PRELIMINARY DATA SHEET

SKY77433 Front-End Module for WCDMA / HSDPA / HSUPA (Tx 1920-1980 MHz), (Rx 2110-2170 MHz)

Applications

- Digital cellular (WCMDA) handsets

Features

- High Speed Downlink Packet Access (HSDPA)
- High Speed Uplink Packet Access (HSUPA)
- Low quiescent current
  - 20 mA
- Low current consumption
  - 500 mA
- Integrated Power Detector
- 16-pad package
- Small profile
  - 4 mm x 7 mm x 1.05 mm
- Low voltage
  - 3.1 V to 4.45 V
- Digital enable pad
- Highly integrated, user friendly solution
- InGaP HBT
- Integrated interstage filter and duplexer
- Supports low collector voltage operation
- Requires few external components

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

The SKY77433 Front-End Module (FEM) is a fully matched, 16-pad surface mount module developed for WCDMA applications. Small and efficient, this WCDMA FEM integrates the interstage filter, the input matching, the power amplifier, the output matching, the power detection, and the duplexer into a single 7 mm x 4 mm x 1.05 mm package.

The SKY77433 meets the stringent spectral requirements of HSDPA standards up to 25.2 dBm output power. The FEM incorporates an InGaP HBT PA and contains circuitry to optimize power detector performance. Different control pads are available to enhance the performance of the FEM at different power levels.

Integration of the RF front-end greatly simplifies the design of the handset radio as all critical matching between the interstage filter, PA, power detection, and duplexer is optimized within the module. By optimizing the efficiency of the InGaP HBT PA MMIC and reducing the RF loss between the integrated components, this FEM achieves current as low as 500 mA at maximum output power (25.2 dBm) that significantly improves the talk time of the WCDMA handset. This small package uses Skyworks' low cost, multi-laminate substrate technology and is approximately half the size of individually packaged component solutions. The SKY77433 front-end module can save handset designers significant board space and design-cycle time.

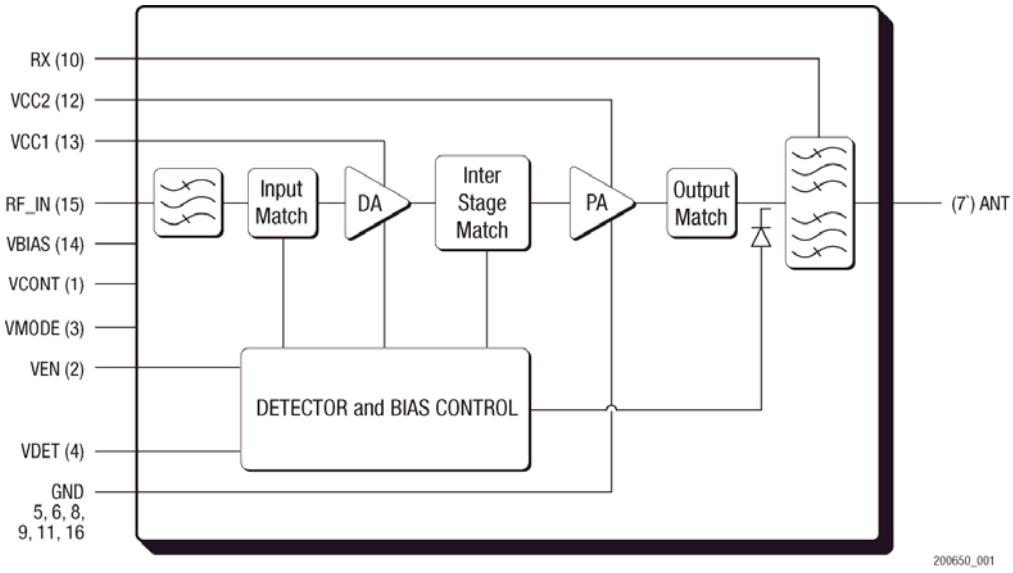


Figure 1. Functional Block Diagram

Electrical Specifications

The following tables list the electrical characteristics of the SKY77433 Front-End Module for WCDMA. Table 1 lists the absolute maximum ratings; Table 2 specifies the recommended operating conditions necessary for achieving the electrical performance listed in Table 3 and Table 4 through Table 7 specifies the standard test configurations in WCDMA, HSDPA, and HSUPA modes, respectively. Table 8 lists parameters specific to power detection performance over recommended operating conditions, including mismatch at the module antenna port up to a VSWR of 2.5:1 for all phase angles. Table 9 shows nominal duplexer performance.

Table 1. Absolute Maximum Ratings [1]

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Input Power		P_{IN}	—	—	10.0	dBm
Supply Voltages	No RF	V_{CC1}, V_{CC2}, V_{BIAS}		3.4	6.0	Volt
	With RF			3.4	4.7	Volt
Bias Control Voltage		V_{CONT}	—	—	2.7	Volt
Mode Control Voltage		V_{MODE}	—	—	3.0	Volts
Enable Control Voltage		V_{EN}	—	—	3.0	Volt
Temperatures	Operating	T_{CASE}	–20	+25	+110	°C
	Storage	T_{STG}	–55	—	+125	

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

Table 2. Recommended Operating Conditions

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
Tx Channel Center Frequency		F_{Tx}	1922.4	1950.0	1977.6	MHz
Rx Channel Center Frequency		$F_{Rx} = F_{Tx} + 190$ MHz	2112.4	2140.0	2167.6	MHz
Supply Voltages		V_{CC1}, V_{CC2}	3.1 [1]	3.4	4.45	Volt
		V_{BIAS}	3.1	3.4	4.45	
Bias Control Voltage		V_{CONT}	0.5	—	1.9	Volt
Mode Control	Low Power Mode (LPM)	V_{MOD_L}	1.5	1.8	2.85	Volt
	High Power Mode (HPM)	V_{MOD_H}	0.0	0.0	0.56	
Enable Control Setting	Disabled	V_{EN_L}	0.0	0.0	0.56	Volt
	Enabled	V_{EN_H}	1.5	1.8	2.85	
Operating Temperature		T_{CASE}	–20	+25	+85	°C

[1] For V_{CC} < 3.4 V, maximum output power = P_{MAX2}

Table 3. Electrical Specifications for Nominal Operating Conditions [1] (1 of 2)

WCDMA (Wide Band Code Division Multiple Access)							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Linear Output Power		P_{MID}	$V_{CC} \geq 3.1$ V HPM, LPM	16.0	—	—	dBm
		P_{MAX2} [2]	$V_{CC} \geq 3.1$ V HPM	24.4	—	—	
		P_{MAX1} [2]	HPM	25.2	—	—	
Gain	Mid-Power	G_{MID}	LPMP_{MID}	11.0	—	23.0	dB
	High Power	G_{HIGH}	P_{MAX1}	19.5	—	28.5	
Current Consumption	Mid-Power	I_{CC}	LPM P_{MID}	—	—	55	mA
	High Power		P_{MAX1}	—	—	500	
Power Added Efficiency	Mid-Power	PAE_MID	LPM P_{MID}	5.3	—	—	%
	High Power	PAE_HIGH	P_{MAX1}	19.5	—	—	
Error Vector Magnitude		EVM	—			5	%
Adjacent Channel Leakage Ratio [3]	5 MHz	ACLR1	—	—	–40	—	dBc
	10 MHz	ACLR2		—	–54	—	
Harmonic Suppression	Second	$2fof$	P_{MAX1}	—	—	–33	dBm
	Third	$3fof$		—	—	–33	

Table 3. Electrical Specifications for Nominal Operating Conditions [1] (2 of 2)

[continued] *WCDMA (Wide Band Code Division Multiple Access)*						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Tx Noise Power in Rx Band	NRx1	P_{MAX1} 869–894 MHz RBW = 3.84 MHz	—	—	–61	dBm
	NRx2	P_{MAX1} 1575.42 MHz RBW = 2.046 MHz	—	—	–100	
	NRx3	P_{MAX1} 1884.5–1879.9 MHz RBW = 3.84 MHz	—	—	–61	
	NRx4	P_{MAX1} 2110–2170 MHz RBW = 3.84 MHz	—	—	–114	
	NRx5	P_{MAX1} 2400–2483.5 MHz RBW = 1.0 MHz	—	—	–90	
	NRx6	P_{MAX1} 921–925 MHz RBW = 100 kHz	—	—	–61	
	NRx7	P_{MAX1} 925–935 MHz RBW = 2.046 MHz	—	—	–61	
	NRx8	P_{MAX1} 1805–1881 MHz RBW = 3.84 MHz	—	—	–72	
	NRx9	P_{MAX1} 1893.5–1919.6 MHz RBW = 3.84 MHz	—	—	–42	
Input Voltage Standing Wave Ratio	VSWR	—	—	—	2:1	
Quiescent Current	I_{CQ}	—	—	—	25	mA
Control Current	I_{CONT}	—	—	—	1	mA
Digital Enable Current	I_{EN}	—	—	—	1	mA
Leakage Current	I_{LEAK}	V_{CC1}, V_{CC2}, V_{BIAS} = 4.45 V V_{CONT} = 0 V V_{EN} = 0 V V_{MODE} = 0 V	—	—	20	µA
Stability (spurious output)	S	8:1 VSWR, all phases	—	—	–65	dBc
Ruggedness – no damage [4]	Ru	—	10:1	—	—	

[1] Unless otherwise specified: V_{CC} = 3.4 V, Temp. = 25 °C.

[2] For STC1 WCDMA, STC2 HSDPA, and STC3 HSUPA modes test conditions. For STC4 HSUPA, power backoff = 2.6 dB.

[3] 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.

[4] All phases, time = 10 seconds, continuous WCDMA/HSDPA modulated signal, V_{CC} = 4.7 V, $P_O = P_{MAX1}$ + 1.5 dB, P_{IN_MAX} = +10 dBm.

Table 4. 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 5. 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-DPDCCH	15 kbps	64	256	Q	—	—	24/15	—	—	–3.012

Table 6. Standard Test Configuration – STC3 HSUPA 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	—	—	—	—	–19.391
DPDCH	960 kbps	1	4	I	—	15/15	—	—	—	–13.931
HS-DPCCH	15 kbps	64	256	Q	—	—	8/15	—	—	–19.391
E-DPCCH	15 kbps	1	256	I	—	—	—	10/15	—	–17.338
E-DPDCH	960 kbps	2	4	I	—	—	—	—	71.5/15	–0.371

Table 7. Standard Test Configuration – STC4 HSUPA Mode

Parameter	Level	Spread Code	Spread Factor	I/Q	βc	βd	βhs	βec	βed	Relative Power (dB)
DPCCH	15 kbps	0	256	Q	6/15	—	—	—	—	–12.499
DPDCH	960 kbps	1	4	I	—	15/15	—	—	—	–4.540
HS-DPCCH	15 kbps	64	256	Q	—	—	2/15	—	—	–22.041
E-DPCCH	15 kbps	1	256	I	—	—	—	12/15	—	–6.478
E-DPDCH	960 kbps	2	4	I	—	—	—	—	15/15	–4.425

Table 8. Electrical Specifications for Power Detector

Tx Power Detection						
Parameter	**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Detector Power Detect Range	P_{DET}		0.0	—	26.0	dBm
Detector Output Range	V_{DET}	3 dBm ≤ P_O ≤ 26 dBm	400 (rms)	—	1800 (peak)	mV

Table 9. Nominal Duplexer Performance

Antenna to Rx Parameter							
Parameter		**Symbol**	**Conditions**	**Minimum**	**Typical**	**Maximum**	**Unit**
Insertion Loss		IL_{Rx}	2110 MHz to 2170 MHz	—	—	2.0	dB
Ripple			Each Rx Frequency	–0.5	—	0.5	dB
Attenuation			DC to 12750 MHz	20	—	—	dB
		A_{RX1}	180 MHz to 200 MHz	40	—	—	
		A_{RX2}	703 MHz to 724 MHz	25	—	—	
		A_{RX3}	1055 MHz to 1085 MHz	45	—	—	
		A_{RX4}	1730 MHz to 1790 MHz	40	—	—	
	Tx Band	A_{RX5}	1920 MHz to 1980 MHz	50	—	—	
		A_{RX6}	2015 MHz to 2025 MHz	23	—	—	
		A_{RX7}	2025 MHz to 2050 MHz	13	—	—	
		A_{RX8}	2050 MHz to 2075 MHz	5	—	—	
	Tx + Rx	A_{RX9}	4030 MHz to 4150 MHz	35	—	—	
	2Tx + Rx	A_{RX10}	5950 MHz to 6130 MHz	35	—	—	
VSWR			—	—	—	2.0:1	
Input			—	—	—	30	dBm
Tx Power @ Rx Port			1920 MHz to 1980 MHz P_{MAX1}	—	—	–25	dBm

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77433, the evaluation board schematic and assembly diagrams are included for preliminary analysis and design. The basic schematic is shown in Figure 2 for the board assembly in Figure 3.

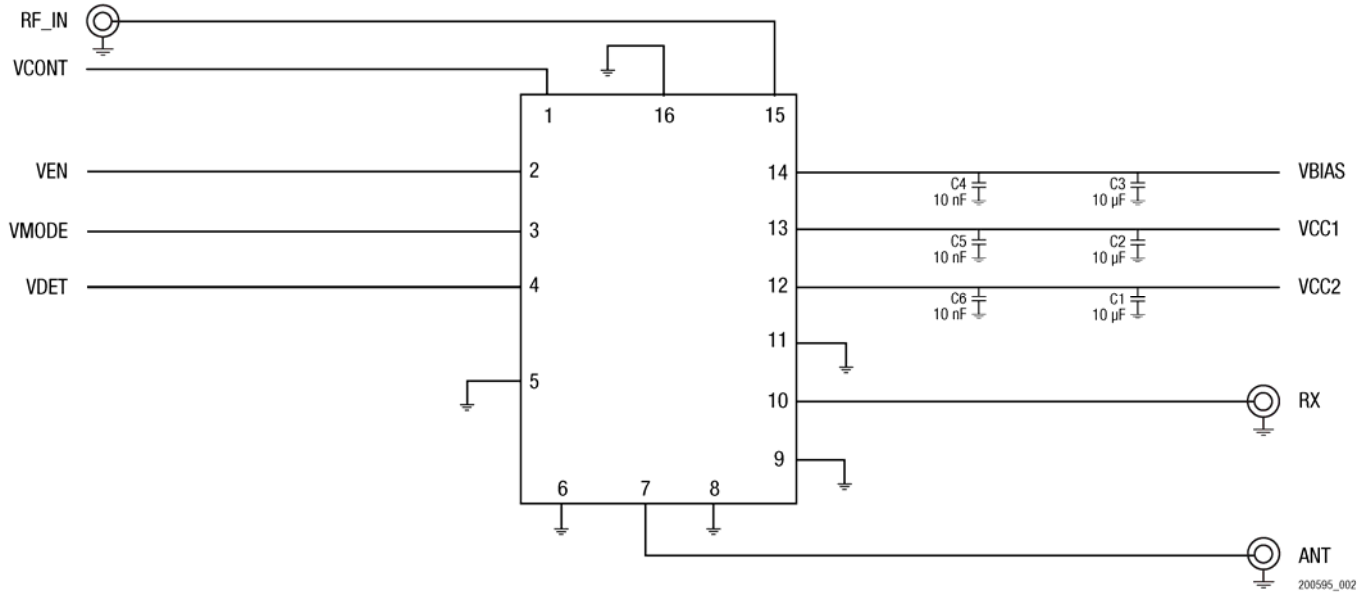


Figure 2. Evaluation Board Schematic Diagram

COMPONENT TABLE		
REF	VALUE	SIZE
C1	10 µF	1206
C2	10 µF	1206
C3	10 µF	1206
C4	10 nF	0402
C5	10 nF	0402
C6	10 nF	0402

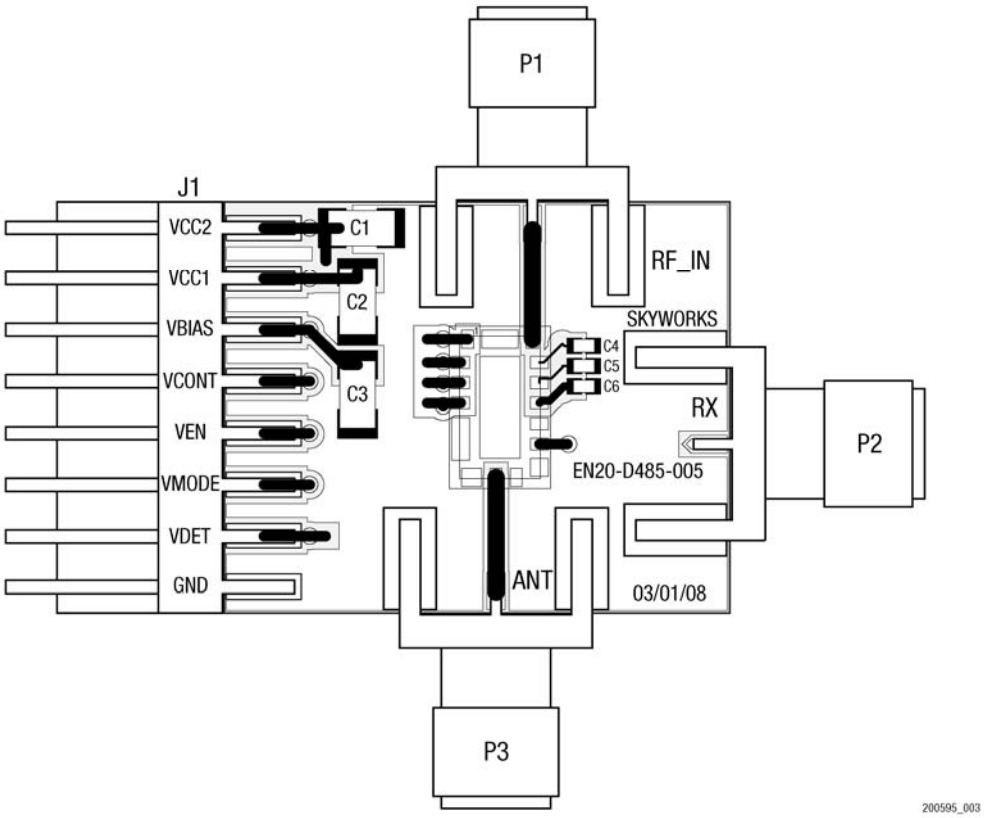
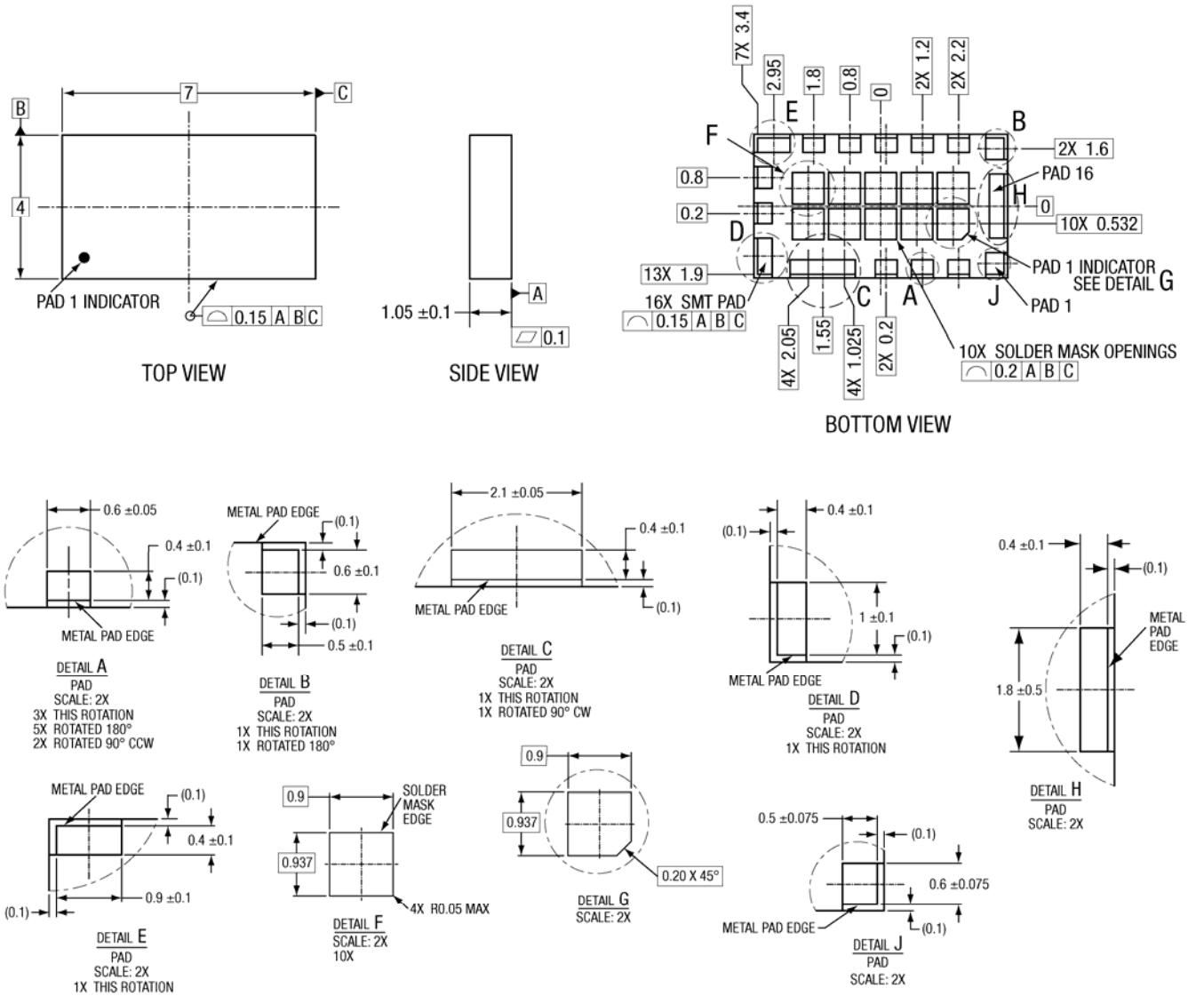


Figure 3. Evaluation Board Assembly Diagram

Package Dimensions

The SKY77433 is a multi-layer laminate base, overmold encapsulated modular package designed for surface-mounted 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 FEM 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 Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS.
3. PADS ARE SOLDER MASK DEFINED ON 3 EDGES & METAL DEFINED ON 1 EDGE.

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Figure 4. Dimensional Diagram for 7 x 4 x 1.05 mm, 16-Pad Package (All Views) – SKY77433

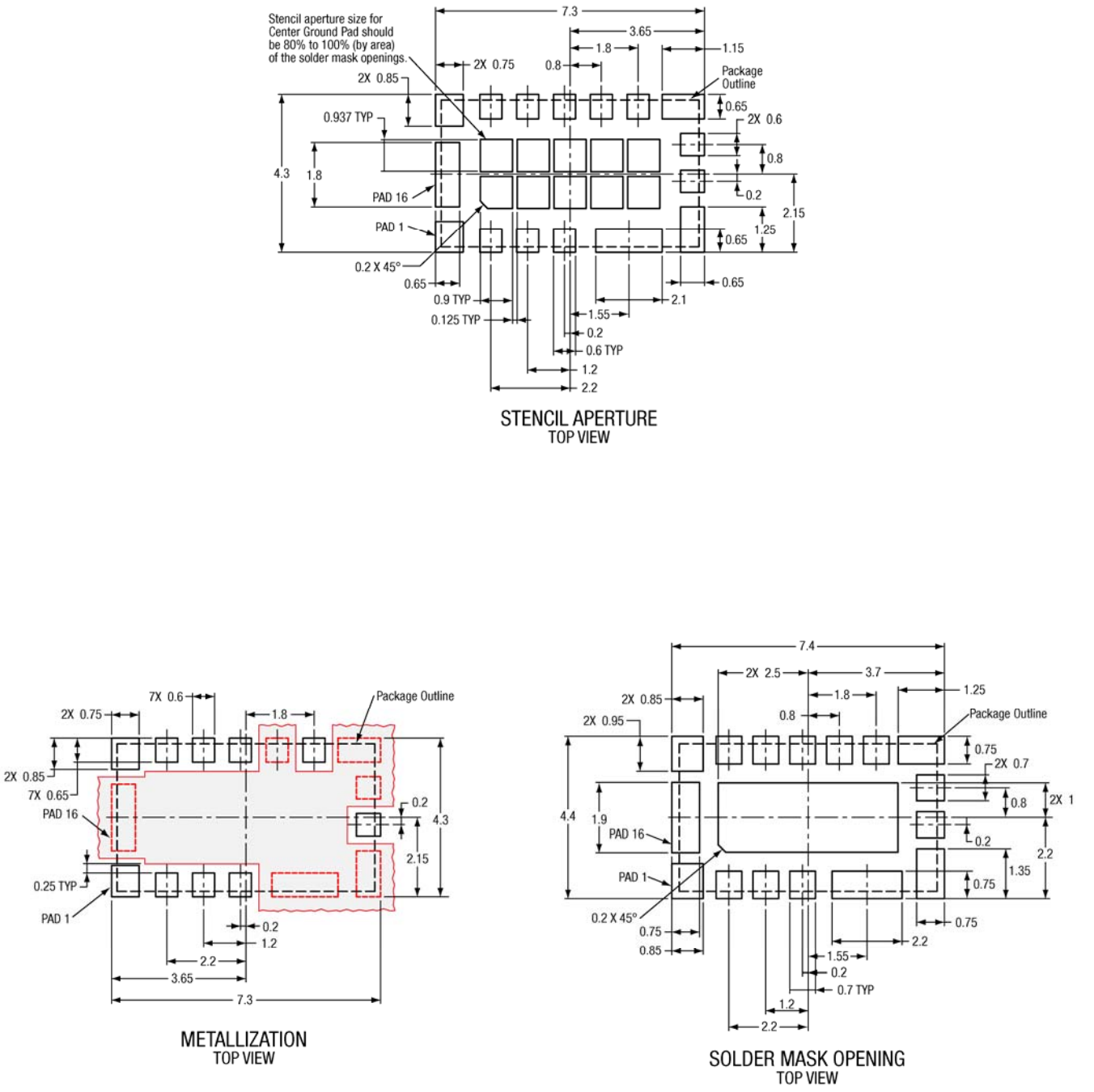

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Figure 5. Phone PCB Layout Footprint for 7 x 4 mm, 16-Pad Package – SKY77433

Package Description

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

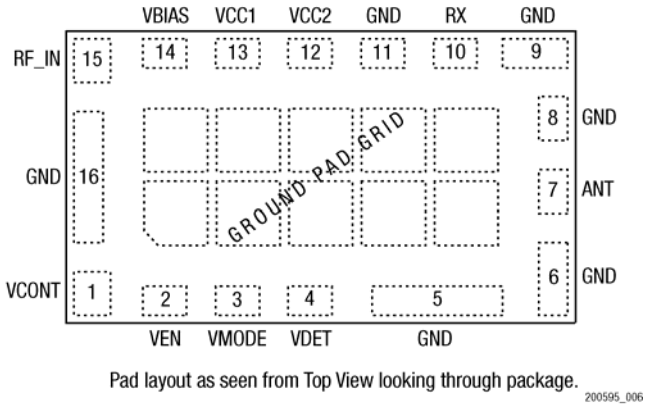

Figure 6. SKY77433 16-Pad Configuration – (Top View)

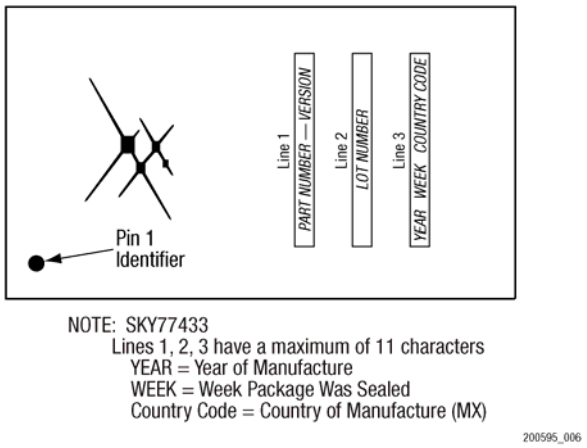

Figure 7. Typical Case Markings (Top View)

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 SKY77433 is currently qualified for MSL3/260 °C. 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 – RF Modules,* Document Number 101568.

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 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
SKY77433	SKY77433		MCM 7 x 4 x 1.05 mm	–20 °C to +85 °C

Revision History

Revision	Date	Description
A	August 29, 2007	Initial Issue – Preliminary Information
B	December 8, 2008	Revise: Features list (p1); Tables 1, 3, 8; Figures 2–5 Add: GREEN tag (p1); Tables 4–7

References

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

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

JEDEC Standard J–STD–020