SKY77189 Power Amplifier Module for WCDMA / HSDPA Band VIII (880–915 MHz)

Applications

- WCDMA handsets
- HSDPA

Features

- Low voltage positive bias supply
  3.2 V to 4.2 V
- Good linearity
- High efficiency
  - 40% @ 28.75 dBm
- Large dynamic range
- Small, low profile package
  - 3 mm x 3 mm x 0.85 mm
  - 10-pad configuration
- Power down control
- InGaP
- Supports low collector voltage operation
- Digital Enable
- No V_{REF} required
- CMOS compatible control signals
- Integrated Directional Coupler

NEW

Skyworks Green™ products are RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, are halogen free according to IEC-61249-2-21, and contain < 1,000 ppm antimony trioxide in polymeric materials.

The SKY77189 Power Amplifier Module (PAM) is a fully matched 10-pad surface mount module developed for Wideband Code Division Multiple Access (WCDMA) applications. This small and efficient module packs full 880–915 MHz bandwidth coverage into a single compact package. Because of high efficiencies attained throughout the entire power range, the SKY77189 delivers unsurpassed talk-time advantages. The SKY77189 meets the stringent spectral linearity requirements of High Speed Downlink Packet Access (HSDPA) data transmission with high power added efficiency. A directional coupler is integrated into the module thus eliminating the need for any external coupler.

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 SKY77189 PAM is manufactured with Skyworks' InGaP GaAs Heterojunction Bipolar Transistor (HBT) BiFET process that provides for all positive voltage DC supply operation while maintaining high efficiency and good linearity. Primary bias to the SKY77189 is supplied directly from any three-cell Ni-Cd, a single-cell Li-Ion, or other suitable battery with an output in the 3.2 to 4.2 volt range. No VREF voltage is required. Power down is accomplished by setting the voltage on VENABLE 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.
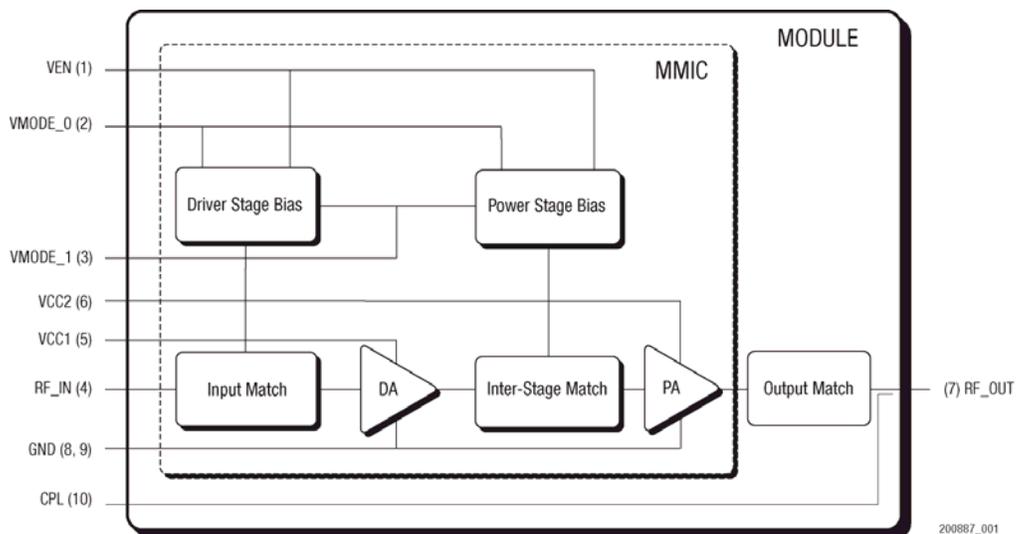
Figure 1. Functional Block Diagram

Electrical Specifications

The following tables list the electrical characteristics of the SKY77189 Power Amplifier. Table 1 lists the absolute maximum ratings, while Table 2 shows the recommended operating conditions to achieve WCDMA and HSDPA performance

characteristics listed in Table 4. Table 3 presents a truth table for the power settings. Table 5 and Table 6 provide the standard test configurations for WCDMA (STC1) and HSDPA (STC2), respectively.

Table 1. Absolute Maximum Ratings [1]

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Input Power		P_{IN}	—	0	10	dBm
Supply Voltage		V_{CC1}, V_{CC2}	—	3.4	6.0	Volts
Enable Control Voltage		V_{EN}	—	1.8	4.2	Volts
Mode Control Voltage		V_{MODE_0}	—	1.8	4.2	Volts
		V_{MODE_1}	—	1.8	4.2	
Case Temperature [2]	Operating	T_{CASE}	−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_{CASE}) 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
RF Output Power [1]	WCDMA	P_{O_MAX}	—	—	28.75	dBm
	HSDPA	P_{O_MAX}	—	—	27.75	
Operating Frequency		F_0	880.0	897.5	915.0	MHz
Supply Voltage		V_{CC1}, V_{CC2}	3.2 [2]	3.4	4.2	Volts
Enable Control Voltage	Low	V_{EN_L}	0.0	0.0	0.5	Volts
	High	V_{EN_H}	1.35	1.8	3.1	
Mode Control Voltage	Low	V_{MODE_0}	1.35	1.8	3.1	Volts
		V_{MODE_1}	1.35	1.8	3.1	
	Medium	V_{MODE_0}	1.35	1.8	3.1	
		V_{MODE_1}	0.0	0.0	0.5	
	High	V_{MODE_0}	0.0	0.0	0.5	
		V_{MODE_1}	0.0	0.0	0.5	
Case Operating Temperature		T_{CASE}	−20	+25	+85	°C

[1] For V_{CC} < 3.4 V, output power back-off = 0.5 dB.

[2] Recommended minimum V_{CC} for maximum power output is indicated. V_{CC2} down to 0.5 V may be used for backed-off power when using DC/DC converter to conserve battery current.

Table 3. Modes of Operation

Power Setting	ENABLE	VMODE_0	VMODE_1	VCC
Power Down Mode	Low	Low	Low	On
Standby Mode	Low	—	—	On
High Power Mode (17.0 dBm ≤ P_{OUT} ≤ 28.75 dBm	High	Low	Low	On
Medium Power Mode (7.0 dBm ≤ P_{OUT} ≤ 17.0 dBm)	High	High	Low	On
Low Power Mode (P_{OUT} ≤ 7.0 dBm)	High	High	High	On
Optional Lower VCC Mode (P_{OUT} ≤ 7.0 dBm)	High	Low	Low	1.5 V

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

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain		G_{LOW}	P_0 = 7.0 dBm	8.0	12.0	16.0	dB
		G_{MID}	P_0 = 17.0 dBm	13.0	18.0	24.0	
		G_{HIGH}	P_0 = 28.75 dBm	24.5	27.0	29.5	
Rx Band Gain		RxG	—	—	—	−0.5	dB
		RxG_GPS	—	—	−14.0	−3.0	
		RxG_ISM	—	—	−20.0	−6.0	
Power Added Efficiency		PAE_{LOW}	P_0 = 7.0 dBm	—	9.0	—	%
		PAE_{MID}	P_0 = 17.0 dBm	—	16.5	—	
		PAE_{HIGH}	P_0 = 28.75 dBm	40.0	—	—	
Total Supply Current		I_{CC_LOW}	P_0 = 7.0 dBm	—	7.5	—	mA
		I_{CC_MID}	P_0 = 17.0 dBm	—	40.0	—	
		I_{CC_HIGH}	P_0 = 28.75 dBm	—	—	550	
Quiescent Current		I_{Q_LOW}	Low Power Mode	—	2.5	—	mA
		I_{Q_MED}	Medium Power Mode	—	10.0	—	
Enable Control Current		I_{EN}	—	—	0.01	0.1	mA
Mode Control Current		I_{MODE_0}	—	—	0.05	0.1	mA
		I_{MODE_1}	—	—	0.05	0.1	
Total Supply Current in Power Down Mode		I_{PD}	V_{CC} = 3.4 V V_{EN} = Low V_{MODE_0} = Low V_{MODE_1} = Low	—	—	10	µA
Adjacent Channel Leakage power Ratio [2]	5 MHz offset	ACLR5	P_0 = 7.0 dBm	—	−42	−36	dBc
			P_0 = 17.0 dBm	—	−46	−36	
			P_0 = 28.75 dBm	—	−40	−36	
	10 MHz offset	ACLR10	P_0 = 7.0 dBm	—	−65	−46	
			P_0 = 17.0 dBm	—	−60	−46	
			P_0 = 28.75 dBm	—	−55	−46	
Harmonic Suppression	Second	f_{o2}	P_0 ≤ 28.75 dBm	—	−45	−35	dBc
	Third	f_{o3}		—	−50	−35	
Tx Noise in Rx Bands	Rx		925 MHz–960 MHz	—	−138	−136	dBm/Hz
	GPS Rx		1574 MHz–1577 MHz	—	−142	−140	
	ISM Rx		2400 MHz–2483.5 MHz	—	−145	−143	
Input Voltage Standing Wave Ratio		VSWR	—	—	1.5:1	1.8:1	—
EVM		EVM1	P_0 = P_{MAX}	—	—	3.35	%
		EVM2	P_0 = P_{MAX} − 3	—	—	2.50	
Rise / Fall Time	DC	$T_{on}DC$	—	—	—	20	µs
		$T_{off}DC$	—	—	—	20	
	RF	$T_{on}RF$	—	—	—	6	
		$T_{off}RF$	—	—	—	6	
Coupling Factor		CPL	P_0 = 28.75 dBm	—	−18	—	dB
Stability (Spurious output)		S	5:1 VSWR All phases	—	—	−70	dBc
Ruggedness – no damage [3]		Ru	P_0 ≤ 28.75 dBm	10:1	—	—	VSWR

[1] Per Table 2 over dynamic range up to 28.75 dBm output power, unless specified otherwise.

[2] ACLR 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.

Table 5. Standard Test Configuration – STC1 WCDMA Mode

Parameter	Level	Spread Code	Spread Factor	I/Q	βc	βd	βhs	βec	βed	Relative Power (dB)
DPCCH	15 kbps	0	256	Q	8/15	—	—	—	—	−6.547
DPDCH	60 kbps	16	64	I	—	15/15	—	—	—	−1.087

Table 6. Standard Test Configuration – STC2 HSDPA Mode

Parameter	Level	Spread Code	Spread Factor	I/Q	βc	βd	βhs	βec	βed	Relative Power (dB)
DPCCH	15 kbps	0	256	Q	12/15	—	—	—	—	−7.095
DPDCH	60 kbps	16	64	I	—	15/15	—	—	—	−5.157
HS-DPCCH	15 kbps	64	256	Q	—	—	24/15	—	—	−3.012

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77189, the evaluation board schematic and assembly diagrams are included for preliminary analysis and design. Figure 2 shows the basic schematic of the board for the 880 MHz to 915MHz range.
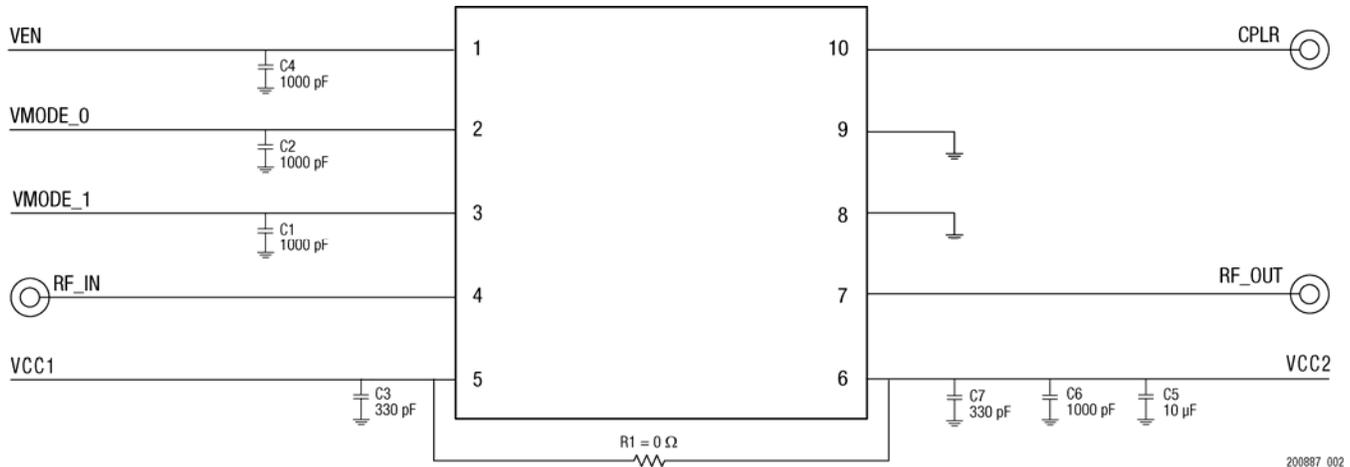
Figure 2. Evaluation Board Schematic
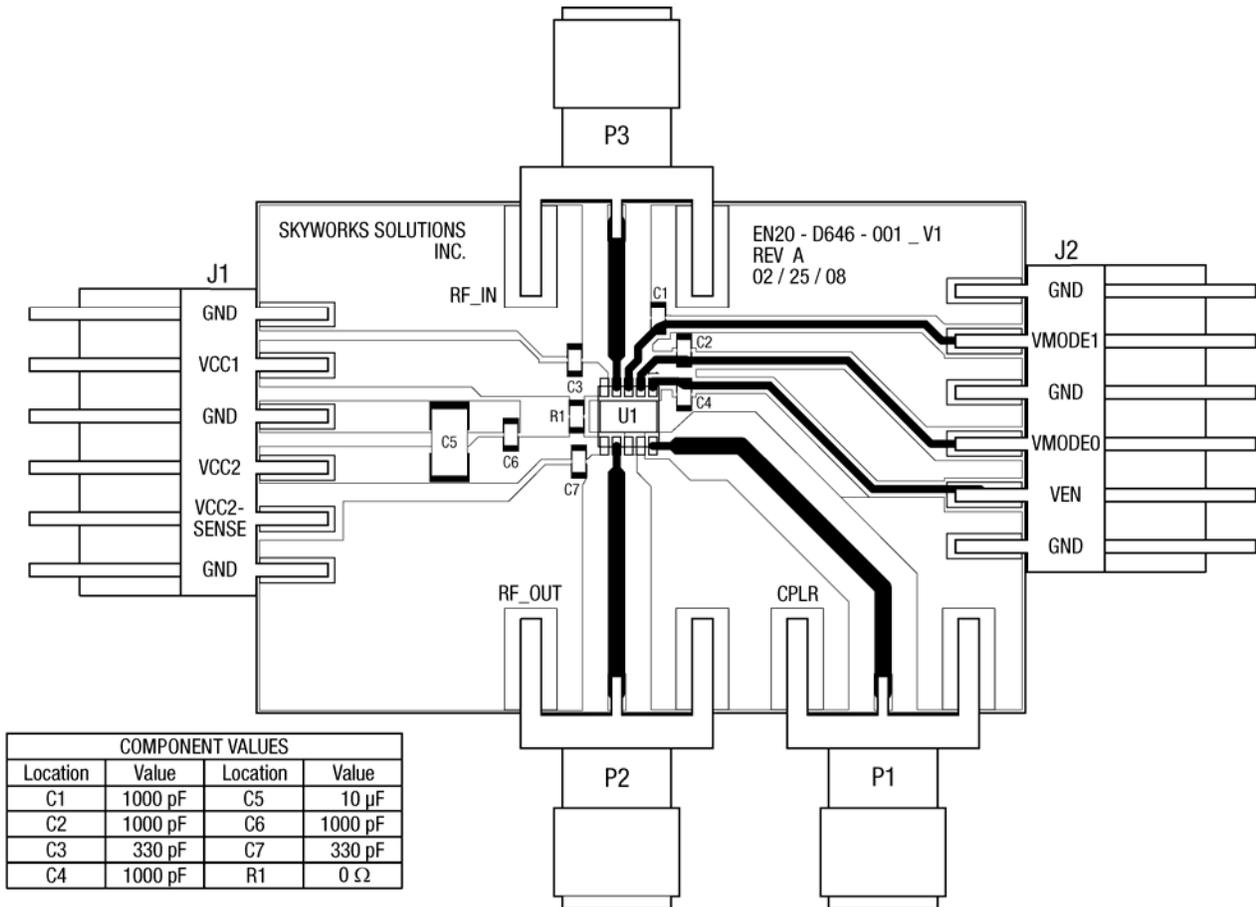
Figure 3. Evaluation Board Assembly Diagram

COMPONENT VALUES			
Location	Value	Location	Value
C1	1000 pF	C5	10 µF
C2	1000 pF	C6	1000 pF
C3	330 pF	C7	330 pF
C4	1000 pF	R1	0 Ω

Package Dimensions

The SKY77189 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.
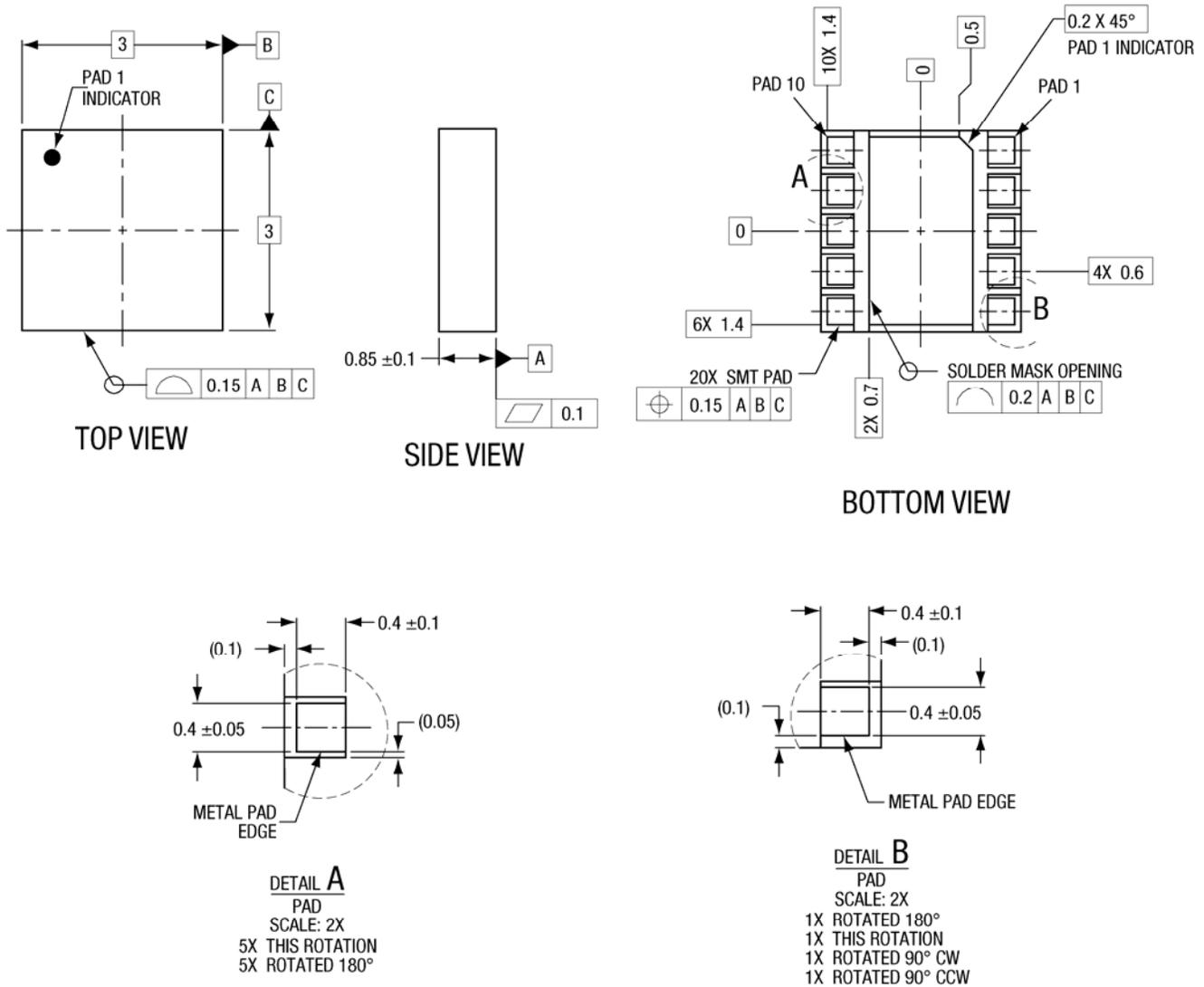
NOTES: Unless otherwise specified.
1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5 – 1994
2. SEE APPLICABLE DIAGRAM AND DEVICE ASSEMBLY DRAWING FOR DIE AND COMPONENT PLACEMENT.
3. PAD DEFINITIONS PER DETAILS ON DRAWING.
4. PCB TYPE 4L PPG TEV MCM (100).

200887_004

Figure 4. Dimensional Diagram for 3 mm x 3 mm x 0.85 mm, 10-Pad Package (All Views) – SKY77189

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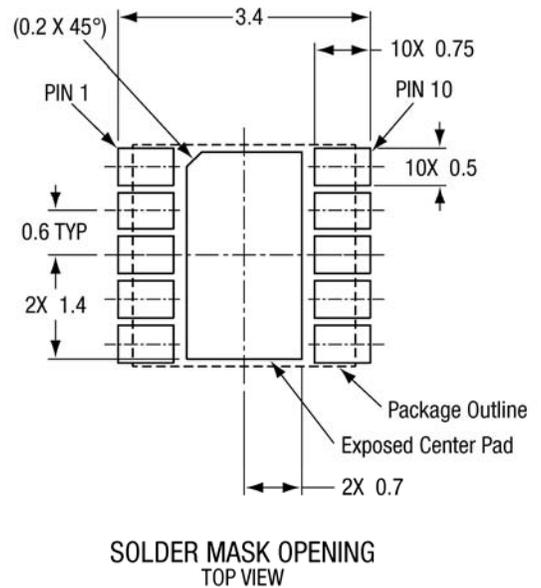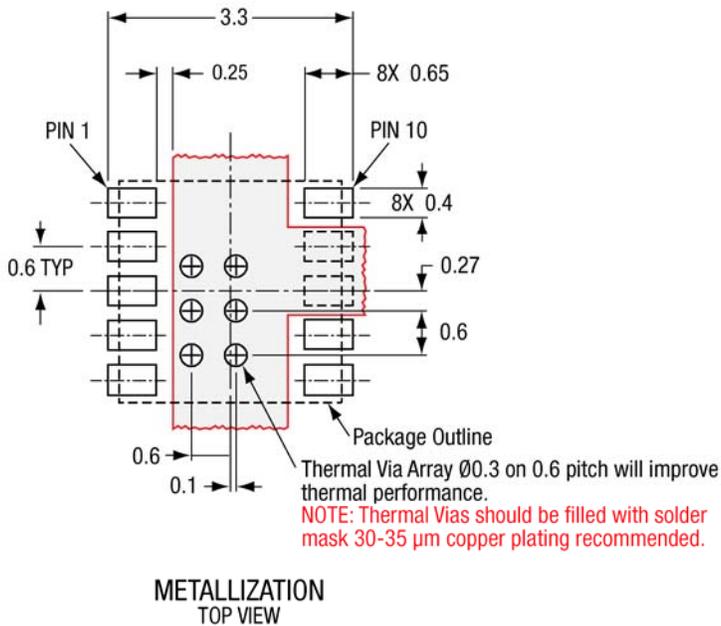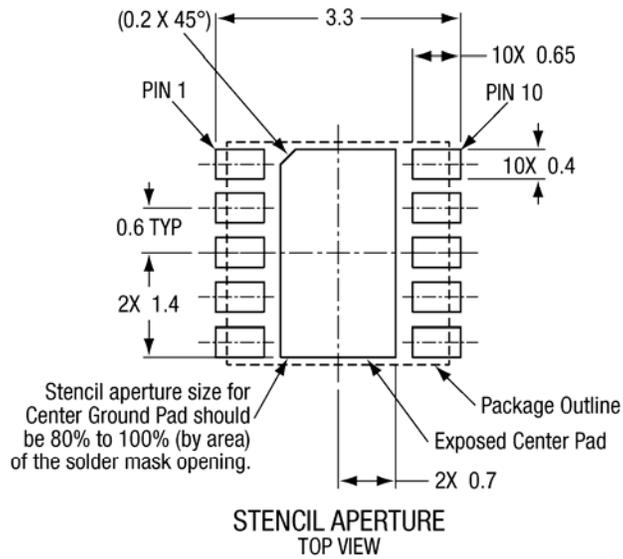
Figure 5. Phone PCB Layout Footprint for 3 mm x 3 mm, 10-Pad Package – SKY77189

Package Description

Figure 6 shows the pad functions and the pad numbering convention, which starts with pad 1 in the upper left and increments counter-clockwise around the package. Typical case markings are illustrated in Figure 7.
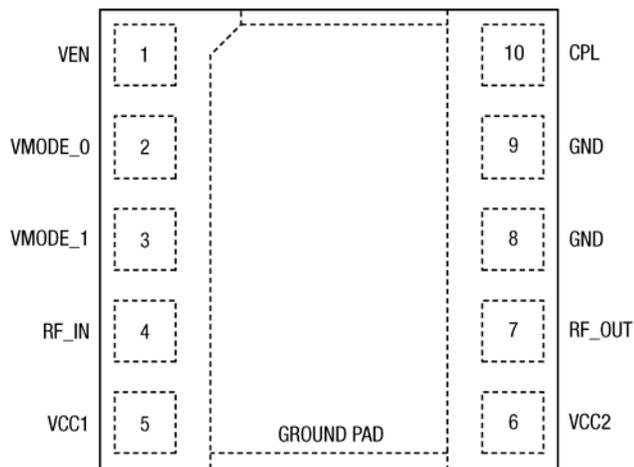
Pad layout as seen from Top View looking through the package.
GROUND PAD is package underside.

200887_006

Figure 6. SKY77189 Pad Names and Configuration (Top View)

NOTE: Lines 1, 2, 3 have a maximum of 7 characters
Line 1 = Part Number and Version
Line 2 = Lot Number
Line 3 = Year–Week–Country Code (MX)

200887_007

Figure 7. Typical Case Markings

Package 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 SKY77189 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 (Figure 8).

Electrostatic Discharge Sensitivity (ESD)

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 $10^9 \, \Omega$ 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
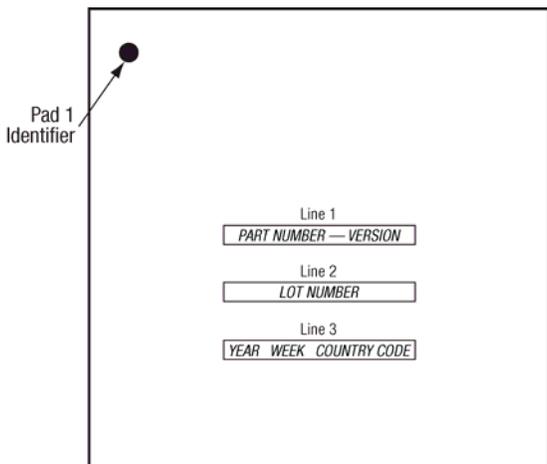
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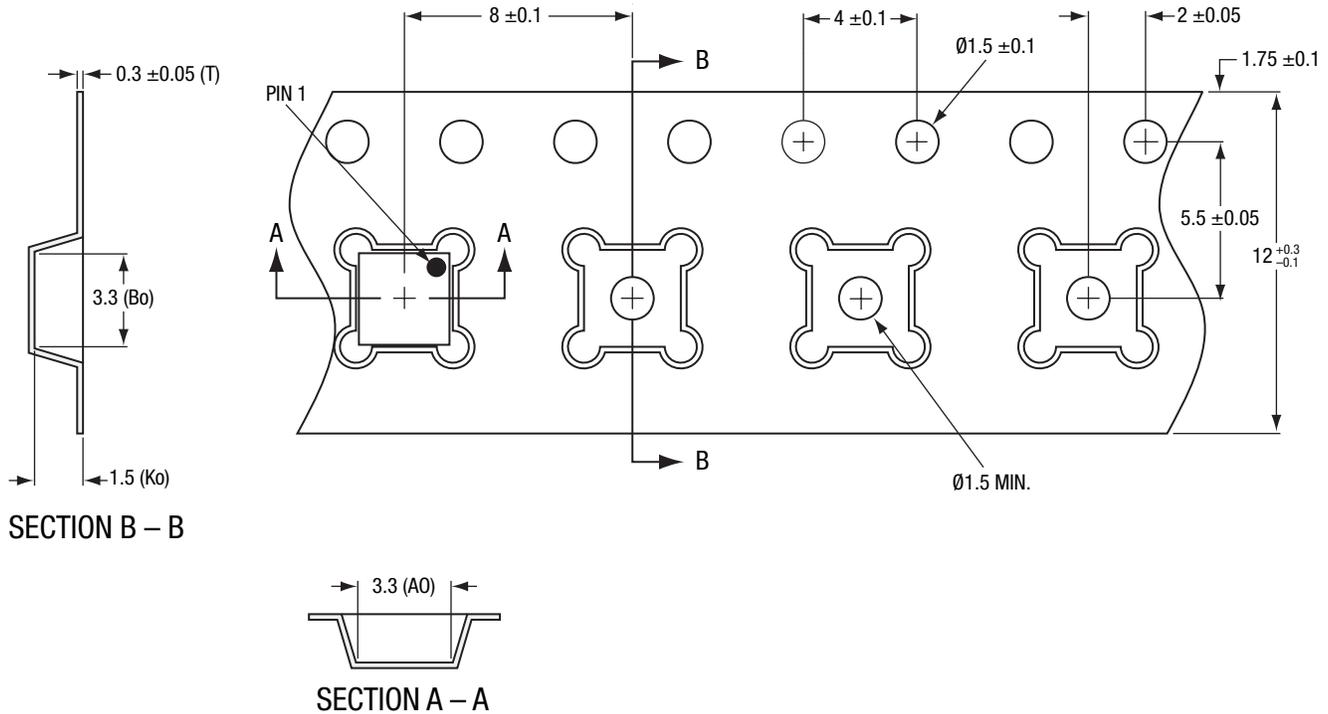
NOTES:
1. CARRIER TAPES MUST MEET ALL REQUIREMENTS OF SKYWORKS GP01–D232 PROCUREMENT SPEC FOR TAPE AND REEL SHIPPING.
2. CARRIER TAPE SHALL BE BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
3. COVER TAPE SHALL BE TRANSPARENT CONDUCTIVE PRESSURE-SENSITIVE ADHESIVE (PSA) MATERIAL W/ 9.3 mm WIDTH.
4. ESD-SURFACE RESISTIVITY SHALL BE $\leq 1 \times 10^{10}$ OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION.
5. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE: ±0.2 mm
6. Ao & Bo MEASURED ON PLANE 0.3 mm ABOVE THE BOTTOM OF THE POCKET.
7. ALL DIMENSIONS ARE IN MILLIMETERS.
8. PART NO.: KS-1208-332 REV. 00 (PLEASE INDICATE ON PURCHASE ORDER).
9. NUMBER OF PARTS per 13 inch (DIAMETER) x 12 mm REEL: 2500/4500.

KOSTAT CARRIER TAPE

CARRIER TAPE   OVERMOLD MCM / RFLGA   3 x 3 x 1.4 mm BODY SIZE   GP01-D232-187C
101568_002

Figure 8. Dimensional Diagram for Carrier Tape Body Size 3 mm x 3 mm x 1.4 mm – MCM

Ordering Information

Model Number	Manufacturing Part Number	Product Revision	Package	Operating Temperature
SKY77189	SKY77189		MCM 3 x 3 x 0.85 mm	−20 °C to +85 °C

Revision History

Revision	Date	Description
A	April 4, 2008	Initial Release – Advance Information
B	April 23, 2008	Revise: Tables 1–4; Figures 1–3, 6; Tx freq. to 880–915; Rx freq. to 925–960
C	May 20, 2008	Revise: Features list (p1); Tables 1, 2, 4, 5; Figures 2–5; Add: Skyworks Green tag (p1)
D	November 13, 2008	Revise: Features list (p1); Figure 3; Tables 1–4; ESD section Add: Tables 5, 6
E	February 3, 2009	Revise: Order Information table, Package column
F	May 15, 2009	Revise: Figure 5 Add: Figure 8
G	February 2, 2010	Revise: Figure 1 Add: Figure 8

References

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

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