Data sheet

SAW RF filter
Automotive telematics
LTE band 13

Series/type: B2613
Ordering code: B39751B2613P810

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Please read Cautions and warnings and Important notes at the end of this document.

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1 Application
- Low-loss RF filter for LTE system (RX diversity)
- No matching required for unbalanced / unbalanced operation
- Usable pass band width 10 MHz

2 Features
- Package size 1.1±0.1 mm × 0.9±0.1 mm
- Package height 0.45 mm (max.)
- Approximate weight 1 mg
- RoHS compatible
- Package for Surface Mount Technology (SMT)
- Ni/Au-plated terminals
- Filter surface passivated
- Electrostatic Sensitive Device (ESD)
- Moisture Sensitivity Level 2a (MSL2a)
- AEC-Q200 qualified component family (Grade 1: −40 °C to +125 °C)
3  Package

BOTTOM VIEW

4  Pin configuration

- 1  Input
- 4  Output
- 2, 3, 5  Ground

Figure 2: Drawing of package with package height A = 0.45 mm (max.). See Sec. Package information (p. 18).
5 Matching circuit

Figure 3: Schematic of matching circuit. No external matching components required.
### 6 Characteristics

Temperature range for specification $T_{\text{SPEC}} = -40 \, ^\circ\text{C} \ldots +85 \, ^\circ\text{C}$

Input terminating impedance $Z_{\text{IN}} = 50 \, \Omega$

Output terminating impedance $Z_{\text{OUT}} = 50 \, \Omega$

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>min. for $T_{\text{SPEC}}$</th>
<th>typ. @ +25 °C</th>
<th>max. for $T_{\text{SPEC}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center frequency $f_c$</td>
<td></td>
<td>751 MHz</td>
<td></td>
</tr>
<tr>
<td>Maximum insertion attenuation $\alpha_{\text{max}}$</td>
<td></td>
<td>2.0 dB</td>
<td>2.8 dB</td>
</tr>
<tr>
<td>Amplitude ripple (p-p) $\Delta \alpha$</td>
<td></td>
<td>0.5 dB</td>
<td>1.3 dB</td>
</tr>
<tr>
<td>Maximum VSWR $VSWR_{\text{max}}$ @ input port</td>
<td></td>
<td>1.6 dB</td>
<td>2.0 dB</td>
</tr>
<tr>
<td>@ output port</td>
<td></td>
<td>1.6 dB</td>
<td>2.0 dB</td>
</tr>
<tr>
<td>Minimum attenuation $\alpha_{\text{min}}$</td>
<td>10... 686 MHz</td>
<td>40 dB</td>
<td>47 dB</td>
</tr>
<tr>
<td></td>
<td>686... 728 MHz</td>
<td>40 dB</td>
<td>44 dB</td>
</tr>
<tr>
<td></td>
<td>771... 772 MHz</td>
<td>30 dB</td>
<td>48 dB</td>
</tr>
<tr>
<td></td>
<td>777... 787 MHz</td>
<td>47 dB</td>
<td>53 dB</td>
</tr>
<tr>
<td></td>
<td>1710... 1755 MHz</td>
<td>40 dB</td>
<td>45 dB</td>
</tr>
<tr>
<td></td>
<td>1850... 1910 MHz</td>
<td>39 dB</td>
<td>45 dB</td>
</tr>
<tr>
<td></td>
<td>2400... 2500 MHz</td>
<td>40 dB</td>
<td>51 dB</td>
</tr>
<tr>
<td></td>
<td>4900... 5950 MHz</td>
<td>39 dB</td>
<td>43 dB</td>
</tr>
</tbody>
</table>
## 7 Maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operable temperature</td>
<td>$T_{\text{OP}} = -40 , ^\circ\text{C} \ldots +125 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Storage temperature 1)</td>
<td>$T_{\text{STG}1)} = -40 , ^\circ\text{C} \ldots +125 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>DC voltage</td>
<td>$</td>
</tr>
<tr>
<td>Input power @ input port: 777 ... 787 MHz</td>
<td>$P_{\text{IN}} = 23 , \text{dBm}$</td>
</tr>
<tr>
<td>Continuous wave for 10000 h @ 85 °C.</td>
<td></td>
</tr>
</tbody>
</table>

1) Not valid for packaging material. Storage temperature for packaging material is $-25 \, ^\circ\text{C}$ to $+40 \, ^\circ\text{C}$.

2) In case of applied DC voltage blocking capacitors are mandatory.
8 Transmission coefficient

Figure 4: Attenuation.
9  Reflection coefficients

**Figure 5:** Reflection coefficient at input port.

**Figure 6:** Reflection coefficient at output port.
10  Packing material
10.1  Tape

Figure 7: Drawing of tape (first-angle projection) with tape dimensions according to Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₀</td>
<td>1.02±0.05 mm</td>
</tr>
<tr>
<td>B₀</td>
<td>1.22±0.05 mm</td>
</tr>
<tr>
<td>D₀</td>
<td>1.55±0.05 mm</td>
</tr>
<tr>
<td>D₁</td>
<td>0.55±0.1 mm</td>
</tr>
<tr>
<td>E₁</td>
<td>1.75±0.1 mm</td>
</tr>
<tr>
<td>E₂</td>
<td>6.25 mm (min.)</td>
</tr>
<tr>
<td>F</td>
<td>3.5±0.05 mm</td>
</tr>
<tr>
<td>G</td>
<td>–</td>
</tr>
<tr>
<td>K₀</td>
<td>0.6±0.05 mm</td>
</tr>
<tr>
<td>P₀</td>
<td>4.0±0.1 mm</td>
</tr>
<tr>
<td>P₁</td>
<td>2.0±0.1 mm</td>
</tr>
<tr>
<td>P₂</td>
<td>2.0±0.05 mm</td>
</tr>
<tr>
<td>T</td>
<td>0.25±0.05 mm</td>
</tr>
<tr>
<td>W</td>
<td>8.0±0.3–0.1 mm</td>
</tr>
</tbody>
</table>

Table 1: Tape dimensions.
10.2 Reel with diameter of 180 mm

![Diagram of reel with diameter of 180 mm]

**Figure 8:** Drawing of reel (first-angle projection) with diameter of 180 mm.

**Dimensions [mm]**
- X = 220±5
- Y = 235±5
- Sealing area 10±3

![Diagram of moisture barrier bag (MBB) for reel with diameter of 180 mm]

**Figure 9:** Drawing of moisture barrier bag (MBB) for reel with diameter of 180 mm.

Surface resistivity < $10^{12}$ Ohms/eq
Figure 10: Drawing of folding box for reel with diameter of 180 mm.

Dimensions [mm]
L = 188
B = 188
H = 30
Tolerance ±5

2 pcs. ESD label (around carton box)

Window for customer label

Flat area of moisture barrier bag for customer label

Identification label on carton box
11 Marking

Products are marked with product type number and lot number encoded according to Table 2:

- **Type number:**

  The 4 digit type number of the ordering code, e.g., B3xxxxB\textsuperscript{1234}xxxx, is encoded by a special BASE32 code into a 3 digit marking.

  Example of decoding type number marking on device in decimal code.

  \[
  16J \\
  1 \times 32^2 + 6 \times 32^1 + 18 = (1) \times 32^0 \\
  \Rightarrow 1234
  \]

  The BASE32 code for product type B2613 is 2HN.

- **Lot number:**

  The last 5 digits of the lot number, e.g., \textsuperscript{12345}, are encoded based on a special BASE47 code into a 3 digit marking.

  Example of decoding lot number marking on device in decimal code.

  \[
  5UY \\
  5 \times 47^2 + 27 = (U) \times 47^1 + 31 = (Y) \times 47^0 \\
  \Rightarrow 12345
  \]

  Adopted BASE32 code for type number

  \[
  \begin{array}{cccc}
  \text{Decimal value} & \text{Base32 code} & \text{Decimal value} & \text{Base32 code} \\
  0 & 0 & 16 & G \\
  1 & 1 & 17 & H \\
  2 & 2 & 18 & J \\
  3 & 3 & 19 & K \\
  4 & 4 & 20 & M \\
  5 & 5 & 21 & N \\
  6 & 6 & 22 & P \\
  7 & 7 & 23 & Q \\
  8 & 8 & 24 & R \\
  9 & 9 & 25 & S \\
  10 & A & 26 & T \\
  11 & B & 27 & V \\
  12 & C & 28 & W \\
  13 & D & 29 & X \\
  14 & E & 30 & Y \\
  15 & F & 31 & Z \\
  \end{array}
  \]

  Adopted BASE47 code for lot number

  \[
  \begin{array}{cccc}
  \text{Decimal value} & \text{Base47 code} & \text{Decimal value} & \text{Base47 code} \\
  0 & 0 & 24 & R \\
  1 & 1 & 25 & S \\
  2 & 2 & 26 & T \\
  3 & 3 & 27 & U \\
  4 & 4 & 28 & V \\
  5 & 5 & 29 & W \\
  6 & 6 & 30 & X \\
  7 & 7 & 31 & Y \\
  8 & 8 & 32 & Z \\
  9 & 9 & 33 & b \\
  10 & A & 34 & d \\
  11 & B & 35 & f \\
  12 & C & 36 & h \\
  13 & D & 37 & n \\
  14 & E & 38 & r \\
  15 & F & 39 & t \\
  16 & G & 40 & v \\
  17 & H & 41 & \backslash \\
  18 & J & 42 & ? \\
  19 & K & 43 & \{ \\
  20 & L & 44 & \} \\
  21 & M & 45 & < \\
  22 & N & 46 & > \\
  23 & P & & \\
  \end{array}
  \]

  Table 2: Lists for encoding and decoding of marking.
12 Soldering profile

The recommended soldering process is in accordance with IEC 60068-2-58 – 3\textsuperscript{rd} edit and IPC/JEDEC J-STD-020B.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>ramp rate</td>
<td>≤ 3 K/s</td>
</tr>
<tr>
<td>preheat</td>
<td>125 °C to 220 °C, 150 s to 210 s, 0.4 K/s to 1.0 K/s</td>
</tr>
<tr>
<td>$T &gt; 220$ °C</td>
<td>30 s to 70 s</td>
</tr>
<tr>
<td>$T &gt; 230$ °C</td>
<td>min. 10 s</td>
</tr>
<tr>
<td>$T &gt; 245$ °C</td>
<td>max. 20 s</td>
</tr>
<tr>
<td>$T ≥ 255$ °C</td>
<td></td>
</tr>
<tr>
<td>peak temperature $T_{\text{peak}}$</td>
<td>250 °C +0/-5 °C</td>
</tr>
<tr>
<td>wetting temperature $T_{\text{min}}$</td>
<td>230 °C +5/-0 °C for 10 s ± 1 s</td>
</tr>
<tr>
<td>cooling rate</td>
<td>≤ 3 K/s</td>
</tr>
<tr>
<td>soldering temperature $T$</td>
<td>measured at solder pads</td>
</tr>
</tbody>
</table>

Table 3: Characteristics of recommended soldering profile for lead-free solder (Sn95.5Ag3.8Cu0.7).

Figure 11: Recommended reflow profile for convection and infrared soldering – lead-free solder.
13 ESD protection of SAW filters

SAW filters are Electro Static Discharge sensitive devices. To reduce the probability of damages caused by ESD, special matching topologies have to be applied.

In general, “ESD matching” has to be ensured at that filter port, where electrostatic discharge is expected.

Electrostatic discharges predominantly appear at the antenna input of RF receivers. Therefore, only the input matching of the SAW filter has to be designed to short circuit or to block the ESD pulse.

Below three figures show recommended “ESD matching” topologies.

For wide band filters the high-pass ESD matching structure needs to be at least of 3rd order to ensure a proper matching for any impedance value of antenna and SAW filter input. The required component values have to be determined from case to case.

![Figure 12: MLC varistor plus ESD matching.](image)

In cases where minor ESD occur, following simplified “ESD matching” topologies can be used alternatively.

![Figure 14: 3rd order high-pass structure for basic ESD protection.](image)

In all three figures the shunt inductor $L_{sh}$ could be replaced by a shorted microstrip with proper length and width. If this configuration is possible depends on the operating frequency and available PCB space.

Effectiveness of the applied ESD protection has to be checked according to relevant industry standards or customer specific requirements.

For further information, please refer to RF360 Application report: “ESD protection for SAW filters”. This report can be found under [www.rf360jv.com/rke](http://www.rf360jv.com/rke). Click on “Applications Notes”.

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14 Annotations

14.1 Matching coils

See TDK inductor pdf-catalog [http://www.tdk.co.jp/tefe02/coil.htm#aname1](http://www.tdk.co.jp/tefe02/coil.htm#aname1) and Data Library for circuit simulation [http://www.tdk.co.jp/etvcl/index.htm](http://www.tdk.co.jp/etvcl/index.htm).

14.2 RoHS compatibility

ROHS-compatible means that products are compatible with the requirements according to Art. 4 (substance restrictions) of Directive 2011/65/EU of the European Parliament and of the Council of June 8th, 2011, on the restriction of the use of certain hazardous substances in electrical and electronic equipment ("Directive") with due regard to the application of exemptions as per Annex III of the Directive in certain cases.

14.3 Scattering parameters (S-parameters)

The pin/port assignment is available in the headers of the S-parameter files. Please contact your local RF360 sales office.
15  Cautions and warnings

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For information on recycling of tapes and reels please contact one of our sales offices.

15.3 Moldability

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15.4 Package information

Landing area

The printed circuit board (PCB) land pattern (landing area) shown is based on RF360 internal development and empirical data and illustrated for example purposes, only. As customers' SMD assembly processes may have a plenty of variants and influence factors which are not under control or knowledge of RF360, additional careful process development on customer side is necessary and strongly recommended in order to achieve best soldering results tailored to the particular customer needs.

Dimensions

Unless otherwise specified all dimensions are understood using unit millimeter (mm).

Dimensions do not include burrs.

Projection method

Unless otherwise specified first-angle projection is applied.
16 Important notes

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