SKYWORKS

DATA SHEET

SKY65336-11: 2.4 GHz Transmit/Receive Front-End Module with Integrated LNA

Applications

- 2.4 GHz ISM band radios
- ZigBee[®] FEMs
- IEEE 802.15.4 applications

Features

- Transmit output power > +20 dBm
- Receive NF < 3 dB
- High efficiency PA
- Programmable transmit power levels
- · Configurable transmit/receive paths
- Internal switching and control circuits
- Internal RF match and bias circuits
- Single DC supply = 3.0 V
- Interfaces seamlessly with Ember EM250 and EM260 ZigBee transceivers
- All RF ports are internally DC blocked
- Small footprint, MCM (28-pin, 8 x 8 mm) SMT package (MSL3, 260 °C per JEDEC J-STD-020)



Skyworks offers lead (Pb)-free RoHS (Restriction of Hazardous Substances) compliant packaging.

Description

Skyworks SKY65336-11 is a high-efficiency Front-End Module (FEM) for ZigBee and other 2.4 GHz ISM band applications. The small

8 x 8 mm Multi-Chip Module (MCM) contains a 2400-2500 MHz high-efficiency transmit path and a low-noise linear receive path.

The transmit path consists of an harmonic filter and high efficiency Power Amplifier (PA) capable of providing +20 dBm of power at the antenna port. Also included is an internal balun to allow use of differential input signals.

The receive path contains a high isolation Transmit/Receive (Tx/Rx) switch, Low Noise Amplifier (LNA), and balun for low noise differential output.

The device is mounted in a 28-pin, 8 x 8 mm MCM Surface-Mounted Technology (SMT) package, which allows for a highly manufacturable low-cost solution.

A block diagram of the SKY65336-11 is shown in Figure 1. The device package and pinout for the 28-pin MCM are shown in Figure 2.

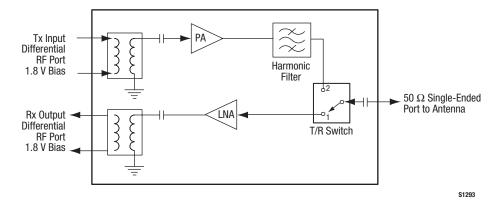


Figure 1. SKY65336-11 Block Diagram

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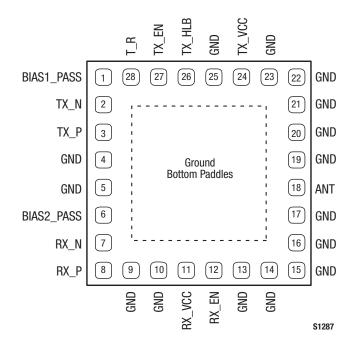


Figure 2. SKY65336-11 Pinout – 28-Pin MCM (Top View)

Technical Description

Transmit/Receive (Tx/Rx) Enable

Pin 27 (TX_EN) and pin 12 (RX_EN) are used to enable the transmit and receive port, respectively.

Tx/Rx Switch

Pin 28 (T_R) is used to control the Tx/Rx switch.

Tx/Rx Enable and Tx/Rx Switch Mode Control

The following control logic is used to configure the transmit or receive mode of the SKY65336-11:

TX_EN	RX_EN	T_R	Mode
High	Low	High	Transmit mode
Low	High	Low	Receive mode

High Power and Low Power Modes

High power mode output is 20 dBm and low power mode output is 10 dBm. Pin 26 (TX_HLB) sets the transmit path in high power or low power mode according to the following logic:

TX_HLB	State
Low	High power mode
High	Low power mode

Bottom Center Paddles

The bottom center paddles must be electrically grounded for proper RF performance. Customers should place adequate thermal vias under the ground paddles for optimum thermal performance. The Evaluation Board layout (see Figures 3 and 4) can be used as a guide for RF ground and thermal layout.

Electrical and Mechanical Specifications

Signal pin assignments and functional pin descriptions are described in Table 1. The absolute maximum ratings of the SKY65336-11 are provided in Table 2. Recommended operating conditions are noted in Table 3 and electrical specifications are provided in Table 4.

Typical performance characteristics of the SKY65336-11 are shown in Figures 3 through 12.

Package and Handling Information

Since the device package is sensitive to moisture absorption, it is baked and vacuum packed before shipping. Instructions on the shipping container label regarding exposure to moisture after the container seal is broken must be followed. Otherwise, problems related to moisture absorption may occur when the part is subjected to high temperature during solder assembly.

The SKY65336-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 $^{\circ}$ C. It can be used for lead or lead-free soldering. For

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Care must be taken when attaching this product, whether it is done manually or in a production solder reflow environment.

Production quantities of this product are shipped in a standard tape and reel format. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.

Pin #	Name	Description	Pin #	Name	Description
1	BIAS1_PASS	Transmit port bias supply	15	GND	Ground
2	TX_N	Negative transmit input port	16	GND	Ground
3	TX_P	Positive transmit input port	17	GND	Ground
4	GND	Ground	18	ANT	Antenna input
5	GND	Ground	19	GND	Ground
6	BIAS2_PASS	Receive port bias supply	20	GND	Ground
7	RX_N	Negative receive output port	21	GND	Ground
8	RX_P	Positive receive output port	22	GND	Ground
9	GND	Ground	23	GND	Ground
10	GND	Ground	24	TX_VCC	Transmit DC supply, +3 V
11	RX_VCC	Receive DC supply, +3 V	25	GND	Ground
12	RX_EN	Receive enable	26	TX_HLB	Transmit power mode
13	GND	Ground	27	TX_EN	Transmit enable
14	GND	Ground	28	T_R	Transmit/receive switch

Table 1. SKY65336-11 Signal Descriptions

Note: The bottom ground pad must be connected to RF ground.

Table 2. SKY65336-11 Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	RX_VCC, TX_VCC	2.1	4	V
Control Voltage	BIAS1_PASS, BIAS2_PASS, TX_EN, RX_EN, TX_HLB, T_R		3.6	V
Bypass voltage	BIAS1_PASS, BIAS2_PASS		1.9	V
RF input power, antenna port	Pin_ant		10	dBm
RF input power, transmit port	Ριν_τχ		+8	dBm
Case operating temperature	Tc	-40	+85	°C
Storage temperature	Тѕт	-55	+125	°C
Junction temperature	TJ		+150	°C

Note 1: Exposure to maximum rating conditions for extended periods may reduce device reliability. There is no damage to device with only one parameter set at the limit and all other parameters set at or below their nominal value. Exceeding any of the limits listed here may result in permanent damage to the device.

CAUTION: Although this device is designed to be as robust as possible, Electrostatic Discharge (ESD) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions should be used at all times.

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage (TX_VCC, RX_VCC)	VCC	2.7	3.0	3.6	V
Tx/Rx bias supply voltage	BIAS1_PASS, BIAS2_PASS	1.7	1.8	1.9	V
Tx/Rx enable voltage: Low High	TX_ENL, RX_ENL TX_ENH, RX_ENH	1.62	0 1.80	0.1 VCC - 0.2	V V
Tx/Rx control voltage: Low High	T_RL, TX_HLBL T_RH, TX_HLBH	1.62	0 1.80	0.1 VCC - 0.2	V V
Frequency range	f	2400		2500	MHz

Table 3. SKY65336-11 Recommended Operating Conditions

Table 4. SKY65336-11 Electrical Specifications (Note 1) (VCC = 3.0 V, Tc = $25 \circ \text{C}$, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Frequency range	f		2400		2500	MHz
Return loss	RL	All RF ports	6	10		dB
Transmitter Section	·	· · ·				
Input power range	Рім	CW, high or low power mode		+3	+5	dBm
Transmit saturated output power	Рѕат_н	High power mode	+19.5	+20		dBm
	PSAT_L	Low power mode	+8	+10		dBm
Operating current	Іор_н	$P_{OUT} = +20 \text{ dBm in high}$ power mode		145	160	mA
	lop_l	$P_{OUT} = +10 \text{ dBm in low}$ power mode		70	80	mA
Harmonic levels	PN	CW, Pout = +20 dBm in high power mode, Pout = +10 dBm in low power mode		-44	-40	dBm
Saturated gain	Gн	CW, high power mode		17		dB
	G∟	CW, low power mode		7		dB
Leakage current	Ileak	No RF input, VCC = 3.0 V, RX_EN = 0 V, TX_EN = 0 V		0.5	2.0	μΑ
Receiver Section (Frequency = 2445 I	MHz)			· · · · · ·		
Small signal gain	G	CW	9.5	10.5		dB
Noise Figure	NF			2.0	3.0	dB
Input 1 dB compression	IP1dB	CW		-11		dBm
Input IP3	IIP3	Two CW tones spaced 1 MHz apart @ $P_{IN} = -9$ dBm	-1	+3		dBm
Operating current	lcc	CW		8	15	mA
Leakage current	Ileak	No RF input, VCC = 3.0 V, RX_EN = 0 V, TX_EN = 0 V		0.5	2.0	μА

Note 1: Performance is guaranteed only under the conditions listed in this Table and is not guaranteed over the full operating or storage temperature ranges. Operation at elevated temperatures may reduce reliability of the device.

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Typical Performance Characteristics

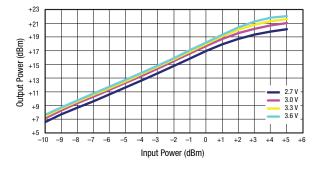


Figure 3. Output Power vs Input Power Over Voltage @ 2450 MHz (TA = 25 °C)

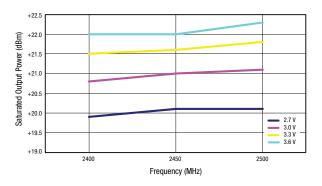


Figure 5. Saturated Output Power vs Frquency Over Voltage (TA = 25 °C)

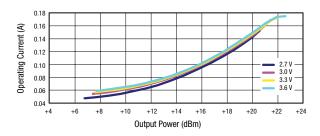


Figure 7. Operating Current vs Output Power Over Voltage @ 2450 MHz (TA = 25 °C)

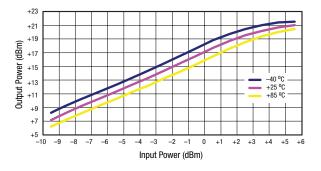


Figure 4. Output Power vs Input Power Over Temperature @ 2450 MHz (VCC = 3 V)

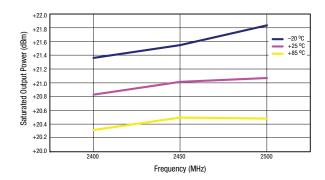


Figure 6. Saturated Output Power vs Frequency Over Temperature (VCC = 3 V)

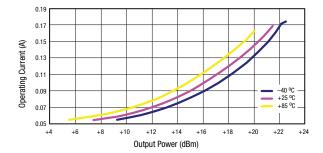


Figure 8. Operating Current vs Output Power Over Temperature @ 2450 MHz (Voltage = 3 V)

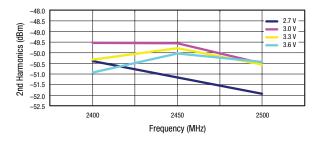


Figure 9. Second Harmonics vs Frequency Over Voltage (High Power Mode)

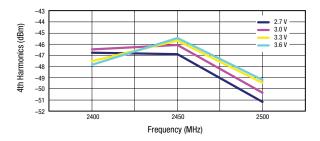


Figure 11. Fourth Harmonics vs Frequency Over Voltage (High Power Mode)

Evaluation Board Description

The SKY65336-11 Evaluation Board is used to test the performance of the SKY65336-11 FEM. The Evaluation Board schematic diagram is shown in Figure 13. An assembly drawing for the Evaluation Board is shown in Figure 14.

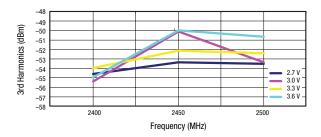


Figure 10. Third Harmonics vs Frequency Over Voltage (High Power Mode)

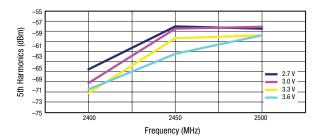


Figure 12. Fifth Harmonics vs Frequency Over Voltage (High Power Mode)

Package Dimensions

The phone board layout footprint for the SKY65336-11 is shown in Figure 15. Package dimensions for the 28-pin MCM are shown in Figure 16, and tape and reel dimensions are provided in Figure 17.

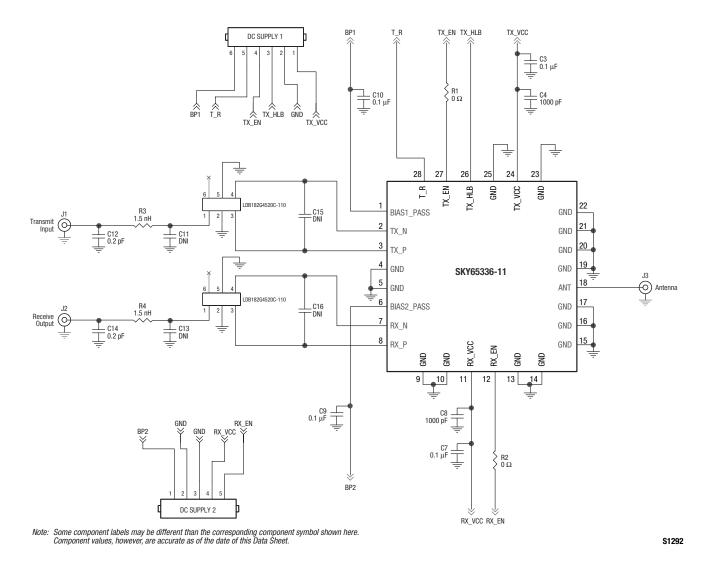


Figure 13. SKY65336-11 Evaluation Board Schematic

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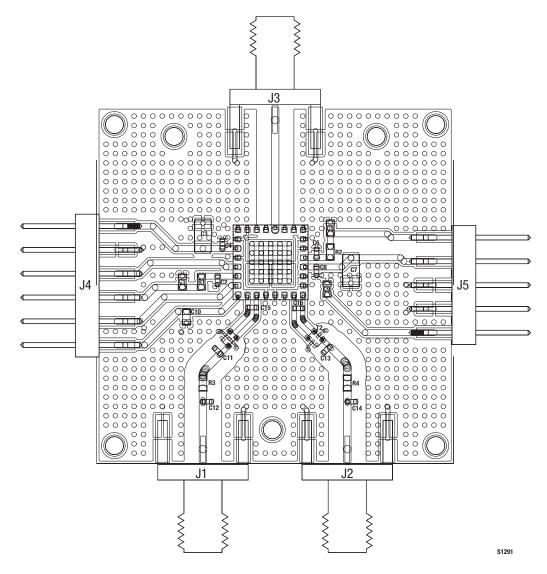
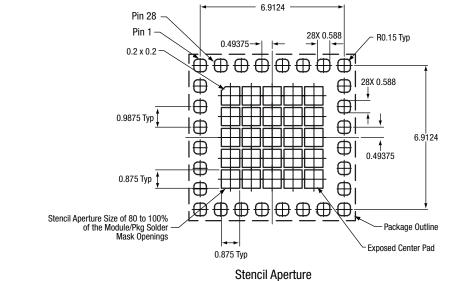


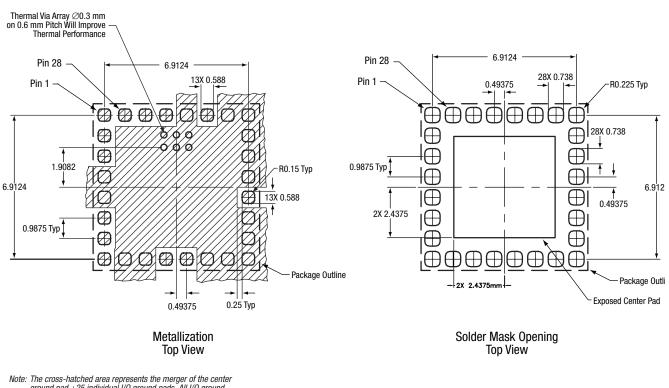
Figure 14. SKY65336-11 Evaluation Board Assembly Drawing

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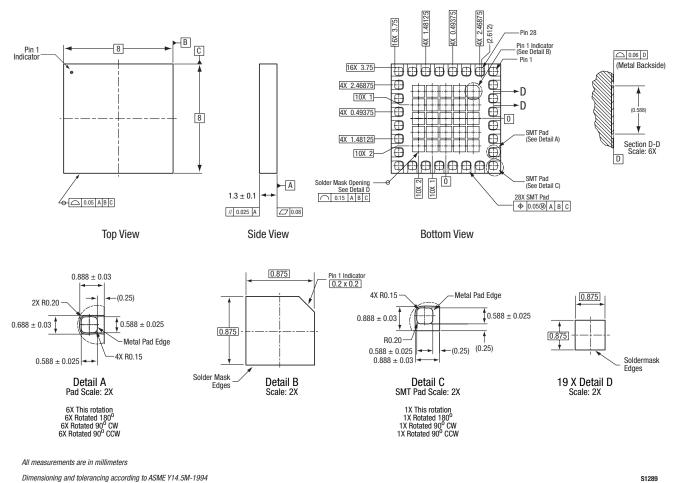
Note: The cross-hatched area represents the merger of the center ground pad +25 individual I/O ground pads. All I/O ground pads should have at least one via connected to internal ground planes for optimum electrical performance.

All measurements are in millimeters

Figure 15. SKY65336-11 Phone Board Layout Footprint

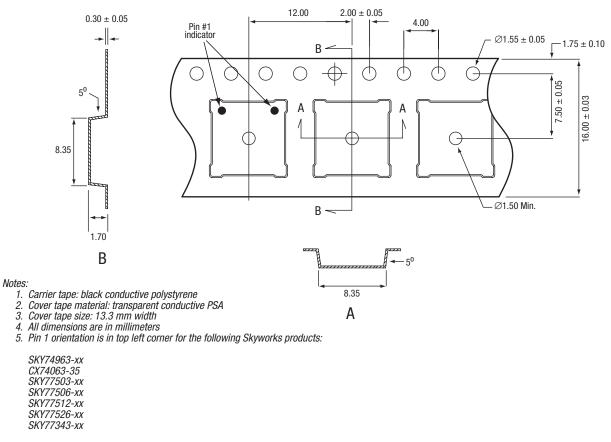
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S1330



Dimensioning and tolerancing according to ASME Y14.5M-1994

Figure 16. SKY65336-11 28-Pin MCM Package Dimensions



For all other 8 x 8 mm MCM/RFLGA products, pin 1 orientation is in top right corner.

S1290

Figure 17. SKY65336-11 28-Pin MCM Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number	
SKY65336-11 Tx/Rx Front-End Module w/LNA	SKY65336-11 (Pb-free package)	TW17-D475-001	

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