SKY77758 Broadband Power Amplifier Module for WCDMA/ HSDPA/ HSUPA/ HSPA+ (Bands I, II, V, VIII)

APPLICATIONS

- WCDMA handsets
- HSDPA
- HSUPA
- HSPA+

Features

- Low voltage positive bias supply: 3.1 V to 4.2 V
- Good linearity
- High efficiency
  - 44% at maximum power output
- Large dynamic range
- Small, low profile package
  - 3 mm x 4.2 mm x 0.9 mm
  - 14-pad configuration
- Power down control
- InGaP
- Digital Enable
- No V_{REF} required
- CMOS compatible control signals
- Integrated Directional Coupler

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to Skyworks *Definition of Green*™, document number SQ04-0074.

The SKY77758 Power Amplifier Module (PAM) is a fully matched, 14-pad, surface mount module developed for Wideband Code Division Multiple Access (WCDMA) applications. This small and efficient module packs full coverage for WCDMA Bands I, II, V, VIII into a single compact package. The SKY77758 meets the stringent spectral linearity requirements of WCDMA, HSDPA, HSUPA, HSPA+ transmission, with high power added efficiency to maximum power output. A directional coupler integrated into the module eliminates 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 SKY77758 PAM 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. No VREF voltage is required. Power down is accomplished by setting the voltage on VEN_HB and VEN_LB 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.
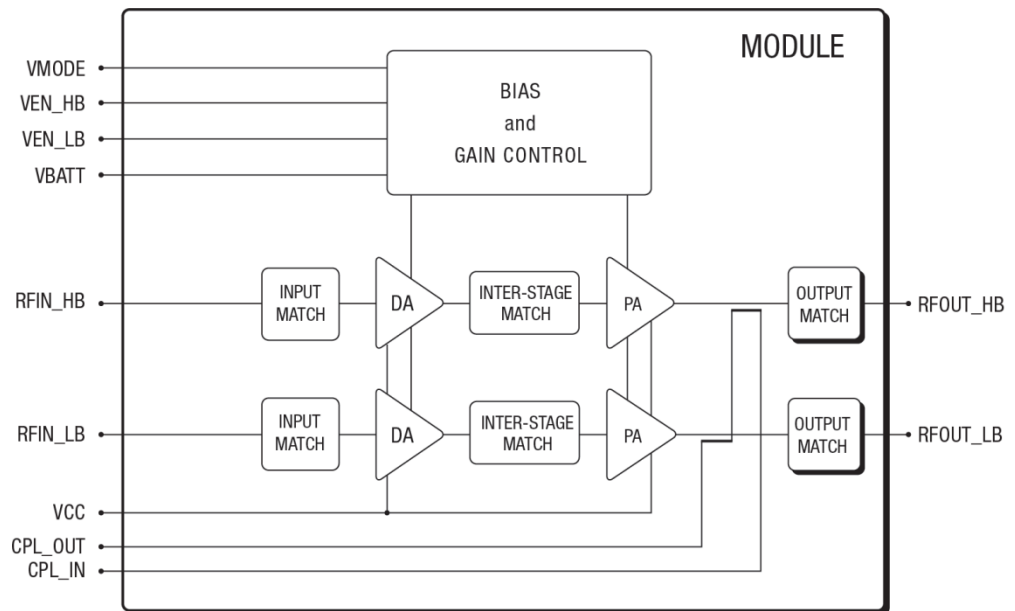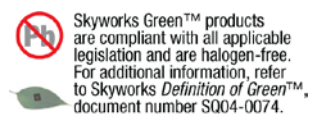
Figure 1. SKY77758 Functional Block Diagram

Electrical Target Specifications

The following tables list the electrical specifications of the SKY77758 Power Amplifier Module. Absolute maximum ratings are listed in Table 1. WCDMA recommended operating conditions for Bands I, II, V, VIII are listed in Table 3. Performance Parameters for the WCDMA bands are shown in Tables 4 through 7.

Table 1. SKY77758 Absolute Maximum Rating

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

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Input Power		P_{IN}			10.0	dBm
Supply Voltage	No RF	V_{BATT}, V_{CC}			6.0	Volts
	RF				4.6	
Mode Control Voltage		V_{MODE}			4.2	Volts
Enable Control Voltage		V_{EN_LB}, V_{EN_HB}			4.2	Volts
Case Temperature[1]	Operating	T_{CASE}	−30	+25	+100	°C
	Storage	T_{STG}	−40	—	+150	

[1] Case Operating Temperature (T_{CASE}) refers to the temperature of the GROUND PAD at the underside of the package.

Table 2. SKY77758 Modes of Operation

Power Setting		Band	V_{EN_HB}	V_{EN_LB}	V_{MODE}	V_{BATT}
Power Down Mode		—	Low	Low	Low	On
Standby Mode		—	Low	Low	X	On
Low Power Mode	($P_{OUT} \leq 17$ dBm)	I, II	High	Low	High	On
High Power Mode	($P_{OUT} = 17$ dBm to P_{MAX})	I, II	High	Low	Low	On
Low Power Mode	($P_{OUT} \leq 17$ dBm)	V, VIII	Low	High	High	On
High Power Mode	($P_{OUT} = 17$ dBm to P_{MAX})	V, VIII	Low	High	Low	On

Table 3. SKY77758 WCDMA Recommended Operating Conditions

WCDMA Bands I, II, V and VIII						
Parameter		Symbol	Minimum	Nominal	Maximum	Unit
Supply Voltage		V_{BATT}, V_{CC}	3.1	3.4	4.2	Volts
Mode Control Voltage	Low	V_{MODE}	0.0	—	0.5	Volts
	High		1.35	1.8	3.1	
Mode Control Current		I_{MODE}			0.1	mA
Enable Control Voltage	Tx Disabled	V_{EN_LB}, V_{EN_HB}	0.0		0.5	Volts
	Tx Enabled		1.35	1.8	3.1	
Enable Control Current		I_{EN}			0.1	mA
Case Operating Temperature	WCDMA	T_{CASE}	−20	+25	+85	°C

SKY77758 BROADBAND POWER AMPLIFIER MODULE for
WCDMA/ HSDPA/ HSUPA/ HSPA+/ LTE (BANDS I, II, V, VIII)/ CDMA (BANDS I, II, V)

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Table 4. Electrical Specifications for SKY77758 Nominal Operating Conditions – WCDMA Band I

Refer to Table 6: Standard Test Configuration – WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Parameter		Symbol	Condition	Minimum	Typical	Maximum	Unit
WCDMA Band I (1920 MHz–1980 MHz); NTC; V_{CC} = 3.4 V; T_{CASE} = +25 °C							
Frequency				1920	1950	1980	MHz
Maximum Output Power in High Power Mode		P_{MAX}	Rel99 WCDMA waveform			28	dBm
Linear Output Power		P_{OUT_LOW}			17		dBm
		P_{OUT_HGH}			28		
Quiescent Current		I_{CQ_LOW}			TBD		mA
		I_{CQ_HIGH}			75		
Power Added Efficiency		PAE_{LOW}			TBD		%
		PAE_{HIGH}			43		
Gain		G_LOW			16.5		dB
		G_HIGH			28.5		
Enable Control Current		I_{EN_HB}, I_{EN_LB}			0.01	0.1	mA
Mode Control Current		I_{MODE}			0.01	0.1	mA
Tx Noise in RX Band		RxN			−140		dBm/Hz
		RxGPS			−142		
		RxISM			−141		
Harmonic Suppression	Second	$2f_0$			−38		dBc
	Third	$3f_0$			−55		
Input Voltage Standing Wave Ratio		VSWR			2.0:1		—
Stability (all spurious)		S	VSWR = 8:1, all phases, power levels			−60	dBc
Ruggedness		Ru		10:1 No damage or degradation			
Adjacent Channel Leakage Power Ratio	5 MHz offset	ACLR1			−42		dBc
	10 MHz offset	ACLR2			−54		
Error Vector Magnitude		EVM			2		%
Coupling Factor		CPL		19	20	21	dB
Coupling Factor Variation		CPL_V		TBD		TBD	dB
Rise / Fall Time	DC	$T_{ON}DC$				20	µs
		$T_{OFF}DC$				20	
	RF	$T_{ON}RF$				5	
		$T_{OFF}RF$				5	
Leakage Current		I_{LEAK}	V_{CC} = high, Enable = low, V_{MODE} = low			10	µA

Table 5. Electrical Specifications for SKY77758 Nominal Operating Conditions – WCDMA Band II

Refer to Table 6: Standard Test Configuration – WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Parameter		Symbol	Condition	Minimum	Typical	Maximum	Unit
WCDMA Band II (1850 MHz–1910 MHz); NTC; V_{CC} = 3.4 V; T_{CASE} = +25 °C						
Frequency				1850	1880	1910	MHz
Maximum Output Power in High Power Mode		P_{MAX}	Rel99 WCDMA waveform			29	dBm
Linear Output Power		P_{OUT_LOW}			17		dBm
		P_{OUT_HGH}			29		
Quiescent Current		I_{CQ_LOW}			TBD		mA
		I_{CQ_HIGH}			75		
Power Added Efficiency		PAE_LOW			TBD		%
		PAE_HIGH			46		
Gain		G_LOW			TBD		dB
		G_HIGH			28		
Enable Control Current		I_{EN_HB}, I_{EN_LB}			0.01	0.1	mA
Mode Control Current		I_{MODE}			0.01	0.1	mA
Tx Noise in RX Band		RxN			−138		dBm/Hz
		RxGPS			−142		
		RxISM			−144		
Harmonic Suppression	Second	$2f_0$			−40		dBc
	Third	$3f_0$			−55		
Input Voltage Standing Wave Ratio		VSWR			2.0:1		
Stability (all spurious)		S	VSWR = 8:1, all phases, power levels			−60	dBc
Ruggedness		Ru	10:1 No damage or degradation				
Adjacent Channel Leakage power Ratio	5 MHz offset	ACLR1			−40		dBc
	10 MHz offset	ACLR2			−54		
Error Vector Magnitude		EVM			2		%
Coupling Factor		CPL		19	20	21	dB
Coupling Factor Variation		CPL_V		TBD		TBD	dB
Rise / Fall Time	DC	$T_{ON}DC$				20	μs
		$T_{OFF}DC$				20	
	RF	$T_{ON}RF$				5	
		$T_{OFF}RF$				5	
Leakage Current		I_{LEAK}	V_{CC} = high, Enable = low, V_{MODE} = low			10	μA

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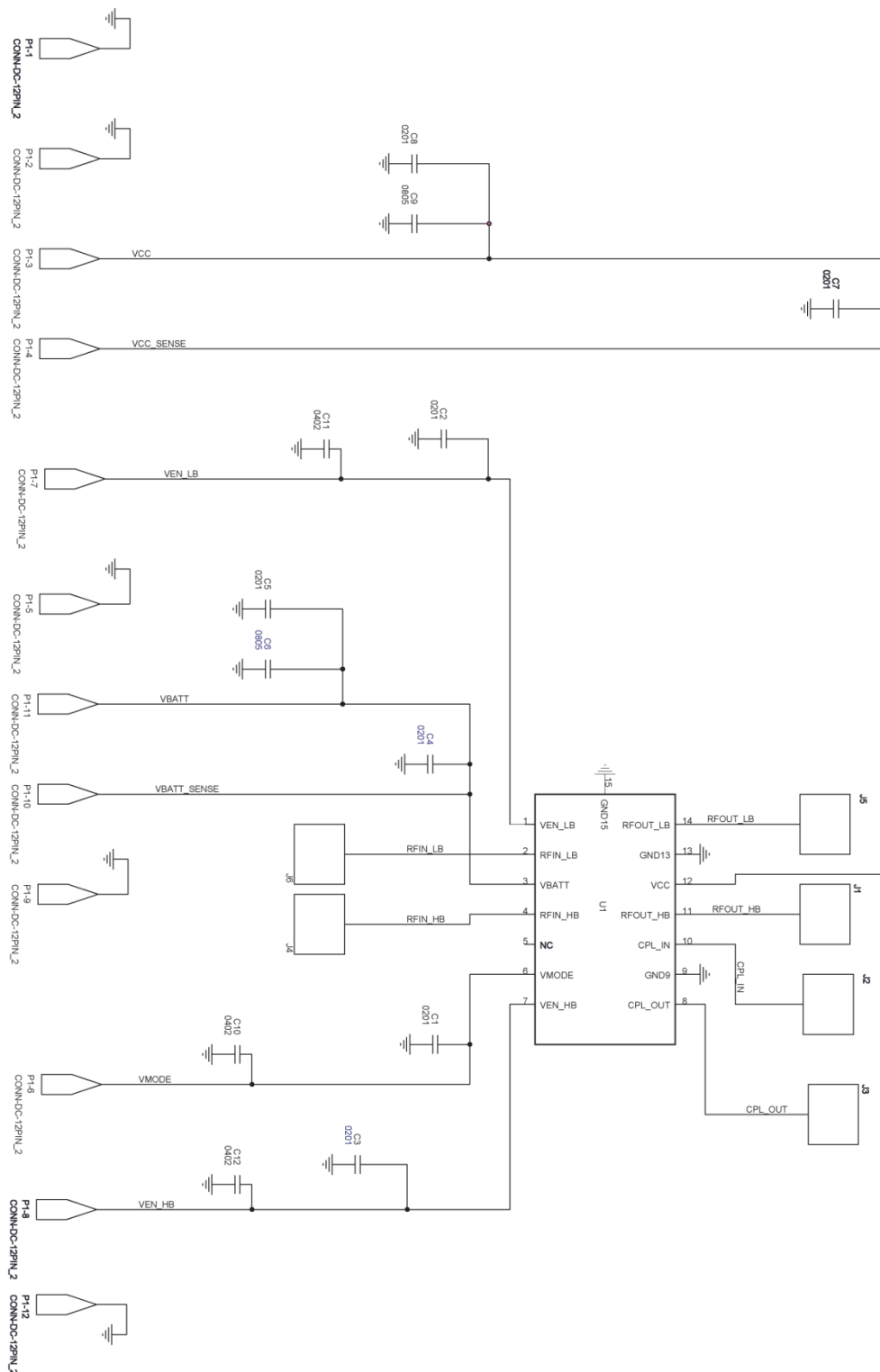
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Table 6. Electrical Specifications for SKY77758 Nominal Operating Conditions – WCDMA Band V

Refer to Table 6: Standard Test Configuration – WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

WCDMA Band V (824 MHz–849 MHz); NTC; V_{CC} = 3.4 V; T_{CASE} = +25 °C							
Parameter		Symbol	Condition	Minimum	Typical	Maximum	Unit
Frequency				824	836.5	849	MHz
Maximum Output Power in High Power Mode		P_{MAX}	Rel99 WCDMA waveform			28	dBm
Linear Output Power		P_{OUT_LOW}			17		dBm
		P_{OUT_HIGH}			28		
Quiescent Current		I_{CQ_LOW}			TBD		mA
		I_{CQ_HIGH}			110		
Power Added Efficiency		PAE_{LOW}			TBD		%
		PAE_{HIGH}			38		
Gain		G_{LOW}			TBD		dB
		G_{HIGH}			30		
Enable Control Current		I_{EN_HB}, I_{EN_LB}			0.01	0.1	mA
Mode Control Current		I_{MODE}			0.01	0.1	mA
Tx Noise in RX Band		RxN			−138		dBm/Hz
		RxGPS			−140		
		RxISM			−145		
Harmonic Suppression	Second	$2f_0$			−38		dBc
	Third	$3f_0$			−55		
Input Voltage Standing Wave Ratio		VSWR			2.0:1		
Stability (all spurious)		S	VSWR = 8:1, all phases, power levels		—	−60	dBc
Ruggedness		Ru		10:1 No damage or degradation			
Adjacent Channel Leakage power Ratio[1,2,3]	5 MHz offset	ACLR1			−42		dBc
	10 MHz offset	ACLR2			−54		
Error Vector Magnitude		EVM			2		%
Coupling Factor		CPL		19	20	21	dB
Coupling Factor Variation		CPL_V		TBD		TBD	dB
Rise / Fall Time	DC	$T_{ON}DC$				20	µs
		$T_{OFF}DC$				20	
	RF	$T_{ON}RF$				5	
		$T_{OFF}RF$				5	
Leakage Current		I_{LEAK}	V_{CC} = high, Enable = low V_{MODE} = low			10	µA

Table 7. Electrical Specifications for SKY77758 Nominal Operating Conditions – WCDMA Band VIII

Refer to Table 6: Standard Test Configuration – WCDMA Voice Mode (Uplink Reference Measurement Channel: 12.2 kbps)

Parameter		Symbol	Condition	Minimum	Typical	Maximum	Unit
WCDMA Band VIII (880 MHz–915 MHz); NTC; V_{CC} = 3.4 V; T_{CASE} = +25 °C							
Frequency				880	897.5	915	MHz
Maximum Output Power in High Power Mode		P_{MAX}	Rel99 WCDMA waveform			28.5	dBm
Linear Output Power[1,2]		P_{OUT_LOW}			17		dBm
		P_{OUT_HIGH}			28.5		
Quiescent Current		I_{CQ_LOW}			TBD		mA
		I_{CQ_HIGH}			110		
Power Added Efficiency		PAE_{LOW}			TBD		%
		PAE_{HIGH}			42		
Gain		$G_{\_LOW}$			17.0		dB
		$G_{\_HIGH}$			29.5		
Enable Control Current		I_{EN_HB}, I_{EN_LB}			0.01	0.1	mA
Mode Control Current		I_{MODE}			0.01	0.1	mA
Tx Noise in RX Band		RxN			−138		dBm/Hz
		RxGPS			−140		
		RxISM			−146		
Harmonic Suppression	Second	$2f_0$			−40		dBc
	Third	$3f_0$			−55		
Input Voltage Standing Wave Ratio		VSWR			2.0:1		—
Stability (all spurious)		S	VSWR = 8:1, all phases, power levels		—	−60	dBc
Ruggedness		Ru	10:1 No damage or degradation				
Adjacent Channel Leakage power Ratio[1,2,3]	5 MHz offset	ACLR1			−42		dBc
	10 MHz offset	ACLR2			−52		
Error Vector Magnitude		EVM			2		%
Coupling Factor		CPL		19	20	21	dB
Coupling Factor Variation		CPL_V		TBD		TBD	dB
Rise / Fall Time	DC	$T_{ON}DC$				20	µs
		$T_{OFF}DC$				20	
	RF	$T_{ON}RF$				5	
		$T_{OFF}RF$				5	
Leakage Current		I_{LEAK}	V_{CC} = high, Enable = low V_{MODE} = low			10	µA

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WCDMA/ HSDPA/ HSUPA/ HSPA+/ LTE (BANDS I, II, V, VIII)/ CDMA (BANDS I, II, V)
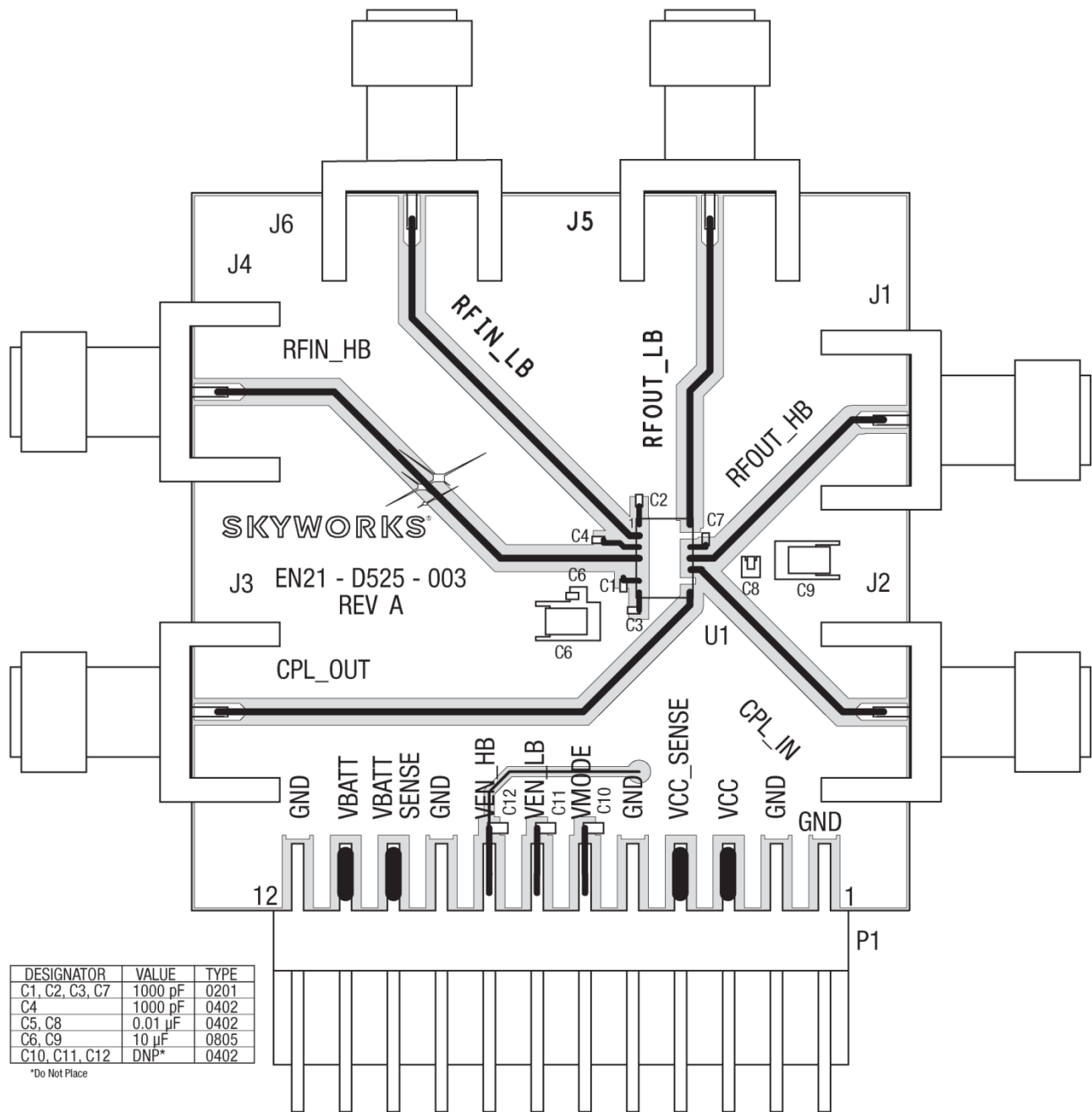
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Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77758, the evaluation board schematic and assembly diagrams are included for preliminary analysis and design. Figure 2 is the basic schematic of the board in Figure 3.

Figure 2. SKY77758 Evaluation Board Schematic Diagram

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DESIGNATOR	VALUE	TYPE
C1, C2, C3, C7	1000 pF	0201
C4	1000 pF	0402
C5, C8	0.01 µF	0402
C6, C9	10 µF	0805
C10, C11, C12	DNP*	0402

*Do Not Place

Figure 3. SKY77758 Evaluation Board Assembly Diagram

SKY77758 BROADBAND POWER AMPLIFIER MODULE for
WCDMA/ HSDPA/ HSUPA/ HSPA+/ LTE (BANDS I, II, V, VIII)/ CDMA (BANDS I, II, V)

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Package Dimensions

The SKY77758 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.
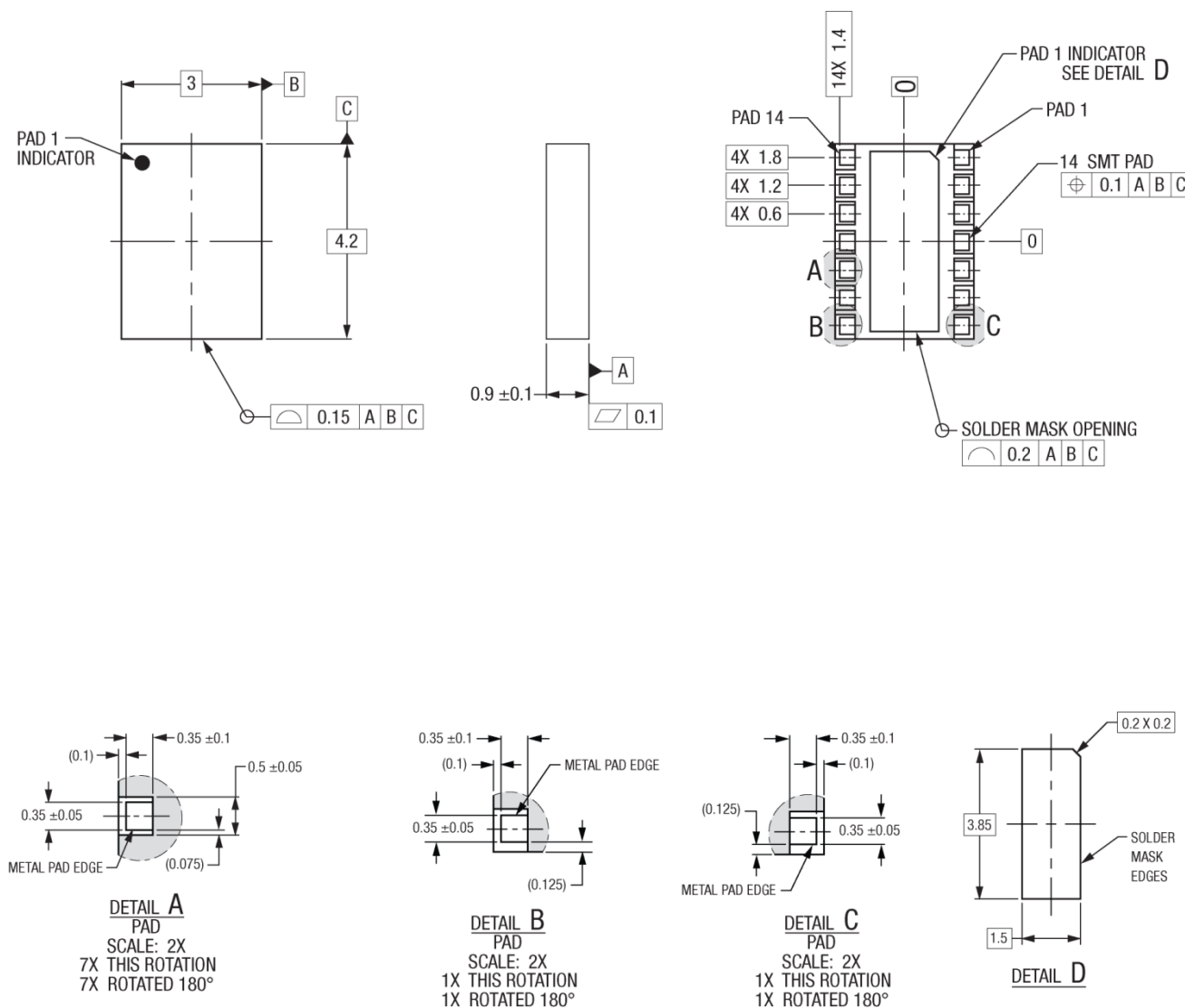
NOTES: UNLESS OTHERWISE SPECIFIED.
1. DIMENSIONING AND TOLERANCING IN ACCORDANCE WITH ASME Y14.5-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. PAD DEFINITIONS PER DETAILS ON DRAWING

Figure 4. SKY77758 Package Drawing – 3 mm x 4.2 mm x 0.9 mm, 14-pad (All Views)

STENCIL APERTURE SIZE FOR CENTER GROUND PAD SHOULD BE 80% TO 100% (BY AREA) OF THE SOLDER MASK OPENING OF THE PACKAGE.

3.3
4X 0.075
8X 0.8
4X 0.15
8X 0.075
8X 0.525
PACKAGE OUTLINE

STENCIL APERTURE
TOP VIEW

3.45
1.5
3.85
PACKAGE OUTLINE

SOLDER MASK OPENING
TOP VIEW

PACKAGE OUTLINE
0.75
0.60
0.075
0.075
0.35
0.50
STENCIL AND METALLIZATION
SOLDER MASK OPENING
0.15

SMT PAD DETAIL
SCALE: 2X
7X THIS ROTATION
7X ROTATED 180 °

PAD 1
(3.3)
PAD 14
0.25 TYP

THERMAL VIA ARRAY
Ø0.3 mm ON 0.6 mm PITCH
ADDITIONAL VIAS IN COMMON
GROUND PAD WILL IMPROVE THERMAL
AND ELECTRICAL PERFORMANCE.
NOTE: THERMAL VIAS SHOULD BE TENTED
WITH SOLDER MASK 30-35 µm COPPER
PLATING RECOMMENDED.

THE SHADED AREA REPRESENTS THE MERGER
OF THE CENTER GROUND + 2 INDIVIDUAL I/O GROUND
PADS. ALL I/O GROUND PADS SHOULD HAVE AT LEAST
ONE VIA CONNECTING TO INTERNAL GROUND PLANES
FOR OPTIMUM ELECTRICAL PERFORMANCE.

0
4X 0.6
4X 1.2
4X 1.8
PACKAGE OUTLINE
(1.8)
(0.6)
0
2X 1.35

METALLIZATION
TOP VIEW

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Figure 5. PCB Layout Footprint for 3 x 4.2 mm, 14-pad Package – SKY77758

SKY77758 BROADBAND POWER AMPLIFIER MODULE for
WCDMA/ HSDPA/ HSUPA/ HSPA+/ LTE (BANDS I, II, V, VIII)/ CDMA (BANDS I, II, V)

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Product Description

Figure 6 shows each pad function and the pad numbering convention, which starts with pad 1 in the lower left and increments clockwise around the package. Figure 7 illustrates typical case markings.

Pad layout as seen from Top View looking through the package

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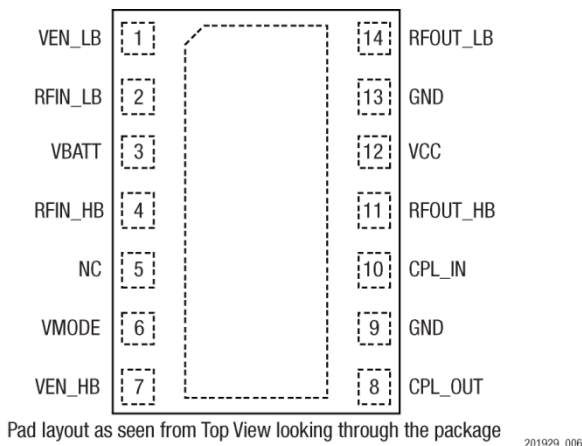
Figure 6. SKY77758 14-pad Configuration and Pad Names (Top View)

TBD

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 SKY77758 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 (ESD) Sensitivity

To avoid ESD damage, both latent and visible, it is very important that the product assembly and test areas follow the 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 1,000 MΩ 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

TBD

Figure 8. Dimensional Diagram for Carrier Tape Body Size 3 mm x 4.2 mm x 0.9 mm – MCM / RFLGA

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Ordering Information

Order Number	Manufacturing Part Number	Evaluation Board Part Number
SKY77758	SKY77758-	EN21-D525-003 REV A

Revision History

Revision	Date	Description
A	August 13, 2012	Initial Release – PRELIMINARY Information

References

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

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