BATTERYLESS NFC HUMIDITY AND TEMPERATURE TAG

Check for samples: EVAL-SNFC-RHAT

FEATURES

- **Battery free**

- **Power harvesting from HF**

- **Contactless self-powering range: 2cm**

- **NFC communication**

- **ISO/IEC 15693 compliant**

- **Data transmission modes:**

    – **NDEF mode (default): URI with sensor values, ~2 s update**

    – **Bulk transfer mode: 100 Hz raw data, 204-byte frames**

- **Relative Humidity sensor**

    – **Operation range: 0%RH to 100%RH**

    – **Accuracy: 2%RH**

    – **Resolution: 0.01%RH**

- **Ambient temperature sensor**

    – **Operation range: -40°C to 85°C**

    – **Accuracy: 0.2°C**

    – **Resolution: 0.01°C**

DESCRIPTION

EVAL-SNFC-RHAT is a wireless and battery free sensor tag that belongs to the SenseNFC (SNFC) family by Kliskatek. Built in a compact PCB format, the tag integrates a relative humidity sensor and an ambient temperature sensor.

The device is powered wirelessly through the 13.56 MHz RF field generated by NFC readers or devices with integrated NFC antennas, such as smartphones or industrial readers. No battery is required.

Depending on the reader capabilities, the tag supports two different operating modes. If the reader only supports standard NFC memory reading, the device operates in NDEF mode. If the reader supports block write operations, the tag can switch to a high-speed bulk data transfer mode.

By default, the NFC family tags initialize in NDEF mode. When read for the first time, the device provides a dynamically generated URL containing the sensor values. When operating in bulk data transfer mode, the tag exposes raw sensor data directly through memory blocks, enabling higher data throughput and faster acquisition.

TECHNICAL DESCRIPTION

EVAL-SNFC-RHAT is based on an NFC interface compliant with ISO/IEC 15693 and NFC Forum Type 5 Tag specifications. The device operates at 13.56 MHz and uses a block-oriented memory architecture with 4-byte block addressing.

Dynamic data exchange is implemented using SRAM mirror mode. The internal microcontroller continuously updates the mirrored memory, allowing real-time sensor data to be accessed by the NFC reader.

Two operating modes are supported:

- **NDEF mode** (default at power-up)

- **Bulk data mode**

Mode selection is controlled through Block 51 of the NFC memory. Writing the value `0xAA` activates bulk data mode; writing `0x00` returns the device to NDEF mode. The device checks this block after every data transmission and switches mode accordingly.

In both modes, temperature values are expressed in hundredths of degrees Celsius (e.g., 24.58 ℃ is represented as 2458) and humidity values are expressed in hundredths of percent RH (e.g., 24.58 %RH is represented as 2458).

NDEF MODE

NDEF mode is the default operating mode at power-up. In this mode, the microcontroller acquires a temperature and humidity measurement, writes an NDEF message to the NFC memory, and waits approximately 2 seconds before repeating the cycle.

The NDEF message is structured as a Type 5 Tag compliant record containing a single URI (well-known type "U"). The URI dynamically encodes the current sensor readings in ASCII format. The full message layout is shown in Table 1.

Table 1: NDEF packet structure (64 bytes)

Offset	Value	Description
0–3	E1 40 80 09	Capability Container (CC)
4	03	NDEF Message TLV type
5	31	TLV length (49 bytes)
6	D1	Record header: MB=1, ME=1, SR=1, TNF=001
7	01	Type length (1 byte)
8	2D	Payload length (45 bytes)
9	55	Record type: "U" (URI)
10	04	URI identifier code: `https://`
11–43	ASCII	`demo.kliskatek.com/nfc/rhat.html#`
44–48	ASCII	Temperature value (5 zero-padded decimal digits)
49	2C	Separator: ","
50–54	ASCII	Humidity value (5 zero-padded decimal digits)
55	FE	Terminator TLV
56–63	00	Padding

The resulting URI has the form:

$$\texttt{https://demo.kliskatek.com/nfc/rhat.html\#TTTTT,HHHHH}$$

where `TTTTT` is the temperature in hundredths of °C and `HHHHH` is the relative humidity in hundredths of %RH, both represented as zero-padded 5-digit ASCII decimal values.

This mode is intended for use with standard NFC devices such as smartphones, which can read the URI record directly and open the corresponding web page displaying the sensor data.

BULK DATA MODE

Bulk data mode is activated when the reader writes the value `0xAA` into Block 51. In this mode, NDEF updates are stopped and the SRAM is used as a high-speed acquisition buffer.

The microcontroller samples the sensor at 100 Hz (10 ms period). Every 50 samples, a 204-byte data frame is written to the NFC memory starting at Block 0 (address `0x2000`). This results in a frame update every 500 ms. The data frame structure is shown in Table 2.

Table 2: Bulk data frame structure (204 bytes)

Offset	Size	Type	Description
0–199	200	int16 × 100	50 interleaved measurement pairs (T_1, RH_1, T_2, RH_2, …, T_{50}, RH_{50})
200–203	4	uint32	Transmission index (incremented with each frame)

Each measurement pair consists of two little-endian 16-bit signed integers: a temperature value followed by a humidity value, occupying 4 bytes per pair. The data stream is interleaved as:

$$T_1, RH_1, T_2, RH_2, T_3, RH_3, \ldots, T_{50}, RH_{50}$$

This structure guarantees that each humidity sample corresponds exactly to the immediately preceding temperature sample, since both originate from the same sensor acquisition cycle.

The transmission index is a 32-bit unsigned counter appended at the end of each data frame. It starts at 1 when entering bulk mode and increments with every frame, allowing the reader to detect new frames and synchronize data acquisition.

A double-buffering scheme is used internally: while one buffer is being transmitted over I2C to the NFC memory, the other buffer collects new sensor data. The buffers are swapped after each transmission, ensuring continuous data acquisition without gaps.

To return to NDEF mode, the reader writes `0x00` to Block 51. The transmission index is reset when the device re-enters bulk mode.

MEMORY MAP

Table 3 summarizes the NFC memory blocks used by the device.

Table 3: NFC memory block assignment

Block	Address	Description
0–15	0x0000–0x000F	NDEF message (64 bytes) in NDEF mode
0–50	0x0000–0x0032	Bulk data frame (204 bytes) in bulk mode
51	0x0033	Mode control register: `0x00` = NDEF, `0xAA` = Bulk

CHARACTERISTICS

SYMBOL	PARAMETER		MIN	TYP	MAX	UNIT
POWER						
r_{sp}	Self-powering range [1]			2		cm
OPERATING CONDITIONS						
T_{OP_TOP}	Operating temperature range		-40		85	°C
RELATIVE HUMIDITY SENSOR						
RH_{range}	Humidity range		0		100	%RH
RH_{acc}	Humidity accuracy					%RH
		20 %RH to 80 %RH	-4	±2	4	%RH
		0 %RH to 100 %RH	-7	±4	7	%RH
RH_{res}	Humidity resolution			0.01		%RH
AMBIENT TEMPERATURE SENSOR						
AT_{range}	Temperature range		-40		85	°C
AT_{acc}	Temperature accuracy					°C
		5 °C to 60 °C	-0.4	±0.2	0.4	°C
		-40 °C to 85 °C	-1.6	±0.8	1.6	°C
AT_{res}	Temperature resolution			0.01		°C
DATA TRANSMISSION						
t_{NDEF}	NDEF update period			2		s
t_{bulk}	Bulk frame period			500		ms
f_s	Bulk sampling rate			100		Hz
N_s	Samples per bulk frame			50		-
L_{bulk}	Bulk frame size			204		bytes
L_{NDEF}	NDEF message size			64		bytes

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[1] With a 2W ERP setup

REFERENCES

The next table shows the available references of the EVAL-SNFC-RHAT.

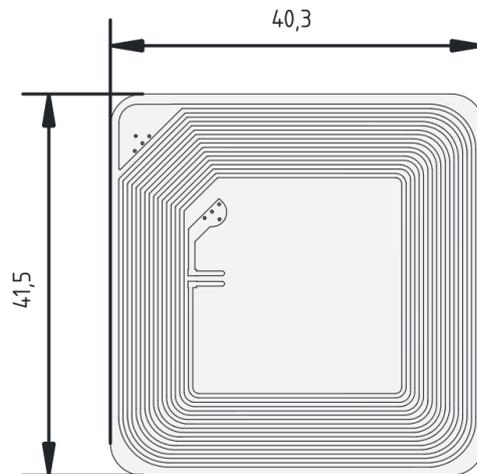| Ref.	Name	Description
KL00300005	EVAL-SNFC-RHAT	EVAL-SNFC-RHAT, magnetic loop antenna, PCB format

For custom references with other antennas and housings, please contact us at sales@kliskatek.com.

MECHANICAL DIMENSIONS

DKW

2D VIEW

3D VIEW