Features
- Low insertion loss
- Low amplitude imbalance
- Low phase imbalance
- Coated CSP on glass
- Small footprint: < 1.5 mm²

Benefits
- Very low profile
- High RF performance
- PCB space saving versus discrete solution
- BOM count reduction
- Efficient manufacturability

Applications
- 2.45 GHz balun with integrated matching network
- Matching optimized for following chipsets: nRF51822-QFAA/AB/AC and nRF51422-QFAA/AB/AC (see Figure 19: nRF51822 and nRF51422 compatibility matrix)

Description
STMicroelectronics BALF-NRF01E3 is an ultraminiature balun. The BALF-NRF01E3 integrates matching network in a monolithic glass substrate. Matching impedance has been customized for the nRF51822-QFAA/AB/AC and nRF51422-QFAA/AB/AC RF transceivers.

It uses STMicroelectronics IPD technology on non-conductive glass substrate which optimizes RF performance.

Figure 1. Pinout diagram (bottom view)
## 1 Characteristics

### Table 1. Absolute maximum ratings (limiting values)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>Input power RF&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>-</td>
<td>20 dBm</td>
</tr>
<tr>
<td>V&lt;sub&gt;ESD&lt;/sub&gt;</td>
<td>ESD ratings MIL STD883C (HBM: C = 100 pF, R = 1.5 kΩ, air discharge)</td>
<td>2000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>ESD ratings charge device model (JESD22-C101-C)</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ESD ratings machine model (MM: C = 200 pF, R = 25 Ω, L = 500 nH)</td>
<td>500</td>
<td>-</td>
</tr>
<tr>
<td>T&lt;sub&gt;OP&lt;/sub&gt;</td>
<td>Operating temperature</td>
<td>-40</td>
<td>+105 °C</td>
</tr>
</tbody>
</table>

### Table 2. Electrical characteristics (T<sub>amb</sub> = 25 °C)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>Nominal differential output impedance</td>
<td>Conjugate match to: nRF51822-QFAA/AB/AC, nRF51422-QFAA/AB/AC</td>
<td>Ω</td>
</tr>
<tr>
<td>Z&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>Nominal input impedance</td>
<td>50</td>
<td>Ω</td>
</tr>
<tr>
<td>F</td>
<td>Frequency range (bandwidth)</td>
<td>2400</td>
<td>2540 MHz</td>
</tr>
<tr>
<td>I&lt;sub&gt;L&lt;/sub&gt;</td>
<td>Insertion loss in bandwidth</td>
<td>2.2</td>
<td>2.7 dB</td>
</tr>
<tr>
<td>R&lt;sub&gt;L&lt;/sub&gt;</td>
<td>Return loss in band</td>
<td>14</td>
<td>15 dB</td>
</tr>
<tr>
<td>φ</td>
<td>imb</td>
<td>Phase imbalance</td>
<td>-10</td>
</tr>
<tr>
<td>A</td>
<td>imb</td>
<td>Amplitude imbalance</td>
<td>-1</td>
</tr>
<tr>
<td>2f₀</td>
<td>(4800-5080 MHz)</td>
<td>15.8</td>
<td>16.3 dB</td>
</tr>
<tr>
<td>3f₀</td>
<td>(7200-7620 MHz)</td>
<td>22.7</td>
<td>24.1 dB</td>
</tr>
</tbody>
</table>
1.1 RF performance ($T_{amb} = 25^\circ C$)

- **Figure 2.** Wide band frequency response
  - DIFF transmission (dB)
  - $F(\text{GHz})$

- **Figure 3.** Insertion loss
  - Insertion loss in band (dB)
  - $F(\text{GHz})$

- **Figure 4.** Phase imbalance
  - Phase imbalance (deg)
  - $F(\text{GHz})$

- **Figure 5.** Amplitude imbalance
  - Amplitude imbalance (dB)
  - $F(\text{GHz})$

- **Figure 6.** Return loss on SE port
  - RL on SE port (dB)
  - $F(\text{GHz})$

- **Figure 7.** Conducted measurement (at 4 dBm mode)
  - Conducted Power (dBm)
  - LIMITS: BALF-NRF01E3
  - Pout, LO, H2, H3, H4
2 Application information

Figure 8. Application schematic
3 Package information

- Epoxy meets UL94, V0
- Lead-free package

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com.
ECOPACK® is an ST trademark.

3.1 LGA package information

Figure 9. LGA package outline
Table 3. LGA package mechanical data

<table>
<thead>
<tr>
<th>Dim.</th>
<th>mm</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td></td>
<td>1.40</td>
<td>1.50</td>
<td>1.60</td>
</tr>
<tr>
<td>W</td>
<td></td>
<td>0.90</td>
<td>1.00</td>
<td>1.10</td>
</tr>
<tr>
<td>T</td>
<td></td>
<td>0.42</td>
<td>0.45</td>
<td>0.48</td>
</tr>
<tr>
<td>a</td>
<td></td>
<td>0.18</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>b</td>
<td></td>
<td>0.18</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>c</td>
<td></td>
<td>0.38</td>
<td>0.40</td>
<td>0.42</td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>0.28</td>
<td>0.30</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Figure 10. PCB layout recommendation

Land pattern exposed pad distance = 350μm
Exposed pad = 4700μm x 4700μm
Land pattern length = 800μm
Center of QFN land pattern to BALF-NRF01E3 pad Center = 1155μm
Solder paste

- 100 µm solder stencil thickness is recommended.
- Halide-free flux qualification ROL0 according to ANSI/J-STD-004.
- “No Clean” solder paste is recommended.
- Offers a high tack force to resist component movement during high speed.
- Solder paste with fine particles: powder particle size is 20-45 µm.

Placement

- Manual positioning is not recommended.
- It is recommended to use the lead recognition capabilities of the placement system, not the outline centering.
- Standard tolerance of ±0.05 mm is recommended.
- 3.5 N placement force is recommended. Too much placement force can lead to squeeze out solder paste and cause solder joints to short. Too low placement force can lead to insufficient contact between package and solder paste that could cause open solder joints or badly centered packages.
- To improve the package placement accuracy, a bottom side optical control should be performed with high resolution.
- For assembly, a strong PCB support is recommended (especially on low thickness PCB) during solder paste printing, pick and place and reflow soldering by using optimized tools.
Table 4. Pad assignment details

<table>
<thead>
<tr>
<th>LGA</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>5</td>
<td>VCC</td>
<td>Common collector voltage</td>
</tr>
<tr>
<td>4</td>
<td>BAL+</td>
<td>Balun positive output</td>
</tr>
<tr>
<td>3</td>
<td>BAL-</td>
<td>Balun negative output</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>1</td>
<td>ANT</td>
<td>Antenna connection</td>
</tr>
</tbody>
</table>

Figure 14. Tape and reel specifications

Note: More information is available in the STMicroelectronics technical note:
TN1197: “IPAD™, CSPG w/o bump: package description and recommendations for use”.

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Figure 15. Footprint - 3 mils stencil - non solder mask defined

Copper pad diameter:
220 µm recommended
180 µm minimum
260 µm maximum

Solder mask opening:
320 µm recommended
300 µm minimum
340 µm maximum

Solder stencil opening:
220 µm recommended

Figure 16. Footprint - 3 mils stencil - solder mask defined

Solder mask opening:
220 µm recommended
180 µm minimum
260 µm maximum

Copper pad diameter:
320 µm recommended
300 µm minimum

Solder stencil opening:
220 µm recommended

Figure 17. Footprint - 5 mils stencil - non solder mask defined

Copper pad diameter:
220 µm recommended
180 µm minimum
260 µm maximum

Solder mask opening:
320 µm recommended
300 µm minimum
340 µm maximum

Solder stencil opening:
330 µm recommended*

*depending on paste, it can go down to 270 µm

Figure 18. Footprint - 5 mils stencil - solder mask defined

Solder mask opening:
220 µm recommended
180 µm minimum
260 µm maximum

Copper pad diameter:
320 µm recommended
300 µm minimum

Solder stencil opening:
330 µm recommended*

*depending on paste, it can go down to 270 µm
Figure 19. nRF51822 and nRF51422 compatibility matrix

<table>
<thead>
<tr>
<th>RF IC Part Number</th>
<th>Package</th>
<th>ST Balun</th>
</tr>
</thead>
<tbody>
<tr>
<td>nRF51822-QFAA0</td>
<td>QFN48</td>
<td>BAL-NRF01D3</td>
</tr>
<tr>
<td>nRF51822-QFAA1</td>
<td>QFN48</td>
<td>BAL-NRF01D3 or BAL-NRF01E3</td>
</tr>
<tr>
<td>nRF51422-QFAA0</td>
<td>QFN48</td>
<td>BAL-NRF01E3</td>
</tr>
<tr>
<td>nRF51822-QFAA0</td>
<td>QFN48</td>
<td>NA</td>
</tr>
<tr>
<td>nRF51422-QFAA0</td>
<td>WLCSP</td>
<td>BAL-NRF02D3</td>
</tr>
</tbody>
</table>
4 Ordering information

Figure 20. Ordering information scheme

<table>
<thead>
<tr>
<th>Order code</th>
<th>Marking</th>
<th>Package</th>
<th>Weight</th>
<th>Base Qty</th>
<th>Delivery mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>BALF-NRF01E3</td>
<td>SYN</td>
<td>LGA</td>
<td>1.324 mg</td>
<td>5000</td>
<td>Tape and Reel(7&quot;)</td>
</tr>
</tbody>
</table>

* See compatibility matrix

5 Revision history

Table 6. Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>28-Nov-2014</td>
<td>1</td>
<td>Initial release.</td>
</tr>
<tr>
<td>07-Jul-2015</td>
<td>2</td>
<td>Updated Table 1.</td>
</tr>
<tr>
<td>22-Jan-2016</td>
<td>3</td>
<td>Updated document title and cover page. Updated Table 2 and Figure 8 and Figure 20. Added Figure 19. Format updated to current standard.</td>
</tr>
</tbody>
</table>