RAIN RFID TRANSPONDER IC WITH CAPACITIVE SENSOR INTERFACE

DESCRIPTION

em|aura-sense is a member of the latest generation family of EM Microelectronic RAIN RFID™ devices. The chip combines capacitive sensing and RAIN RFID technology used for long range application purposes.

Target applications and market segments include smart manufacturing and industry 4.0 applications, predictive maintenance, Internet of Things (IoT), industrial sensing, and home automation.

The chip is compliant with ISO/IEC 18000-63 and EPC™ Gen2v2.

The em|aura-sense device allows to interface and capture sensing data with external sensor(s). Sensor commands are available to request sensing acquisition and store in the memory.

The capacitive sensor is external to the chip and can either be integrated in the inlay or as a separately mounted component, e.g. as an SMD component.

em|aura-sense offers a versatile non-volatile memory which is accessible via the RAIN RFID air interface and can be used for storing sensing information. Each IC is manufactured with a 96-bit unique Tag Identifier (TID) and delivered with a default 96-bit EPC encoded value that is a copy of the 96-bit TID.

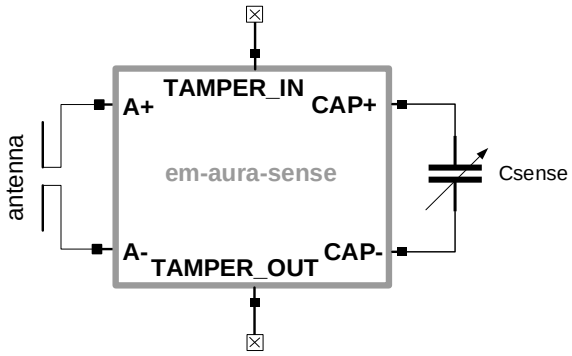
FEATURES

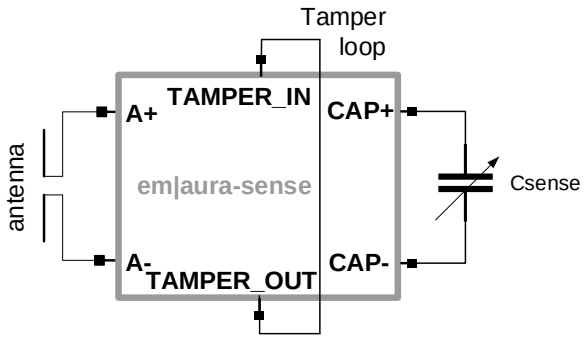
- Advanced RAIN RFID technology
- Sensing sensitivity: -18dBm with dipole antenna
- Read sensitivity with sensing disabled: -19.5dBm with dipole antenna
- Sensing and data storing: -15.5dBm with dipole antenna
- Capacitance sensing effective range: 15pF
- 7-bit analog to digital conversion of inlay sensing capacitance
- Sensitivity:160fF/LSB, noiseRMS: 250fF
- Sensing at boot and reporting with standard commands
- On demand sensing using Select or Write/BlockWrite command
- User Memory up to 2kbit memory
- Compatible with sensor + 1-step inlay manufacturing caps/resistive sensor
- Minimum 10 years data retention
- Extended temperature range: -40 to +85C

MEMORY

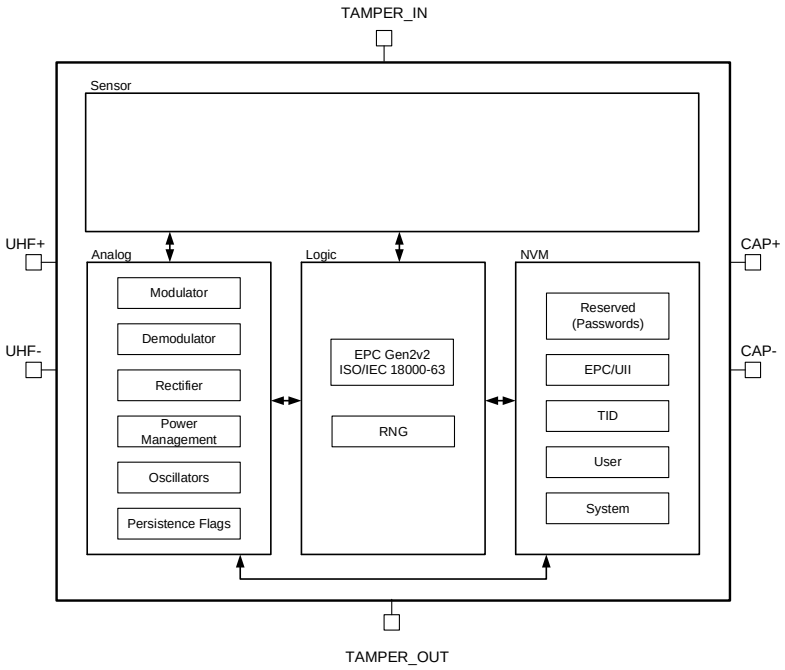
- Configurable 2048-bit memory used for:
  - Up to 480-bit EPC/UII encodings
  - USER memory of 124X16bits

1. TYPICAL OPERATING CONFIGURATIONS





2. BLOCK DIAGRAM



3. ELECTRICAL SPECIFICATIONS

3.1. ABSOLUTE MAXIMUM RATINGS

PARAMETER	VALUE		UNIT
	MIN	MAX	
RF power at antenna attached to A+, A- [1)]		25	dBm
Storage Temperature Range (T_{STG})	-50	125	°C
Electrostatic discharge to ANSI/ESDA/JEDEC JS-001 for HBM [2)]	-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

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Operating temperature	T_{OP}	-40	25	+85	°C
Operating RF power at antenna attached to A+, A-	P_{MAX-OP}			20	dBm
RF carrier frequency	f_A	860		960	MHz

3.4. ELECTRICAL CHARACTERISTICS

Unless otherwise specified: T_{OP}=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
IC input capacitance	CP	Parallel	-	TBD	-	pF
IC equivalent serial input resistance[3)]	Z_{AB}	fA=866MHz, at read sensitivity P_{READ} fA=915MHz, at read sensitivity P_{READ}	-	TBD TBD	-	Ω
Typical assembled serial input resistance	Z_{ASSY}	fA=866MHz fA=915MHz	-	TBD TBD	-	Ω
IC read sensitivity [4)5)6)]	P_{READ}	Sensing is deactivated (see section **Error! Reference source not found.**) fA=866MHz fA=915MHz	-	-17.5 -17.5	-	dBm dBm
IC write sensitivity [4)5)6)]	P_{WRITE}	Sensing activated or deactivated fA=866MHz fA=915MHz	-	-13.5 -13.5	-	dBm dBm
IC sense and read sensitivity [4)5)6)]	P_{SENSE}	Sensing activated fA=866MHz fA=915MHz	-	-16 -16	-	dBm dBm

Note 3: Measured directly on wafer with a 100Ω differential network analyzer at minimum operating RF power level
Note 4: IC impedance conjugate matched to antenna at read sensitivity (P_{SENSE})
Note 5: Interrogator using PR-ASK modulation with link parameters Tari = 25 µs, PR = 1.5, BLF = 256 KHz with Miller-4 encoding
Note 6: Sensitivity values are for IC devices in die form and do not include antenna gain

3.5. CAPACITIVE SENSING ELECTRICAL CHARACTERISTICS

Unless otherwise specified: T_{OP}=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
C_{SENSE} Sensing capacitance range	C_{RANGE}		0		17	pF
Sensing resolution	C_{RES}		-	7	-	bit
Capacitive Sensitivity	$C_{SENSITIVITY}$	Ideal regression sensitivity curve (excluding Non-linearity and noise)		0.161		pF/LSB
Noise	$NOISE_{RMS}$	RMS noise at room temperature C_{SENSE} <17pF C_{SENSE} <15pF		 0.08 0.043		 pF pF
Integral Non-Linearity	INL_{SENSE}	Error between the measured capacitance and best fit line on 25%-85% of the sensing capacitance range at room temperature C_{SENSE} <17 C_{SENSE} <15		 0.37 0.21		 pF pF

3.6. TAMPER LOOP ELECTRICAL CHARACTERISTICS

Unless otherwise specified: T=T_{OP}

PARAMETER	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
Input impedance between TAMPER_IN and TAMPER_OUT	Z_{TAMPER}	RF power = PREAD; Pads configured for HI-Z; fA = 866MHz		5.2 -j106		Ω
		RF power = PREAD; Pads configured for Tamper Loop; fA = 866MHz		17.5 -j106		Ω
		RF power = PREAD; Pads configured for HI-Z; fA = 915MHz		5.1 -j101		Ω
		RF power = PREAD; Pads configured for Tamper Loop; fA = 915MHz		16.1 -j101		Ω

3.7. NVM ELECTRICAL CHARACTERISTICS

Unless otherwise specified: T=T_{OP}

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Retention	T_{RET}	T = 55ºC	10			Years

4. PRODUCT OVERVIEW

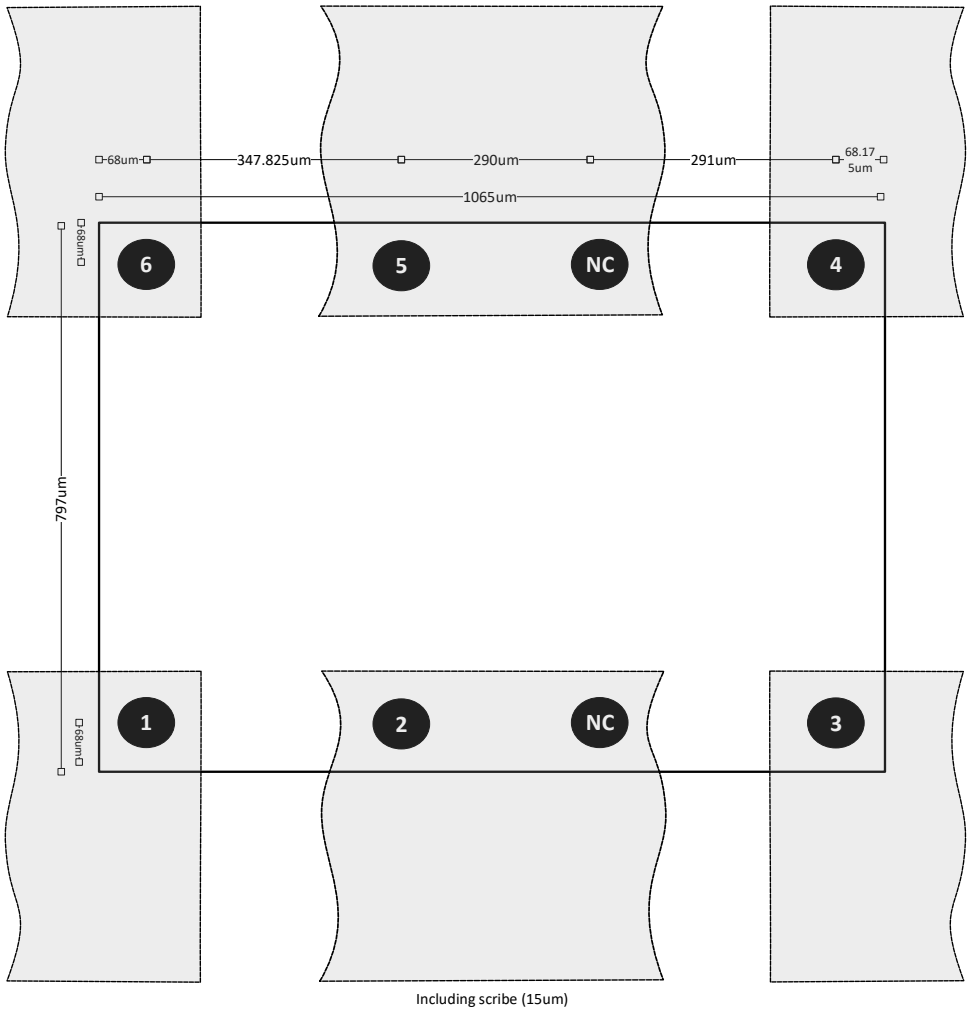
em|aura-sense is used in passive UHF applications operating at 860MHz-960MHz. It is powered by the RF energy transmitted by the UHF reader, which is received and rectified to generate a supply voltage for the IC.
This device is compliant with the following UHF standards:

- "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.

In addition to the preceding standards, the device is able to handle sensor acquisitions, triggered by standard commands. These sensing operating modes are described in the following section **Error! Reference source not found.**. This product includes the vendor defined snapshot sensor in accordance with the pending revision of ISO/IEC 18000-63.

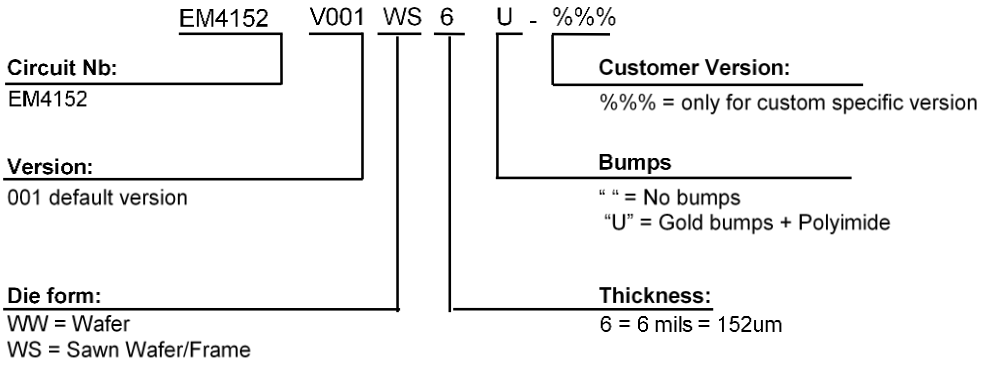
5. PAD LOCATION DIAGRAM

All dimensions in µm.



NO.	NAME	I/O TYPE	DESCRIPTION
1	A-	RF	antenna terminal
2	TAMPER_OUT	analog	Tamper pad: connected to the tamper loop Unused in application: HI-Z
3	CAP+	analog	Connection pad to the sensor
4	CAP-	analog	Connection pad to the sensor
5	TAMPER_IN	analog	Tamper pad: connected to the tamper loop Unused in application: HI-Z
6	A+	RF	antenna terminal

6. ORDERING INFORMATION



6.1. 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 Nb	Package form	Delivery form	Description
EM4152V001WS6U	Sawn wafer / Gold bumped + PI : wafer thickness of 6 mils	Sawn wafer	Standard version delivery wafer in Gold bump[7)]

Note 7: standard IC version delivered with gold bumps. Other bumping technologies under discussion.

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 .