RAINFC AUTHENTICITY TRANSPONDER IC

DESCRIPTION

em|echo-V corresponds to the latest generation of EM Microelectronic RAINFC devices, bringing innovative features to the HF, NFC, and RAIN RFID™ worlds. The chip combines all functionalities on a single die, with NFC for proximity range, HF for vicinity range, and RAIN technology used for long range application purposes. All protocols make use of a shared memory and a common IC serial number.

Targeted applications and market segments include retail, product authentication, consumer engagement, industrial, automotive, and aerospace logistics.

A tag or label based on the em|echo-V provides multiple benefits and usages via the RAIN communication interface like stock inventory, product returns, and data privacy. The same tag or label also enables new consumer services like product authentication, product information, or loyalty programs using an NFC enabled smartphone.

The chip is a dual frequency device supporting ISO/IEC 15693, ISO/IEC 18000-3 Mode 1, NFC Forum Type 5 Tag, ISO/IEC18000-63, EPC™ Gen2v2, and ISO/IEC 29167-10.

The em|echo-V offers a user configurable non-volatile memory which is accessible by NFC, HF, and UHF air interfaces.

APPLICATIONS

- Inventory and supply chain management
- Customer engagement, coupons, loyalty programs
- Product authentication with tamper evidence detection
- Industrial, automotive, and aerospace logistics

FEATURES

- Advanced RAIN RFID technology
- AES-128 crypto for NFC web based authentication
- Digital signature for authenticity
- Tamper Detection
- Shared memory
- Dual Frequency 1-step inlay manufacturing
- Minimum 100k write cycles endurance
- Minimum 50 years data retention
- On-chip resonant capacitor: 50pF
- Extended temperature range: -40°C to +85°C
- Sawn wafers, 6-mil thickness, gold bumps

HF INTERFACE

- ISO/IEC 15693 and 18000-3 compliant
- Optional random ID and secure customer privacy
- Protected memory using password
- Control of UHF privacy features with password
- Tamper Alarm

NFC INTERFACE

- NFC Forum Type 5 Tag compliant
- Optional app-free web based crypto authentication
- Optional app-free tamper detection
- Optional ACCESS counter increased at first reading
- Optional app access of protected memory with password protection
- Optional app control of UHF privacy features with password protection

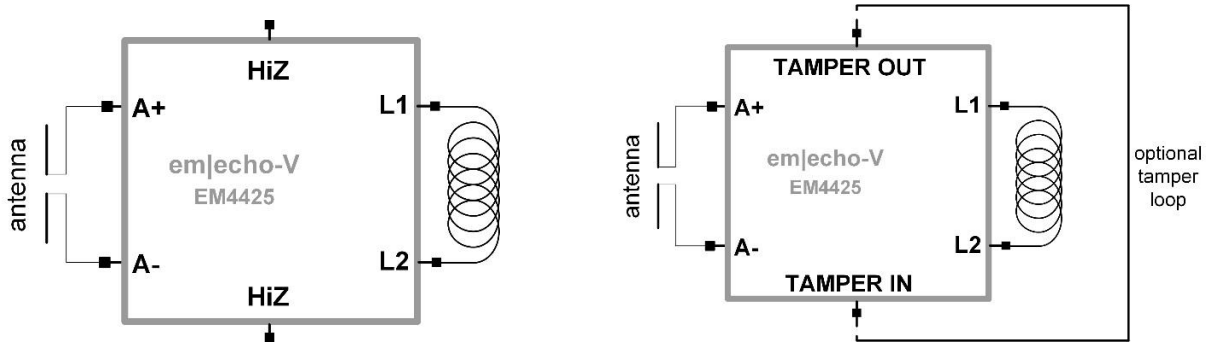
UHF INTERFACE

- ISO/IEC 18000-63 compliant
- EPC™ Generation-2 Version 2 (Gen2v2) compliant:
  - Alteration EAS compliant
  - Tag Alteration (Core) compliant
- Read sensitivity up to -20dBm with a dipole antenna
- Write sensitivity up to -14.5dBm with a dipole antenna
- Optional NFC ACCESS counter is readable
- Tamper Alarm

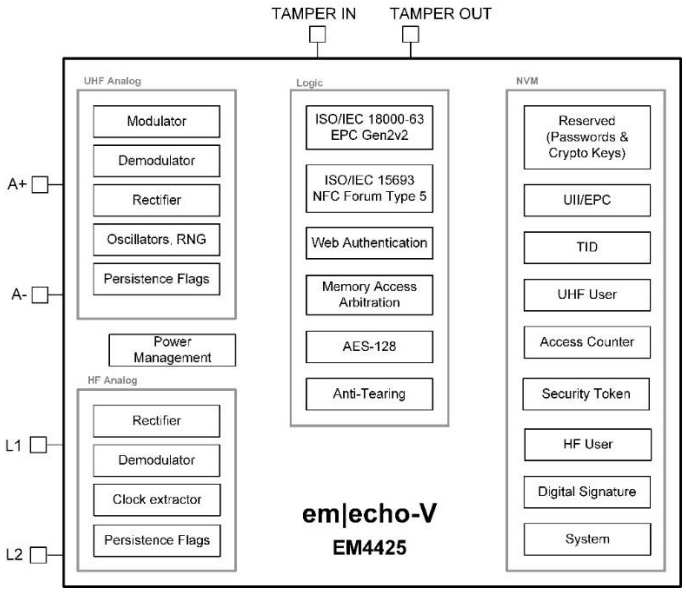
MEMORY

- Shared unique IC serial number included in:
  - 64-bit UID (HF)
  - 96-bit TID (UHF)
- Configurable 2048-bit memory used for:
  - HF USER memory
  - Up to 480-bit EPC/UII encodings
  - UHF USER memory
  - Optional Digital Signature (none, 256b, 384b, 512b)
- 1-step tag encoding possible from either HF or UHF interface.

1. TYPICAL OPERATING CONFIGURATIONS



2. BLOCK DIAGRAM



3. ELECTRICAL SPECIFICATIONS

3.1. ABSOLUTE MAXIMUM RATINGS

Parameters	Symbol	Min.	Max.	Unit
Storage temperature	$T_{STORAGE}$	-50	125	°C
RF power at antenna attached to A+, A- [1)]	$P_{MAX-ABS}$		25	dBm
AC current induced on L1, L2	$I_{MAX-ABS}$		50	mA
Electrostatic discharge on all pads/pins [2)]	V_{ESD}	-2000	2000	V

Note 1: Antenna matched to IC impedance at read sensitivity (P_{READ})

Note 2: Human Body Model (HBM; 100pF; 1.5kOhm) for all combinations between pads/pins. ESD measurements are made with die mounted into CDIP packages

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.

3.2. 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 specified, proper operation can only occur when all terminal voltages are kept within the voltage range. Unused inputs must always be tied to a defined logic voltage level.

3.3. OPERATING CONDITIONS

Parameters	Symbol	Min.	Max.	Unit
Operating temperature	T_{OP}	-40	+85	°C
RF power at antenna attached to A+, A- [1)]	P_{MAX-OP}		20	dBm
RF carrier frequency	f_A	860	960	MHz
AC peak current induced on L1, L2	I_{MAX-OP}		30	mA

3.4. ELECTRICAL CHARACTERISTICS – HF INTERFACE

Operating conditions (unless otherwise specified): V_{coil} = 4V (peak to peak), V_{SS} = 0V, fc = 13.56MHz sine wave, T_{OP} = 25°C.

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating frequency	fc		-	13.56	-	MHz
Resonance Capacitor	C_{r50}	fc = 13.56MHz; U = 2Vrms	47.5	50	52.5	pF

3.5. ELECTRICAL CHARACTERISTICS – UHF INTERFACE

Operating conditions (unless otherwise specified): T_{OP} = 25°C.

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Unit
IC input capacitance	C_p	Parallel	-	0.57	-	pF
IC impedance [3)]	Z_{AB}	f_A=866MHz f_A=915MHz	-	19.1–j286 17.6-j273	-	Ω
Typical assembly capacitance [4)]	C_{ASSY}	f_A=915MHz	-	0.2	-	pF
IC read sensitivity [5)6)7)8)9)]	P_{READ}	f_A=866MHz f_A=915MHz	-	-17.9 -17.9	-	dBm dBm
IC write sensitivity [5)6)7)8)9)]	P_{WRITE}	f_A=866MHz f_A=915MHz	-	-12.5 -12.5	-	dBm dBm

Note 3: Measured directly on wafer with a 100Ω differential network analyzer at minimum operating RF power level

Note 4: Estimated input capacitance from assembly

Note 5: IC impedance conjugate matched to antenna at read sensitivity (P_{READ})

Note 6: IC is configured with tamper pads disabled and EPC/UII encoding of 96 bits

Note 7: Interrogator using PR-ASK modulation with link parameters Tari = 25 µs, PR = 1.5, BLF = 256 KHz with Miller-4 encoding

Note 8: HF field is not present

Note 9: Sensitivity values are for IC devices in die form and do not include antenna gain

3.6. TAMPER LOOP ELECTRICAL CHARACTERISTICS

Operating conditions (unless otherwise specified): T_{OP} = 25°C.

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Unit
Tamper loop maximum capacitance	C_{max}	Measured between tamper pads			12.5	pF
Tamper loop maximum inductance	L_{max}	Measured between tamper pads			40	nH
Resistance connected between TAMPER_IN and TAMPER_OUT to assure a closed (short) loop	R_{CLOSED}	Cloadmax between tamper pads/pins = 12.5pF; Tamper loop enabled			1	MΩ
Resistance connected between TAMPER_IN and TAMPER_OUT to assure an open (broken) loop	R_{OPEN}	Cloadmax between tamper pads/pins = 12.5pF; Tamper loop enabled	10			MΩ
Capacitance connected between TAMPER_IN and TAMPER_OUT to assure an open (broken) loop	C_{OPEN}	Cloadmax between tamper pads/pins = 12.5pF; Tamper loop enabled	47			pF
Input impedance between TAMPER_IN and TAMPER_OUT	Z_{TAMPER}	RF power = P_{READ}; Pads configured for HI-Z; f_A = 866MHz		5.2-j106		Ω
		RF power = P_{READ}; Pads configured for Tamper Loop; f_A = 866MHz		17.5-j106		Ω
		RF power = P_{READ}; Pads configured for HI-Z; f_A = 915MHz		5.1-j101		Ω
		RF power = P_{READ}; Pads configured for Tamper Loop; f_A = 915MHz		16.1-j101		Ω

3.7. NVM ELECTRICAL CHARACTERISTICS

Parameters	Symbol	Conditions	Min.	Typ.	Max.	Unit
Erase / write endurance	T_{CYC}	T_{OP} = 25ºC	100,000			Cycles
Retention	T_{RET}	T_{OP} = 55ºC	50			Years

4. PRODUCT OVERVIEW

em|echo-V is used in passive transponder applications and provides support for use as either an HF / UHF product, an NFC / UHF product, or as an HF / NFC / UHF product.

The user defines the IC memory partitions which determine the size of HF User memory, UHF User memory, UHF EPC/UII memory, and Digital Signature memory.

Both the HF / NFC and UHF interfaces have access to all of memory although access operations may be protected and require the use of passwords. No priority is given to either air interface. The memory cannot be accessed in parallel and memory access arbitration is performed on a per command basis as the commands are received over the air interfaces.

The user has the option to enable the tamper detection feature which checks impedance of a continuity loop at power-up between two pads/pins to determine if the loop is intact (closed) or broken (open).

This device is in full compliance with the following documents:

HF :

- "ISO/IEC 15693-2:2006 Identification cards – Contactless integrated circuit cards – Vicinity cards – Part 2: Air interface and initialization", Publication Date: 2006-12
- "ISO/IEC 15693-3:2009 Identification cards – Contactless integrated circuit cards – Vicinity cards – Part 3: Anticollision and transmission protocol", Publication Date: 2009-04
- "ISO/IEC 15693-3:2009/Amd 2:2017 Identification cards – Contactless integrated circuit cards – Vicinity cards – Part 3: Anticollision and transmission protocol AMENDMENT 2: Clarification of use of Data Elements", Publication Date: 2015-08
- "ISO/IEC 15693-3:2009/Amd 4:2017 Identification cards – Contactless integrated circuit cards – Vicinity cards – Part 3: Anticollision and transmission protocol AMENDMENT 4: Security framework", Publication Date: 2017-05
- "ISO/IEC 18000-3:2010 Information technology – Radio frequency identification for item management – Part 3: Parameters for air interface communications at 13,56 MHz", Publication Date: 2010-11

NFC :

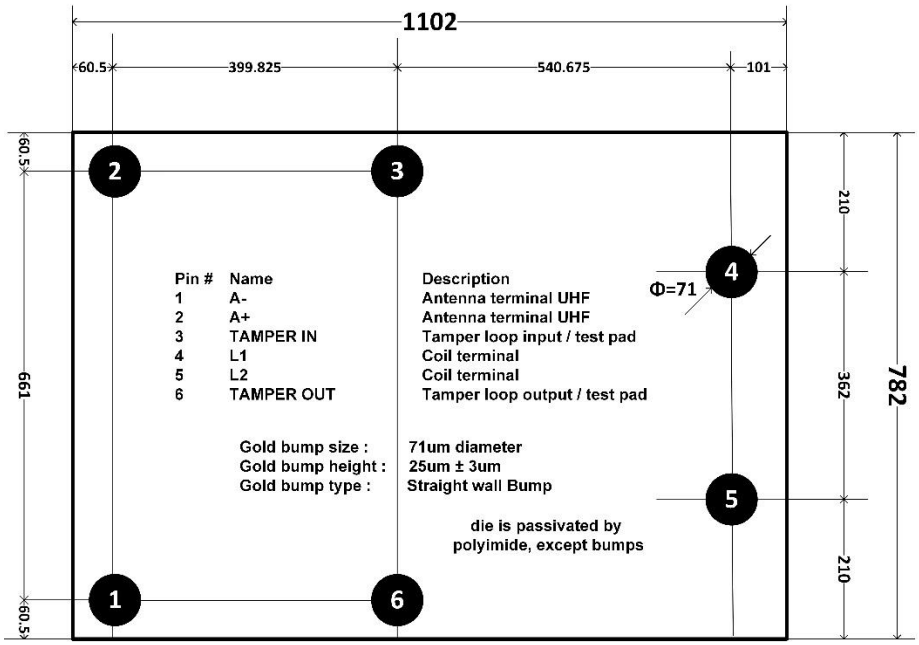
- "NFC Forum Analog, Technical Specification, Version 2.1", Publication Date: 2018-02-19
- "NFC Forum Activity, Technical Specification, Version 2.0", Publication Date: 2017-04-30
- "NFC Forum Digital Protocol, Technical Specification, Version 2.0", Publication Date: 2017-05-09
- "NFC Forum Type 5 Tag Operation, Technical Specification, Version 1.0", Publication Date: 2015-07-07

UHF :

- "ISO/IEC 18000-63:2015 Information technology – Radio frequency identification for item management – Part 63: Parameters for air interface communications at 860 MHz to 960 MHz Type C", Publication Date: 2015-10
- "EPC™ Radio-Frequency Identity Protocols, Generation-2 UHF RFID, Specification for RFID Air Interface Protocol for Communications at 860 MHz - 960 MHz, Release 2.1, Ratified, Jul 2018" from GS1 EPCglobal Inc.
- "EPC Tag Data Standard, Version 1.11, Ratified, Sep-2017" from GS1 EPCglobal Inc.

5. PAD LOCATION DIAGRAM

All dimensions in µm.



Pad	Name	Description
1	A-	Antenna terminal for UHF
2	A+	Antenna terminal for UHF
3	TAMPER IN	Tamper loop input
4	L1	Coil terminal for HF
5	L2	Coil terminal for HF
6	TAMPER OUT	Tamper loop output

6. ORDERING INFORMATION

EM4425 Vxy WS 6 U - %%%

Circuit Nb:
EM4425

Version:
See table below

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

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

Bumps
" " = No bumps
"U" = Gold bumps + Polyimide

Thickness:
6 = 6 mils = 152um

6.1. VERSIONS

Versions are identified as “EM4425V1y” where y is a variable defined in the following table.

y	HF Security
1	None
2	Web Based OTP
3	RFU
4	RFU

6.2. STANDARD VERSIONS AND SAMPLES

The versions below are considered standard and should be readily available. For other delivery form, please contact EM Microelectronic-Marin S.A. For samples, please order exclusively from the standard versions.

Part Number	Package / Die Form	Delivery Form
EM4425V1yWS6U	Sawn wafer / Gold bumped +PI – thickness of 6 mils	Wafer on frame

7. PRODUCT SUPPORT

This document is a short datasheet, an extract from a full datasheet with the same product type number(s) and title. It is intended to be used as a quick reference only and therefore should not be relied upon to contain detailed and full information.

For detailed and complete information see the relevant full datasheet, which is available on request through our website at www.emmicroelectronic.com by using the contact form. Questions can be submitted to rfidsupport@emmicroelectronic.com .