SKY77171 AutoSmart™ Power Amplifier Module for WCDMA (1920-1980 MHz)

Applications

- WCDMA handsets

Features

- Low voltage positive bias supply
  - 3.2 V to 4.2 V
- Low V_{REF}
  - 2.85 V, nominal
- Low IREF
  - Less than 1 mA
- Supports low collector voltage operation
- Good linearity
- High efficiency
- Large dynamic range
- 10-pad package
  - 4 x 4 x 1.15 mm
- Power down control
- InGaP

NEW Skyworks offers lead (Pb)-free "environmentally friendly" packaging that is RoHS compliant (European Parliament for the Restriction of Hazardous Substances).

Description

The SKY77171 AutoSmart™ Power Amplifier Module (PAM) is a fully matched 10-pad surface mount module developed for Wideband Code Division Multiple Access (WCDMA) handsets. This small and efficient module packs full 1920–1980 MHz bandwidth coverage into a single compact package. The SKY77171 meets the stringent spectral linearity requirements of WCDMA transmission with high power added efficiency for power output of up to 28 dBm.

AutoSmart™ power amplifier technology internally adjusts the RF transistor bias level throughout the dynamic operating range to minimize battery current consumption and ensure sufficient linear performance to meet WCDMA system requirements. The result is a significant savings in average battery current without the complications of a system-supplied mode function signal or analog bias control. AutoSmart™ response time is more than adequate for RF access probe and discontinuous transmission operation.

The single Gallium Arsenide (GaAs) Microwave Monolithic Integrated Circuit (MMIC) contains all active circuitry in the module. The MMIC contains on-board bias circuitry, as well as input and interstage matching circuits. Output match into a 50-ohm load is realized off-chip within the module package to optimize efficiency and power performance.

The SKY77171 AutoSmart™ PAM is manufactured with Skyworks' GaAs Heterojunction Bipolar Transistor (HBT) process that provides for all positive voltage DC supply operation while maintaining high efficiency and good linearity. Primary bias to the SKY77171 is supplied directly from a three-cell nickel cadmium, a single-cell lithium ion, or other suitable battery with an output in the 3.2 to 4.2 volt range. Power down is accomplished by setting the voltage on the low current reference pin to zero volts. No external supply side switch is needed as typical "off" leakage is a few microamperes with full primary voltage supplied from the battery.
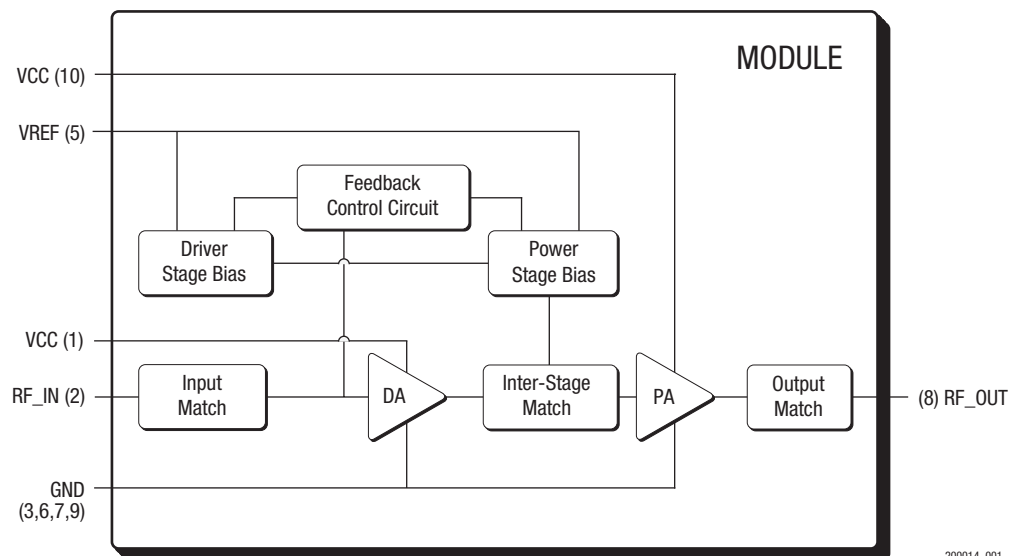
Figure 1. Functional Block Diagram

Electrical Target Specifications

The following tables list the electrical characteristics of the SKY77171 Power Amplifier. Table 1 lists the absolute maximum ratings, while Table 2 shows the recommended operating conditions to achieve the performance characteristics listed in Table 4. Table 3 presents a truth table for the power settings.

Table 1. Absolute Maximum Rating [1]

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Input Power		P_{IN}	—	0	7	dBm
Supply Voltage		V_{CC}	—	3.4	6.0	Volts
Reference Voltage		V_{REF}	—	2.85	2.95	Volts
Case Temperature [2]	Operating	T_C	−30	25	+110	°C
	Storage	T_{STG}	−55	—	+125	

[1] No damage assuming only one parameter is set at limit at a time with all other parameters set at nominal value.

[2] Case Operating Temperature (T_C) refers to the temperature of the GROUND PAD at the underside of the package.

Table 2. Recommended Operating Conditions

Parameter	Symbol	Minimum	Nominal	Maximum	Unit
Power Output	P_O	—	—	28.0	dBm
Operating Frequency	F_O	1920.0	1950.0	1980.0	MHz
Supply Voltage	V_{CC}	3.2	3.4	4.2	Volts
Reference Voltage	V_{REF}	2.75	2.85	2.95	Volts
Case Operating Temperature	T_C	−30	+25	+85	°C

Table 3. Power Range Truth Table

Power Setting	V_{REF}	Output Power
Power On	2.85 V	28 dBm
Shut Down	0.0 V	—

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Table 4. Electrical Specifications for WCDMA Nominal Operating Conditions [1]

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain conditions		G_{LOW}	$P_0 = 0$ dBm	—	23	—	dB
		G_{MID}	$P_0 = 16$ dBm	—	26	—	
		G_{HIGH}	$P_0 = 28$ dBm	—	28	—	
Power Added Efficiency		PAE_{LOW}	$P_0 = 0$ dBm	—	0.8	—	%
		PAE_{HIGH}	$P_0 = 28$ dBm	—	41.0	—	
Total Supply current		I_{CC_LOW}	$P_0 = 0$ dBm	—	35	—	mA
		I_{CC_HIGH}	$P_0 = 28$ dBm	—	450	—	
Quiescent current		I_Q	No RF In	—	25	—	mA
Reference Current		I_{REF}	—	—	1	—	mA
Total Supply current in Power-down Mode		I_{PD}	$V_{CC} = 3.4$ V $V_{REF} = 0$ V	—	3	—	µA
Adjacent Channel Power [2]	5 MHz offset	ACP5	$P_0 = 0$ dBm	—	−45	—	dBc
			$P_0 = 28$ dBm	—	−41	—	
	10 MHz offset	ACP10	$P_0 = 0$ dBm	—	−60	—	
			$P_0 = 28$ dBm	—	−52	—	
Harmonic Suppression	Second	fo2	—	—	34.5	—	dBc
	Third	fo3	—	—	50.0	—	
Noise Power in RX Band 2110-2170 MHz		RxBN	$P_0 \leq 28$ dBm	—	−141	—	dBm/Hz
Noise Figure		NF	—	—	4	—	dB
Input Voltage Standing Wave Ratio (VSWR)		VSWR	—	—	1.5:1	—	—
Stability (Spurious output)		S	5:1 VSWR All phases	—	—	−70	dBc
Ruggedness [3]		Ru	$P_0 \leq 28$ dBm	10:1	—	—	VSWR

[1] Unless specified otherwise: $V_{CC} = +3.4$ V, $V_{REF} = +2.85$ V, Temp = +25 °C, Freq. = 1950 MHz.

[2] ACP is expressed as a ratio of total adjacent power to WCDMA modulated in-band, both measured in 3.84 MHz bandwidth at specified offsets.

[3] All phases, time = 10 seconds.

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of t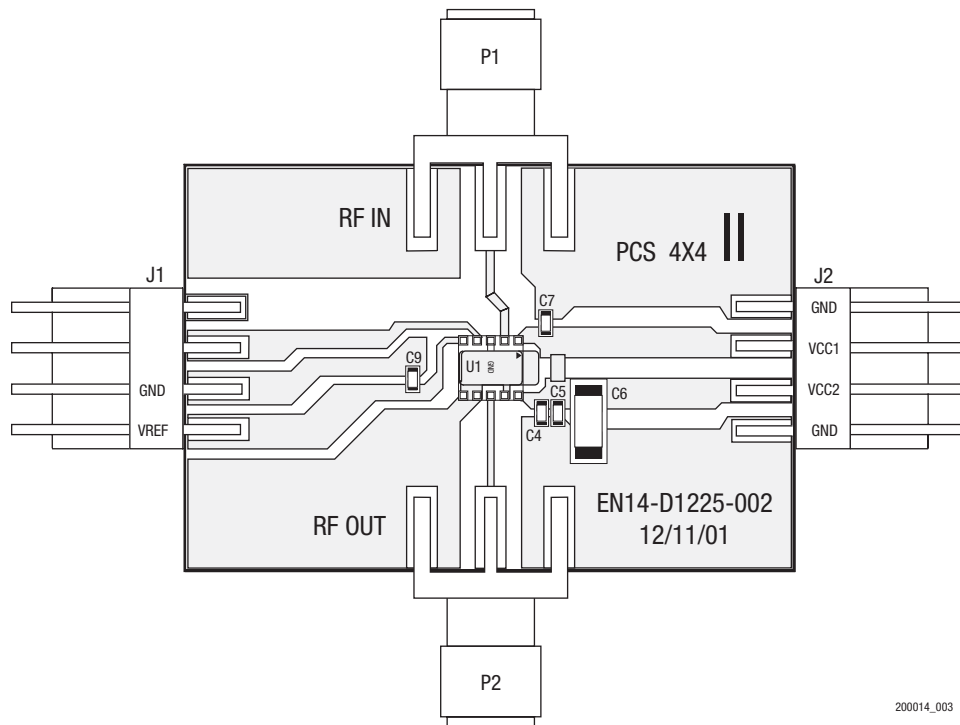he SKY77171, the evaluation board schematic and diagram are included for preliminary analysis and design. Figure 2 shows the basic schematic of the board for the 1920 MHz to 1980 MHz range and Figure 3 is the assembly diagram.
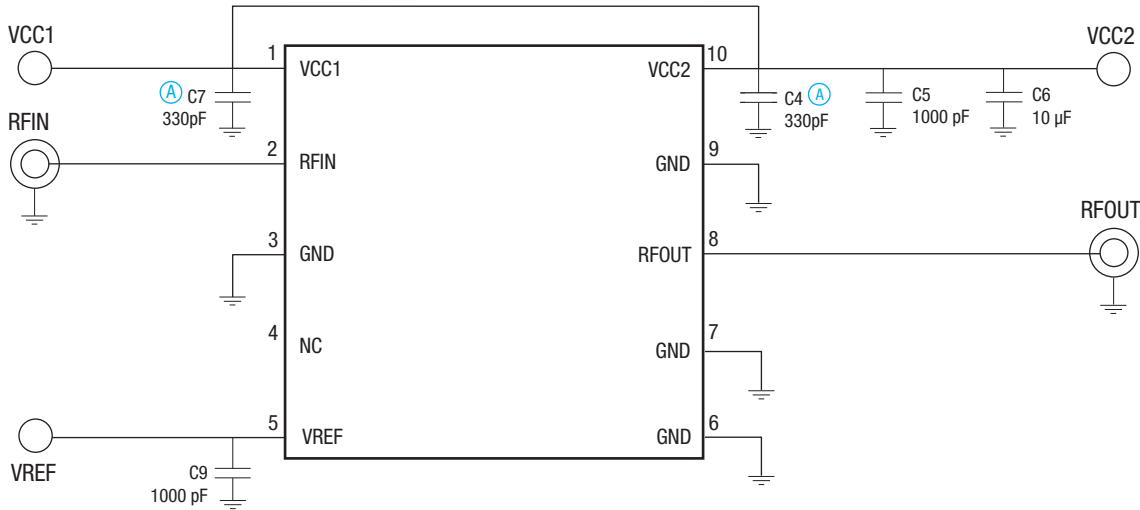
Ⓐ Place caps at closest proximity to PA module with the capacitor grounds directly connected to the PAM grounds.

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Figure 2. Evaluation Board Schematic

Figure 3. Evaluation Board Assembly Diagram

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Package Dimensions and Pad Descriptions

The SKY77171 is a multi-layer laminate base, overmold encapsulated modular package designed for surface mount solder attachment to a printed circuit board. Figure 4 is a mechanical drawing of the pad layout for this package. Figure 6 shows each pad function and the pad numbering convention, which starts with pad 1 in the upper left and increments counter-clockwise around the package. Figure 7 illustrates typical case markings.

TOP VIEW

SIDE VIEW

BOTTOM VIEW
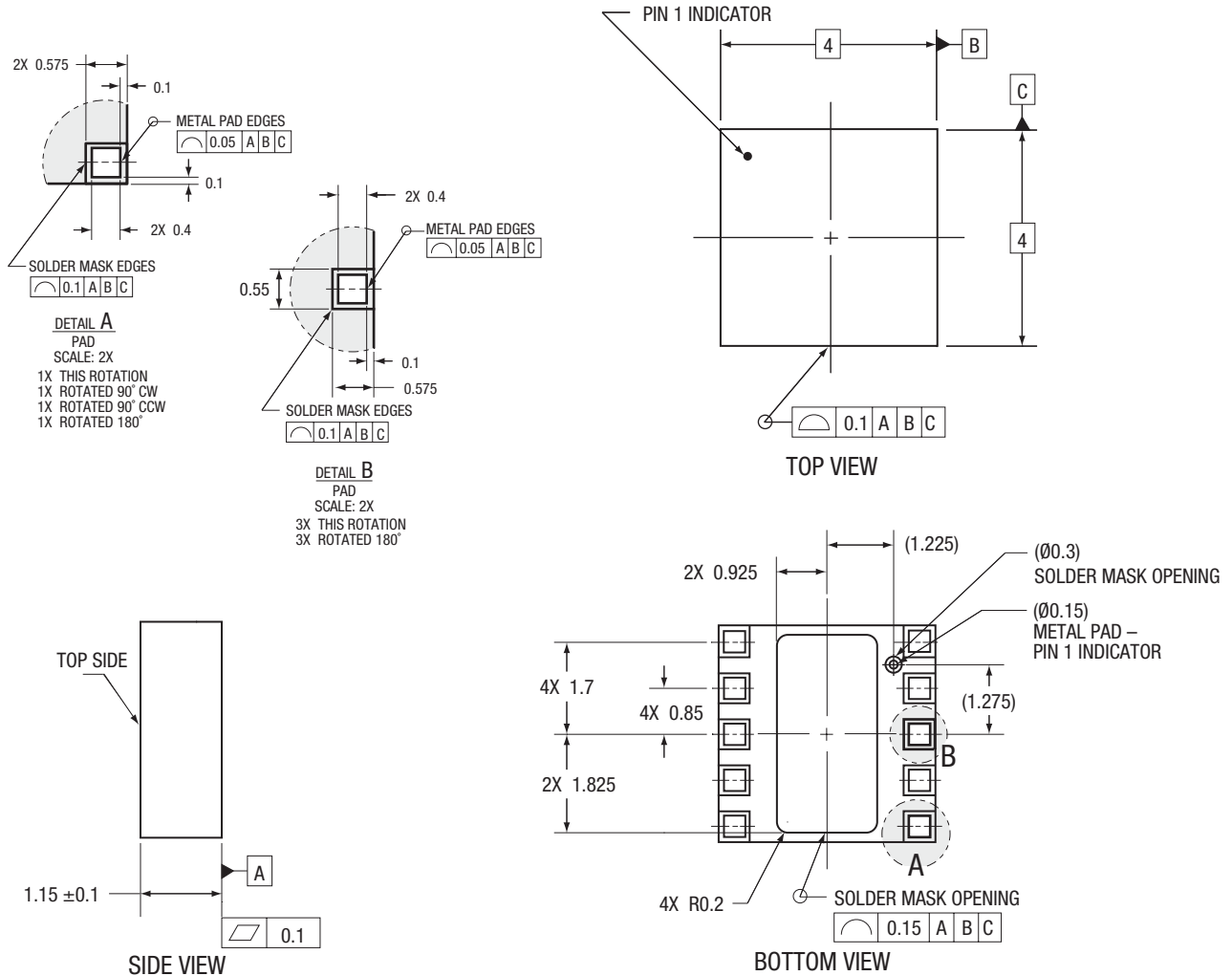
NOTES: Unless otherwise specified
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5M–1994.
3. SEE APPLICABLE BONDING DIAGRAM AND DEVICE ASSEMBLY DRAWING FOR DIE AND COMPONENT PLACEMENT.
4. PADS ARE METAL DEFINED; THE CENTER PAD IS SOLDER MASK DEFINED.

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Figure 4. SKY77171 Package Drawing
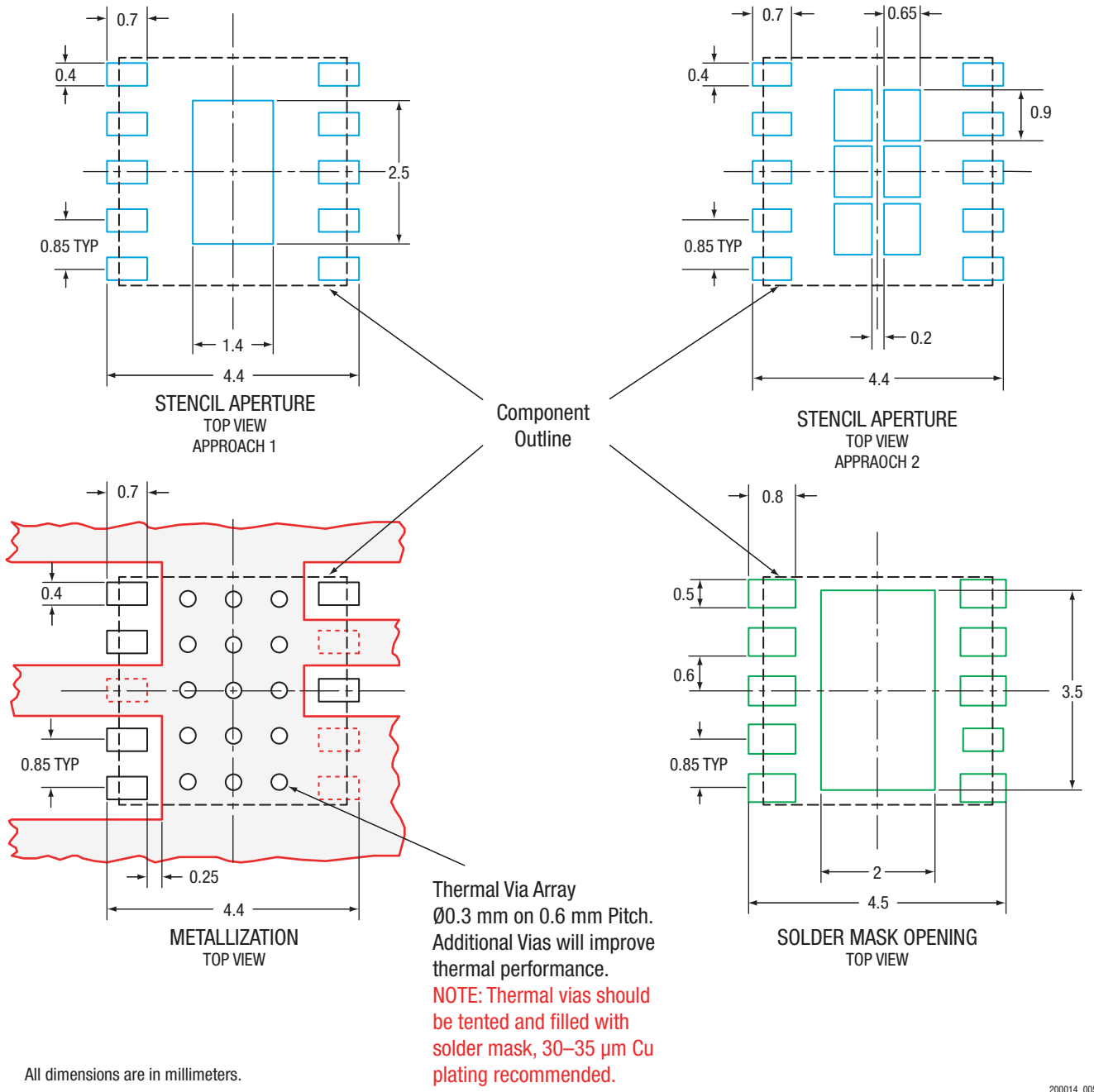
Figure 5. Phone PCB Layout for 4 x 4 mm, 10-Pad Package – SKY77171

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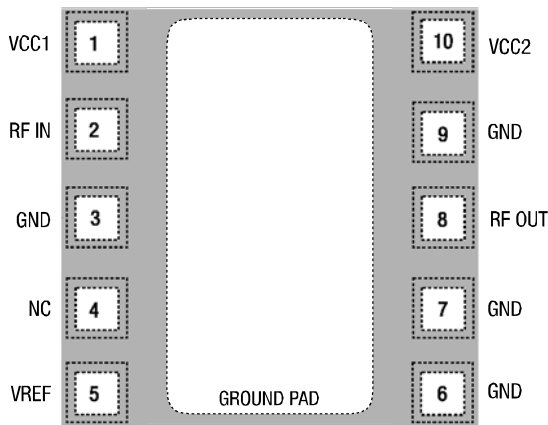
Pad layout as seen from top view looking through package. Package underside is GND.

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Figure 6. Pad Names and Configuration (Top View)
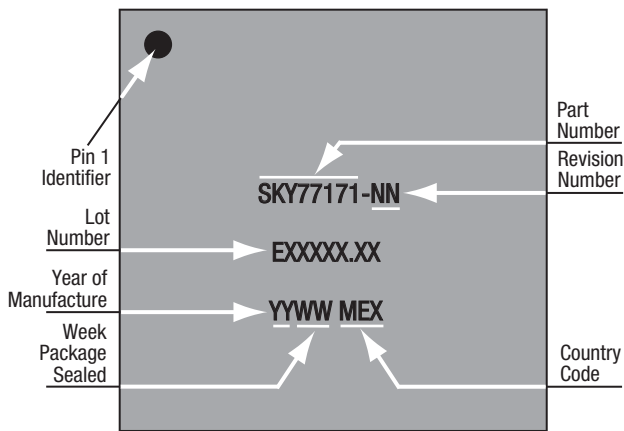
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Figure 7. Typical Case Markings

Package and Handling Information

Because of its sensitivity to moisture absorption, this device package is baked and vacuum-packed prior to shipment. Instructions on the shipping container label must be followed regarding exposure to moisture after the container seal is broken, otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY77171 is capable of withstanding an MSL3/250 °C solder reflow. Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment. If the part is attached in a reflow oven, the temperature ramp rate should not exceed 3 °C per second; maximum temperature should not exceed 250 °C. If the part is manually attached, precaution should be taken to insure that the part is not subjected to temperatures exceeding 250 °C for more than 10 seconds. For

details on attachment techniques, precautions, and handling procedures recommended by Skyworks, please refer to Skyworks Application Note: *PCB Design and SMT Assembly/Rework*, Document Number 101752. Additional information on standard SMT reflow profiles can also be found in the *JEDEC Standard J-STD-020B*.

Production quantities of this product are shipped in the standard tape-and-reel format. For packaging details, refer to Skyworks Application Note: *Tape and Reel Information – RF Modules*, Document Number 101568.

Electrostatic Discharge Sensitivity

The SKY77171 is a Class 2 device. Figure 8 lists the Electrostatic Discharge (ESD) immunity level for each non-ground pad of the SKY77171 product. The numbers in Figure 8 specify the ESD threshold level for each pad where the I-V curve between the pad and ground starts to show degradation.

The ESD testing was performed in compliance with MIL-STD-883E Method 3015.7 using the Human Body Model. If ESD damage threshold magnitude is found to consistently exceed 2000 volts on a given pad, this so is indicated. If ESD damage threshold below 2000 volts is measured for either polarity, numbers are indicated that represent worst case values observed in product characterization.

Various failure criteria can be utilized when performing ESD testing. Many vendors employ relaxed ESD failure standards, which fail devices only after "the pad fails the electrical specification limits" or "the pad becomes completely non-functional". Skyworks employs most stringent criteria and fails devices as soon as the pad begins to show any degradation on a curve tracer.

To avoid ESD damage, both latent and visible, it is very important that the product assembly and test areas follow the Class-1 ESD handling precautions listed in Table 5.
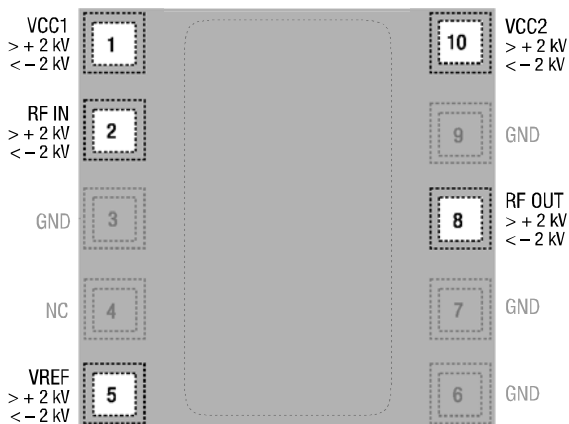
Pad layout as seen from top view looking through package.

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Figure 8. ESD Sensitivity of Non-ground Pads (Top View)

Table 5. Precautions for Handling GaAs IC-based Products to Avoid Induced Damage

Personnel Grounding	Wrist Straps Conductive Smocks, Gloves and Finger Cots Antistatic ID Badges
Facility	Relative Humidity Control and Air Ionizers Dissipative Floors (less than $10^9 \Omega$ to GND)
Protective Packaging & Transportation	Bags and Pouches (Faraday Shield) Protective Tote Boxes (Conductive Static Shielding) Protective Trays Grounded Carts Protective Work Order Holders
Protective Workstation	Dissipative Table Tops Protective Test Equipment (Properly Grounded) Grounded Tip Soldering Irons Conductive Solder Suckers Static Sensors

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Ordering Information

Model Number	Manufacturing Part Number	Product Revision	Package	Operating Temperature
SKY77171	SKY77171		MCM 4x4	−30 °C to +85 °C

Revision History

Revision	Level	Date	Description
P1		January 6, 2005	Preliminary Information
P2		July 20, 2005	Revise: change digital bias control to AutoSmart™: Features (p1); Tables 1, 2, 3, 4: Figures 1–5, 6, 8
P3		October 14, 2005	Add: Pb-Free statement, p1

References

Application Note: PCB Design and SMT Assembly/Rework, Document Number 101752

Application Note: Tape and Reel Information – RF Modules, Document Number 101568

Standard SMT Reflow Profiles: JEDEC Standard J–STD–020.