listed maximum ratings may cause permanent damage to the device. Exposure to the absolute maximum rating conditions for an extended period may affect the device reliability. Only one absolute maximum rating can be applied at a time.

Table 2-1: Absolute Maximum Rating

Parameter	Symbol	Min	Typ	Max	Unit
Operating temperature	T_A	-40		+85	°C
Storage temperature	T_S	-40		+125	°C

2.2 Environment and Data Reliability

Table 2-2: Environment and Data Reliability

Parameter	Description	Min	Typ	Max	Unit
Programming cycle	@25°C	100k			Cycles
Data retention time	@50°C storage temp.	20			Years
ESD immunity	IEC 801-2	2			kV
Vibration	IEC 68-2-6 Test 10g, 10-2000Hz, 2axis	2.5			Hr
Drop	Test 1.8m free fall	100			Time
Shock	IEC 68-2-29 Test 40g, 18ms	2000			Time

2.3 Environment and Data Reliability

Table 2-3: Electrical Characteristic

Parameter	Symbol	Min	Typ	Max	Unit
Operating coil's inductance	L_{coil}		3.4		mH
Operating coil's quality factor	Q_{coil}		45		
Operating resonant frequency	f_{RES}		134.2		kHz
Low bit response frequency	f_L	132.2	134.7	136.7	kHz
High bit response frequency	f_H	120.2	123.7	126.7	kHz
Operating RF level	$V_{H,Cmd}$	4			V
Operating RF level for memory programming	$V_{H,Prog}$	5			V

2.4 Timing Characteristic

Timing parameters listed in the table specify RF protocol pattern in **Error! Reference s ource not found.**.

Table 2-4: Timing Characteristic

Parameter	Symbol	Min	Typ	Max	Unit
Operating coil's inductance	L_{coil}		3.4		mH
Operating coil's quality factor	Q_{coil}		45		
DST80: PWM (t_{Hdet} = 48 clk)					
Pulse-off for low bit	t_{OffL}		23		clk
Pulse-on for low bit	t_{OnL}		44		clk
Low bit duration	t_{BitL}			360	clk
Pulse-off for high bit	t_{OffH}		64		clk
Pulse-on for high bit	t_{OnH}		70		clk
High bit duration	t_{BitH}			360	clk
DST80: PPM (t_{Hdet} = 64 clk)					
Pulse-off for low bit	t_{OffL}		23		clk
Pulse-on for low bit	t_{OnL}		31		clk
Low bit duration	t_{BitL}			63	clk
Pulse-off for high bit	t_{OffH}		23		clk
Pulse-on for high bit	t_{OnH}		47		clk
High bit duration	t_{BitH}			220	clk
Execution (t_{EXE})					
Authentication time (40 bits/80 bits)	t_{AUTH}		8		ms
Mutual authentication time (40 bits/80 bits)	t_{MAUTH}		10		ms
Memory programming time (40 bits)	t_{PROG40}		15		ms
Memory programming time (80 bits)	t_{PROG80}		30		ms
Mutual authentication and memory programming time (40 bits)	$t_{MPROG40}$		18		ms
Memory locking time	t_{LOCK}		15		ms
Mutual authentication and memory locking time	t_{MLOCK}		18		ms
Memory protection setting time	t_{PROT}		15		ms
Response (t_{resp})*					
Tag response duration* (96 bits)	t_{RESP}		11.4		ms
Reader's read time before sending next command*	t_{READ}		15.0		ms

Note:
* This timing is measured at 134.2 kHz. The value may be changed from various factors such as detuning and coupling factor with reader antenna.
** 1 clk = 1 period of RF cycle

3. Memory organization

3.1 EEPROM Organization

SIC614D contains 552 bits of non-volatile EEPROM memory, which is shown into in the figure below starting with MSbit first.

Table 3-1: Downlink timing characteristic

	Page	Byte				Access
		M 4 L	M 3 L	M 2 L	M 1 L	M 0 L	
Memory	0						-
	1	SA					RW
	2	USR1					RW
	3	SERIAL			MAN		RO
	4	AUTHKEY					WO
	5	EXT_AUTHKEY					-
	6	EXT_MAUTHKEY					-
	7	MAUTHKEY					WO
	8	USR2					RW
	9	USR3					RW
	10	USR4					RW
	11	USR5					RW
	12	USR6					RW
	13	USR7					RW
	14	USR8					RW
	15	USR9					RW
	16						-
	17						
	18	USR10					RW
	19						-
	.						
	.						
	29						
	30	FUNC2	FUNC1				RW
	31						-

This SIC614D memory contains all mandatory information of the tag such as serial number, manufacturing code, selective address, function bytes, and encryption key. This memory section can be accessed using classic commands such as ***READ, AUTHEN, PROGRAM, LOCK, SET_PROTECTION***, and etc. Each memory data field is described in the table below.

4. Packaging Information

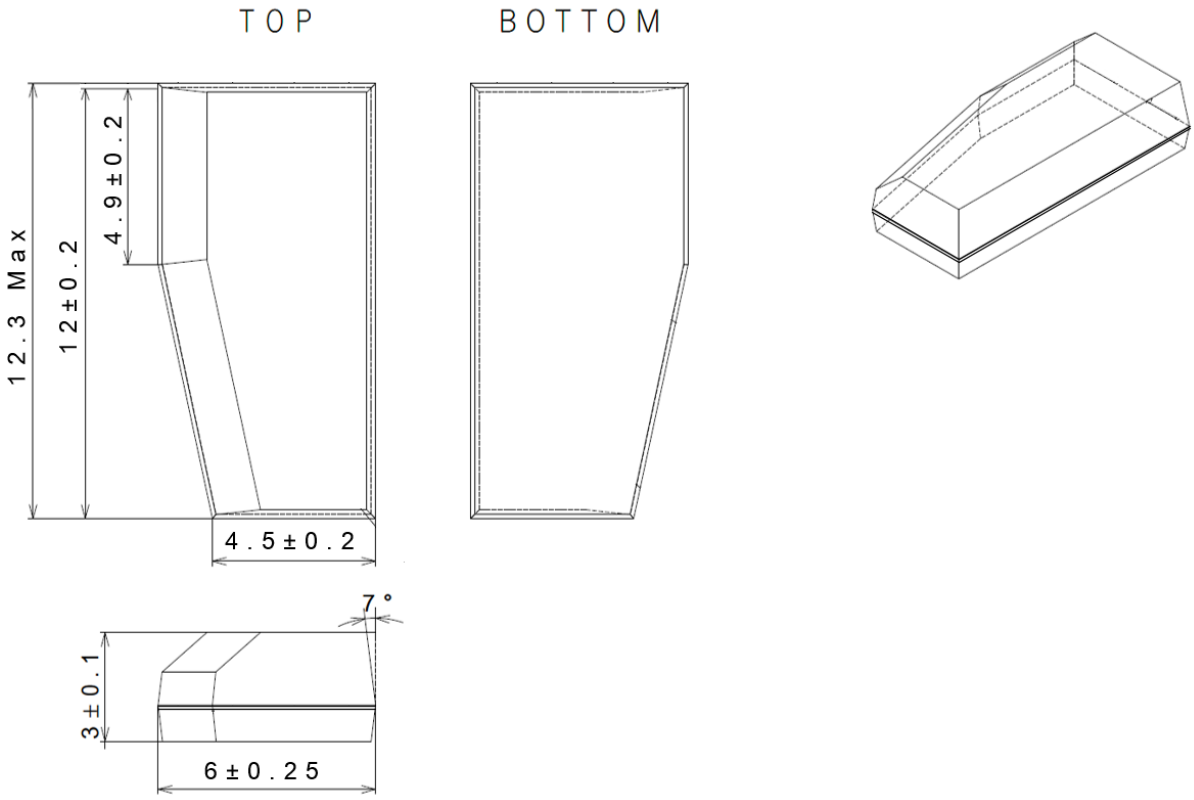

Figure 4-1: Wedge Transponder Drawing

Table 4-1: Physical Characteristic

Parameter	Symbol	Min	Typ	Max	Unit
Width	W	5.75	6	6.25	mm
Length	L	11.9	12	12.3	mm
Height	H	2.9	3	3.1	mm

5. Packing Specification

Figure 5-1: Product packing

Table 5-1: Canister information

Packing information	Value	Unit
Canister PVC dimension	ø116 x 128.5	mm
Product quantity per canister	2,000	ea.
Canister weight (Included product)	0.93	kg

Figure 5-2: Inner box dimension

Table 5-2: Inner box information

Packing information	Value	Unit
Inner box dimension (l x w x h)	255 x 255 x 180	mm
Canister quantity per inner box	4	ea.
Inner box weight (Included product)	3.96	kg

Figure 5-3: Outer box dimension

Table 5-3: Outer box standard packing information

Outer box standard	Outer box dimensions l x w x h (mm)	Total maximum weight (kg)	Inner box quantity
1	330 x 240 x 310	4.46	1
2	390 x 380 x 390	8.92	2
3	620 x 390 x 390	17.14	4

The outer box has three standard box sizes depending on the order.