BALF-SPI2-01D3

50 Ω nominal input / conjugate match balun to ST S2-LP, 868-927 MHz with integrated harmonic filter

Datasheet - production data

Description
This device is an ultra-miniature balun. The BALF-SPI2-01D3 integrates matching network and harmonics filter. Matching impedance has been customized for the ST S2-LP transceiver.
The BALF-SPI2-01D3 uses STMicroelectronics IPD technology on non-conductive glass substrate which optimizes RF performance.

Features
- 50 Ω nominal input / conjugate match to ST S2-LP for 868 - 927 MHz frequency operation
- Low insertion loss
- Low amplitude imbalance
- Low phase imbalance
- Small footprint
- ECOPACK®2 compliant component

Benefits
- Very low profile < 620 μm after reflow
- High RF performance
- RF BOM and area reduction

Applications
- 868 - 927 MHz impedance matched balun filter
- Optimized for ST S2-LP sub GHz RFIC

Figure 1: Bump layout (top view)

Flip-Chip (6 bumps) package

Downloaded from Arrow.com.
# Characteristics

Table 1: Absolute ratings ($T_{\text{amb}} = 25^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_{\text{IN}}$</td>
<td>Input power RF</td>
<td>20</td>
<td>dBm</td>
</tr>
<tr>
<td>$V_{\text{ESD}}$</td>
<td>ESD ratings human body model (JESD22-A114-C), all I/O one at a time while others connected to GND</td>
<td>2000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>ESD ratings machine model, all I/O</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>$T_{\text{OP}}$</td>
<td>Operating temperature</td>
<td>-40 to +105</td>
<td>°C</td>
</tr>
</tbody>
</table>

Table 2: Impedances ($T_{\text{amb}} = 25^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z_{\text{RX}}$</td>
<td>Nominal differential RX balun impedance</td>
<td>matched ST S2-LP</td>
<td>Ω</td>
</tr>
<tr>
<td>$Z_{\text{TX}}$</td>
<td>Nominal TX filter impedance</td>
<td>- 50</td>
<td></td>
</tr>
<tr>
<td>$Z_{\text{ANT}}$</td>
<td>Antenna impedance</td>
<td>-</td>
<td>Ω</td>
</tr>
</tbody>
</table>

Table 3: Electrical characteristics and RF performance ($T_{\text{amb}} = 25^\circ \text{C}$)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f$</td>
<td>Frequency range (bandwidth)</td>
<td>868 927</td>
<td>MHz</td>
</tr>
<tr>
<td>$I_{\text{IL,RX-ANT}}$</td>
<td>Insertion loss in bandwidth without mismatch loss (RX balun)</td>
<td>1.7 2.0</td>
<td>dB</td>
</tr>
<tr>
<td>$I_{\text{IL,TX-ANT}}$</td>
<td>Insertion loss in bandwidth without mismatch loss (TX filter)</td>
<td>1.7 2.1</td>
<td>dB</td>
</tr>
<tr>
<td>$R_{\text{RL,RX-ANT}}$</td>
<td>Input return loss in bandwidth (RX balun)</td>
<td>10 14</td>
<td>dB</td>
</tr>
<tr>
<td>$R_{\text{RL,TX-ANT}}$</td>
<td>Input return loss in bandwidth (TX filter)</td>
<td>15 20</td>
<td>dB</td>
</tr>
<tr>
<td>$</td>
<td>\phi_{\text{rms}}</td>
<td>$</td>
<td>Output phase imbalance (RX balun) – absolute value</td>
</tr>
<tr>
<td>$</td>
<td>A_{\text{amb}}</td>
<td>$</td>
<td>Output amplitude imbalance (RX balun) – absolute value</td>
</tr>
<tr>
<td>$\text{Att}$</td>
<td>Harmonic levels (TX filter)</td>
<td>Attenuation at 2$f_0$ 40 45</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation at 3$f_0$ 47 51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation at 4$f_0$ 60 65</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation at 5$f_0$ 66 72</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation at 6$f_0$ 50 57</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuation at 7$f_0$ 46 50</td>
<td></td>
</tr>
</tbody>
</table>
1.1 RF measurements (RX balun)

- **Figure 2:** Insertion loss (RX balun)
- **Figure 3:** Return loss antenna (RX balun)
- **Figure 4:** Amplitude imbalance (RX balun)
- **Figure 5:** Phase imbalance (RX balun)
1.2 RF measurements (TX filter)

Figure 6: TX filter transmission

Figure 7: Insertion loss (TX filter)

Figure 8: Return loss antenna (TX filter)
1.3 ST S2-LP evaluation board with BALF-SPI2-01D3

Figure 9: Evaluation board with BALF-SPI2-01D3
2 Package information

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.

2.1 Flip-Chip 6 bumps package information

Figure 10: Flip-Chip 6 bumps package outline (top and side view)

Table 4: Flip-Chip 6 bumps dimensions

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Dimensions (millimeters)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Min.</td>
<td>Typ.</td>
<td>Max.</td>
</tr>
<tr>
<td>A1</td>
<td>0.180</td>
<td>0.205</td>
<td>0.230</td>
</tr>
<tr>
<td>A2</td>
<td>0.380</td>
<td>0.400</td>
<td>0.420</td>
</tr>
<tr>
<td>b</td>
<td>0.230</td>
<td>0.255</td>
<td>0.280</td>
</tr>
<tr>
<td>D</td>
<td>2.050</td>
<td>2.100</td>
<td>2.150</td>
</tr>
<tr>
<td>D1</td>
<td>1.210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>0.500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>1.500</td>
<td>1.550</td>
<td>1.600</td>
</tr>
<tr>
<td>E1</td>
<td>1.060</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fD1</td>
<td>0.195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fD2</td>
<td>0.195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fE1</td>
<td>0.195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fE2</td>
<td>0.295</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.2 Flip-chip 6 bumps packing information

Figure 11: Marking

Dot, ST logo
ECOPACK grade
xx = marking
z = manufacturing location
yww = datecode

Figure 12: Flip Chip tape and reel specifications

Dot identifying PinA1 location

All dimensions are typical values in mm

User direction of unreeling

More packing information is available in the application note:
- AN2348 Flip-Chip: “Package description and recommendations for use”
3 Recommendation on PCB assembly

3.1 Land pattern

Figure 13: Recommended balun land pattern
3.2 Stencil opening design

**Figure 14: 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 15: Footprint - 3 mils stencil - solder mask defined**

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

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

- Solder stencil opening:
  - 220 µm recommended

---

**Figure 16: 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 17: Footprint - 5 mils stencil - solder mask defined**

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

- Solder mask opening:
  - 320 µm recommended
  - 300 µm minimum

- Solder stencil opening:
  - 330 µm recommended

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

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3.3 Solder paste

1. Halide-free flux qualification ROL0 according to ANSI/J-STD-004.
2. “No clean” solder paste is recommended.
3. Offers a high tack force to resist component movement during high speed.
4. Use solder paste with fine particles: powder particle size 20-38 µm.
3.4 Placement

1. Manual positioning is not recommended.
2. It is recommended to use the lead recognition capabilities of the placement system, not the outline centering.
3. Standard tolerance of ±0.05 mm is recommended.
4. 1.0 N placement force is recommended. Too much placement force can lead to squeezed 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.
5. To improve the package placement accuracy, a bottom side optical control should be performed with a high resolution tool.
6. For assembly, a perfect supporting of the PCB (all the more on flexible PCB) is recommended during solder paste printing, pick and place and reflow soldering by using optimized tools.

3.5 PCB design preference

1. To control the solder paste amount, the closed via is recommended instead of open vias.
2. The position of tracks and open vias in the solder area should be well balanced. A symmetrical layout is recommended, to avoid any tilt phenomena caused by asymmetrical solder paste due to solder flow away.

3.6 Reflow profile

Figure 18: ST ECOPACK® recommended soldering reflow profile for PCB mounting

Minimize air convection currents in the reflow oven to avoid component movement.
4 Ordering information

Table 5: Ordering information

<table>
<thead>
<tr>
<th>Order code</th>
<th>Marking</th>
<th>Package</th>
<th>Weight</th>
<th>Base qty.</th>
<th>Delivery mode</th>
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</thead>
<tbody>
<tr>
<td>BALF-SPI2-01D3</td>
<td>TM</td>
<td>Flip-Chip 6 bumps</td>
<td>3.4 mg</td>
<td>5000</td>
<td>Tape and reel</td>
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</table>

5 Revision history

Table 6: Document revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Revision</th>
<th>Changes</th>
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</thead>
<tbody>
<tr>
<td>08-Aug-2017</td>
<td>1</td>
<td>Initial release.</td>
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