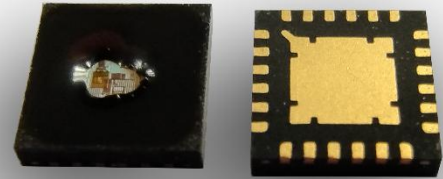


Fully-Passive UHF RFID Humidity Sensor

Features

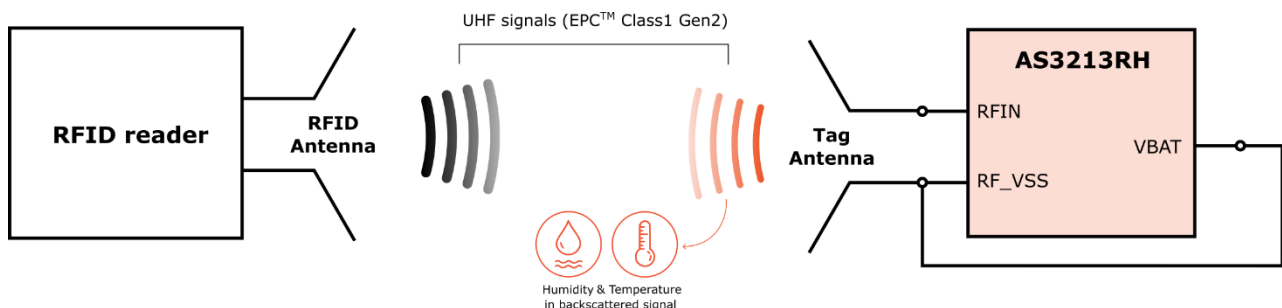
- ✓ EPC™ Class1 Gen2 compliant
- ✓ **Embedded Humidity & Temperature Sensors**
- ✓ **Extended Temperature Range -40 to +125 °C** (-40 to +257 °F)
- ✓ **Fully passive**
- ✓ Sensitivity < -15 dBm (up to 7 meters reading range) with 2.14 dBi dipole antenna
- ✓ 512 bits of non-volatile memory (EEPROM) organized in 4 banks (UID/EPC, User, TID, Reserved)
- ✓ Forward link data rates: 26.7 to 128 kbps assuming equiprobable data
- ✓ Return link data rates: 40 to 640 kbps with subcarrier modulated data rates of 0.625 to 320 kbps



Applications

- ✓ Condition monitoring (RH, water presence, isolation...)
- ✓ Supply chain management, tracking and tracing
- ✓ Agriculture sensing

Typical Setup Configuration



Description

AS321x is a family of passive UHF RFID chips embedding an analog sensor interface and internal sensors. AS321x chips are fully compliant with EPC™ Class-1 Generation-2 for UHF RFID applications and RAIN-RFID standards, so they can be interfaced by any standard reader, with no need for any custom command or pre-charge sequence, and achieve state-of-the-art sensitivity performance, including sensor biasing and readout.

In a passive mode, the harvested energy from the RF field is enough to enable all tag functionality, including sensor measurements. The chip design is optimized for passive operation, however, a battery can be added to operate in Battery-Assisted-Passive

(BAP) mode and slightly increase the read range.

Each chip embeds 512 bits of low-power non-volatile memory (EEPROM) organized in 4 banks supporting the EPC data structure, and delivered with a Unique Identifier (UID) to ensure full traceability. Sensor data are available on demand by a simple read command in the memory, following EPC standard.

AS3213RH.6 is the product variant embedding both internal humidity and temperature sensors, along with their acquisition channel, including an amplifier and a 10-bit Analog to Digital Converter (ADC).

Pin Description

QFN24

Marking view
Dimensions 4 x 4 x 0.5 mm

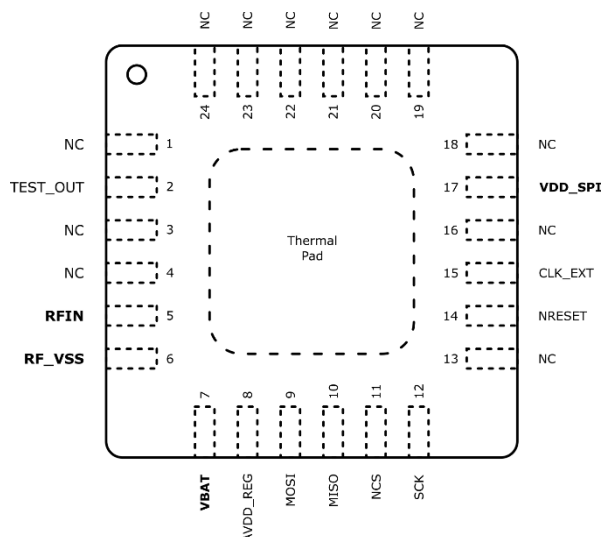


Figure 1: QFN24 pinout

Notes:

For RFID applications, only pads 5, 6, 7 and the thermal pad must be connected. Most of the others are for SPI communication, which is not described here.

Bare Die

Active area (pads side) view
Dimensions 1300 x 1300 μm

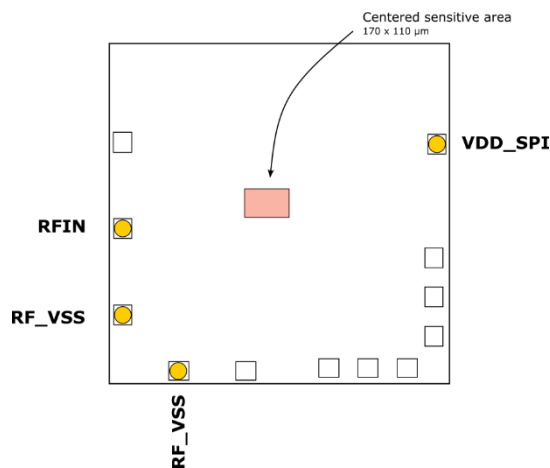


Figure 2: Bare die pinout.

Notes:

IO pads are on the top.
DXF files available on request.

Pin	Name	Type	I/O	Description
1	NC	NA	--	Not Connected
2	TEST_OUT	D	O	Digital output test pin
3-4	NC	NA	--	Not Connected
5	RFIN	RF	I	Antenna input
6	RF_VSS	A	I	For antenna connection only (RF ground)
7	VBAT	A	I	Connect to RF_VSS for passive operation External Power Supply in BAP operation [1.8V;2.5V] *
8	AVDD_REG	A	O	1.0V Regulated Power Supply
9	MOSI	D	I	1.8V SPI MOSI signal
10	MISO	D	O	1.8V SPI MISO signal
11	NCS	D	I	1.8V SPI Chip Select
12	SCK	D	I	1.8V SPI Clock signal
13	NC	NA	--	Not Connected
14	NRESET	D	I	1.8V external reset for digital part in SPI mode
15	CLK_EXT	D	I	External clock for digital part in SPI mode
16	NC	NA	--	Not Connected
17	VDD_SPI	A	I	SPI 1.8V Power supply
18-24	NC	NA	--	Not Connected

Table 1: QFN pinout table. A: Analog, D: Digital

* For write operation in the NVM, power supply should be higher than 2.2V.

Package	Body size	Shipment condition	Comment
Bare Dies	1.3 x 1.3 x 0.254 * mm	Waffle box	Max 400 bumped dies per box.
QFN	4 x 4 x 0.5 mm	Plastic strip	25 units/strip
		Waffle box	49 units/box (max)
Demo Tag	80 x 35 x 0.8 mm	Unit	

Table 2: Delivery format

* On demand: custom thinning to any value from 125 to 780 µm.

Specifications

Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
Storage Temperature	-50	150	°C
Voltage on all pads/pins (except GND)	0	3.3	V
RF power into pad/pin RFIN		15	dBm
Electrostatic discharge on all pads except RFIN	-1000	1000	V
Electrostatic discharge on RFIN	-500	500	V

Table 3: Absolute maximum ratings

ESD are Human Body Model (HBM) values.

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

Performances Specifications

Parameter	Conditions	Min.	Typ.	Max.	Unit
Operating conditions					
Operating temperature		-40		+125	°C
Max RF power at RFIN				15	dBm
RF carrier frequency		860		960	MHz
Electrical Characteristics @25 °C					
Battery voltage for EEPROM read operation		0.9		3.3	V
Battery voltage for EEPROM power check, erase, and write operations		1.8		3.3	V
Average battery current in Sleep mode (No RF applied to the antenna)			3.8		uA
RF Characteristics @25 °C					
Input impedance	Die form @ Pin=-10dBm				
	Fcarrier = 866MHz		7-j406		Ω
	Fcarrier = 915MHz		8.5-j383		Ω
	QFN24 @ Pin=-10dBm				
	Fcarrier = 866MHz		11-j300		Ω
	Fcarrier = 915MHz		9-j288		Ω
Write sensitivity in passive mode			-12		dBm
Read sensitivity in passive mode			-13		dBm
Write sensitivity in BAP	VBAT=2.2V		-16		dBm
Read sensitivity in BAP	VBAT=2.2V		-16		dBm

Table 4: Specifications table

Delivery information

QFN24 Package

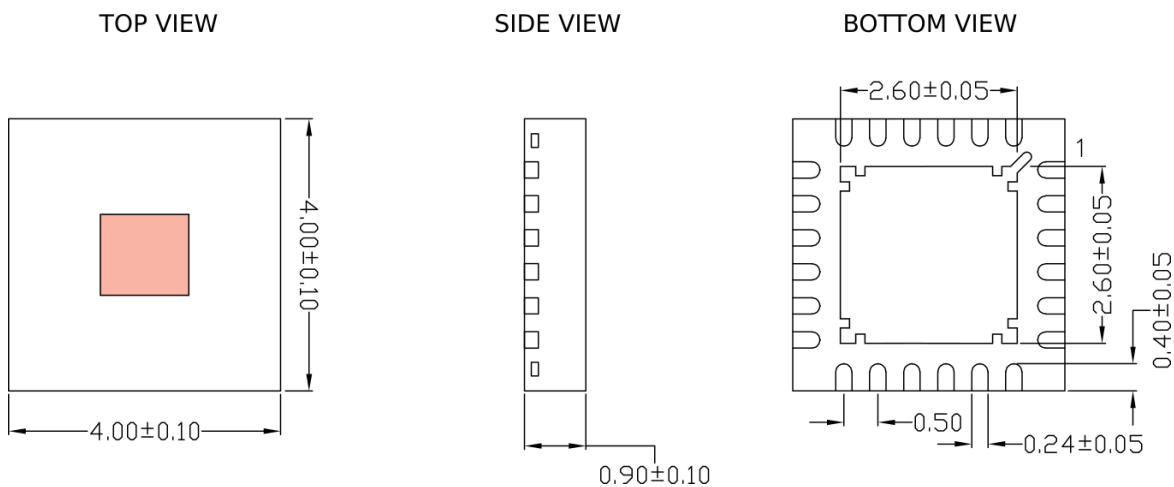


Figure 3: QFN24 package drawings

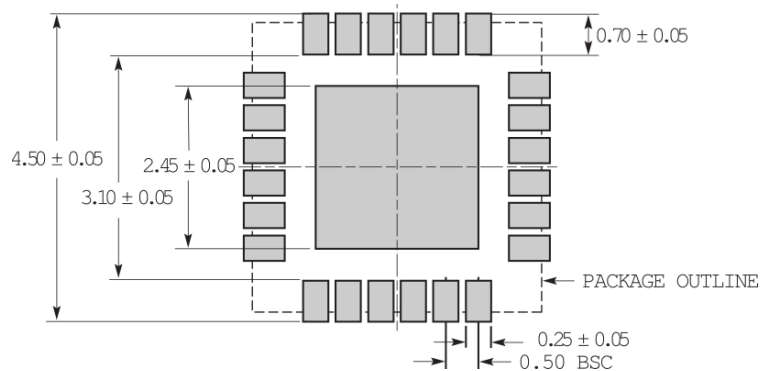


Figure 4: QFN24 Recommended landing pattern

Bare Dies in Waffle box

Die information:

Dimensions: 1.3 x 1.3 x 0.254 mm

DXF of the bumped die available on the support website.

Bump properties:

- Pads size: 70µm x 77µm
- Passivation opening: 66µm x 73µm
- Bumps type: Accu bumps (Au)
- Bumps thickness: 45µm
- Bumps diameter: 80µm

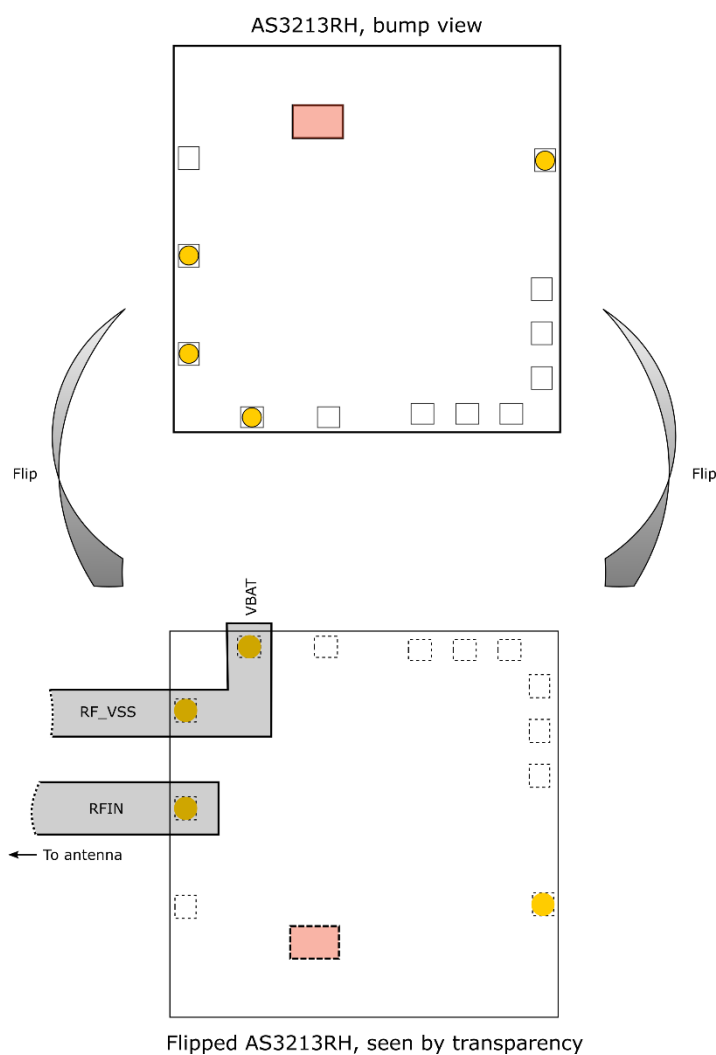


Figure 5: Recommended landing pattern for flip-chip assembly of bumped dies (front assembly view, **flipped die**)

Product Support

Application Notes can be found on ASYGN support site: <https://as321x.asygn.com/>

General company information: www.asygn.com

Customer support mail: support@asygn.com

Revision History

Revision	Date	Comment
2.0	2025-07-30	Datasheet updated; initial version of this document

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