nanoSplatch™ nSP250
Embedded WiFi/WLAN Antenna

The nanoSplatch™ nSP250 is a surface-mount antenna for embedded WiFi/WLAN and other 2.4 GHz or 5.8 GHz ISM or U-NII frequency band applications. It uses a grounded-line technique to achieve outstanding performance in a tiny surface-mount package. The nSP250 exhibits low proximity effect with a very hemispherical radiation pattern, making it ideal for handheld devices and applications typically subject to interference.

The nSP250 is available in tape and reel packaging and is designed for reflow-solder mounting directly to a printed circuit board for high-volume applications.

Features
- Ultra-compact package (9.6 mm x 8.4 mm x 1.1 mm)
- Excellent performance with smallest ground plane (40 mm x 20 mm)
- Resistant to proximity effect
- Omnidirectional radiation pattern
- Direct surface-mount PCB attachment
- Reflow- or hand-solder assembly
- High gain (2.7 dBi at 2.4 GHz, 3.7 dBi at 5.8 GHz)
- High efficiency (66% at 2.4 GHz, 69% at 5.8 GHz)

Applications
- Single- and dual-band WiFi/WLAN/802.11
- Bluetooth® and ZigBee®
- Smart Home networking
- Sensing and remote monitoring
- Hand-held devices
- Internet of Things (IoT) devices
- U-NII and ISM applications

Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANT-DB1-nSP250-B</td>
<td>Bulk quantities supplied in cut tape</td>
</tr>
<tr>
<td>ANT-DB1-nSP250-T</td>
<td>Tape and reel (1000 per reel)</td>
</tr>
<tr>
<td>AEK-DB1-nSP250</td>
<td>Antenna evaluation kit</td>
</tr>
</tbody>
</table>

Available from Linx Technologies and select distributors and representatives.
Datasheet

nanoSplatch™ nSP250

Electrical Specifications

<table>
<thead>
<tr>
<th></th>
<th>2.4 GHz ISM</th>
<th>U-NII</th>
<th>5.8 GHz ISM/ U-NII-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>2.4 GHz to 2.5 GHz</td>
<td>5.150 GHz to 5.725 GHz</td>
<td>5.725 GHz to 5.875 GHz</td>
</tr>
<tr>
<td>VSWR</td>
<td>≤ 2.0 : 1</td>
<td>≤ 2.2 : 1</td>
<td>≤ 2.4 : 1</td>
</tr>
<tr>
<td>Peak Gain</td>
<td>2.7 dBi</td>
<td>4.3 dBi</td>
<td>3.7 dBi</td>
</tr>
<tr>
<td>Average Gain</td>
<td>-1.8 dBi</td>
<td>-1.9 dBi</td>
<td>-1.6 dBi</td>
</tr>
<tr>
<td>Efficiency</td>
<td>65%</td>
<td>60%</td>
<td>70%</td>
</tr>
<tr>
<td>Polarization</td>
<td>Linear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiation</td>
<td>Omnidirectional</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Power</td>
<td>5 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wavelength</td>
<td>1/4-wave</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection</td>
<td>Surface-mount</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>0.16 g (0.006 oz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensions</td>
<td>9.6 mm x 8.4 mm x 1.1 mm (0.38 in x 0.33 in x 0.04 in)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-40 °C to +130 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ESD Sensitivity</td>
<td>NOT ESD sensitive. As a best practice, Linx may use ESD packaging.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Electrical specifications and plots measured with a 40 mm x 20 mm (1.6 in x 0.8 in) reference ground plane.

VSWR

Figure 1 provides the voltage standing wave ratio (VSWR) across the nSP250 bandwidth. The target 2.4 GHz and 5.8 GHz ISM bands used for WiFi/WLAN are highlighted, as is the U-NII band. VSWR describes the power reflected from the antenna back to the radio. A lower VSWR value indicates better antenna performance at a given frequency. Reflected power is also shown on the right-side vertical axis as a gauge of the percentage of transmitter power reflected back from the antenna.

![Figure 1. nSP250 VSWR with Frequency Band Highlights](image-url)
Return Loss
Return loss (Figure 2), represents the loss in power at the antenna due to reflected signals. Like VSWR, a lower return loss value indicates better antenna performance at a given frequency.

Figure 2. nSP250 Return Loss with Frequency Band Highlights

Peak Gain
The peak gain across the nSP250 bandwidth is shown in Figure 3. Peak gain represents the maximum antenna input power concentration across 3-dimensional space, and therefore peak performance at a given frequency, but does not consider any directionality in the gain pattern.

Figure 3. nSP250 Peak Gain with Frequency Band Highlights
**Average Gain**

Average gain (Figure 4), is the average of all antenna gain in 3-dimensional space at each frequency, providing an indication of overall performance without expressing antenna directionality.

![Figure 4. nSP250 Average Gain with Frequency Band Highlights](image1)

**Radiation Efficiency**

Radiation efficiency (Figure 5), shows the ratio of power delivered to the antenna relative to the power radiated at the antenna, expressed as a percentage, where a higher percentage indicates better performance at a given frequency.

![Figure 5. nSP250 Radiation Efficiency with Frequency Band Highlights](image2)
Product Dimensions

![Figure 6. nSP250 Dimensions](image)

Product Signals
The signal definitions for the nSP250 are provided in Figure 7.

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx/Tx</td>
<td>Castellation marked as &quot;1&quot;</td>
</tr>
<tr>
<td>GND</td>
<td>Unmarked castellation</td>
</tr>
</tbody>
</table>

![Figure 7. nSP250 Pin-Out Table](image)

Proximity Effect
Wireless devices are often designed based on antenna performance measured on an evaluation board. In practice, however, many wireless devices are used in the presence of materials near the antenna which were not present during evaluation. These materials, such as batteries, components on the PCB, or even a person's body or hand¹, can cause a shift in the frequency performance of the antenna, resulting in less than optimal device performance. The shift in the frequency performance can be quite dramatic, especially for monopole (1/4 wavelength) antennas.

The nSP250 antenna is designed to help reduce the impact of nearby objects on the performance of the antenna by using a grounded line technique to reduce the overall length of the antenna radiator to provide wider bandwidth for better immunity to frequency shifts, while using a multilayer PCB to maintain a lower profile and small size. Matching components can be added, if necessary, to mitigate larger proximity effects from features like metal shields or enclosures.

Radiation Patterns
Radiation patterns provide information about the directionality and 3-dimensional gain performance of the antenna by plotting gain at specific frequencies in three orthogonal planes. Radiation patterns (Figure 8), are shown using polar plots covering 360 degrees. The antenna graphic above the plots provides reference to the plane of the column of plots below it. Note: when viewed with typical PDF viewing software, zooming into radiation patterns is possible to reveal fine detail.

Notes
¹ Antenna Proximity Effects for Talk and Data Modes in Mobile Phones; M. Pelosi, et al; IEEE Antennas and Propagation Magazine, Vol. 52, Issue 3, June 2010
nanoSplatch™ nSP250  Datasheet

Radiation Patterns

2.4 GHz to 2.5 GHz

5.15 GHz to 5.73 GHz

5.72 GHz to 5.88 GHz

Figure 8. nSP250 Radiation Patterns
**Datasheet**

**nanoSplatch™ nSP250**

**Recommended Layout**

The recommended printed circuit board (PCB) layout for the nSP250 is shown in Figure 9. This layout is used for the nSP250 evaluation board which is available for purchase as listed under Ordering Information. Contact Linx for availability of PCB layout design files.

The recommended layout includes a matching network, ground plane and PCB transmission line from the antenna to the matching network, and to the connector or radio circuitry. The connector used for the evaluation board is optional, the transmission line may be run directly to the radio if on the same PCB.

Linx recommends inclusion of a 3-element, surface mount Pi matching network of two parallel capacitors, \((C_1, C_2)\) and one serial inductor, \((L_1)\) in all designs. Surface mount components should be 0603 size. 0402 size components are also supported. The nSP250, as designed, does not require matching, but matching may improve end-product antenna performance depending on the effects of the enclosure, PCB and other electronic components. If no matching is necessary, the serial element may be populated with a zero-ohm resistor and no components in the two capacitor positions. This is the configuration of the Linx evaluation board as supplied. Linx believes in wireless made simple® and offers matching network design support.

![Figure 9. Linx nSP250 Recommended Layout](image)

**Recommended PCB Footprint**

Figure 10 shows the recommended printed circuit board footprint and spacing for the nSP250 antenna. The footprint recommendation should be used in conjunction with the recommended layout configuration shown in Figure 9.

![Figure 10. nanoSplatch Placement on PCB](image)
Transmission Lines for Embedded Antennas
For most designs, Linx recommends a microstrip transmission line for the nSP250. A microstrip transmission line is a PCB trace that runs over a ground plane to maintain the characteristic impedance for optimal signal transfer between the antenna and radio circuitry. Linx designs all antennas with a characteristic impedance of 50 Ω.

Important practices to observe when designing a transmission line are:

- Keep all transmission lines to a minimum length for best signal performance.
- Use RF components that also operate at a 50 Ω impedance.
- If the radio is not on the same PCB as the antenna the microstrip should be terminated in a connector enabling a shielded cable to complete the antenna connection to the radio, as exemplified on the nSP250 evaluation board.
- For designs subject to significant electromagnetic interference, a coplanar waveguide transmission line may be used on the PCB.

The design of a PCB transmission line can be aided by many commercially available software packages which can calculate the correct transmission line width and gap dimensions based upon the PCB thickness and dielectric constant used.

Reflow Solder Profile
The nSP250 uses a typical RoHS solder reflow profile. Refer to application note AN-00504 on the Linx website for more information.
Tape and Reel Packaging

Figure 11 shows the dimensions of the tape in which the nSP250 is packaged. Reel dimensions are provided in Figure 12.

Figure 11. Tape Specifications for the nanoSplatch Antenna

Figure 12. Reel Specifications for the nanoSplatch Antenna