PRELIMINARY DATA SHEET

SKY77336 Power Amplifier Module for Quad-Band GSM / GPRS

Applications

- Quad-band cellular handsets
- GMSK Modulation
  - Class 4 GSM850/900
  - Class 1 DCS1800/ PCS1900
  - Class 12 GPRS multi-slot operation
- EDGE modulation
  - Class E2 GSM850/900
  - Class E2 DCS1800/ PCS1900

Features

- High efficiency:
  - GSM850, 55%
  - GSM900, 55%
  - DCS, 53%
  - PCS, 53%
- Small outline
  - 5 x 5 mm
- Low profile
  - 1.15 mm Max
- Low VRAMP current
  - 10 µA

NEW Skyworks Green™ products are lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, and are free from antimony trioxide and brominated flame retardants.

Description

SKY77336 Power Amplifier Module (PAM) is designed in a compact form factor for quad-band cellular handsets comprising GSM850/900, DCS1800 and PCS1900, supporting Gaussian Minimum-Shift Keying (GMSK) and Polar Enhanced Data for GSM Evolution (EDGE) modulation. Class 12 General Packet Radio Service (GPRS) multi-slot operation is also supported.

The module consists of GSM850/900 PA and DCS1800/PCS1900 PA blocks, impedance matching circuitry for 50 Ω input and output impedances, and a Power Amplifier Control (PAC) block. The custom CMOS integrated circuit provides the internal PAC function and interface circuitry. Fabricated in InGaP/GaAs, the Heterojunction Bipolar Transistor (HBT) PA blocks support the GSM850/900 bands and DCS1800/PCS1900 bands. Both PA blocks share common power supply pads to distribute current. The InGaP/GaAs die, Silicon (Si) controller die, and passive components are mounted on a multi-layer laminate substrate and the entire assembly is encapsulated with plastic overmold.

RF input and output ports of the SKY77336 are internally matched to a 50 Ω load to reduce the number of external components for a quad-band design. Extremely low leakage current (10 µA, typical) of the PAM module maximizes handset standby time.

The SKY77336 also contains band-select switching circuitry to select GSM (logic 0) or DCS/PCS (logic 1) as determined from the Band Select (BS) signal. See Figure 1 shown below.

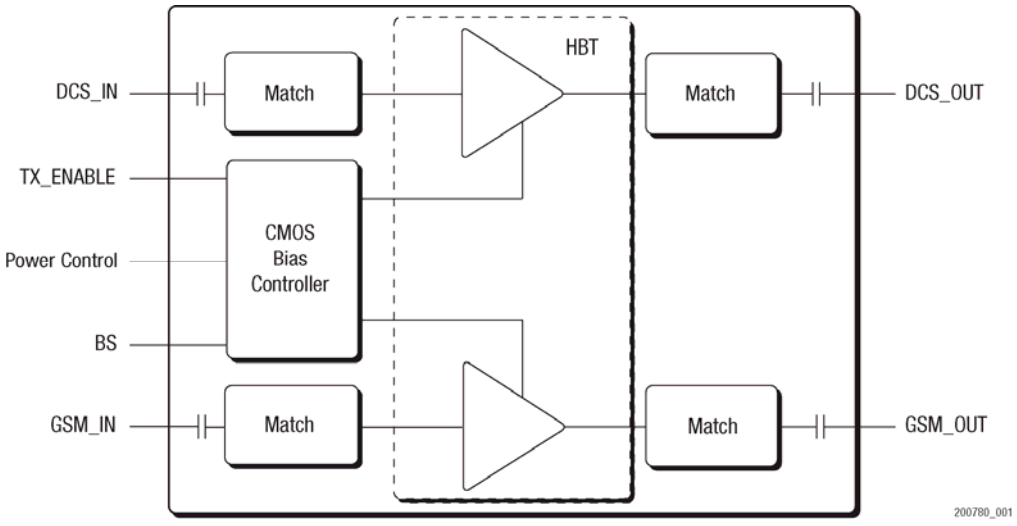

Figure 1. SKY77336 Functional Block Diagram

Electrical Specifications

The absolute maximum ratings of SKY77336 are provided in Table 1. Table 2 specifies the recommended operating conditions for achieving the electrical performance shown in Table 5 through Table 11. Table 3 provides loop requirement and Table 4 provides the mode control logic.

Table 1. SKY77336 Absolute Maximum Ratings [1]

Parameter		Symbol	Minimum	Nominal	Maximum	Units
RF Input Power		P_{IN}	—	6	15	dBm
Supply Voltage (≤ 100 ms) Supporting Operation at Max. P_{OUT} @ 50 ohm Load @ +25 °C		V_{BATT}	—	3.5	5.5	V
Logic Signals (ENABLE, BS)		V_{CONT}	–0.5	—	V_{BATT} – 0.2	V
Input Modulating Signal and Power Control		V_{APC}	–0.5	1.6	V_{BATT} – 0.2	V
Temperatures	Operating [2]	T_{CASE}	–30	25	+90	°C
	Storage	T_{STG}	–55	—	+150	
	Re-flow solder	T_{SOLDER}	—	—	J-STD-020C	
	Moisture Sensitivity Level	MSL	—	—	3/260	
Burst Duty Cycle		D_B	—	12.5	50	%
Voltage Standing Wave Ratio		VSWR	—	2.5:1	100:1	

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

2 Case Operating Temperature refers to the temperature of the GROUND PAD at the underside of the package.

Table 2. SKY77336 Recommended Operating Conditions

Parameter		Symbol	Minimum	Nominal	Maximum	Units
Supply Voltage		V_{BATT}	3.0	3.5	4.8	V
Leakage Current	V_{BATT} = 4.8 V Tx_{EN} = 0 V V_{APC} = 0-1.6 V No RF applied	I_L	—	—	10	uA
Operating Temperature (full specifications)		T_{CASE}	–25	+25	+85	°C
Power Supply Noise Rejection			—	TBD	—	
Tx Enable Switch Time			—	—	1	us
Tx Enable Current			—	10	20	uA
Band Select Current			—	10	20	uA
Duty Cycle			—	—	50	%
Analog Power Control Voltage Range			0.0	—	1.6	V
Analog Power Control Input Current			—	—	10	uA
Impedance System for RF Ports		Z	—	50	—	Ω

Table 3. SKY77336 Loop Requirement

Parameter	Symbol	Test Conditions	Minimum	Typical	Maximum	Unit
V_{APC} Bandwidth (Corresponding to the f – 3 dB of the Transfer Function V_{OUT}/V_{APC})	BW_V_{APC}	P_{IN} = Min. to Max. P_{OUT} = Min. to Max. V_{BATT} = Min. to Max. T_{CASE} = Min. to Max.	6	9	14	MHz

Table 4. SKY77336 Control Logic

Mode	Input Control Bits		850/EGSMTx	DCS/PCSTx
	Tx_EN	BS		
Standby	0	X	Disable	Disable
Tx 850/EGSM	1	0	Enable	Disable
Tx DCS/PCS	1	1	Disable	Enable

Table 5. SKY77336 Electrical Specifications [1] *(1 of 2)*

850/900 Tx GMSK & EDGE Mode							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency	GSM850	f	—	824	—	849	MHz
	GSM900		—	880	—	915	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Leakage Current		I_L	V_{BATT} = 3.5 V $V_{APC} \leq$ 25 mV T_{CASE} = +25 °C No input power	—	—	10	µA
Harmonics	2^{ND}	2fo	6.5 dBm ≤ P_{OUT} ≤ 34.5 dBm at 50 ohm load	—	—	–10	dBm
	3^{RD} to 15^{TH}	3f0 to 15f0	6.5 dBm ≤ P_{OUT} ≤ 34.5 dBm at 50 ohm load	—	—	–15	
	3^{RD} to 7^{TH}	3f0 to 7f0	6.5 dBm ≤ P_{OUT} ≤ 34.5 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C Load: VSWR of 5:1 for all phases.	—	–12	–10	
Cross Harmonics			Fundamental	—	—	5	dBm
			Harmonics	—	—	–20	
Current at Mismatch		I_{BATT_LOAD}	Load VSWR = 5:1, all phase angles. V_{APC} is set to the number that delivers P_{OUT} = 34.5 dBm at 50 ohm load	—	2.1	—	A
Input VSWR		Γ_{IN}	$P_{OUT} \leq$ 34.5 dBm	—	—	2.5:1	

Table 5. SKY77336 Electrical Specifications [1] *(2 of 2)*

[continued] ***850 / 900 Tx GMSK & EDGE Mode***							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Forward Isolation			Tx_EN = low P_{IN} = 8 dBm	—	—	–30	dBm
			Tx_EN = high P_{IN} = 8 dBm $V_{APC} \leq 0.2$ V	—	—	–15	
Stability		S	All combinations of the following parameters. P_{IN} = Min. to Max. V_{BATT} = 3.0 V to 4.8 V T_{CASE} = –20 °C to +85 °C Load VSWR = 10:1, all phase angles.	No parasitic oscillation > –36 dBm			
Spurious			f < 1 GHz Load VSWR = 8:1	—	—	–36	dBm
			f > 1 GHz Load VSWR = 8:1	—	—	–30	
Ruggedness		Ru	All combinations of the following parameters. P_{IN} = Min. to Max. V_{BATT} = 3.0 V to 4.8 V V_{BATT} = 7.0 V for ≤ 1 µs V_{BATT} = 5.5 V for ≤ 100 ms Load VSWR= 10:1, all phase angles	No module damage or permanent degradation			
Noise Power	GSM 850	P_{NOISE}	RX = 869 to 894 MHz V_{BATT} = 3.5 V P_{IN} = 6 dBm T_{CASE} = +25 °C	—	–87	—	dBm/ 100 kHZ
	GSM 900		RX = 925 to 935 MHz V_{BATT} = 3.5 V P_{IN} = 6 dBm T_{CASE} = +25 °C	—	—	–76	
	GSM 900		RX = 935 to 960 MHz V_{BATT} = 3.5 V P_{IN} = 6 dBm T_{CASE} = +25 °C	—	–87	—	

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

Table 6. SKY77336 Electrical Specifications [1]

850 / 900 Tx GMSK Mode							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f	—	824	—	849	MHz
	GSM900		—	880	—	915	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Output Power (Average)		P_{OUT}	P_{IN} = 6 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C	34.5	35.0	—	dBm
		P_{OUT_DEG}	P_{IN} = 0 dBm V_{BATT} = 3.4 V – 4.8 V T_{CASE} = –20 °C to 85 °C V_{APC} is set to deliver P_{OUT} = 34.5 dBm at V_{BATT} = 3.5 V T_{CASE} = +25° C	32.5	—	—	
Power Added Efficiency		PAE	P_{IN} = 6 dBm P_{OUT} = Max. V_{BATT} = 3.5 V T_{CASE} = +25 °C	50	55	—	%
Phase Change			The change in phase for P_{OUT} V_{APC} = sawtooth signal f = 2166 Hz $P_{OUT} \leq$ 34.5 dBm	—	1	—	deg./dB
Dynamic Range			—	49.5	—	—	dB

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

Table 7. SKY77336 Electrical Specifications [1]

850 / 900 Tx EDGE Mode							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM850	f	—	824	—	849	MHz
	GSM900		—	880	—	915	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Output Power (average)		P_{OUT}	P_{IN} = 6 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C	29	—	—	dBm
		$P_{OUT\_DEG\ 1}$	P_{IN} = 0 dBm V_{BATT} = 3.0 V – 4.8 V T_{CASE} = –30 °C to 90 °C at V_{BATT} = 3.5 V T_{CASE} = +25 °C	28.5	—	—	
Power Added Efficiency		PAE	P_{IN} = 6 dBm P_{OUT} = 28.5 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C	24	28	—	%

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

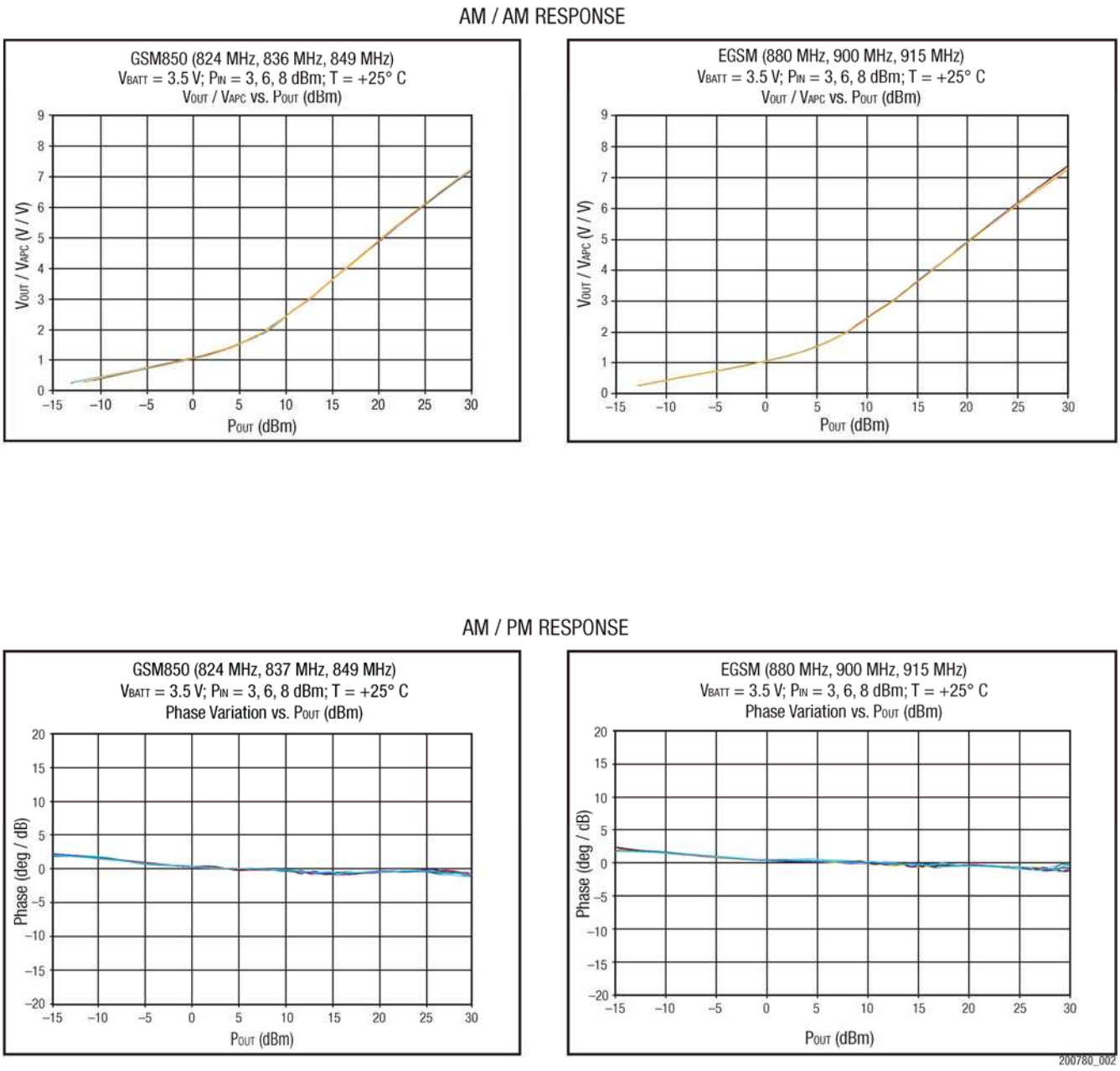

Figure 2. Typical AM/AM and AM/PM Response Charts for Low Band – SKY77336 Power Amplifier Module

Table 8. SKY77336 Electrical Specifications [1] *(1 of 2)*

1800 / 1900 Tx GMSK & EDGE Mode							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	DCS 1800	f	—	1710	—	1785	MHz
	PCS 1900		—	1850	—	1910	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Leakage Current		I_L	V_{BATT} = 3.5 V $V_{APC} \leq$ 25 mV T_{CASE} = +25 °C No input power	—	—	10	µA
Harmonics	2^{ND}	$2f_0$	1.5 dBm ≤ P_{OUT} ≤ 32 dBm at 50 ohm load	—	—	–10	dBm
	3^{RD} to 7^{TH}	$3f_0$ to $7f_0$	1.5 dBm ≤ P_{OUT} ≤ 32 dBm at 50 ohm load	—	—	–15	
	3^{RD} to 7^{TH}	$3f_0$ to $7f_0$	1.5 dBm ≤ P_{OUT} ≤ 32 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C Load: VSWR of 5:1 for all phases.	—	–12	–10	
Current at Mismatch		I_{BATT_LOAD}	Load VSWR = 5:1, all phase angles. V_{APC} set to the number that delivers P_{OUT} = 32 dBm at 50 ohm load.	—	1.4	—	A
Input VSWR		Γ_{IN}	$P_{OUT} \leq$ 32 dBm	—	—	2.5:1	

Table 9. SKY77336 Electrical Specifications [1] *(2 of 2)*

[continued] ***1800 / 1900 Tx GMSK & EDGE Mode***							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Forward Isolation			Tx_EN = low P_{IN} = 8 dBm	—	—	–30	dBm
			Tx_EN = high P_{IN} = 8 dBm $V_{APC} \leq$ 0.2 V	—	—	–20	
Cross Harmonics			Fundamental	—	—	5	dBm
			Harmonics	—	—	–20	
Stability		S	All combinations of the following parameters. P_{IN} = Min. to Max. V_{BATT} = 3.0 V to 4.8 V T_{CASE} = -20 °C to +85 °C Load VSWR = 10:1, all phase angles.	No parasitic oscillation > –36 dBm			
Spurious			f < 1 GHz Load VSWR = 8:1	—	—	–36	dBm
			f > 1 GHz Load VSWR = 8:1	—	—	–30	
Ruggedness		Ru	All combinations of the following parameters. P_{IN} = Min. to Max. V_{BATT} = 3.0 V to 4.8 V V_{BATT} = 7.0 V for ≤ 1 µs V_{BATT} = 5.5 V for ≤ 100 ms Load VSWR= 10:1, all phase angles.	No module damage or permanent degradation			
Noise Power	DCS	P_{NOISE}	RX = 1805 to 1880 MHz V_{BATT} = 3.5 V P_{IN} = 6 dBm T_{CASE} = +25 °C	—	—	–79	dBm/ 100 kHz
	PCS		RX = 1930 to 1990 MHz V_{BATT} = 3.5 V P_{IN} = 6 dBm T_{CASE} = +25 °C	—	—	–79	

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

Table 10. SKY77336 Electrical Specifications [1]

1800 / 1900 Tx GMSK							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM1800	f	—	1710	—	1785	MHz
	GSM1900		—	1850	—	1910	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Output Power (average)		P_{OUT}	P_{IN} = 6 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C	32.0	33	—	dBm
		P_{OUT_DEG}	P_{IN} = 0 dBm V_{BATT} = 3.4 V – 4.8 V T_{CASE} = –20 °C to 85 °C V_{APC} is set to deliver P_{OUT} = 32 dBm at V_{BATT} = 3.5 V T_{CASE} = +25 °C	30.5	—	—	
Power Added Efficiency		PAE	P_{IN} = 6 dBm P_{OUT} = Max. V_{BATT} = 3.5 V T_{CASE} = +25° C duty cycle = 1:8	48	53	—	%
Phase Change			The change in phase for P_{OUT} V_{APC} = sawtooth signal f = 2166 Hz $P_{OUT} \leq$ 32 dBm	—	1		deg./dB
Dynamic Range			—	52	—	—	dB

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

Table 11. SKY77336 Electrical Specifications [1]

1800 / 1900 Tx EDGE							
Parameter		**Symbol**	**Condition**	**Minimum**	**Typical**	**Maximum**	**Unit**
Frequency Range	GSM1800	f	—	1710	—	1785	MHz
	GSM1900		—	1850	—	1910	
Input Power		P_{IN}	—	3.0	6.0	8.0	dBm
Supply Voltage		V_{BATT}	—	3.0	3.5	4.8	V
Output Power (average)		P_{OUT}	P_{IN} = 6 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C	28.5	—	—	dBm
		$P_{OUT\_DEG\ 1}$	P_{IN} = 0 dBm V_{BATT} = 3.0 V – 4.8V T_{CASE} = –30 °C to 90 °C at V_{BATT} = 3.5 V T_{CASE} = +25 °C	28	—	—	
Power Added Efficiency		PAE	P_{IN} = 6 dBm P_{OUT} = 28.5 dBm V_{BATT} = 3.5 V T_{CASE} = +25 °C duty cycle = 1:8	26	30	—	%

1 Unless otherwise specified:
50 Ω system; pulsed operation with pulse width 2308 µs; duty cycle 1:8; T_{CASE} = –20 °C to 85 °C; V_{BATT} = 3.0 V to 4.8 V

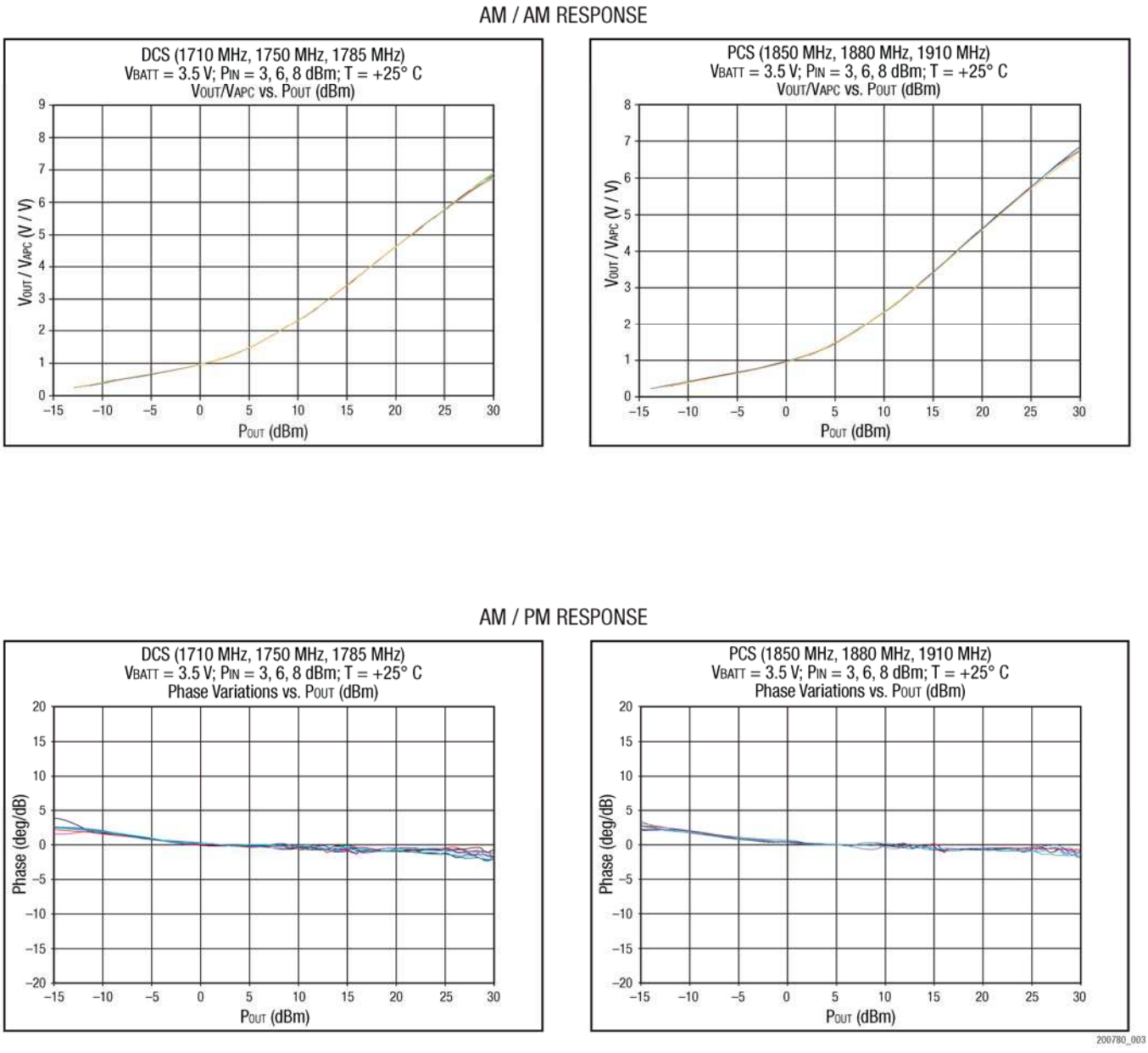

Figure 3. Typical AM/AM and AM/PM Response Charts for High Band – SKY77336 Power Amplifier Module

Package Dimensions

Figure 4 is a mechanical drawing of the pad layout for the SKY77336, a 16-pad, leadless, PA module. 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.

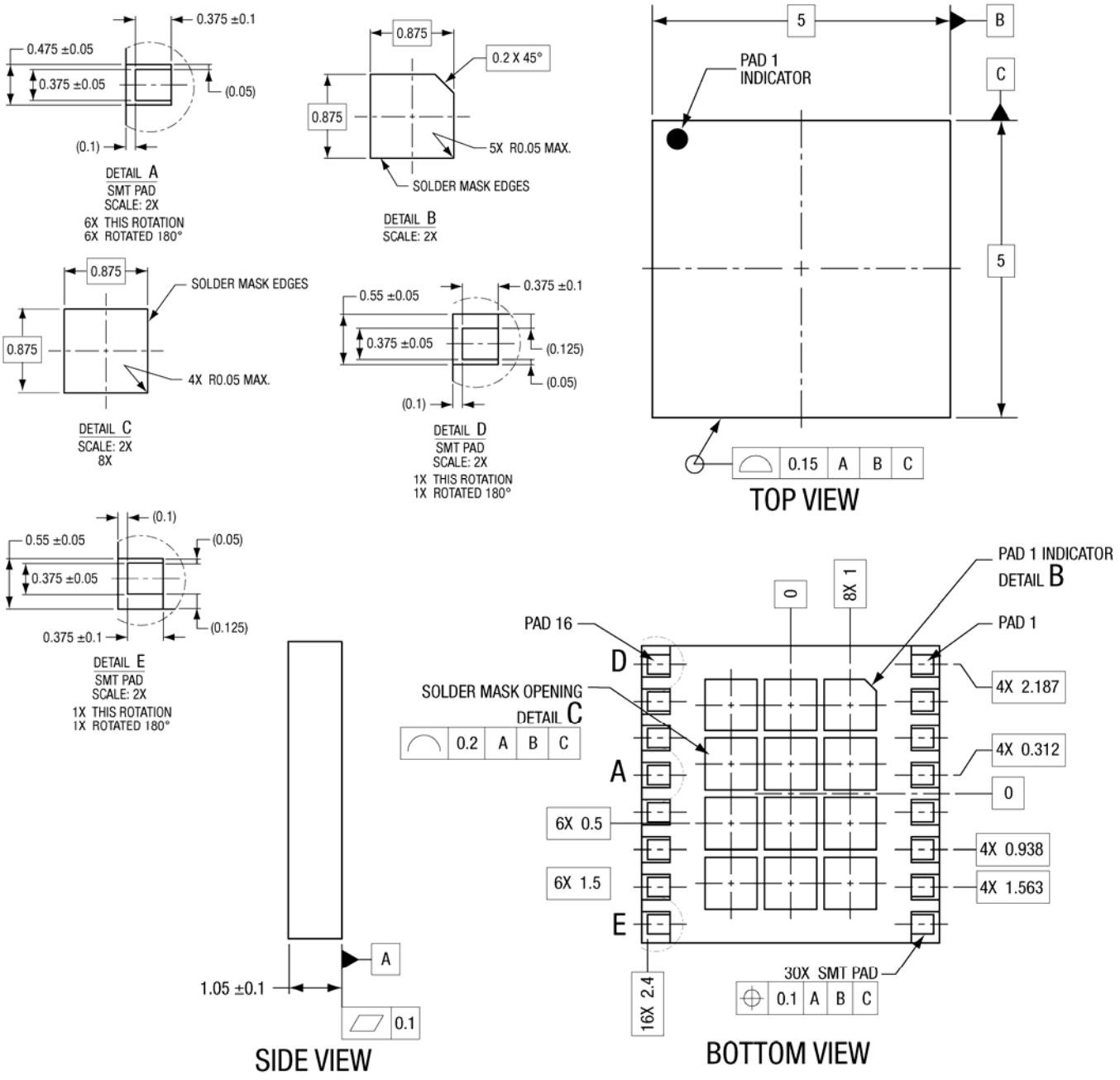

Figure 4. Dimensional Diagram for 5 mm x 5 mm x 1.05 mm, 16-Pad MCM Package – SKY77336 Specific

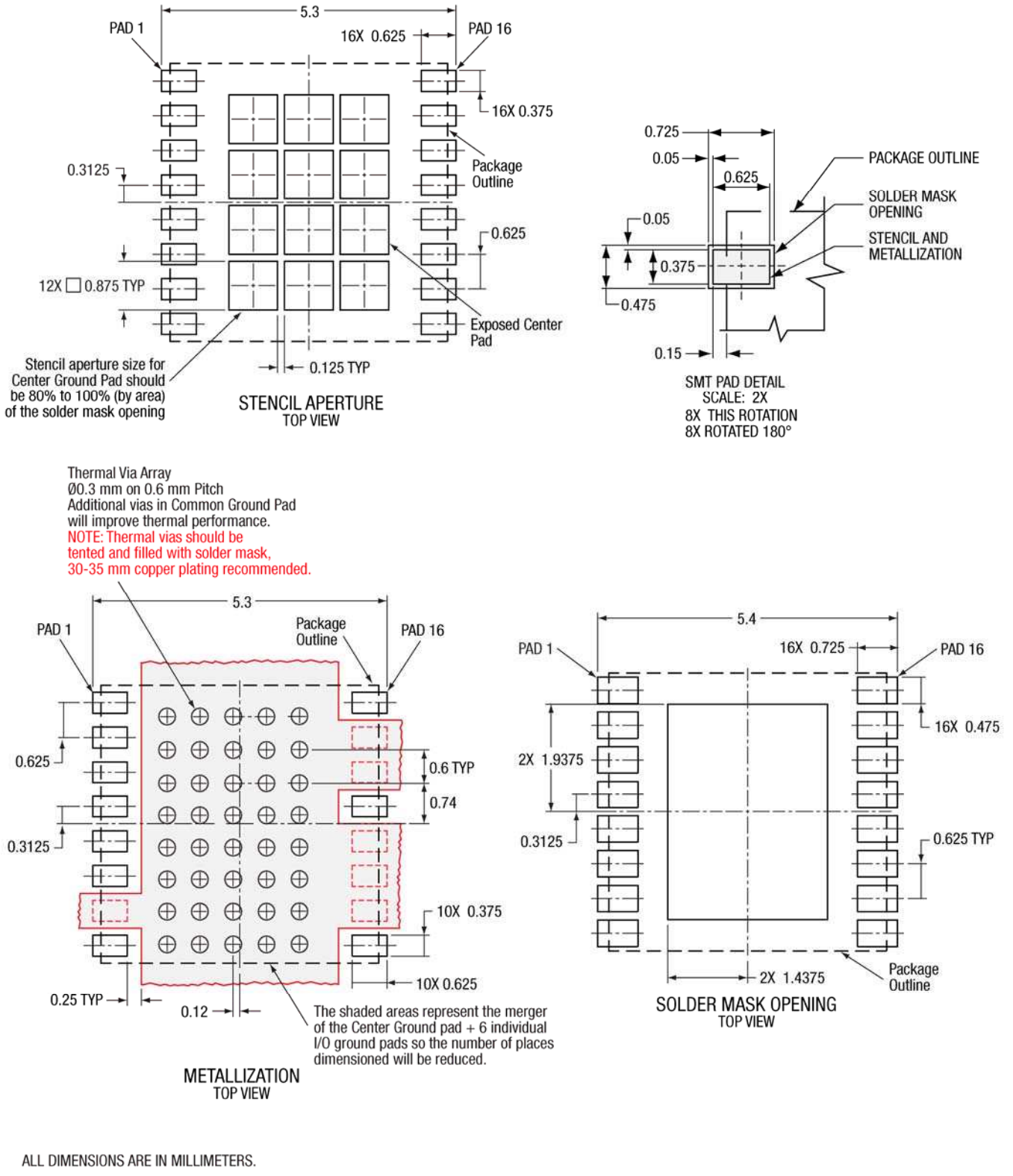

Figure 5. Phone Board Layout Footprint for 5 x 5 mm MCM Package – SKY77336

Package Description

Figure 6 shows the device pad configuration and numbering convention, which starts at the upper left as indicated, and increments counter-clockwise around the package. Table 12 lists the pad names and signal descriptions. Figure 1 interprets typical case markings.

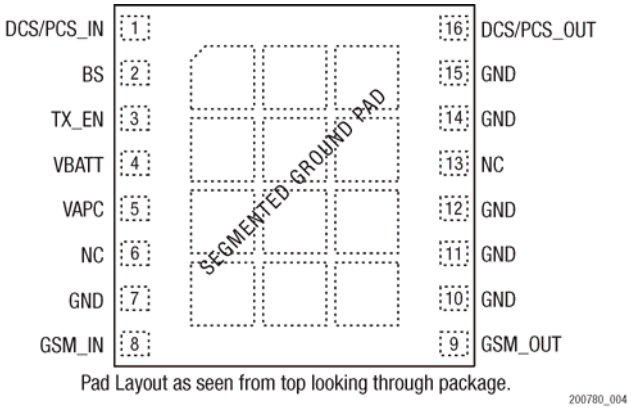

Figure 6. SKY77336 Pad Configuration

Table 12. Pad Signal Names and Functions

Pad	Signal	Function
1	DCS/PCS_IN	Input Tx signal 1800 / 1900 MHz
2	BS	Band Select
3	TX_EN	Enable
4	VBATT	Battery Supply Voltage
5	VAPC	Input modulating signal / power control
6	NC	No connect
7	GND	Ground
8	GSM_IN	Input Tx signal 850 / 900 MHz
9	GSM_OUT	Output Tx signal 850 / 900 MHz
10	GND	Ground
11	GND	Ground
12	GND	Ground
13	NC	No Connect
14	GND	Ground
15	GND	Ground
16	DCS_OUT	Output Tx signal 1800 / 1900 MHz
GROUND PAD		Segmented Ground Pad is device underside

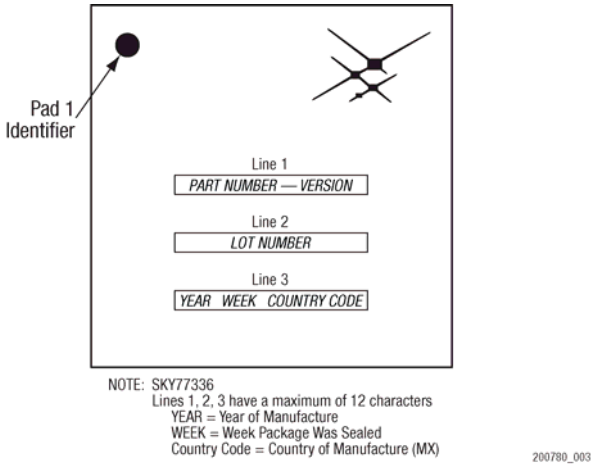

Figure 7. Typical Case Marking

Package Handling Information

Because of its sensitivity to moisture absorption, this device package is baked and vacuum–packed prior to shipment in accordance with IPC J–STD 033 guidelines. Instructions on the shipping container label are in accordance with IPC J–STD 020B regarding exposure to moisture after the container seal is broken. These instructions must be followed; otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

SKY77336 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

SKY77336 is a Class 1 device. ESD testing was performed in compliance with JEDEC standards JESD22–A114 (Human Body Model), JESD22–A115 (Machine Model), and JESD22–C101 (Charged Device Model).

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' most stringent criteria fail 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
SKY77336	SKY77336		5 x 5 x 1.05 MCM–16	–25 °C to +85 °C

Revision History

Revision	Date	Description
A	November 12, 2007	Initial Release – Preliminary Information
B	March 13, 2008	Revise: Table 2, add Nominal column; Page 5, Table 5 (2 of 8), Forward Isolation, first row, Maximum Column: change –10 to –30
C	May 28, 2008	Revise: Features (p1) Low profile 1.0 to 0.9 Add: GREEN tag (p1)
D	July 24, 2008	Revise: Figure 6 and Table 6, rename pad 13 from VCC_OUT to NC
E	September 19, 2008	Revise: Features (p1) Low profile 0.9 mm to 1.15 mm Max.; Tables 2, 5-11; Figure 4

References

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

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

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

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-A114 Human Body Model (HBM)

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-A115 Machine Model (MM)

Electrostatic Discharge Sensitivity (ESD) Testing: JEDEC Standard, JESD22-C101 (Charged Device Model)