DATA SHEET

SKY77174 Power Amplifier Module for WCDMA / HSDPA (1920–1980 MHz)

Applications

- WCDMA Handsets
- HSDPA Handsets
- Personal Communications Services (PCS)
- Wireless local loop (WLL)

Features

- No V_{REF} required
- Low voltage positive bias - 3.1 V to 4.6 V
- Supports low collector voltage operation
- Good linearity
- High efficiency at all power levels (17.5% at 16 dBm)
- Large dynamic range
- Low Profile package - 4 mm x 4 mm x 1.1 mm
- 10-pad configuration
- Power down control
- InGaP
- Digital V_{ENABLE}
- Digital or Analog $V_{CONTROL}$

NEW Skyworks offers lead (Pb)-free, RoHS (European Parliament for the Restriction of Hazardous Substances) -compliant packaging.

Description

The SKY77174 Power Amplifier module is a fully matched 10-pad surface mount module developed for Wideband Code Division Multiple Access (WCDMA) applications. This small and efficient power amplifier packs full coverage of the 1920–1980 MHz bandwidth into a single compact package. The SKY77174 meets the stringent spectral linearity requirements of HSDPA (High Speed Downlink Packet Access) data transmission with high power added efficiency for power output of up to 28 dBm. Because of high efficiencies attained throughout the entire power range, the SKY77174 delivers unsurpassed talk-time advantages.

The single Gallium Arsenide (GaAs) Microwave Monolithic Integrated Circuit (MMIC) contains all active circuitry in the module. The MMIC includes on-board bias circuitry, as well as input and interstage matching circuits. The output match is realized off-chip within the module package to optimize efficiency and power performance into a 50 Ω load. This device is manufactured with Skyworks' InGaP 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 SKY77174 is supplied directly from a three-cell Ni-Cd, a single-cell Li-Ion, or other suitable battery with an output in the 3.1 to 4.6 volt range. No V_{REF} voltage is required. Power down is accomplished by setting the voltage on V_{ENABLE} to zero volts. Digital bias control can be used to optimize efficiency at high and low power or analog bias control can be used to optimize efficiency over the entire power range. No external supply side switch is needed as typical "off" leakage is a few microamperes with full primary voltage supplied from the battery.

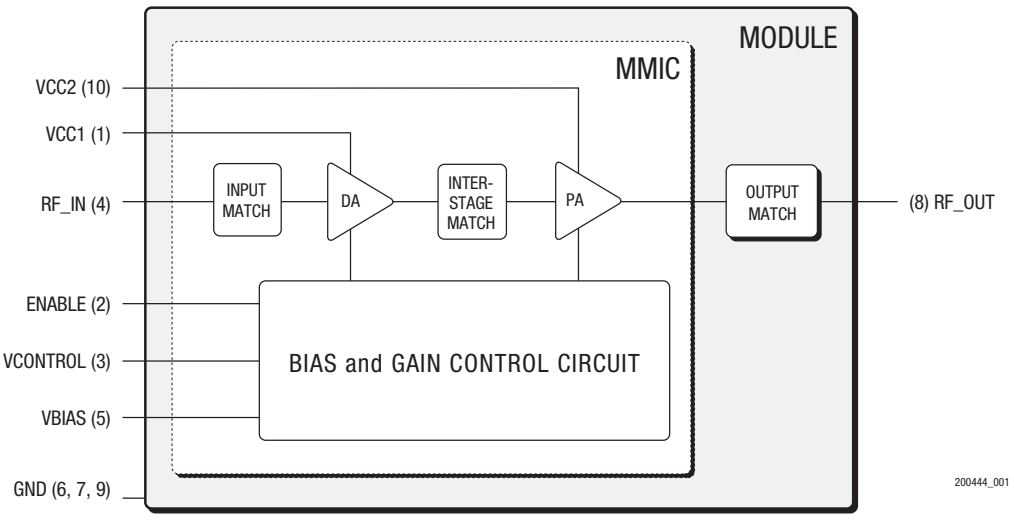


Figure 1. SKY77174 Functional Block Diagram

Electrical Target Specifications

The following tables list the electrical characteristics of the SKY77174 Power Amplifier. Table 1 lists the absolute maximum ratings, while Table 2 shows the recommended operating conditions to achieve the performance characteristics for WCDMA and HSDPA listed, respectively, in Table 3 and Table 5. Standard test configurations for WCDMA and HSDPA are shown in Table 4 and Table 6, respectively. Table 7 specifies the recommended control and collector voltages vs. output power for low collector voltage operation.

Table 1. Absolute Maximum Ratings [1]

Parameter		Symbol	Minimum	Maximum	Unit
RF Input Power		P_{IN}	—	8.0	dBm
Supply Voltage		V_{CC}, V_{BIAS}	—	6.0	Volts
Control Voltage		V_{CONT}	0	2.0	Volts
Enable Voltage		V_{EN}	—	2.0	Volts
Case Temperature	Operating	T_{CASE}	–30	110	°C
	Storage	T_{STG}	–55	125	
Ruggedness – no damage [2]		Ru	—	10:1	VSWR

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

2 P_{O_MAX}, all phases, time = 10 sec, continuous modulated signal.

Table 2. Recommended Operating Conditions

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Output Power	WCDMA	P_{O_MAX}	—	—	28.5	dBm
	HSDPA		—	—	28.0	
Operating Frequency		F_O	1920	1950	1980	MHz
Supply Voltage [1]	V_{BATT}	V_{CC}	3.1	3.4	4.6	Volts
	DC/DC		1.5	3.4	3.4	
Bias Voltage		V_{BIAS}	3.1	3.4	4.6	Volts
Enable Voltage	PA On	V_{EN}	0.8	1.1	2.0	Volts
	PA Off		0.0	—	0.5	
$V_{CONTROL}$ Range	High Power Range	V_{CONT}	0.5	1.2	1.2	Volts
Load Mismatch (all angles)		VSWR	—	1.0	—	VSWR
Case Operating Temperature		T_{CASE}	–20	25	85	°C

1 When V_{CC} supply is 3.1 V, P_{O_MAX} must be backed off 1 dB.

Table 3. SKY77174 Electrical Specifications for WCDMA — Recommended Operating Conditions [1]
Refer to Table 4. Standard Test Configuration — WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain Conditions	High Power	G_{HIGH}	P_{O_MAX}	26.0	28.5	32.0	dB
	Low Power	G_{LOW}	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm T_{CASE} = 25 °C	20.0	24.5	27.0	
Gain Variation Over Frequency			—	—	—	1	dB
Total Gain Reduction			—	—	4	—	dB
Power Added Efficiency @ V_{CC} = 3.4 V	High Power	PAE_{HIGH}	P_{O_MAX} T_{CASE} = 25 °C	36.0	38.0	—	%
	Low Power	PAE_{LOW}	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	14.0	17.5	—	
Error Vector Magnitude		EVM	—	—	2	3	%
Adjacent Channel Leakage power Ratio [2]	5 MHz offset	ACLR1_H	P_{O_MAX}	—	–42.0	–36.0	dBc
		ACPR1_L	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	—	–48.0	–38.0	
	10 MHz offset	ACLR2_H	P_{O_MAX}	—	–53.5	–48.0	
		ACLR2_L	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	—	–59.0	–53.0	
Harmonic Suppression	Second	fH2	V_{CC} = 3.4 V	—	–45	–43.5	dBc
	Third	fL3		—	–55	–53.5	
Noise Power		$P_{N\_GSM\_II}$	875 to 925 MHz	—	—	–90	dBm/30 kHz
		P_{N_GPS}	1570 to 1580 MHz	—	—	–90	
		P_{N_PHS}	1893.5 to 1919.6 MHz	—	—	–53	
		P_{N_DCS}	1805 to 1880 MHz	—	—	–83	
		P_{N_WRX}	2110 to 2170 MHz	—	—	–93	
		P_{N_WRX2}	RX = 2110 MHz TX = 1980 MHz	—	—	–70	
		P_{N_BT}	2400 to 2480 MHz	—	—	–80	
Noise Figure		NF	—	—	—	5	dB
Input Voltage Standing Wave Ratio (VSWR)		VSWR	—	—	1.5	2.0	—
Stability		S	VSWR = 6:1	—	—	–65	dBc

Table 3. [continued] **SKY77174 Electrical Specifications for WCDMA — Recommended Operating Conditions [1]**
Refer to Table 4. Standard Test Configuration — WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Characteristics	Symbol	Condition	Minimum	Typical	Maximum	Unit
Quiescent Current	I_{CQ_H}	V_{CC} = 3.4 V V_{CONT} = 1.2 V	—	100	—	mA
	I_{CQ_L}	V_{CC} = 1.6 V V_{CONT} = 0.8 V	—	65	—	
Control Current	I_{CONT}	—	—	—	200	µA
Enable Current	I_{EN}	$V_{EN} \geq$ 1.0 V	—	—	5	µA
Leakage Current	I_{LEAK}	V_{REF} = off V_{EN} = off	—	10	12	µA

1 Per Table 2, unless otherwise specified. Data in Table 3 were verified with the WCDMA test configuration shown in Table 4.

2 ACLR is specified per 3GPP as the ratio of total in-band power to adjacent power, both measured in 3.84 MHz bandwidth at specified offsets.

Table 4. Standard Test Configuration — WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Parameter	Level	Spread Code	Spread Factor	I/Q	βc	βd	βhs	Relative Power
Information Bit Rate	12.2 kbps	—	—	—	—	—	—	—
DPCCH	15.0 kbps	0	256	Q	8/15	—	—	–6.547 dB
DPDCH	60.0 kbps	16	64	I	—	15/15	—	–1.087 dB
TFCI	On	—	—	—	—	—	—	—

Table 5. SKY77174 Electrical Specifications for HSPDA — Recommended Operating Conditions [1]
Refer to Table 6. Standard Test Configuration — HSDPA Mode

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain Conditions	High Power	G_{HIGH}	P_{O_MAX}	26	28	32	dB
	Low Power	G_{LOW}	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm T_{CASE} = 25 °C	20	24	27	
Gain Variation Over Frequency			—	—	—	1	dB
Total Gain Reduction			—	—	4	—	dB
Power Added Efficiency @ VCC = 3.4 V	High Power	PAE_{HIGH}	P_{O_MAX}	35.0	37.0	—	%
	Low Power	PAE_{LOW}	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	14.0	17.5	—	
Error Vector Magnitude		EVM	—	—	2	3	%
Adjacent Channel Leakage power Ratio [2]	5 MHz offset	ACLR1_H	P_{O_MAX}	—	–38	–35	dBc
		ACLR1_L	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	—	–48	–38	
	10 MHz offset	ACLR2_H	P_{O_MAX}	—	–53	–48	
		ACLR2_L	V_{CC} = 1.6 V V_{CONT} = 0.8 V P_O = 16 dBm	—	–60	–53	

[1] Per Table 2, unless otherwise specified. Data in Table 5 were verified with the HSDPA test configuration shown in Table 6.

[2] ACLR is specified per 3GPP as the ratio of in-band power to adjacent power, both measured in 3.84 MHz bandwidth at specified offsets.

Table 6. Standard Test Configuration — HSDPA Mode

Parameter	Level	Spread Code	Spread Factor	I/Q	βc	βd	βhs	Relative Power
DPCCH	15 kbps	0	256	Q	12/15	—	—	–8.17 dB
DPDCH	60 kbps	16	64	I	—	15/15	—	–6.23 dB
HS– DPDCH	15 kbps	64	256	Q	—		24/15	–2.15 dB
TFCI	On	—	—	—	—	—	—	—

Table 7. Recommended Controls for Low Collector Voltage Operation

PSET WCDMA	PSET HSDPA	VCONT	VCC	VEN	VBIAS
–10.0	–10.0	0.50	1.5	1.1	3.4
0.0	0.0	0.50	1.5	1.1	3.6
5.0	5.0	0.50	1.5	1.1	3.6
9.0	9.0	0.60	1.5	1.1	3.6
13.0	13.0	0.70	1.5	1.1	3.6
15.0	15.0	0.75	1.5	1.1	3.6
16.0	16.0	0.80	1.6	1.1	3.6
17.0	17.0	0.80	1.7	1.1	3.6
18.0	18.0	0.85	1.8	1.1	3.6
20.0	20.0	0.90	2.0	1.1	3.6
23.0	23.0	1.00	2.3	1.1	3.6
24.0	24.0	1.05	2.6	1.1	3.6
25.0	25.0	1.10	2.8	1.1	3.6
26.0	26.0	1.15	3.0	1.1	3.6
27.5	27.0	1.20	3.1	1.1	3.6
28.5	28.0	1.20	3.4	1.1	3.6
28.5	28.0	1.20	4.6	1.1	3.6

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77174, the evaluation board schematic and diagrams are included for preliminary analysis and design. Figure 2 shows the basic schematic of the board for the 1920 MHz to 1980 MHz range.

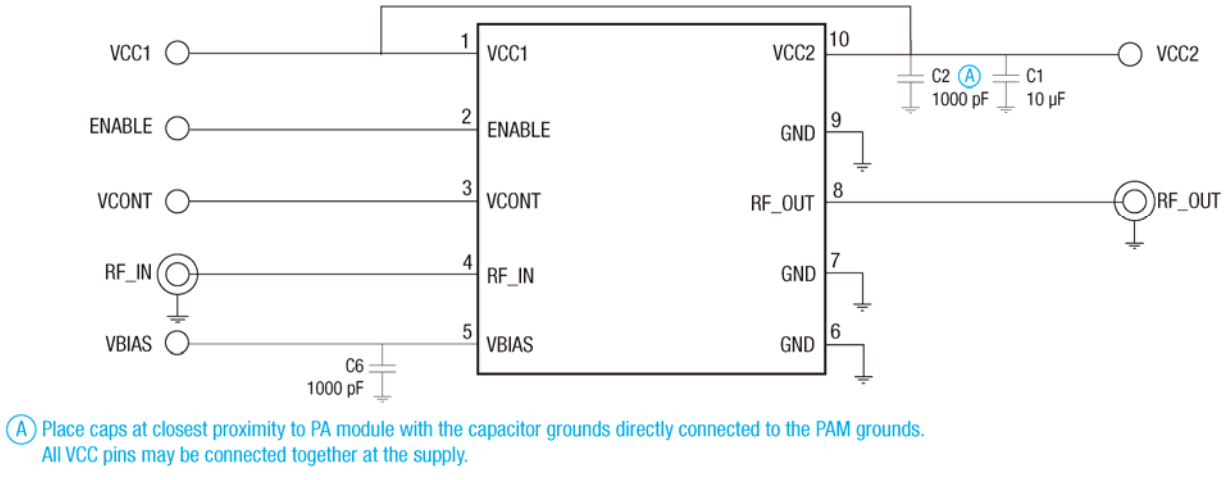
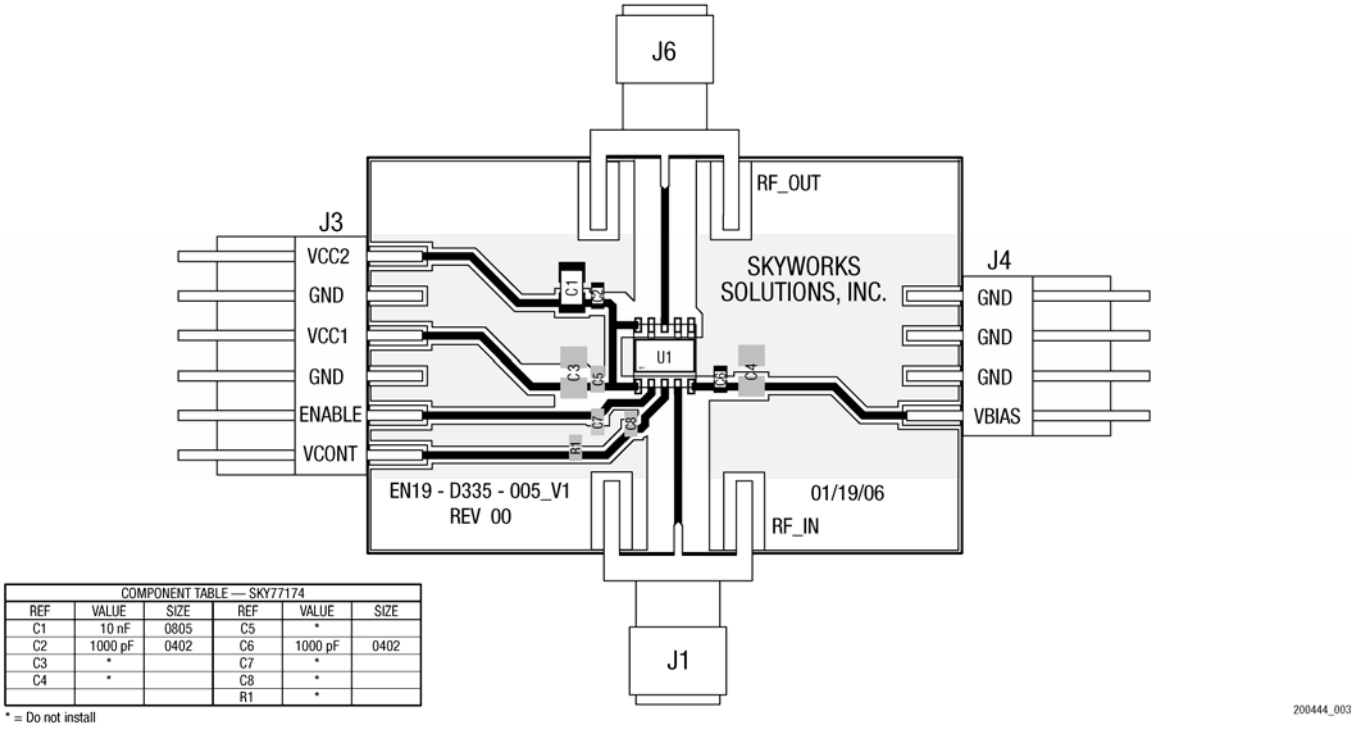


Figure 2. Evaluation Board Schematic



COMPONENT TABLE — SKY77174					
REF	VALUE	SIZE	REF	VALUE	SIZE
C1	10 nF	0805	C5	*	
C2	1000 pF	0402	C6	1000 pF	0402
C3	*		C7	*	
C4	*		C8	*	
			R1	*	

* = Do not install

Figure 3. Evaluation Board Assembly Diagram

Package Dimensions and Pad Descriptions

The SKY77174 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 5 provides a recommended phone board layout footprint for the PAM to help the designer attain optimum thermal conductivity, good grounding, and minimum RF discontinuity for the 50-ohm terminals. Figure 6 shows the pad names and the pad numbering convention, which starts with pad 1 at the upper left, and increments counter-clockwise around the package. Figure 7 illustrates typical case markings.

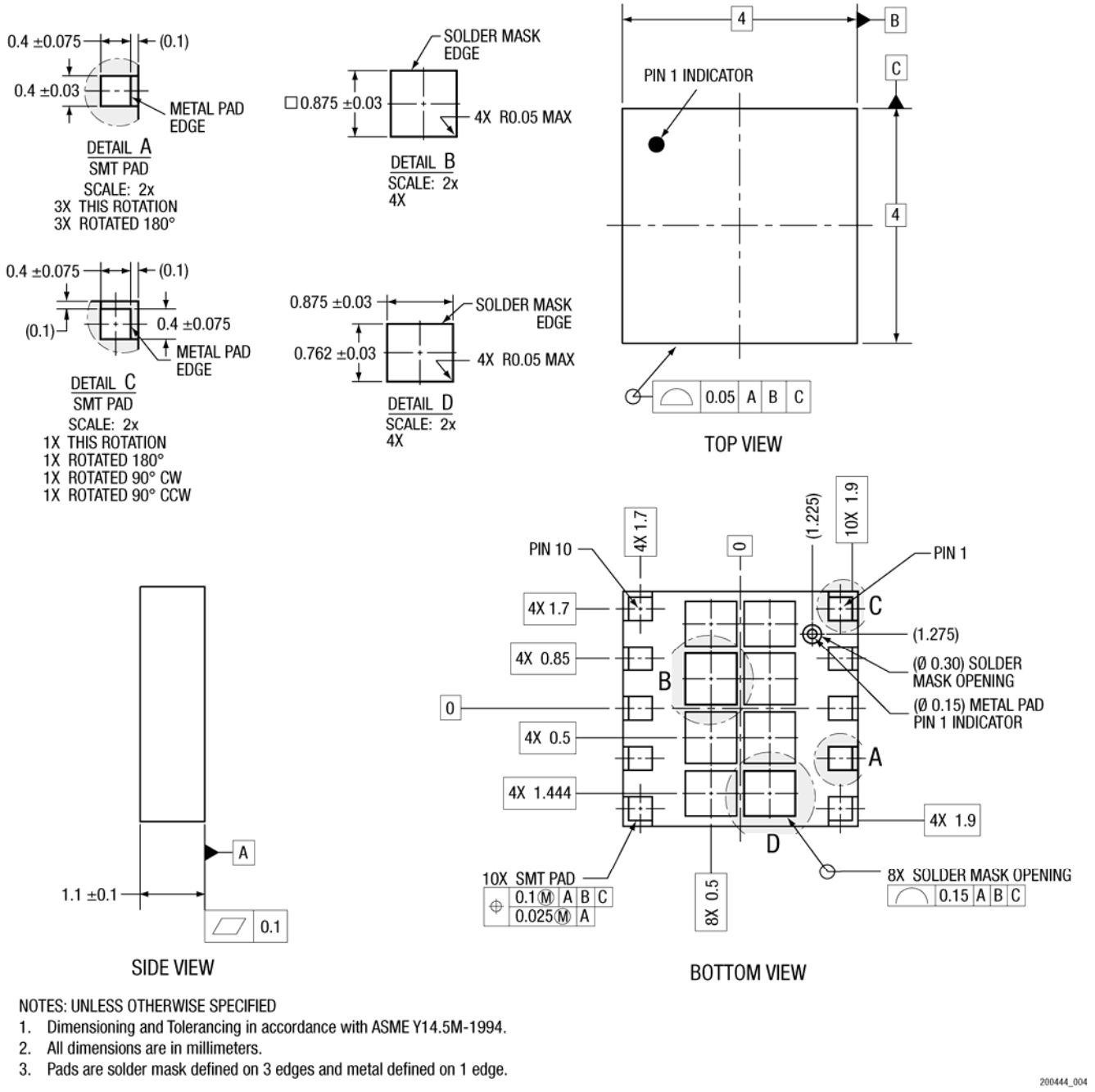


Figure 4. Drawing for 4 mm x 4 mm x 1.1 mm, 10-Pad Package – SKY77174 (All Views)

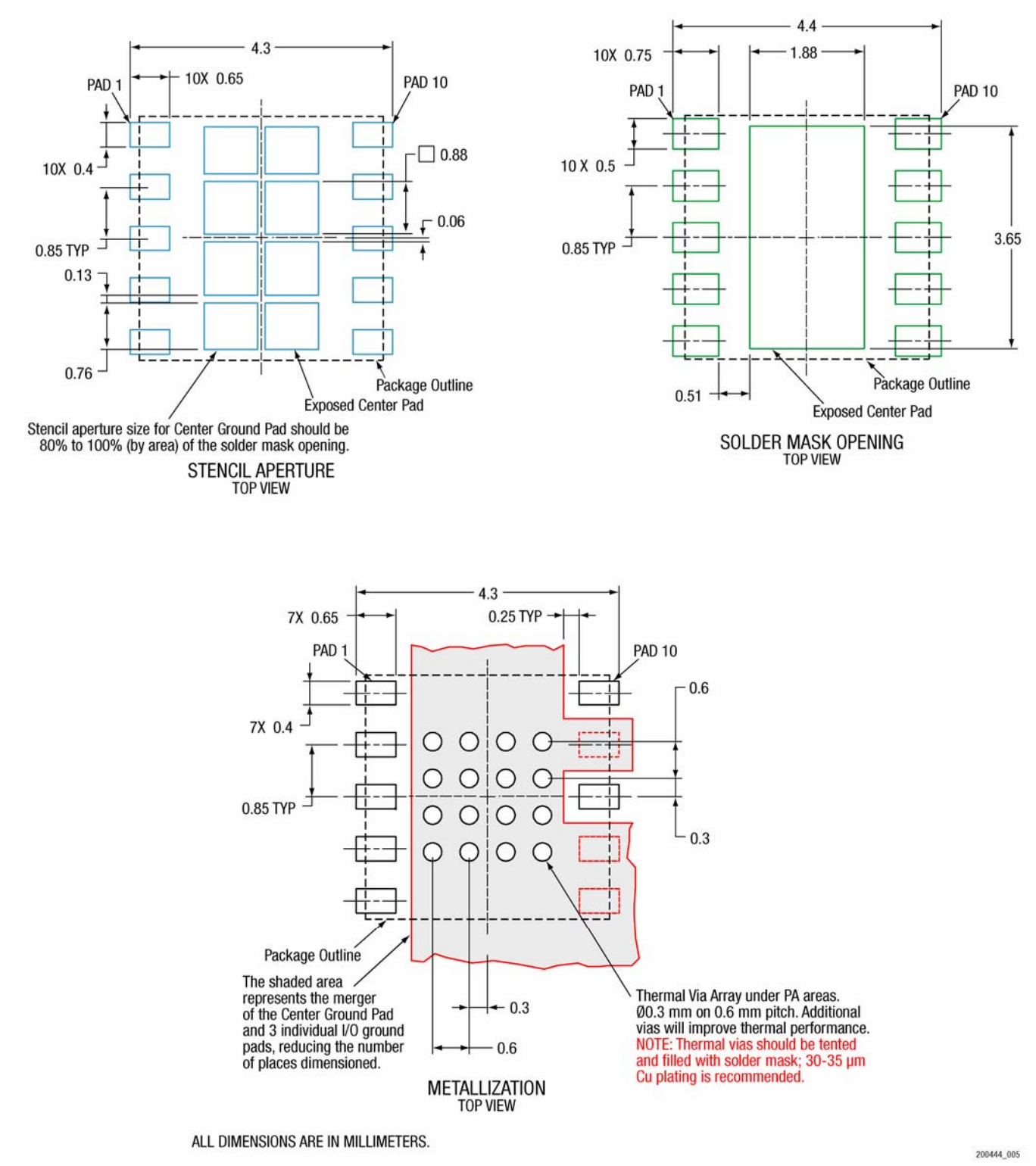


Figure 5. Phone PCB Layout Footprint for 4 x 4 x 1.1 mm, 10-Pad Package – SKY77174

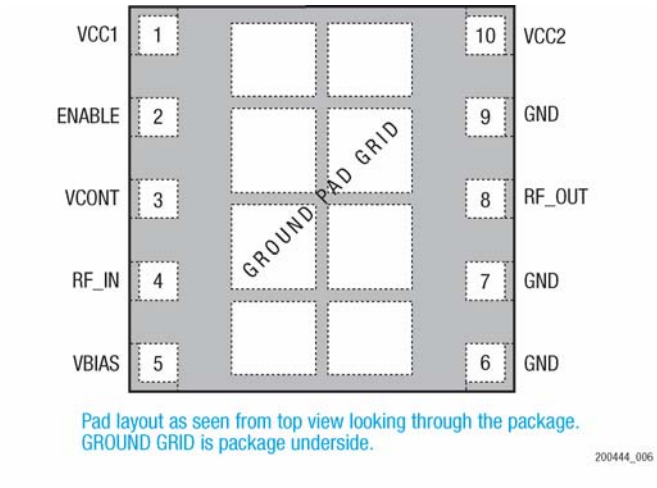


Figure 6. SKY77174 Pad Names and Configuration

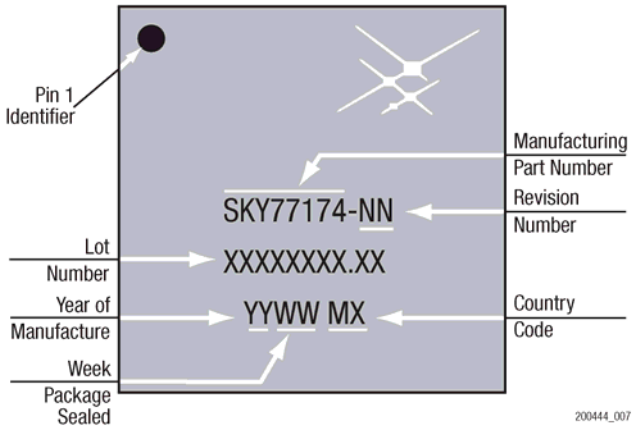


Figure 7. Typical Case Markings

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 SKY77174 is capable of withstanding an MSL3/260 ° 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 260 °C. If the part is manually attached, precaution should be taken to insure that the part is not subjected to temperatures exceeding 260 °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–020*.

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 SKY77174 is a Class 1 device. Figure 8 lists the Electrostatic Discharge (ESD) immunity level for each non-ground pad of the SKY77174 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. 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.

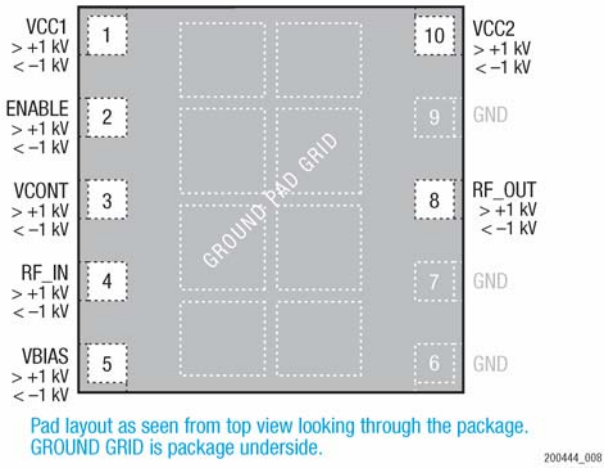


Figure 8. SKY77174 ESD Sensitivity Areas

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, 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 below.

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

Ordering Information

Model Number	Manufacturing Part Number	Product Revision	Package	Operating Temperature
SKY77174	SKY77174		MCM4x4LM–16	–20 °C to 85 °C

Revision History

Revision	Level	Date	Description
P1		September 30, 2005	Initial Issue – Advance Information
P2		January 5, 2006	Revise: Table 2, Figures 2, 3, 4 Add: Figure 5
P3		January 24, 2006	Revise: Tables 1, 2, 3
P4		March 14, 2006	Revise: Features list (p1); Table 3; Figures 1, 2, 3
A		July 24, 2007	Add: Tables 4, 6, 7 Revise: Change data sheet Revision suffix from P5 to A; remove Advance data sheet status; Features list (p1); Figures 2–4, 6, 8; Tables 1–3, 5; Package and Handling Information section.

References

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

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

Standard SMTP Reflow Profiles: JEDEC Standard J–STD–020