

EMMY-W1 Antenna reference design

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|-----------------|---|------------------|-----------|
| Topic : | EMMY-W1 Antenna reference design | | |
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| Checked | | | |
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1 Scope

This document defines the essential specifications necessary to implement the EMMY-W1 antenna reference designs. The information contained herein and its references should be sufficient to guide a skilled person in an attempt to implement the design on a host carrier. It will provide the designer with PCB layout details and expected performance specifications.

The document supports the four different PCB designs for Wi-Fi:

- Two connector-based designs for the use of external antennas (one for each antenna pin of the module)
- Two designs based on SMD antennas (one for each antenna pin of the module)

This document also supports general guidelines for the design of the NFC interface.

2 FCC/IC ID reference

| Model | FCC ID | IC ID |
|-----------|-------------|----------------|
| EMMY-W161 | XPYEMMYW161 | 8595A-EMMYW161 |
| EMMY-W163 | XPYEMMYW163 | 8595A-EMMYW163 |
| EMMY-W165 | XPYEMMYW165 | 8595A-EMMYW165 |

Table 1: FCC and IC IDs for different models of EMMY-W1 series

3 General description

When using the EMMY-W1 together with this antenna reference design, the circuit trace layout must be made in strict compliance with the instructions below.

All the components placed on each RF trace must be kept as indicated in the reference design, even if not used. The PCB areas of unused reference designs must be flooded with ground.

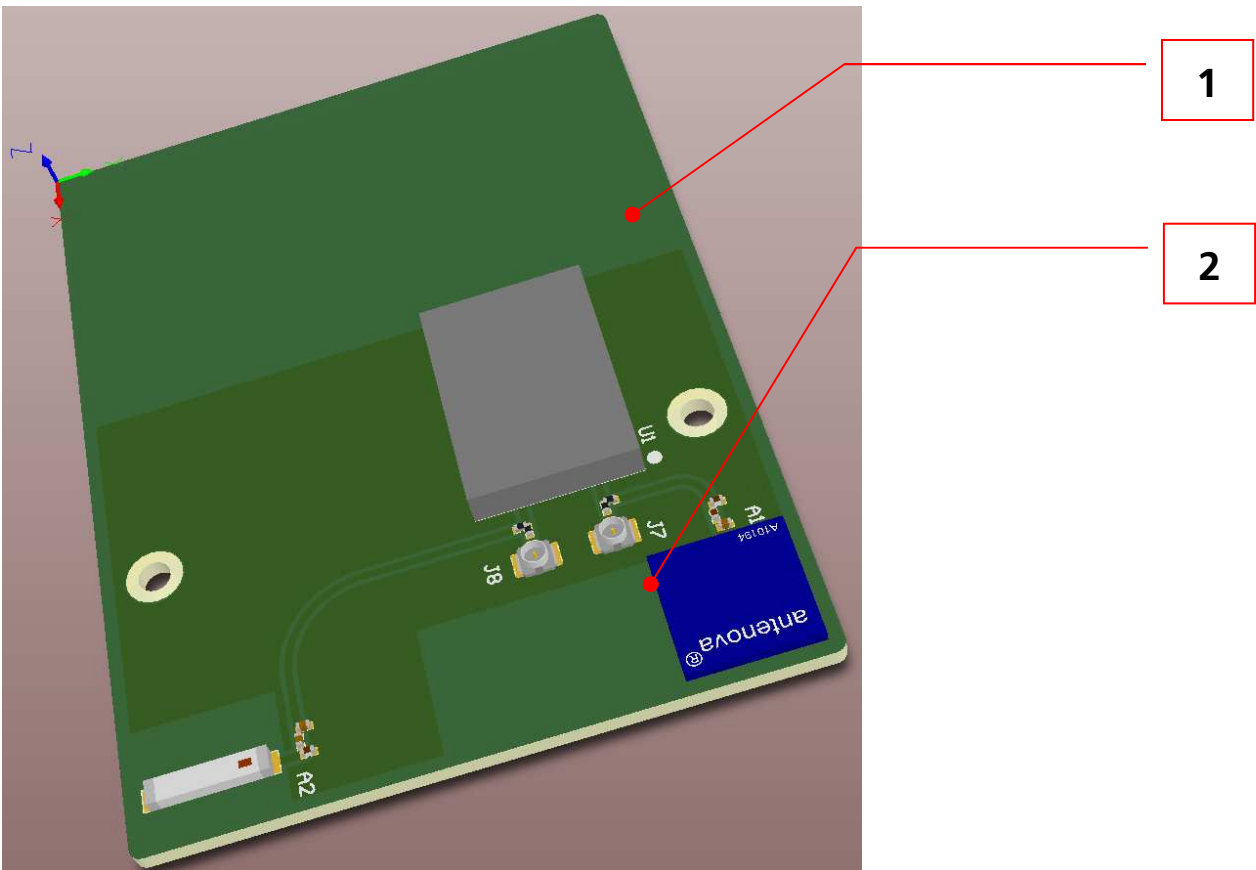


Figure 1: Antenna Reference design embedded in a host carrier PCB

| Reference | Description |
|-----------|---------------------------------------|
| 1 | Host carrier PCB (light green) |
| 2 | Antenna reference design (dark green) |

3.1 Floor plan and PCB stack-up

This section describes where the critical components are positioned on the reference design. It also presents the stack-up of the four layers of the PCB.

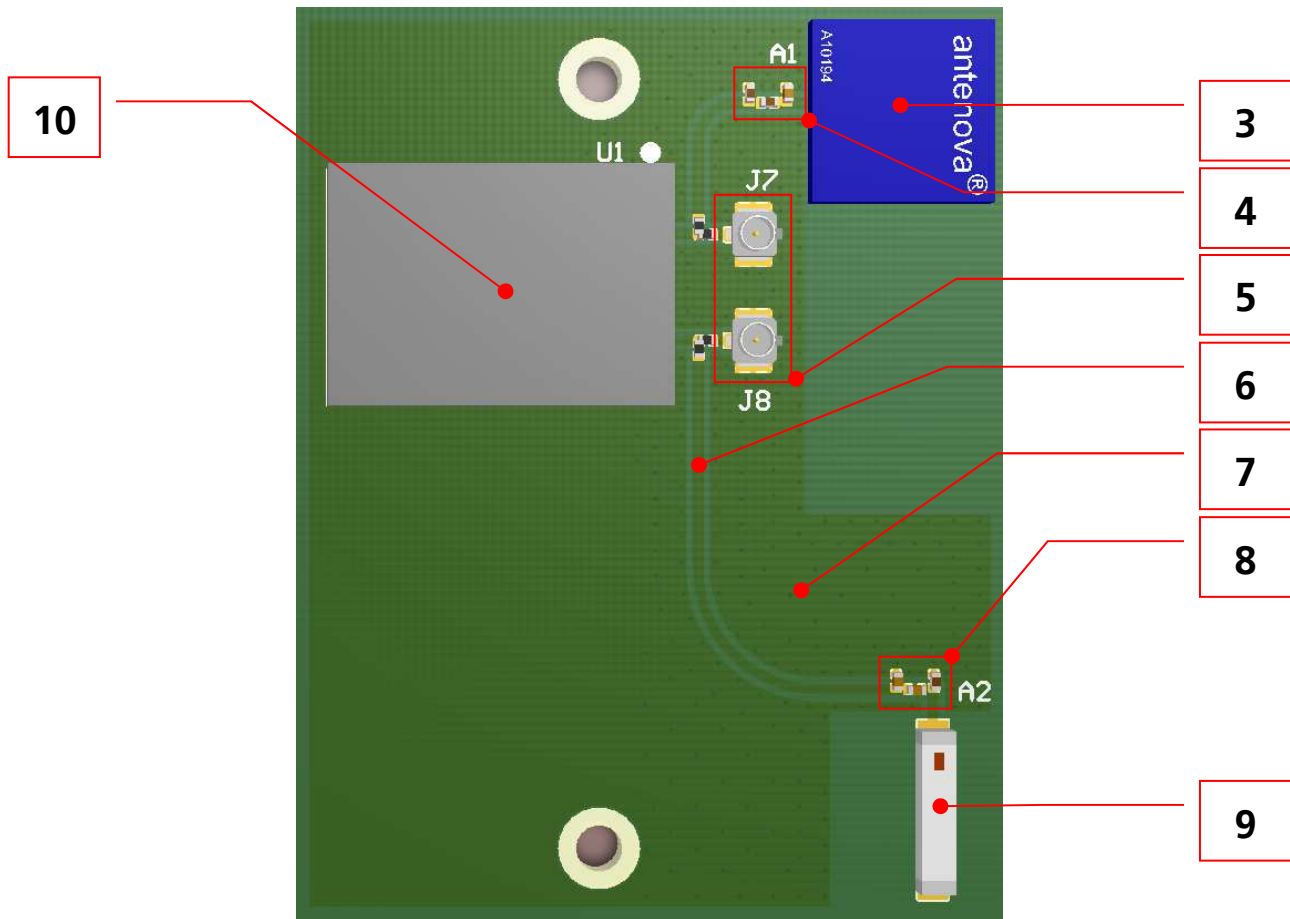


Figure 2: EMMY-W1 antenna reference design

| Reference | Description |
|-----------|---|
| 3 | SMD antenna |
| 4 | Antenna impedance matching network |
| 5 | Connectors for external antenna |
| 6 | Antenna coplanar microstrip, matched to 50 Ω |
| 7 | Top layer GND-plane |
| 8 | Antenna impedance matching network |
| 9 | SMD antenna |
| 10 | ELLA-W1 module |

3.2 PCB stack-up

The stack-up used in the reference design is specified in Table 2.

| PCB Layer | Material | Thickness |
|-------------------|------------------------|--------------------------|
| Soldermask Top | Generic LPI Soldermask | 25 μm |
| Top | Copper Foil | 35 μm |
| Dielectric | Pre-preg 2x7628 | 360 μm |
| L2 | Copper Foil | 35 μm |
| Dielectric | Core | 700 μm +/-10% |
| L3 | Copper Foil | 35 μm |
| Dielectric | Pre-preg 2x7628 | 360 μm |
| Bottom | Copper Foil | 35 μm |
| Soldermask Bottom | Generic LPI Soldermask | 25 μm |

Table 2: Stack-up of EVK-EMMY-W1

3.2.1 RF trace specification

The 50 Ω coplanar micro-strip dimensions used in these reference designs are stated in Figure 3 and Table 3.

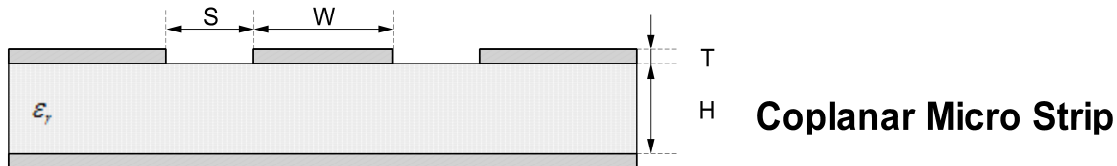


Figure 3: Coplanar micro-strip dimension specification

| Item | Value |
|------|-------------------|
| S | 400 μm |
| W | 600 μm |
| T | 35 μm |
| H | 360 μm |

Table 3: Coplanar micro-strip specification

3.3 Mechanical dimensions

The Mechanical dimensions and position of the components are specified in Figure 4.

The layers beneath the 'top layer' have the same dimensions and are filled with ground. No RF traces are routed in those layers.

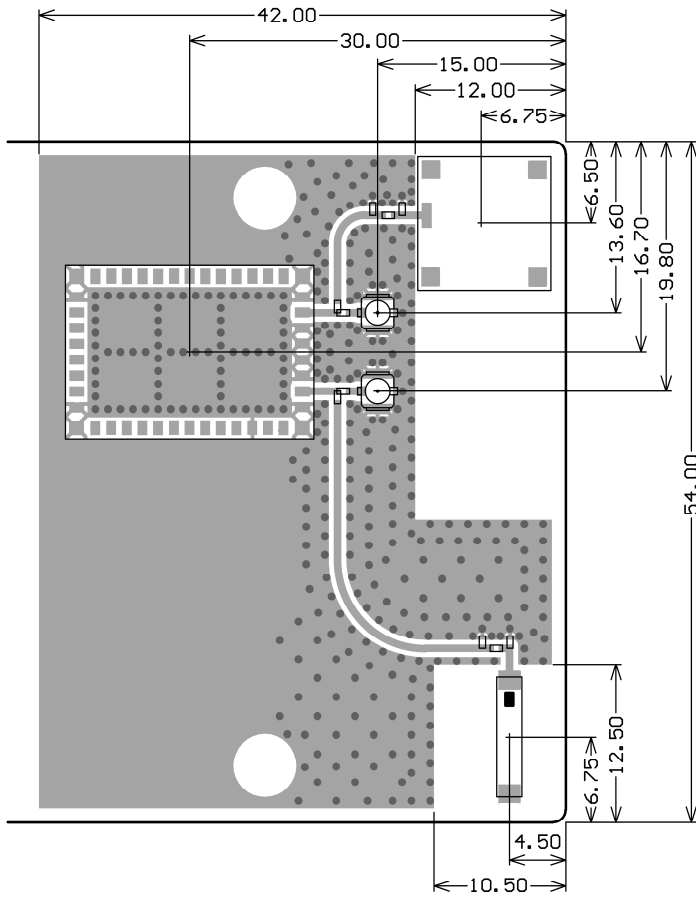


Figure 4: Mechanical dimensions of EVK-EMMY-W1, top layer

4 Reference designs for antenna pin 1

This section describes the available designs for the antenna pin 1 of the EMMY-W1 modules.

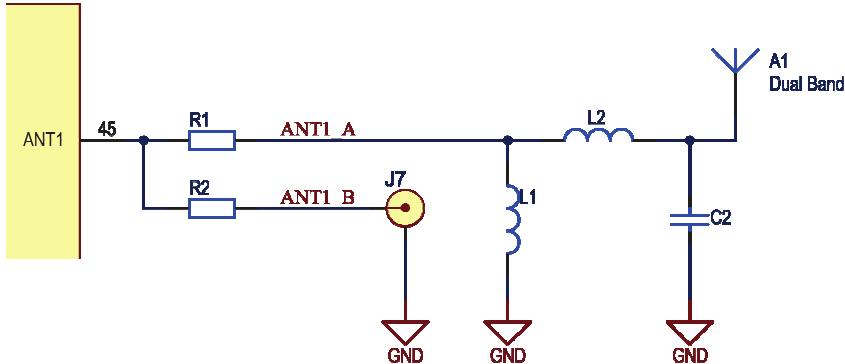


Figure 5: Reference schematic for antenna pin 1

4.1 Internal antenna

The reference design with internal antenna uses the SMD Antenna type A10194 dual band antenna that is connected to the module RF-port via a coplanar micro-strip transmission line.

4.1.1 Bill of materials

| Reference designator | Description | Manufacturer | P/N |
|----------------------|---|---------------------|---------------|
| A1 | Antenna CHIP 2.45 & 5 GHz | Antenova | A10194 |
| L1 | IND, Multilayer Ceramic, 10nH, +/-5%, 300mA, SMD 0402 | Johanson Technology | L-07C10NV6ST |
| L2 | IND, Multilayer Ceramic, 1nH, +/-0.3nH, 300mA, SMD 0402 | Johanson Technology | L-07C1N0SV6T |
| C2 | CAP, CER, 0.2pF, +/-0.1pF, COG, 50V, SMD 0402 | Johanson Technology | 500R07S0R2BV4 |
| R1 | 0 Ω resistor, 0402 | Generic | - |
| R2 | Do not Assembly | - | - |
| J7 | Do Not Assembly | - | - |

4.1.2 Antenna characteristics

| Parameter | Low band | High band | Unit |
|--------------------------|-------------------|-------------|--------------|
| Frequency Range | 2.4 – 2.5 | 4.9 – 5.875 | GHz |
| Peak Gain | 1.8 | 4.1 | dBi |
| VSWR | < 1.4:1 | < 1.8:1 | - |
| Efficiency | >75 | >60 | % |
| Polarisation | Linear | | - |
| Radiation pattern | Omnidirectional | | - |
| Temperature range | -40 to +85 | | $^{\circ}$ C |
| Impedance | 50 | | Ω |
| Dimension (L x W x H) | 10.0 x 10.0 x 0.9 | | mm |

4.2 External antenna

The reference design with external antenna uses the micro coaxial connector that is connected to the external antenna via a 50 Ω pigtail. See section 6 for a list of available external antennas.

4.2.1 Bill of materials

| Reference designator | Description | Manufacturer | P/N |
|----------------------|-----------------------------------|--------------|------------------|
| A1 | Do Not Assembly | - | - |
| L1 | Do Not Assembly | - | - |
| L2 | Do Not Assembly | - | - |
| C2 | Do Not Assembly | - | - |
| R1 | Do Not Assembly | - | - |
| R2 | 0 Ω resistor, 0402 | Generic | - |
| J7 | Coaxial Connector, 0 – 6 GHz, SMD | Hirose | U.FL-R-SMT-1(10) |

5 Reference designs for antenna pin 2

This section describes the available designs for the antenna pin 2 of the EMMY-W1 modules.

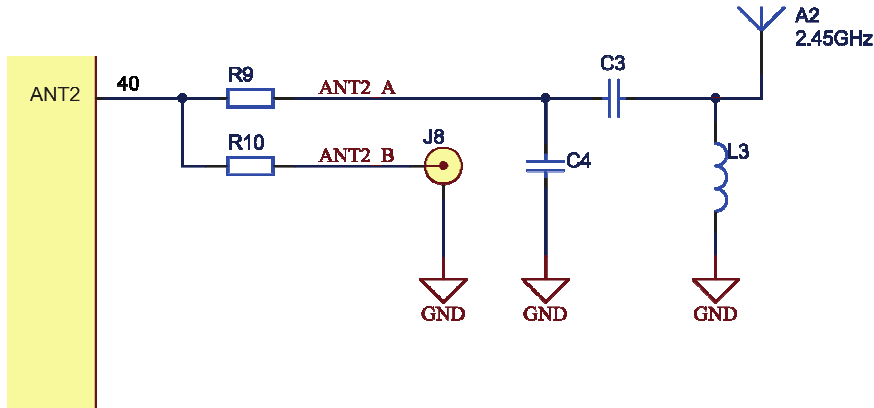


Figure 6: Reference schematic for antenna pin 2

5.1 Internal antenna

The reference design with internal antenna uses the SMD Johanson Technology type 2450AT45A100 antenna that is connected to the module RF-port via a coplanar micro-strip transmission line.

5.1.1 Bill of materials

| Reference designator | Description | Manufacturer | P/N |
|----------------------|---|---------------------|---------------|
| A2 | Antenna CHIP 2.4-2.5GHz | Johanson Technology | 2450AT45A100 |
| C3 | CAP, CER, 2.2pF, +/-0.1pF, COG, 50V, SMD 0402 | Johanson Technology | 500R07S2R2BV4 |
| C4 | CAP, CER, 1.8pF, +/-0.1pF, COG, 50V, SMD 0402 | Johanson Technology | 500R07S1R8BV4 |
| L3 | IND, Multilayer Ceramic, 3.9nH, +/-0.3nH, 300mA, SMD 0402 | Johanson Technology | L-07C3N9SV6T |
| R9 | 0 Ω resistor, 0402 | Generic | - |
| R10 | Do not Assembly | - | - |
| J8 | Do Not Assembly | - | - |

5.1.2 Antenna characteristics

| Parameter | Low band | Unit |
|--------------------------|-----------------|--------------------|
| Frequency Range | 2.4 – 2.5 | GHz |
| Peak Gain | 2.2 | dBi |
| VSWR | < 2:1 | - |
| Polarisation | Linear | - |
| Radiation pattern | Omnidirectional | - |
| Temperature range | -40 to +125 | $^{\circ}\text{C}$ |
| Impedance | 50 | Ω |
| Dimension (L x W x H) | 9.5 x 2.0 x 1.2 | mm |

5.2 External antenna

The reference design with external antenna uses the micro coaxial connector that is connected to the external antenna via a 50 Ω pigtail. See section 6 for a list of available external antennas.

5.2.1 Bill of materials

| Reference designator | Description | Manufacturer | P/N |
|----------------------|-----------------------------------|--------------|------------------|
| A2 | Do not Assembly | - | - |
| C3 | Do Not Assembly | - | - |
| C4 | Do not Assembly | - | - |
| L3 | Do not Assembly | - | - |
| R9 | Do Not Assembly | - | - |
| R10 | 0 Ω resistor, 0402 | Generic | - |
| J8 | Coaxial Connector, 0 – 6 GHz, SMD | Hirose | U.FL-R-SMT-1(10) |

6 Approved external antenna list

For Bluetooth operation on EMMY-W163, the module has been tested and approved for use with antennas listed in Table 4.

| Model name | Manufacturer and description | Gain [dBi] (peak) |
|-------------------|-------------------------------------|-------------------|
| ANT-2.4-CW-RCT-RP | Linx, Single-band dipole antenna | 2.2 |
| ANT-2.4-CW-RH | Linx, Single-band monopole antenna | -0.9 |
| GW.26.0151 | Taoglas, Single-band dipole antenna | 1.8 |

Table 4: Approved antennas list, single-band operation

For Bluetooth and Wi-Fi operations in the 2.4 GHz band and Wi-Fi operation in the 5 GHz band, the module has been tested and approved for use with antennas listed in Table 5.

| Model name | Manufacturer and description | Gain [dBi] (peak) |
|--------------------|-----------------------------------|--|
| ANT-DB1-RAF-RPS | Linx, Dual-band dipole antenna | 2.5 @ 2.4GHz band 4.6 @ 5GHz band |
| GW.40.2153 | Taoglas, Dual-band dipole antenna | 3.74 @ 2.4GHz band 2.5 @ 5GHz band |
| GW.59.3153 | Taoglas, Dual-band dipole antenna | 2.37 @ 2.4GHz band 2.93 @ 5GHz band |
| RFDPA870900SBLB8G1 | Walsin, Dual-band dipole antenna | 2 @ 2.4GHz band 3 @ 5GHz band |
| 88395 | Delock, Dual-band dipole antenna | 1.5 @ 2.4GHz band 2.1 @ 5GHz band |

Table 5: Approved antennas list, dual-band operation

7 NFC reference design

This section describes the available design for the NFC coil antenna of the EMMY-W1 modules.

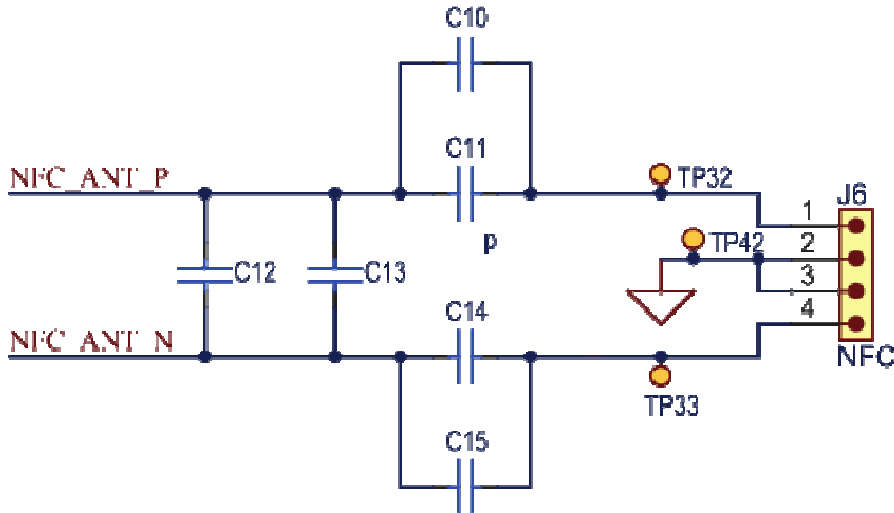


Figure 7: Reference schematic for NFC coil antenna

7.1 Internal antenna

The reference design uses a NFC coil antenna designed by u-blox.

7.1.1 Bill of materials

| Reference designator | Description | Manufacturer | P/N |
|----------------------|---|--------------|-------------------|
| J6 | Pin Header, Pitch 2.54mm, 1x4 Way, Through Hole | Samtec | TSW-104-07-G-S |
| C10 | Do Not Place | - | - |
| C11 | CAP, CER, 220pF, 5%, NP0, 50V, SMD 0402 | Murata | GRM1555C1H221JA01 |
| C12 | CAP, CER, 820pF, 5%, NP0, 50V, SMD 0402 | Murata | GRM1555C1H821JA01 |
| C13 | Do Not Place | - | - |
| C14 | CAP, CER, 820pF, 5%, NP0, 50V, SMD 0402 | Murata | GRM1555C1H821JA01 |
| C15 | Do Not Place | - | - |

7.1.2 NFC coil characteristics

| Parameter | Low band | Unit |
|------------------------------|----------|------|
| Frequency Range | 13.56 | MHz |
| Number of turns | 4 | - |
| Trace width | 0.4 | mm |
| Trace spacing (edge to edge) | 0.4 | mm |
| Dimensions (L x W) | 30 x 30 | mm |

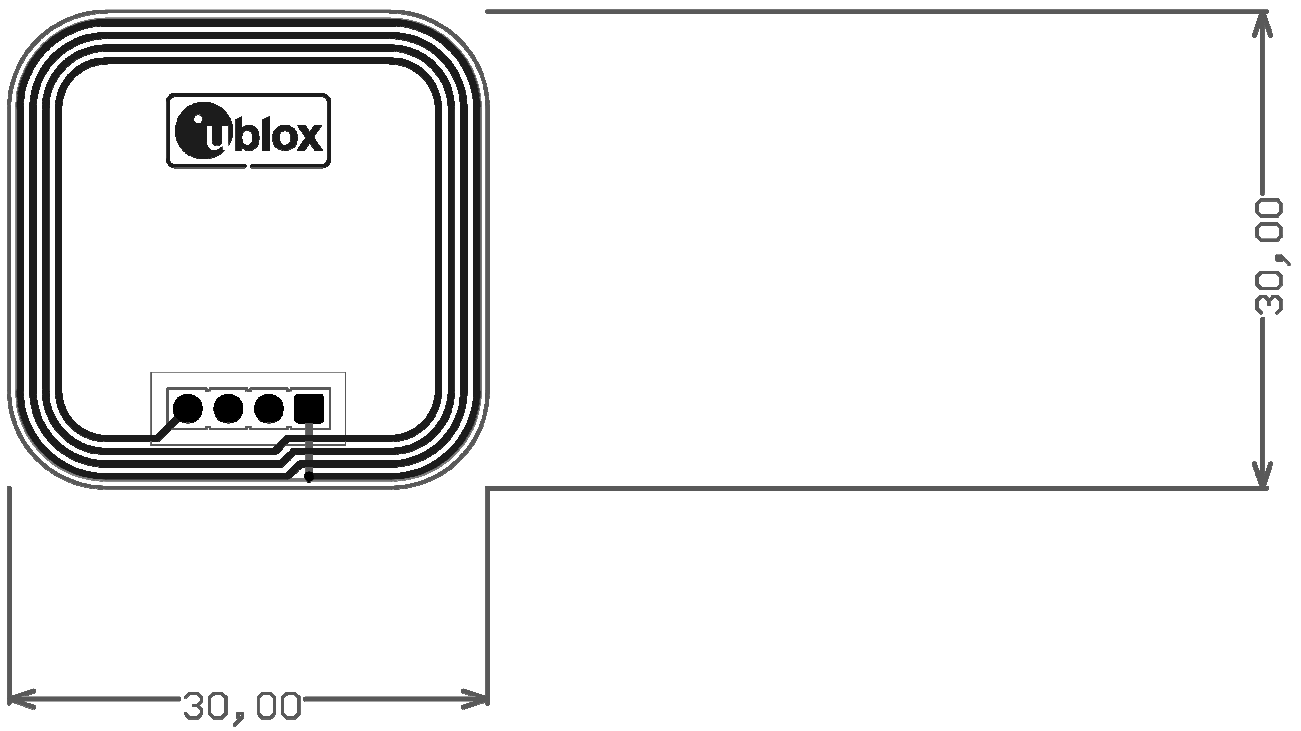


Figure 8: EMMY-W1 reference coil antenna, mechanical dimensions