DATA SHEET

SKY77761-12 Power Amplifier Module for CDMA/ WCDMA/ HSDPA/ HSUPA/ HSPA+/ LTE – Band I (1920–1980 MHz)

Applications

- WCDMA handsets
- HSDPA
- HSUPA
- HSPA+
- LTE
- CDMA2000
- EVDO

Features

- Low voltage positive bias supply 3.0 V to 4.5 V
- Good linearity
- High efficiency
  - 46% at 28.25 dBm
- Large dynamic range
- Small, low profile package
  - 3 mm x 3 mm x 0.9 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

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.

Description

The SKY77761-12 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 1920-1980 MHz bandwidth coverage into a single compact package. Because of high efficiencies attained throughout the entire power range, the SKY77761-12 delivers unsurpassed talk-time advantages. The SKY77761-12 meets the stringent spectral linearity requirements of High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), and Long Term Evolution (LTE) data transmission with high power added efficiency. An integrated directional coupler eliminates the need for any external coupler.

The Gallium Arsenide (GaAs) Microwave Monolithic Integrated Circuit (MMIC) contains all amplifier active circuitry, including input and interstage matching circuits. The silicon CMOS support die, providing precision biasing for the MMIC affords a true CMOS-compatible control interface. Output match into a 50-ohm load, realized off-chip within the module package, optimizes efficiency and power performance.

The SKY77761-12 is manufactured with Skyworks' InGaP GaAs Heterojunction Bipolar Transistor (HBT) process which provides for all positive voltage DC supply operation and maintains high efficiency and good linearity. While primary bias to the SKY77761-12 can be supplied directly from any suitable battery with an output of 3.2 V to 4.2 V, optimal performance is obtained with VCC2 sourced from a DC-DC power supply adjusted within 0.5 V to 3.6 V based on target output power levels. Power down executes by setting 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.

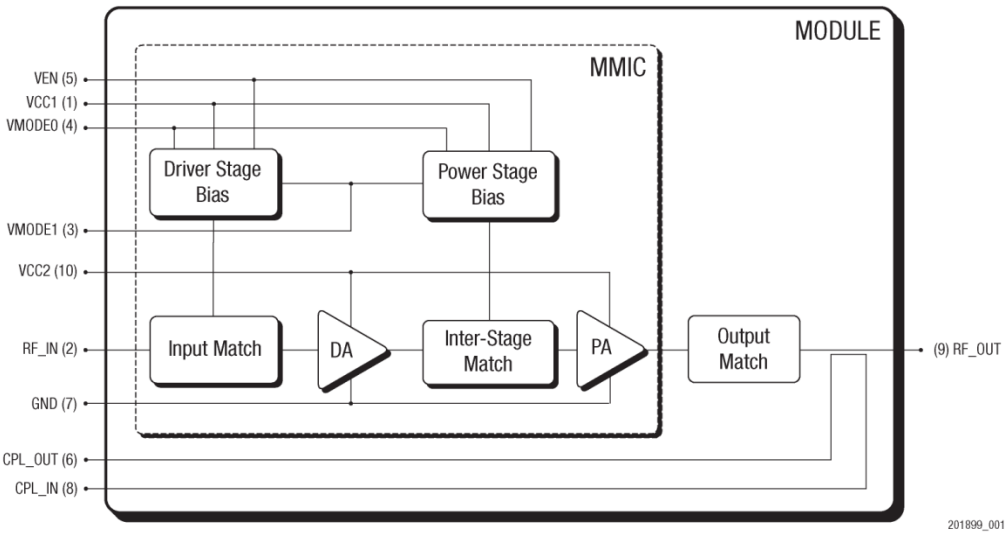


Figure 1. SKY77761-12 Functional Block Diagram

Electrical Specifications

The following tables list the electrical characteristics of the SKY77761-12 Power Amplifier. Table 1 lists the absolute maximum ratings and Table 2 shows the recommended operating conditions. Electrical specifications for nominal operating conditions are listed in Table 4. Table 3 presents a truth table for the power settings. Tables 5 through 8 provide the standard test configurations for WCDMA (STC1), HSDPA (STC2), and HSUPA (STC3, STC4) respectively.

Table 1. Absolute Maximum Operating Conditions

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}	—	0	10	dBm
Supply Voltage	No RF	V_{CC1} V_{CC2}	—	3.4	6.0	Volts
	With RF		—	—	4.6	
Enable Control Voltage		V_{EN}	—	1.8	4.2	Volts
Mode Control Voltage		V_{MODE0}	—	1.8	4.2	Volts
		V_{MODE1}	—	1.8	4.2	
Case Temperature[1]	Operating	T_{CASE}	–30	25	+110	°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. Recommended Operating Conditions

Parameter		Symbol	Minimum	Nominal	Maximum	Unit
RF Output Power[1]	WCDMA	P_{OUT_MAX}	28.25	—	—	dBm
	HSDPA		27.25	—	—	
	HSUPA		24.65	—	—	
	LTE		27.00	—	—	
	CDMA2000		27.75	—	—	
Operating Frequency		f_O	1920	1950	1980	MHz
Supply Voltage[2]		V_{CC1}	3.0	3.4	4.5	Volts
		V_{CC2}	0.5	—	3.6	
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_{MODE0}	0.0	0.0	0.5	Volts
		V_{MODE1}	0.0	0.0	0.5	
	High	V_{MODE0}	1.35	1.8	3.1	
		V_{MODE1}	1.35	1.8	3.1	
Case Operating Temperature[3]		T_{CASE}	–20	+25	+85	°C

1 0.5 dB output power back-off when 3.2 V ≤ V_{CC2} < 3.4 V.

2 Specifications in Table 4 are specified at V_{CC1} = 3.2 V–4.2 V.

3 Equivalent to –30 °C to +75 °C Ambient Operating Temperature.

Table 3. Modes of Operation

Power Setting	ENABLE	VMODE0	VMODE1	VCC
Power Down Mode	Low	Low	Low	On
Standby Mode	Low	—	—	On
High Power Mode (17.0 dBm ≤ P_{OUT} ≤ 28.25 dBm)	High	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

Table 4. Electrical Specifications for Nominal Operating Conditions (1 of 2)

Per Table 2 over dynamic range up to 28.25 dBm output power for STC1 modulation, unless otherwise specified.

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Gain		G_{LOW}	P_{OUT} = 7.0 dBm V_{CC2} = 0.8 V	12.0	16.0	19.0	dB
		G_{MED}	P_{OUT} = 17.0 dBm V_{CC2} = 1.3 V	19.0	23.0	28.0	
		G_{HIGH}	P_{OUT} = 28.25 dBm	25.5	28.5	32.5	
Rx Band Gain		RxG	—	—	—	–1	dB
		$RxG_{\_GPS}$	—	—	—	–3	
		$RxG_{\_ISM}$	—	—	—	–6	
Power Added Efficiency		PAE_{LOW}	P_{OUT} = 7.0 dBm	10	13	—	%
		PAE_{MED}	P_{OUT} = 17.0 dBm	22	28	—	
		PAE_{HIGH}	P_{OUT} = 28.25 dBm	43	46	—	
Total Supply Current		I_{CC_LOW}	P_{OUT} = 7.0 dBm	—	45	60	mA
		I_{CC_MED}	P_{OUT} = 17.0 dBm	—	120	150	
		I_{CC_HIGH}	P_{OUT} = 28.25 dBm	—	420	457	
Quiescent Current		I_{Q_LOW}	Low Power Mode	—	23	—	mA
		I_{Q_MED}	Medium Power Mode	—	34	—	
Enable Control Current		I_{EN}	—	—	20	40	µA
Mode Control Current		I_{MODE0}	—	—	20	40	µA
		I_{MODE1}	—	—	20	40	
Total Supply Current in Power Down Mode		I_{PD}	V_{CC} = 4.5 V V_{EN} = Low V_{MODE0} = Low V_{MODE1} = Low	—	1	10	µA
ICC1 Current		I_{CC1_HIGH}	—	—	—	10	mA
Adjacent Channel Leakage power Ratio[1]	5 MHz offset	ACLR5	P_{OUT} = 7.0 dBm	—	–45	–38	dBc
			P_{OUT} = 17.0 dBm	—	–45	–39	
			P_{OUT} = 28.25 dBm	—	–42	–39	
	10 MHz offset	ACLR10	P_{OUT} = 7.0 dBm	—	–65	–50	
			P_{OUT} = 17.0 dBm	—	–61	–50	
			P_{OUT} = 28.25 dBm	—	–56	–50`	

Table 4. Electrical Specifications for Nominal Operating Conditions (2 of 2)

Per Table 2 over dynamic range up to 28.25 dBm output power for STC1 modulation, unless otherwise specified.

Characteristics		Symbol	Condition	Minimum	Typical	Maximum	Unit
Adjacent Channel Leakage power Ratio[5]	EUTRA offset	ACLR_EUTRA	$P_{OUT} \leq (P_{OUT\_MAX} - MPR^{6})$	—	–40	—	dBc
	UTRA offset	ACLR1_UTRA		—	–40	—	
		ACLR2_UTRA		—	—	—	
Adjacent Channel Power Ratio[3,4]	1.25 MHz offset	ACPR1	P_{OUT} = 27.75 dBm	—	–49	—	dBc
	1.98 MHz offset	ACPR2		—	–56	—	
Harmonic Suppression	Second	fo2	$P_{OUT} \leq$ 28.25 dBm	—	–53.0	–39.2	dBc
	Third	fo3		—	–50.0	–43.0	
Tx Noise in Rx Bands[7]	Rx Band 1		2110 MHz–2170 MHz	—	—	–140.0	dBm/Hz
	GPS Rx		1574 MHz–1577 MHz	—	—	–139.5	
	ISM Rx		2400 MHz–2483.5 MHz	—	—	–141.0	
LTE NS05 PHS Emissions			1884.5 MHz–1919.6 MHz	—	—	–42	dBm/ 300 kHz
EVM		EVM1	$P_{OUT} = P_{OUT\_MAX}$	—	—	3.35	%
		EVM2	$P_{OUT} = P_{OUT\_MAX} - 3$	—	—	2.50	
Rise / Fall Time	DC	TON_DC	—	—	5.0	20	µs
		TOFF_DC	—	—	5.0	20	
	RF	TON_RF	—	—	0.5	6	
		TOFF_RF	—	—	0.5	6	
Coupling Factor		CPL	$P_{OUT} = P_{OUT\_MAX}$	–22	–20	–18	dB
CPL_{OUT} / P_{OUT} Power Ratio Variation Over Output VSWR			2.5:1 VSWR at P_{OUT} all VSWR phases CPL_{IN} 50 Ω terminated	—	±0.4	—	dB
Daisy-chain	VSWR		CPL_{IN} and CPL_{OUT} ports 698 MHz to 2620 MHz V_{EN} = Low	—	—	1.5:1	dB
	Insertion Loss		CPL_{IN} to CPL_{OUT} ports 698 MHz to 2620 MHz V_{EN} = Low	—	—	0.25	
Input Voltage Standing Wave Ratio		VSWR	—	—	1.2:1	1.8:1	—
Stability (Spurious output)		S	6:1 VSWR All phases	—	—	–70	dBc
Ruggedness – no damage[2]		Ru	$P_{OUT} \leq$ 28.25 dBm	10:1	—	—	VSWR

1 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.

2 All phases, time = 10 seconds.

3 ACPR is specified per IS95 as the ratio of the total in-band power (1.23 MHz BW) to adjacent power in a 30 kHz BW.

4 For CDMA2000 test configured as [PCD at –7.40 dB, DCCH–9600 bps at –15.35 dB; SCHO–9600 bps at –15.63 dB] and other test configurations that yield a peak-to-average up to 4.02 dB for CCDF = 1%, up to 1 dB power back off from the maximum listed for IS95 may be required to meet specified maximum ACP performance under worst-case conditions.

5 LTE: ACLR is measured with QPSK modulation with 20 MHz bandwidth and 100 resource blocks.

6 MPR is the maximum power reduction as defined in 3GPP TS36.101

7 Over conditions

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

Table 7. 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 8. 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

Evaluation Board Description

The evaluation board is a platform for testing and interfacing design circuitry. To accommodate the interface testing of the SKY77761-12, the evaluation board schematic and assembly diagrams are included for analysis and design. Figure 2 shows the basic schematic of the board for the 1920 MHz to 1980 MHz range shown in Figure 3. Figure 4 is a schematic of the recommended application shown in Figure 5.

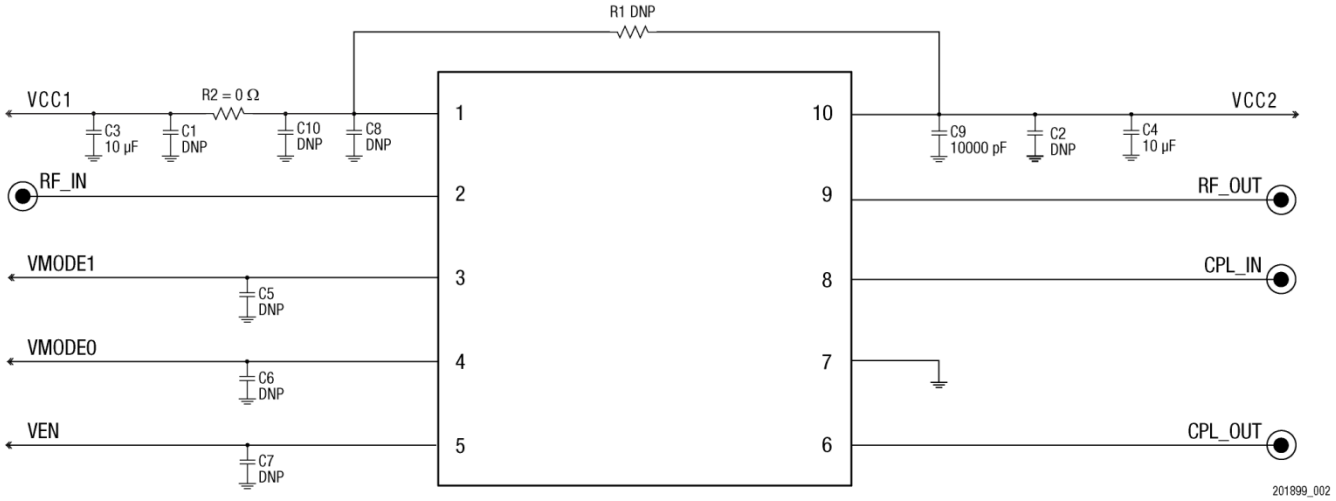


Figure 2. Evaluation Board Schematic

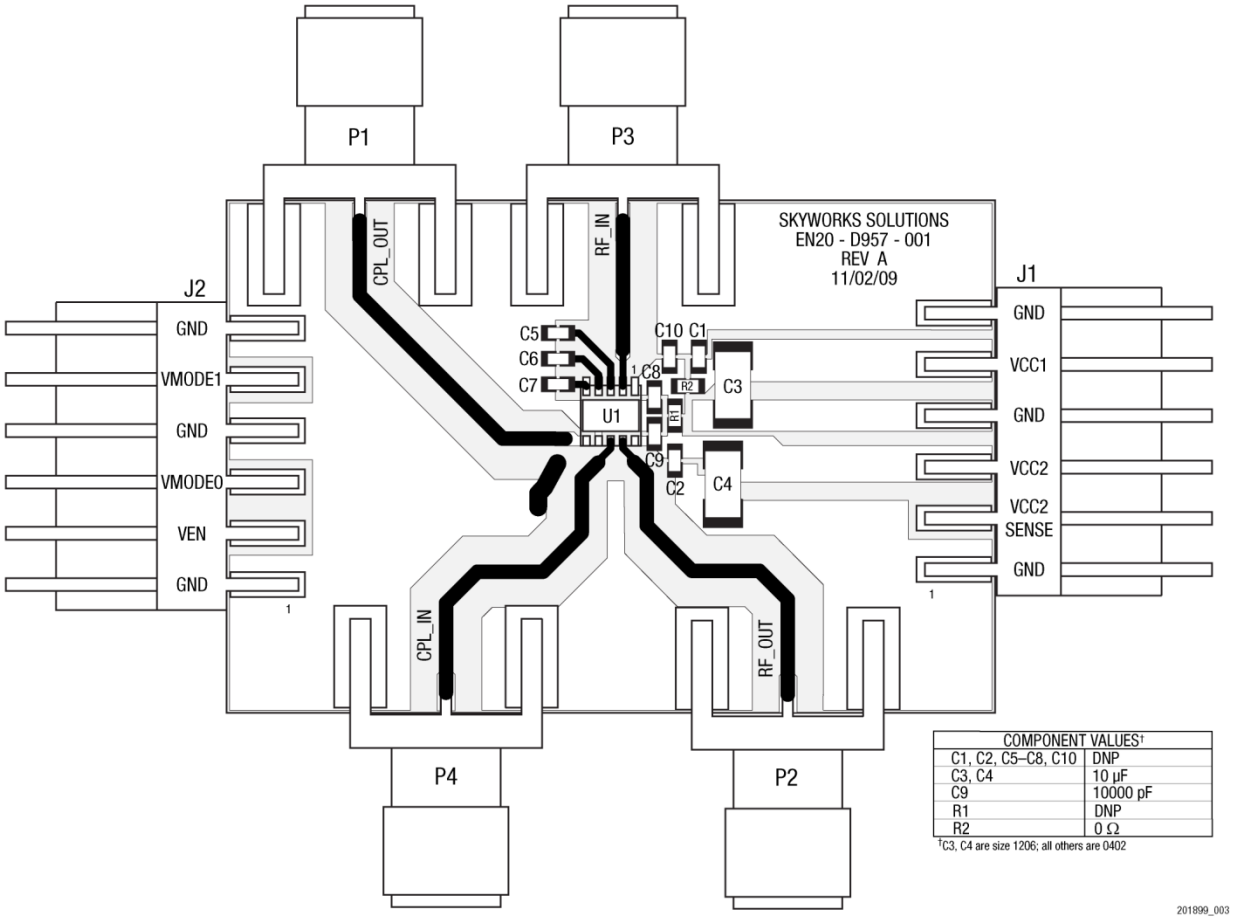


Figure 3. Evaluation Board Assembly Diagram

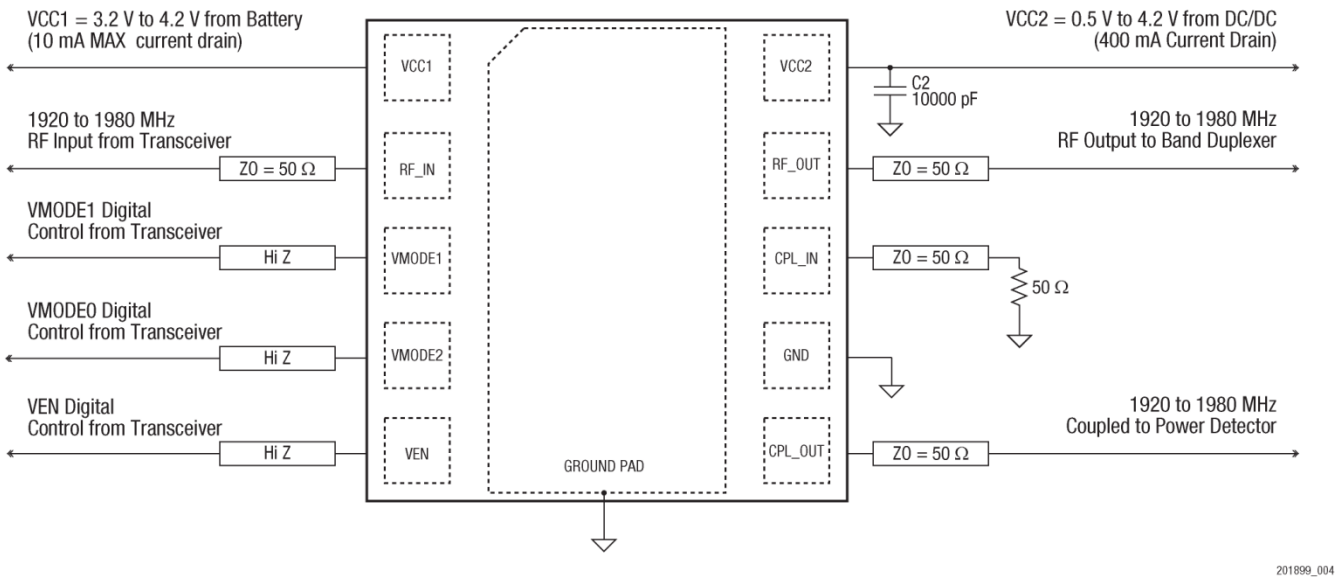


Figure 4. SKY77761-12 Schematic for Recommended Application Diagram

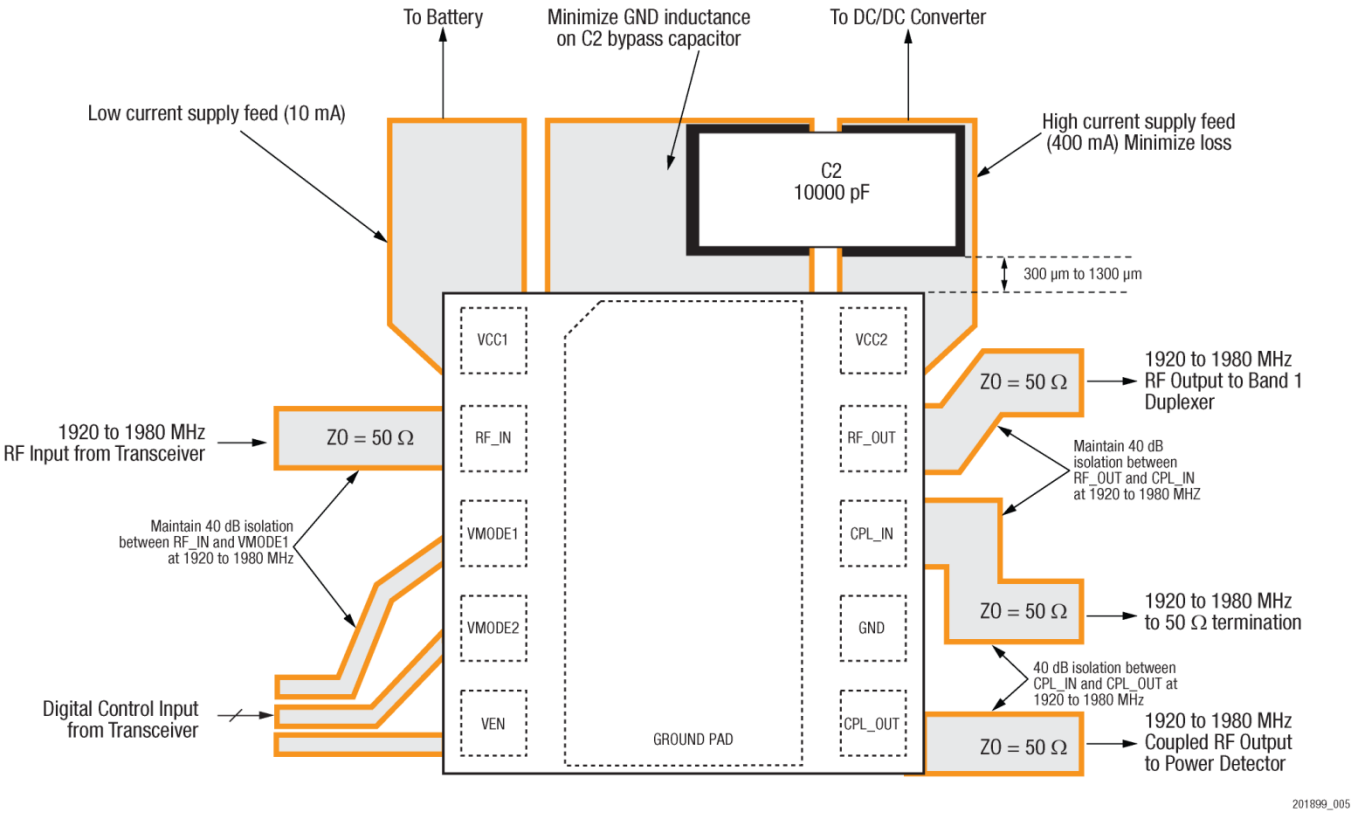
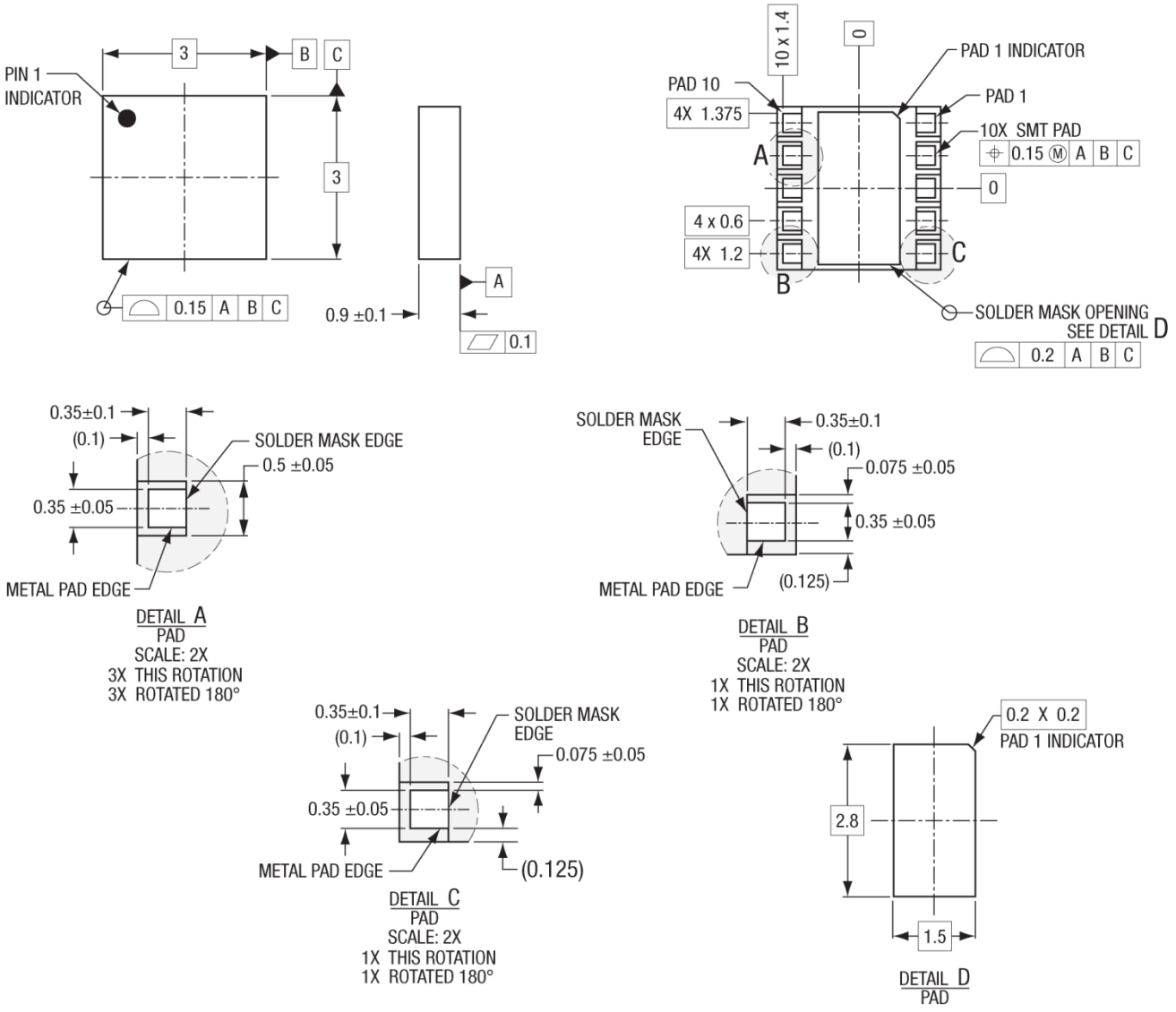


Figure 5. SKY77761-12 Recommended Application Diagram

Package Dimensions

The SKY77761-12 is a multi-layer laminate base, overmold encapsulated modular package designed for surface mount solder attachment to a printed circuit board. Figure 6 is a mechanical drawing of the pad layout for this package. Figure 7 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 Y14.5M–1994
2. All dimensions are in millimeters.

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Figure 6. Dimensional Diagram for 3 mm x 3 mm x 0.9 mm Package – SKY77761-12 Specific

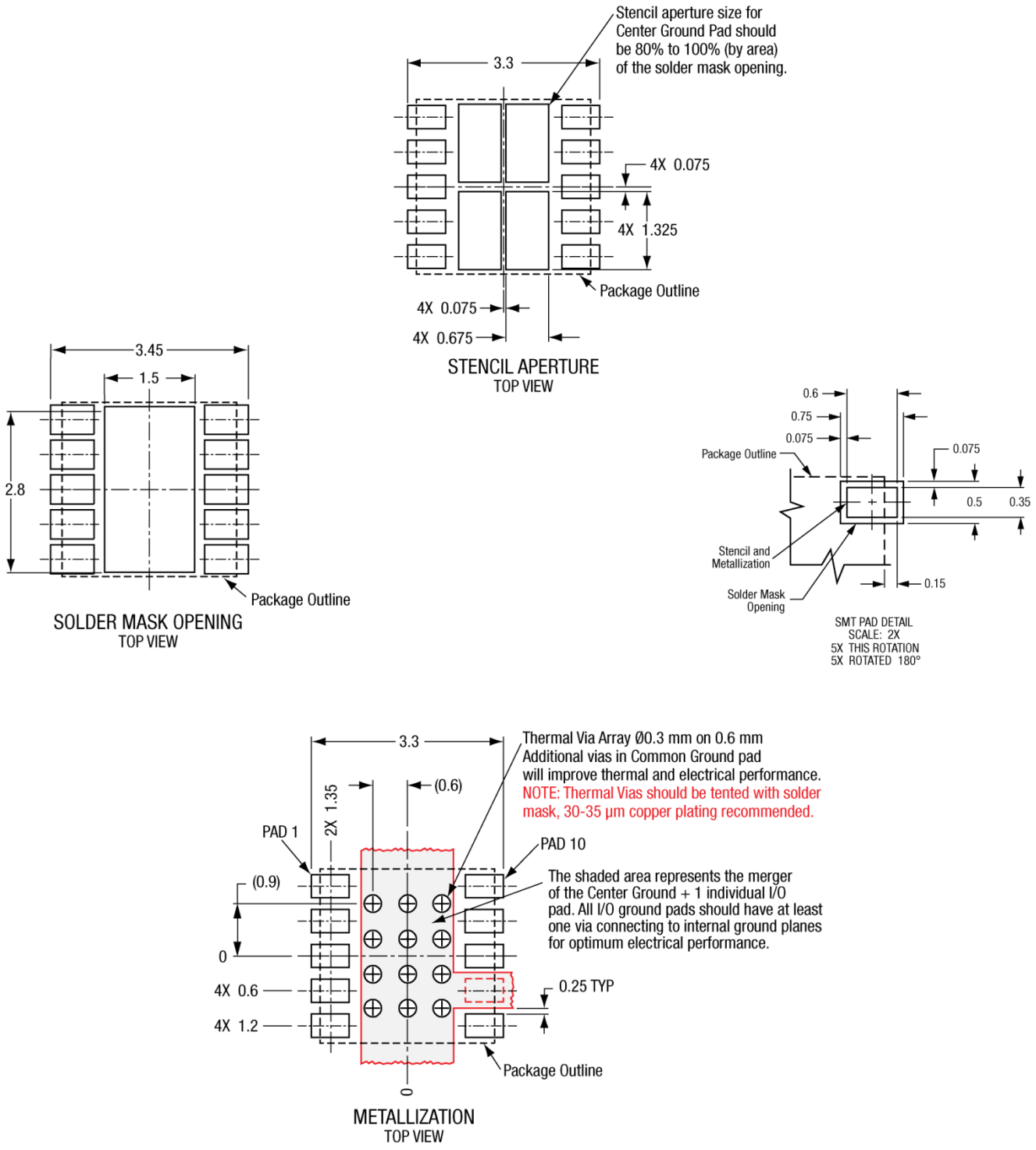
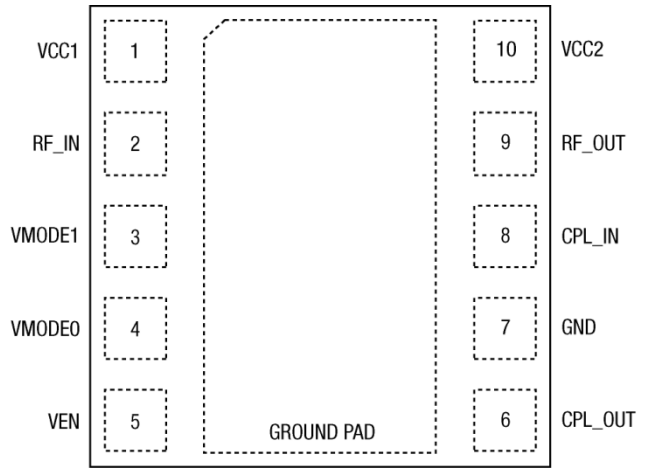


Figure 7. Phone PCB Layout Diagram – 3 mm x 3 mm, 10-Pad Package – SKY77761-12

Package Description

Figure 8 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 9.



Pad layout as seen from Top View looking through the package.
GROUND PAD is package underside.

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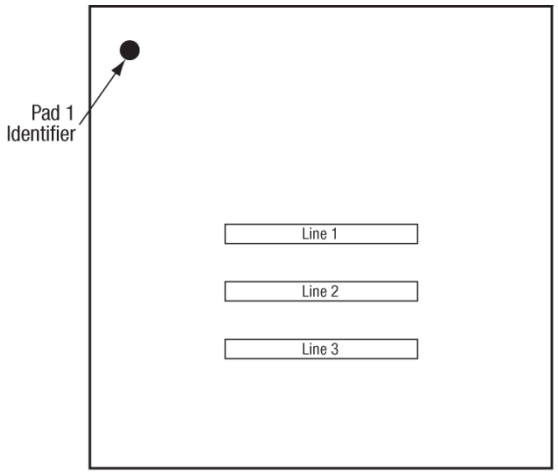
Figure 8. SKY77761-12 Pad Names and Configuration (Top View)



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)

201899_009

Figure 9. 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 SKY77761-12 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.

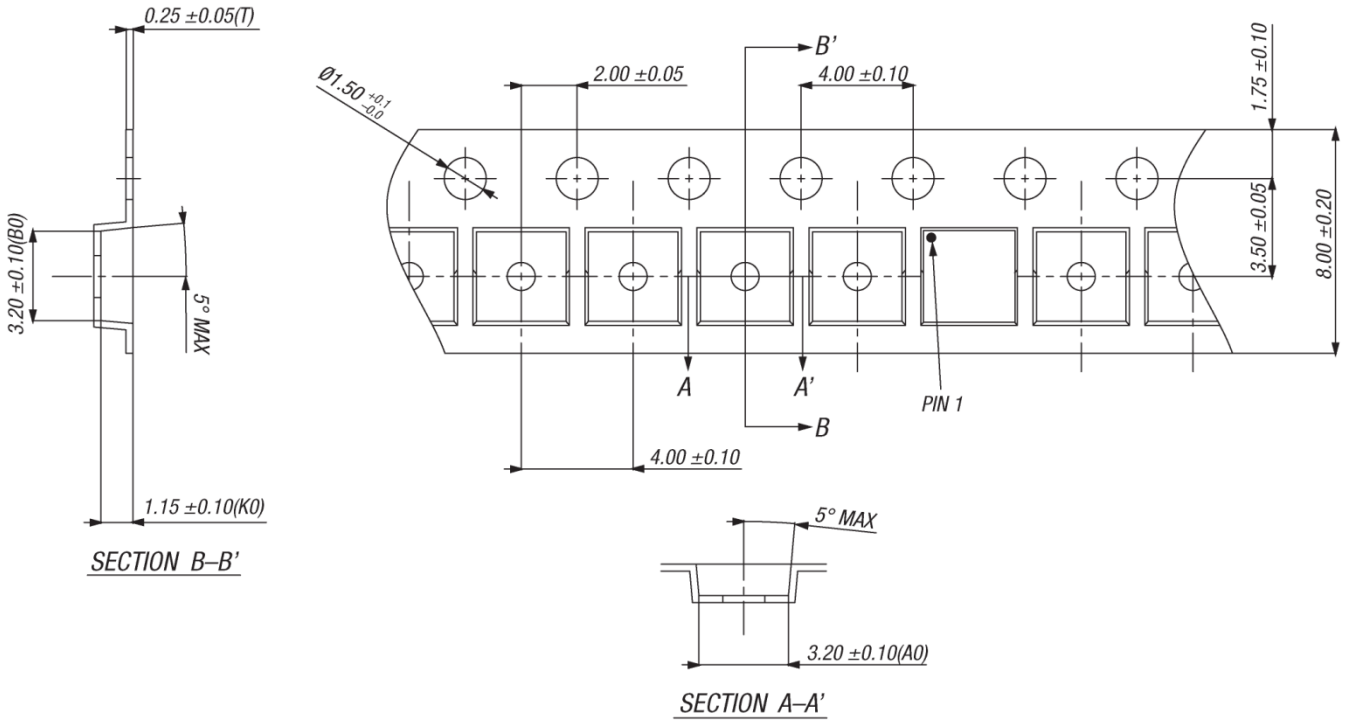
Production quantities of this product are shipped in the standard tape-and-reel format (Figure 10).

Electrostatic Discharge (ESD) Sensitivity

The SKY77761-12 meets class 1C JESD22-A114 Human Body Model (HBM), class IV JESD22-C101 Charged-Device Model (CDM), and class A JESD22-A115 Machine Model (MM) electrostatic discharge (ESD) sensitivity classification.

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



NOTES:

1. CARRIER TAPE IS BLACK CONDUCTIVE POLYCARBONATE OR POLYSTYRENE.
2. COVER TAPE IS TRANSPARENT AND CONDUCTIVE.
3. ESD-SURFACE RESISTIVITY IS $\leq 1 \times 10^{10}$ OHMS/SQUARE PER EIA, JEDEC TNR SPECIFICATION.
4. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE: ±0.2 mm
5. Ao & Bo MEASURED ON PLANE 0.3 mm ABOVE THE BOTTOM OF THE POCKET.
6. ALL DIMENSIONS ARE IN MILLIMETERS.

CARRIER TAPE OVERMOLD MCM / RFLGA 3 x 3 x 0.75 / 0.95 mm BODY SIZE -150A nnnnnn_xxx

Figure 10. Dimensional Diagram for Carrier Tape Body Size 3 mm x 3 mm x 0.75 / 0.90 mm – MCM

Ordering Information

Product Name	Order Number	Evaluation Board Part Number
SKY77761 Power Amplifier Module	SKY77761-12	EN20-D957-001 REV A

Revision History

Revision	Date	Description
A	April 30, 2012	Initial Release – Information
B	August 15, 2012	Revise: Table 2, added footnote 3; Table 4
C	September 19, 2012	Revise: Change Data Sheet status from PRELIMINARY to FINAL; Tables 2, 4

References

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

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 (CDM).