

# 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 over temperature, voltage and process.

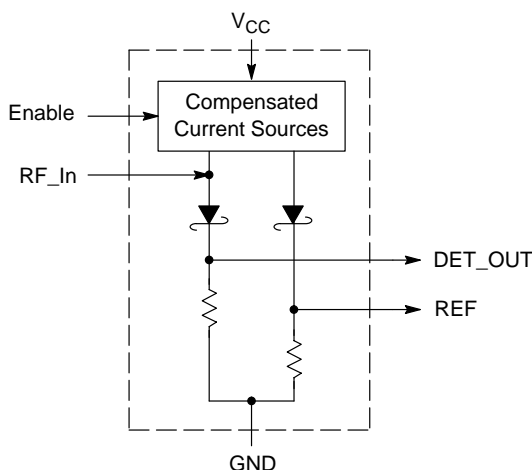
The NCS5000 is housed in a very small TSOP-6 package ideal for portable applications. The TSOP-6 package is a lower profile, footprint compatible package to the SOT23-6.

### Features

- Wide Operating Frequency Range to 2.0 GHz
- 2.7–5.5 V Operating Voltage
- Very Low Operating Current of 300  $\mu$ A
- Enable Control to Place the Part in a Low Current Standby Mode
- Typical Standby Current of < 1.0  $\mu$ A
- –40 to 85°C Operating Temperature Range
- Very Small TSOP-6 Package

### Typical Applications

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



This circuit has 28 active transistors

Figure 1.



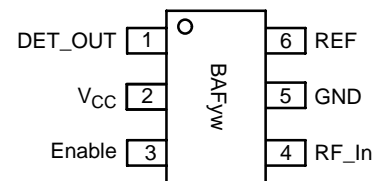
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TSOP-6  
SN SUFFIX  
CASE 318G

### PIN CONNECTIONS AND MARKING DIAGRAM



(Top View)

BAF = Specific Device Code  
yw = Date Code

### ORDERING INFORMATION

Device	Package	Shipping
NCS5000SNT1	TSOP-6	3000/Tape & Reel

# NCS5000

## PIN DESCRIPTION

Pin	Name	Description
1	DET_OUT	This is the RF Detector Output. This signal is proportional to the peak RF voltage applied at the RF_In pin.
2	V <sub>CC</sub>	Input power supply.
3	Enable	Control signal to turn on and off the device. If this signal is not used, this pin should be connected directly to V <sub>CC</sub> . A logic high on this input turns on the device.
4	RF_In	This is the input to the RF detector. The signal must be AC-coupled into this input with a good quality RF capacitor.
5	GND	Ground.
6	REF	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.

## MAXIMUM RATINGS (T<sub>A</sub> = 25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Maximum Input Power on RF Pin	P <sub>MAX</sub>	28	dBm
Maximum Power Supply	V <sub>CCMAX</sub>	6.0	V
ESD Rating for RF_In (HBM) All Other Pins are 2.5 kV (HBM)	–	500	V
Storage Temperature Range	T <sub>stg</sub>	–40 to +125	°C
Maximum Junction Temperature	T <sub>J</sub>	+150	°C
Maximum Input Voltage on Pins	V <sub>IMAX</sub>	V <sub>CC</sub> + 0.3 V	–
Minimum Input Voltage on Pins	V <sub>IMIN</sub>	–0.3 V	–

## RECOMMENDED OPERATING CONDITIONS

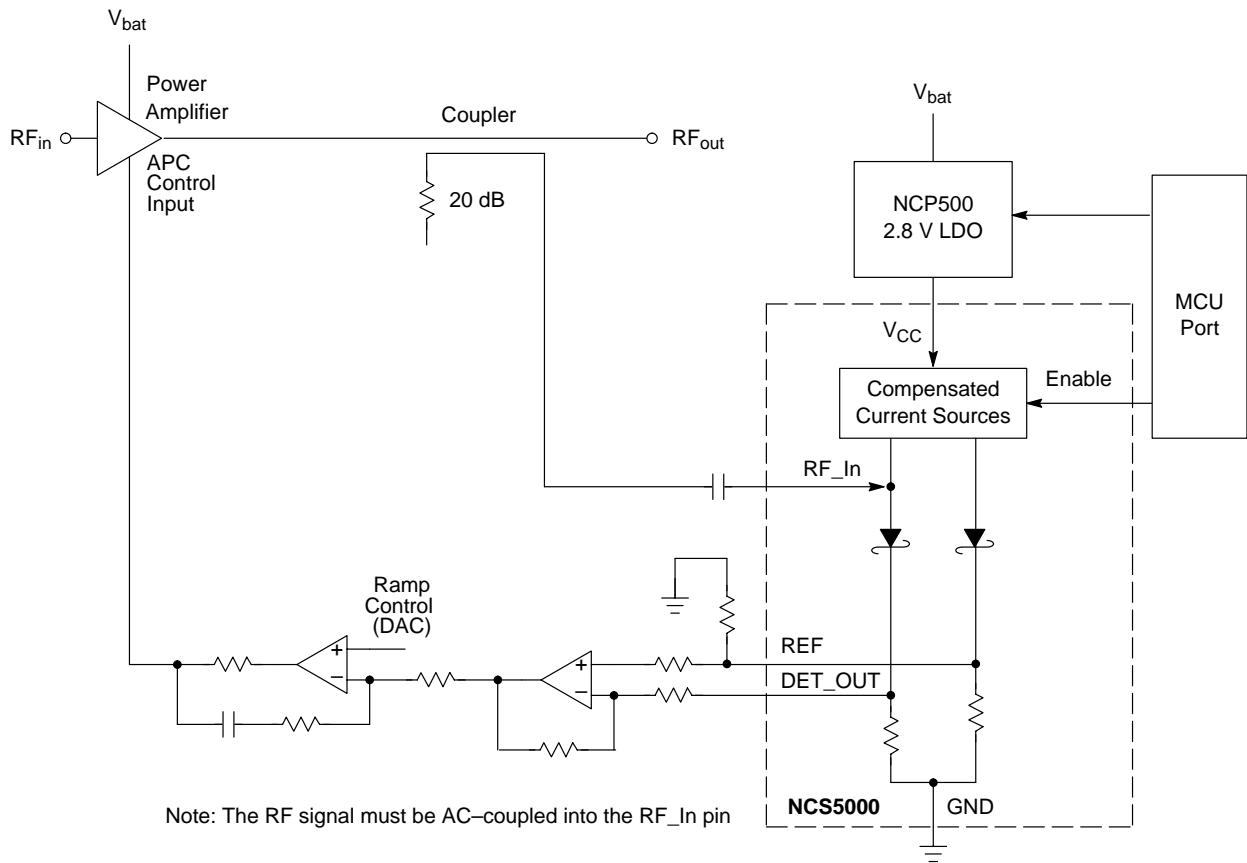
Characteristic	Symbol	Min	Typ	Max	Unit
RF Input (50 Ω Equivalent)	RF <sub>in</sub>	–	–	25	dBm
Supply Voltage	V <sub>CC</sub>	2.7	–	5.5	V
Operating Temperature Range	T <sub>A</sub>	–40	–	85	°C

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = 2.8 V, for typical values; T<sub>A</sub> = 25°C, for min and max values; T<sub>A</sub> = –40 to 85°C unless otherwise noted.)

Characteristic	Symbol	Pin	Min	Typ	Max	Unit
RF Operating Frequency	–	4	100	–	2000	MHz
Operating Current Consumption (V <sub>enable</sub> = 2.4 V, No RF Applied)	I <sub>cc(op)</sub>	2	–	–	500	μA
Standby Current Consumption (V <sub>enable</sub> = 0.4 V, No RF Applied)	I <sub>cc(stby)</sub>	2	–	1	10	μA
Power Supply Ripple Rejection (V <sub>CC</sub> = 3.6 V, V <sub>ripple</sub> = 0.5 V <sub>PP</sub> , No RF)	RR	2	–	56 41	–	dB
			1 kHz	–	–	
			10 kHz	–	–	
Detector Output (No RF Applied)	DET_OUT	1	40	45	50	mV
Reference Output (No RF Applied)	REF	6	50	55	60	mV
Reference – Detector Output Differential Voltage (No RF Applied)	REF– DET_OUT	1,6	5	10	15	mV
Detector Output F <sub>in</sub> = 1.0 GHz, RF <sub>in</sub> = –5.0 dBm (50 Ω) F <sub>in</sub> = 1.0 GHz, RF <sub>in</sub> = 5.0 dBm (50 Ω) F <sub>in</sub> = 1.0 GHz, RF <sub>in</sub> = 15 dBm (50 Ω)	–	–	–	100 335 1285	–	mV
Enable Logic High	V <sub>ih</sub>	3	2.4	–	–	V
Enable Logic Low	V <sub>il</sub>	3	0	–	0.4	V
Enable Input Current, V <sub>CC</sub> = 2.7 V, V <sub>enable</sub> = 2.4 V	I <sub>in</sub>	3	0	–	30	μA

# NCS5000



**Figure 2. Typical Application Block Diagram**

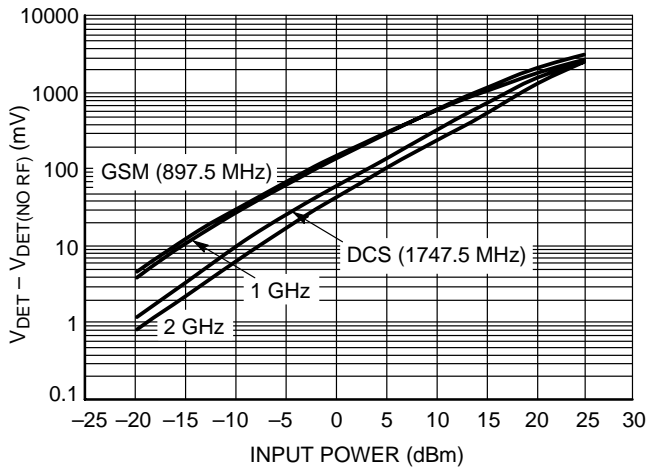
## APPLICATION INFORMATION

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 2.7–5.5 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

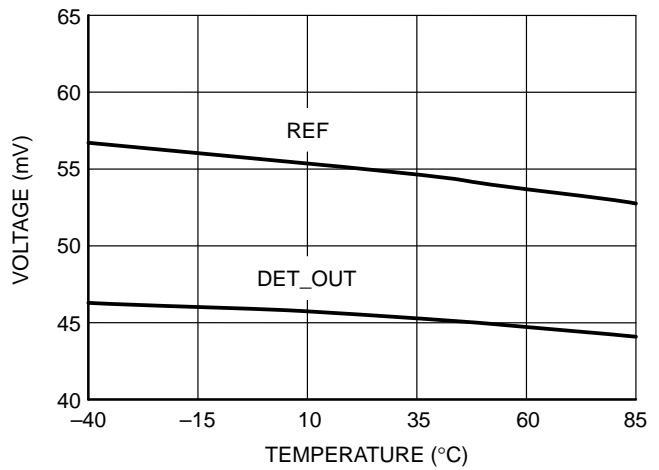
device to be placed into a very low power state ( $< 3.0 \mu\text{W}$ ) when not in use.

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  $45 \mu\text{A}$  of current and there is a built-in offset of 10 mV (nom) between the RF and the Reference Detector.

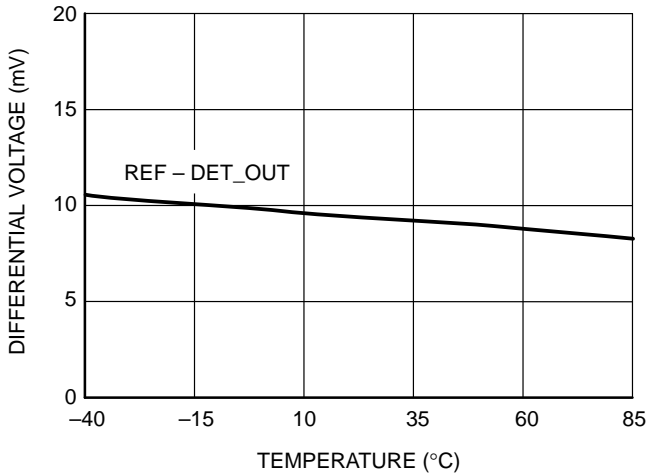
# NCS5000



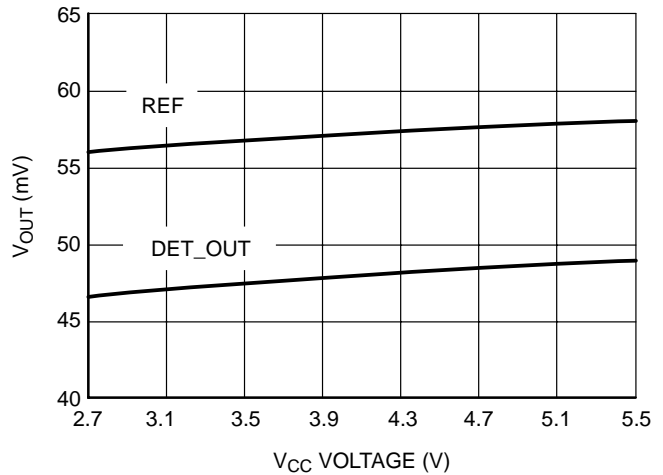
**Figure 3. Detector Output Voltage vs. RF Input Power ( $V_{CC} = 2.7\text{ V}$ )**



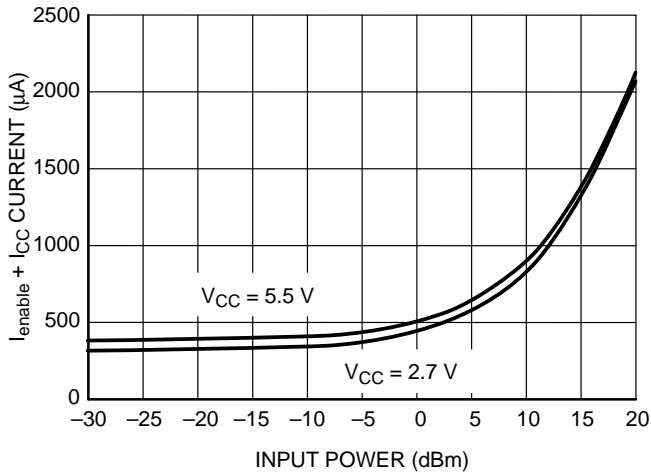
**Figure 4. Detector and Reference Output Variation Over Temperature ( $V_{CC} = 2.7\text{ V}$ , No RF Applied)**



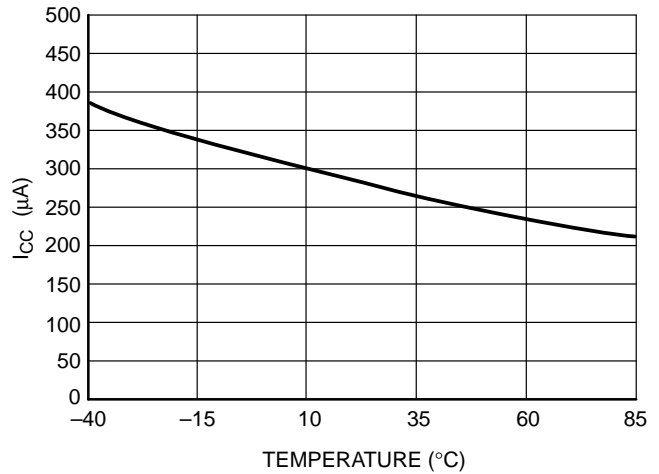
**Figure 5. Offset Between RF Detector and Reference Detector Output Voltage Over Temperature ( $V_{CC} = 2.7\text{ V}$ , No RF Applied)**



**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  $T_A = 25^\circ\text{C}$ ,  $F_{in} = 100\text{ MHz}$**



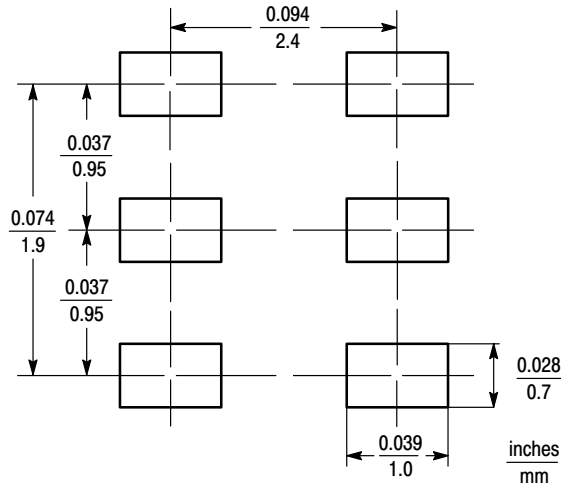
**Figure 8.  $I_{CC}$  Variation Over Temperature  $V_{CC} = 5.5\text{ V}$ , No RF Applied**

**INFORMATION FOR USING THE TSOP-6 SURFACE MOUNT PACKAGE**

**MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS**

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection

interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



**TSOP-6**

**TSOP-6 POWER DISSIPATION**

The power dissipation of the TSOP-6 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by  $T_{J(max)}$ , the maximum rated junction temperature of the die,  $R_{\theta JA}$ , the thermal resistance from the device junction to ambient, and the operating temperature,  $T_A$ . Using the values provided on the data sheet for the TSOP-6 package,  $P_D$  can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature  $T_A$  of 25°C, one can calculate the power dissipation of the device which in this case is 400 milliwatts.

$$P_D = \frac{150^\circ\text{C} - 25^\circ\text{C}}{300^\circ\text{C/W}} = 417 \text{ milliwatts}$$

The 300°C/W for the TSOP-6 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 417 milliwatts.

**SOLDERING PRECAUTIONS**

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.\*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference should be a maximum of 10°C.

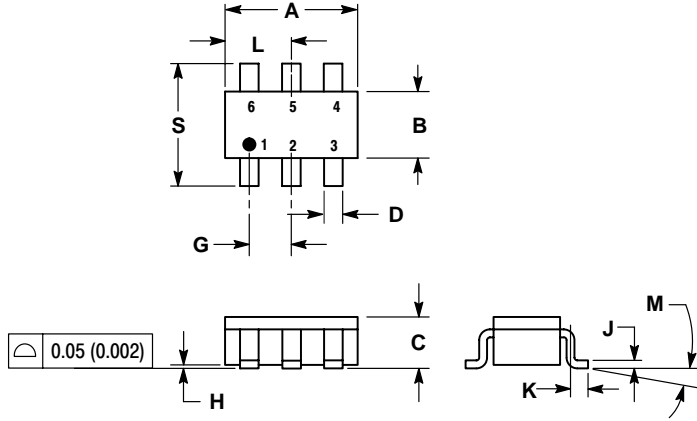
- The soldering temperature and time should not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient should be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

\*Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

# NCS5000

## PACKAGE DIMENSIONS

TSOP-6  
SN SUFFIX  
CASE 318G-02  
ISSUE H



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

**Notes**

# NCS5000

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