NCS5000

Integrated RF Schottky Detector

The NCS5000 is an integrated Schottky detector intended for use as a level detector in RF measurement/power control applications such as those found in GSM handsets. The detector converts the peak RF voltage applied to a DC level. The circuit consists of an RF Schottky detector, a reference Schottky diode, as well as biasing and control circuitry. There is an enable input that allows the part to be placed in a low power state when not in use.

The detector is designed for operation up to 2.0 GHz and can operate with input power levels up to +25 dBm. There is a fixed offset of 10 mV (nominal) between the Reference Detector and the RF Detector under no applied RF. The two detectors are monolithically integrated so that they closely track overtemperature, voltage and process.

The NCS5000 is housed in a very small TSOP–6 package ideal for portable applications. The TSOP–6 package is a lower profile, footprint compatible package to the SOT23–6.

Features
• Wide Operating Frequency Range to 2.0 GHz
• 2.7 V – 5.5 V Operating Voltage
• Very Low Operating Current of 300 μA
• Enable Control to Place the Part in a Low Current Standby Mode
• Typical Standby Current of < 1.0 μA
• −40°C to 85°C Operating Temperature Range
• Very Small TSOP–6 Package
• Pb–Free Package is Available

Typical Applications
• Cellular Handsets (GSM and DCS1800/PCS1900)
• Wireless Data Modems
• Transmitter Power Measurement and Control
• Test Equipment

![PIN CONNECTIONS AND MARKING DIAGRAM](Figure 1.)

This circuit has 28 active transistors

![http://onsemi.com](http://onsemi.com)

ON Semiconductor®

http://onsemi.com

TSOP–6
SN SUFFIX
CASE 318G

PIN CONNECTIONS AND MARKING DIAGRAM

<table>
<thead>
<tr>
<th>Pin</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>O</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
</tr>
<tr>
<td>4</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>E</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
</tr>
</tbody>
</table>

(Top View)

BAC = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
* = Pb–Free Package

(Note: Microdot may be in either location)

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Device</th>
<th>Package</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCS5000SNT1</td>
<td>TSOP–6</td>
<td>3000/Tape &amp; Reel</td>
</tr>
<tr>
<td>NCS5000SNT1G</td>
<td>TSOP–6 (Pb–Free)</td>
<td>3000/Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
PIN DESCRIPTION

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DET_OUT</td>
<td>This is the RF Detector Output. This signal is proportional to the peak RF voltage applied at the RF_In pin.</td>
</tr>
<tr>
<td>2</td>
<td>VCC</td>
<td>Input power supply.</td>
</tr>
<tr>
<td>3</td>
<td>Enable</td>
<td>Control signal to turn on and off the device. If this signal is not used, this pin should be connected directly to VCC. A logic high on this input turns on the device.</td>
</tr>
<tr>
<td>4</td>
<td>RF_In</td>
<td>This is the input to the RF detector. The signal must be AC-coupled into this input with a good quality RF capacitor.</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground.</td>
</tr>
<tr>
<td>6</td>
<td>REF</td>
<td>This is the reference detector output. Nominal this signal is 10 mV higher than DET_OUT when no RF signal is applied at RF_In.</td>
</tr>
</tbody>
</table>

MAXIMUM RATINGS (TA = 25°C, unless otherwise noted.)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Input Power on RF Pin</td>
<td>PMAX</td>
<td>28</td>
<td>dBm</td>
</tr>
<tr>
<td>Maximum Power Supply</td>
<td>VCCMAX</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>ESD Rating for RF_In (HBM) All Other Pins are 2.5 kV (HBM)</td>
<td>–</td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>Tslg</td>
<td>−40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Junction Temperature</td>
<td>TJ</td>
<td>+150</td>
<td>°C</td>
</tr>
<tr>
<td>Maximum Input Voltage on Pins</td>
<td>VIMAX</td>
<td>VCC + 0.3 V</td>
<td>–</td>
</tr>
<tr>
<td>Minimum Input Voltage on Pins</td>
<td>VIMIN</td>
<td>−0.3 V</td>
<td>–</td>
</tr>
</tbody>
</table>

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Input (50 Ω Equivalent)</td>
<td>RFin</td>
<td>–</td>
<td>–</td>
<td>25</td>
<td>dBm</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>VCC</td>
<td>2.7</td>
<td>–</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>TA</td>
<td>−40</td>
<td>–</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>
## ELECTRICAL CHARACTERISTICS (V\text{CC} = 2.8 V, for typical values; Min and Max values at TA = 25°C)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Pin</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RF Operating Frequency</strong></td>
<td>−4</td>
<td>100</td>
<td>−</td>
<td>2000</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td><strong>Operating Current Consumption</strong> (V\text{enable} = 2.4 V, No RF Applied)</td>
<td>I\text{CC(op)}</td>
<td>2</td>
<td>−</td>
<td>−</td>
<td>500</td>
<td>μA</td>
</tr>
<tr>
<td><strong>Standby Current Consumption</strong> (V\text{enable} = 0.4 V, No RF Applied)</td>
<td>I\text{CC(stby)}</td>
<td>2</td>
<td>−</td>
<td>1</td>
<td>10</td>
<td>μA</td>
</tr>
<tr>
<td><strong>Power Supply Ripple Rejection</strong> (V\text{CC} = 3.6 V, V\text{ripple} = 0.5 V\text{pp}, No RF)</td>
<td>R\text{R}</td>
<td>2</td>
<td>−</td>
<td>56</td>
<td>−</td>
<td>dB</td>
</tr>
<tr>
<td><strong>Detector Output (No RF Applied)</strong></td>
<td>DET_OUT</td>
<td>1</td>
<td>40</td>
<td>45</td>
<td>50</td>
<td>mV</td>
</tr>
<tr>
<td><strong>Reference Output (No RF Applied)</strong></td>
<td>REF</td>
<td>6</td>
<td>50</td>
<td>55</td>
<td>60</td>
<td>mV</td>
</tr>
<tr>
<td><strong>Reference – Detector Output Differential Voltage</strong> (No RF Applied)</td>
<td>REF_DET_OUT</td>
<td>1,6</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>mV</td>
</tr>
<tr>
<td><strong>Detector Output</strong></td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>100</td>
<td>−</td>
<td>mV</td>
</tr>
<tr>
<td>F\text{in} = 1.0 GHz, RF\text{in} = −5.0 dBm (50 Ω)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>335</td>
<td>−</td>
<td>mV</td>
</tr>
<tr>
<td>F\text{in} = 1.0 GHz, RF\text{in} = 5.0 dBm (50 Ω)</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>1285</td>
<td>−</td>
<td>mV</td>
</tr>
<tr>
<td><strong>Enable Logic High</strong></td>
<td>V\text{ih}</td>
<td>3</td>
<td>2.4</td>
<td>−</td>
<td>−</td>
<td>V</td>
</tr>
<tr>
<td><strong>Enable Logic Low</strong></td>
<td>V\text{il}</td>
<td>3</td>
<td>0</td>
<td>−</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td><strong>Enable Input Current, V\text{CC} = 2.7 V, V\text{enable} = 2.4 V</strong></td>
<td>I\text{in}</td>
<td>3</td>
<td>0</td>
<td>−</td>
<td>30</td>
<td>μA</td>
</tr>
</tbody>
</table>

![Figure 2. Typical Application Block Diagram](http://onsemi.com)

Note: The RF signal must be AC-coupled into the RF\_In pin.
Figure 3. Detector Output Voltage vs. RF Input Power

Figure 4. Detector and Reference Output Variation Overtemperature ($V_{CC} = 2.7 \text{ V}, \text{No RF Applied}$)

Figure 5. Offset Between RF Detector and Reference Detector Output Voltage Overtemperature ($V_{CC} = 2.7 \text{ V}, \text{No RF Applied}$)

Figure 6. Detector and Reference Output Variation Over $V_{CC}$ Bias ($T_A = 25^\circ \text{C}$, No RF Applied)

Figure 7. Current Consumption vs. Input Power

Figure 8. $I_{CC}$ Variation Overtemperature $V_{CC} = 5.5 \text{ V}, \text{No RF Applied}$
The NCS5000 is an integrated RF Schottky detector designed for use in level detector and power amplifier control circuits. The device is optimized for large signal applications ($P_{in} > -20$ dBm) such as those found in GSM handsets and data modems. This device has been designed for applications that require operation from a single Li–Ion or multi– Ni–MH battery pack. The operating range is 2.7 V – 5.5 V so the device can be powered directly from the battery or a low drop out regulator. To support power sequencing, an Enable circuitry is included which allows the device to be placed into a very low power state ($< 3.0 \mu W$) when not in use.

In addition to the RF detector, a reference detector is included so the NCS5000 can be used to implement a differential detector. Since the RF and reference detectors are integrated on the same silicon, they track each other tightly over temperature, bias voltage, and process. Each detector is biased with approximately 45 $\mu A$ of current and there is a built–in offset of 10 mV (nom) between the RF and the Reference Detector.
PACKAGE DIMENSIONS

TSOP−6
SN SUFFIX
CASE 318G−02
ISSUE M

NOTES:
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

<table>
<thead>
<tr>
<th>DIM</th>
<th>MILLIMETERS</th>
<th>INCHES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.90</td>
<td>0.1142</td>
</tr>
<tr>
<td></td>
<td>3.10</td>
<td>0.1220</td>
</tr>
<tr>
<td>B</td>
<td>0.90</td>
<td>0.0354</td>
</tr>
<tr>
<td></td>
<td>1.10</td>
<td>0.0433</td>
</tr>
<tr>
<td>C</td>
<td>0.25</td>
<td>0.0098</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>0.0197</td>
</tr>
<tr>
<td>D</td>
<td>0.85</td>
<td>0.0335</td>
</tr>
<tr>
<td></td>
<td>1.05</td>
<td>0.0413</td>
</tr>
<tr>
<td>G</td>
<td>0.013</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>0.10</td>
<td>0.0040</td>
</tr>
<tr>
<td>H</td>
<td>0.0005</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>0.0040</td>
<td>0.0016</td>
</tr>
<tr>
<td>J</td>
<td>0.20</td>
<td>0.0079</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>0.0102</td>
</tr>
<tr>
<td>L</td>
<td>0.125</td>
<td>0.0493</td>
</tr>
<tr>
<td></td>
<td>0.155</td>
<td>0.0610</td>
</tr>
<tr>
<td>M</td>
<td>0.05 (0.002)</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>2.50</td>
<td>0.0985</td>
</tr>
<tr>
<td></td>
<td>3.00</td>
<td>0.1181</td>
</tr>
</tbody>
</table>

SOLDERING FOOTPRINT

NOTES:
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