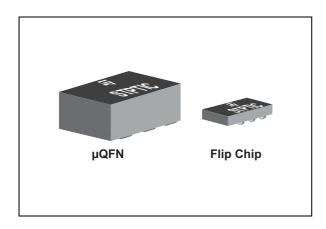




### Parascan<sup>™</sup> tunable integrated capacitor

Datasheet - production data



### **Features**

- High power capability (+36 dBm)
- High tuning range (3.5/1)
- High quality factor (Q)
- High linearity device
- Low leakage current
- Capacitor bias is DC blocked
- Frequency of operation from DC to 3 GHz
- 8 values available: 1.2 pF, 2.7 pF, 3.3 pF, 3.9 pF, 4.7 pF, 5.6 pF, 6.8 pF and 8.2 pF
- Analog control voltage
- Compatible with high voltage control IC (STHVDAC series)
- Available in plastic molded package:
  - μQFN package 1.2 x 1.6 x 0.9 mm
  - Flip Chip 0.65 x 1.0 x 0.3 mm
  - Flip Chip 0.65 x 1.2 x 0.3 mm
- ECOPACK<sup>®</sup>2 compliant component

### **Benefit**

 RF tunable passive implementation in mobile phones to optimize antenna radiated performances.

### **Applications**

- Cellular Antenna open loop tunable matching network in multi-band GSM/WCDMA/LTE mobile phone
- · Open loop tunable RF filters

### Description

The ST integrated tunable capacitor, offers excellent RF performance, low power consumption and high linearity required in adaptive RF tuning applications. The fundamental building block of PTIC is a tunable material called Parascan, which is a version of barium strontium titanate (BST) developed by Paratek microwave.

BST capacitances are tunable capacitances intended for use in mobile phone application, and dedicated to RF tunable applications. These tunable capacitances are controlled through a bias voltage ranging from 2 to 20 V. The use of BST tunable capacitance in mobile phones enables significant improvement in terms of radiated performances making the performance almost insensitive to the external environment.

TM: Parascan is a trade mark of Paratek microwave Inc.

#### **Functional characteristics** 1

DC Bias NC RF2 RF1 RF2 RF1

Figure 1. PTIC functional block diagram

Table 1. Signal descriptions

| Ball/Pad number | Pin name Description  |                   |  |  |
|-----------------|-----------------------|-------------------|--|--|
| A1              | DC BIAS               | DC bias voltage   |  |  |
| B1              | RF2 RF input / output |                   |  |  |
| C1              | RF2                   | RF input / output |  |  |
| A2              | NC                    | Not connected     |  |  |
| B2              | RF1                   | RF input / output |  |  |
| C2              | RF1                   | RF input / output |  |  |

## 2 Electrical characteristics

Table 2. Absolute maximum ratings (limiting values)

| Symbol                                | Parameter  | Rating      | Unit               |   |
|---------------------------------------|--|-------------|--------------------|---|
| P <sub>IN</sub>                       | Input peak power RF <sub>IN</sub> (CW mode)/all RF ports | +36         | dBm                |   |
|                                       |  | STPTIC-12   | 500                | ٧ |
|                                       |  | STPTIC-27   | 400 <sup>(1)</sup> |   |
|                                       |  | STPTIC-33   | 400 <sup>(1)</sup> |   |
| \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ | Human body model, JESD22-A114-B, all I/O                 | STPTIC-39   | 500                |   |
| V <sub>ESD(HBM)</sub>                 |  | STPTIC-47   | 500                |   |
|                                       |  | STPTIC-56   | 500                |   |
|                                       |  | STPTIC-68   | 500                |   |
|                                       |  | STPTIC-82   | 500                |   |
| V <sub>ESD(MM)</sub>                  | Machine model, JESD22-A114-B, all I/O                    | 100         | V                  |   |
| T <sub>device</sub>                   | Device temperature                                       | +125        | ့င                 |   |
| T <sub>stg</sub>                      | Storage temperature                                      | -55 to +150 | O                  |   |
| V <sub>x</sub>                        | Bias voltage   | 25          | V                  |   |

<sup>1.</sup> Currently failing around 400 V, improvement on going to withstand 500 V on 2p7 and 3p3.

Table 3. Recommended operating conditions

| Symbol              | Parameter  |     | I I m i A |            |      |
|---------------------|--|-----|-----------|------------|------|
|                     | Parameter  |     | Тур.      | Max.       | Unit |
| P <sub>IN</sub>     | RF input power (50% duty cycle mode) RF <sub>IN</sub> (LB) RF <sub>IN</sub> (HB) |     |           | +35<br>+33 | dBm  |
| F <sub>OP</sub>     | Operating frequency  | 700 |           | 3000       | MHz  |
| T <sub>device</sub> | Device temperature   |     |           | +100       | °C   |
| T <sub>OP</sub>     | Operating temperature  | -30 |           | +85        |      |
| V <sub>x</sub>      | Bias voltage   | 2   |           | 20         | ٧    |

Electrical characteristics STPTIC

Table 4. Representative performances ( $T_{amb}$  = 25 °C)

| Oh al           | Parameter                   | On distance ( an  | Value |       |      |      |
|-----------------|-----------------------------|---|-------|-------|------|------|
| Symbol          |                             | Conditions  | Min   | Тур   | Max  | Unit |
|                 |                             | STPTIC-12   | 1.08  | 1.20  | 1.32 | pF   |
|                 |                             | STPTIC-27   | 2.43  | 2.7   | 2.97 | pF   |
|                 |                             | STPTIC-33   | 2.97  | 3.3   | 3.63 | pF   |
| _               | Capacitance at 2V bias      | STPTIC-39   | 3.51  | 3.9   | 4.29 | рF   |
| C <sub>2V</sub> | Capacitatice at 2 v bias    | STPTIC-47   | 4.23  | 4.7   | 5.17 | рF   |
|                 |                             | STPTIC-56   | 5.04  | 5.6   | 6.16 | рF   |
|                 |                             | STPTIC-68   | 6.12  | 6.8   | 7.48 | pF   |
|                 |                             | STPTIC-82   | 7.38  | 8.2   | 9.02 |      |
| IL              | Leakage current             | Measured with V <sub>bias</sub> = 20 V                              |       |       | 100  | nA   |
| ΔC              | Tuning range                | Ratio between C <sub>2V</sub> /C <sub>20V</sub> measured at 100 kHz | 3/1   | 3.5/1 |      |      |
| Q <sub>LB</sub> | Quality factor              | Measured at 900 MHz   |       | 65    |      |      |
| Q <sub>HB</sub> | Quality factor              | Measured at 1800 MHz  |       | 45    |      |      |
| IP3             | Third arder intercent point | $V_{bias} = 2 V^{(1)}$ and $^{(3)}$                                 |       | 60    |      | dBm  |
| IPS             | Third order intercept point | V <sub>bias</sub> = 20 V <sup>(1)</sup> and <sup>(3)</sup>          |       | 70    |      | dBm  |
| 110             | Second harmonic             | $V_{bias} = 2 V^{(2)}$ and $^{(3)}$                                 |       | -65   |      | dBm  |
| H2              |                             | V <sub>bias</sub> = 20 V <sup>(2)</sup> and <sup>(3)</sup>          |       | -65   |      | dBm  |
| НЗ              | Third because a             | $V_{bias} = 2 V^{(2)}$ and $^{(3)}$                                 |       | -45   |      | dBm  |
| ПЗ              | Third harmonic              | V <sub>bias</sub> = 20 V <sup>(2)</sup> and <sup>(3)</sup>          |       | -45   |      | dBm  |
| t_              | Transition time             | From C <sub>min</sub> to C <sub>max</sub> <sup>(4)</sup>            |       | 135   |      | μs   |
| t <sub>T</sub>  | Transition time             | From C <sub>max</sub> to C <sub>min</sub> <sup>(4)</sup>            |       | 100   |      | μs   |

<sup>1.</sup>  $F_1 = 894 \text{ MHz}, F_2 = 849 \text{ MHz}, P_1 = 20 \text{ dBm}, P_2 = -15 \text{ dBm}, 2f_1 - f_2 = 939 \text{ MHz}$ 

<sup>2. 894</sup> MHz,  $P_{in} = 34 \text{ dBm}$ 

<sup>3.</sup> IP3 and harmonics are measured in the shunt/series configuration in a 50  $\Omega$  environment

<sup>4.</sup> One or both of  $\mathrm{RF}_{\mathrm{in}}$  and  $\mathrm{RF}_{\mathrm{out}}$  must be connected to DC ground

STPTIC Package information

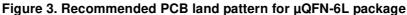
## 3 Package information

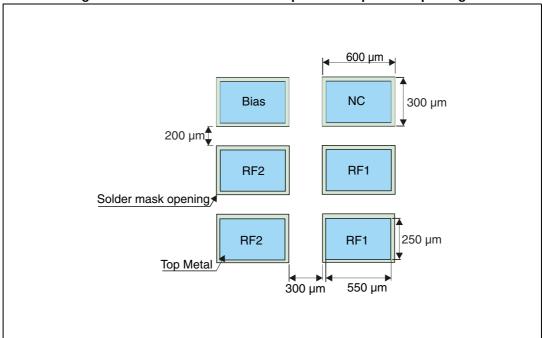
- Epoxy meets UL94, V0
- Lead-free package

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

1.2 mm ± 0.05 mm 0.7 mm .6 mm ± 0.05 mm (A2) A1 0.5 mm B2 (B1) (C2) C1 0.25 mm ± 0.03 mm 0.425 mm 0.35 mm 0.9 mm ± 0.03 mm ± 0.1 mm

Figure 2. µQFN-6L package dimension





Package information STPTIC

Figure 4. Flip Chip dimensions (size for 1p5)

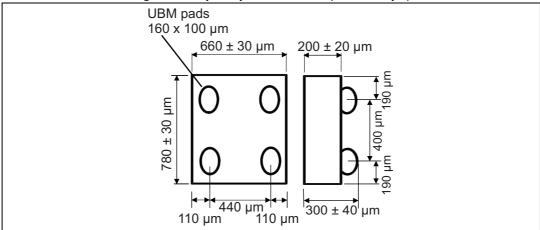


Figure 5. Flip Chip dimensions (size for 2p7, 3p3, 3p9, and 4p7)

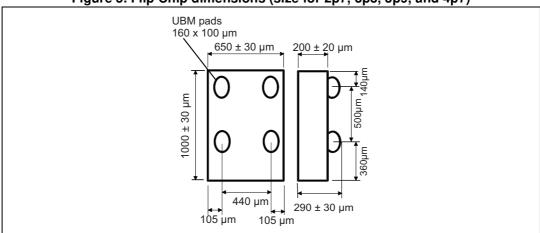
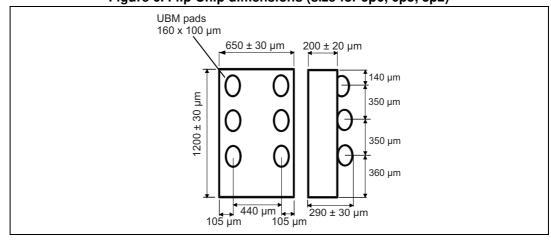


Figure 6. Flip Chip dimensions (size for 5p6, 6p8, 8p2)



STPTIC Package information

Figure 7. Recommended PCB land pattern for Flip Chip package (metal defined pads, solder mask 25 µm larger)

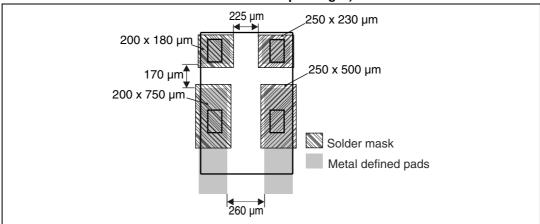
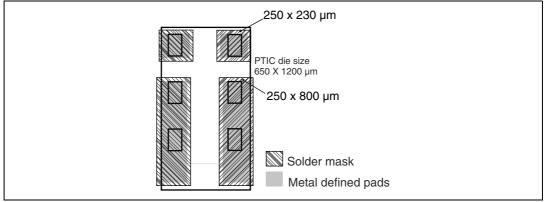


Figure 8. Recommended PCB land pattern for Flip Chip PTIC (die size 650 x 1200)



Package information STPTIC

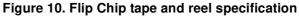
Dot identifying bump A1 location

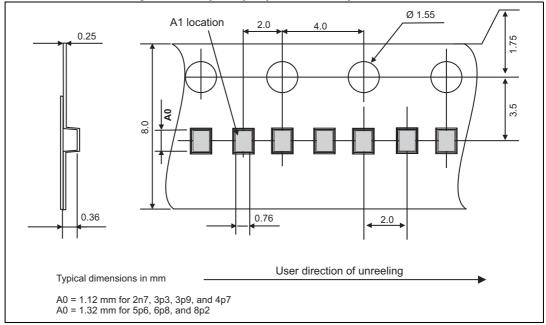
0.25

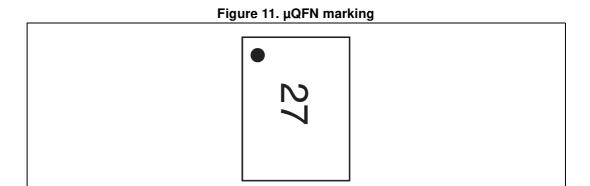
1.05

User direction of unreeling

Figure 9. µQFN-6L tape and reel specification

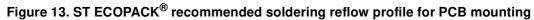


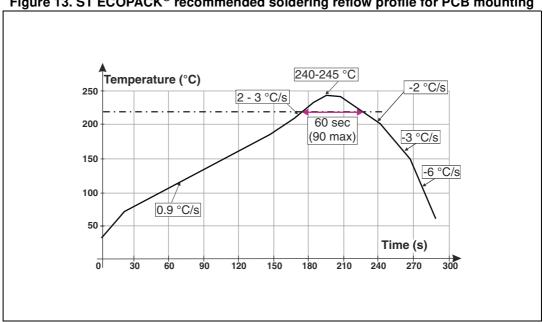




**Reflow profile STPTIC** 

#### **Reflow profile** 4





Note: Minimize air convection currents in the reflow oven to avoid component movement.

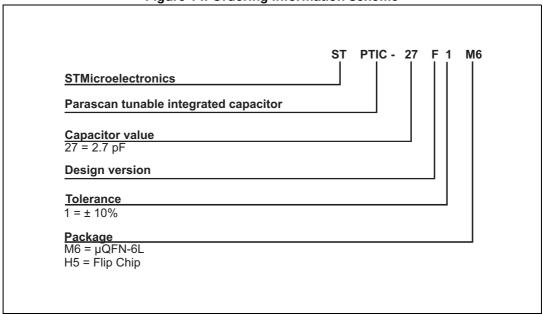
Table 5. Recommended values for soldering reflow

| Profile   | Value         |         |  |
|---|---------------|---------|--|
| Fiolile   | Typical       | Max.    |  |
| Temperature gradient in preheat (T = 70-180 °C) | 0.9 °C/s      | 3 °C/s  |  |
| Temperature gradient (T = 200-225 °C)           | 2 °C/s        | 3 °C/s  |  |
| Peak temperature in reflow                      | 240-245 °C    | 260 °C  |  |
| Time above 220 °C                               | 60 s          | 90 s    |  |
| Temperature gradient in cooling                 | -2 to -3 °C/s | -6 °C/s |  |
| Time from 50 to 220 °C                          | 160 to 220 s  |         |  |

STPTIC Ordering information

# 5 Ordering information

Figure 14. Ordering information scheme



**Table 6. Ordering information** 

| Part Number   | Marking | Weight | Base Qty | Delivery Mode |  |
|---------------|---------|--------|----------|---------------|--|
| STPTIC-12F1M6 | 12      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-27F1M6 | 27      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-33F1M6 | 33      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-39F1M6 | 39      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-47F1M6 | 47      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-56F1M6 | 56      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-68F1M6 | 68      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-82F1M6 | 82      | 4.8 mg | 3000     | Tape and reel |  |
| STPTIC-12G1H5 | TBD     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-27G1H5 | l1x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-33G1H5 | l3x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-39G1H5 | I2x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-47G1H5 | I5x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-56G1H5 | I4x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-68G1H5 | I7x     | 0.7 mg | 15000    | Tape and reel |  |
| STPTIC-82G1H5 | l6x     | 0.7 mg | 15000    | Tape and reel |  |

Revision history STPTIC

# 6 Revision history

**Table 7. Document revision history** 

| Date        | Revision | Changes  |
|-------------|----------|--|
| 02-Nov-2012 | 1        | Initial release.   |
| 03-Jul-2013 | 2        | Removed 6-pad 650 x 1000 Flip-Chip package.                          |
| 10-Jan-2014 | 3        | updated: Features, Table 2, Table 4, Table 6 and added new Figure 4. |
| 13-Feb-2014 | 4        | Updated Applications.  |

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