

**DATA SHEET**

# SKY65160-11: 350-470 MHz, 4 W High Power PA Module

## Applications

- Terrestrial Trunked Radios (TETRA)
- GSM450 and GSM480
- NMT450
- Wireless Local Loops
- UHF TV broadcasts

## Features

- Wideband frequency operation: 350 to 470 MHz
- High efficiency: 45% PAE
- High gain: 37 dB
- P1dB = +33 dBm
- Saturated power = +36 dBm
- Single DC supply = 3.6 V
- Internal RF match and bias circuits
- PA on/off voltage control
- Unconditionally stable under any load impedance
- Small, MCM (16-pin, 8 x 10 mm) package (MSL3, 260 °C per JEDEC J-STD-020)

## Description


The SKY65160-11 is a fully-matched, 4 W Power Amplifier (PA). Its high efficiency is designed for use in the 350 to 470 MHz frequency range.

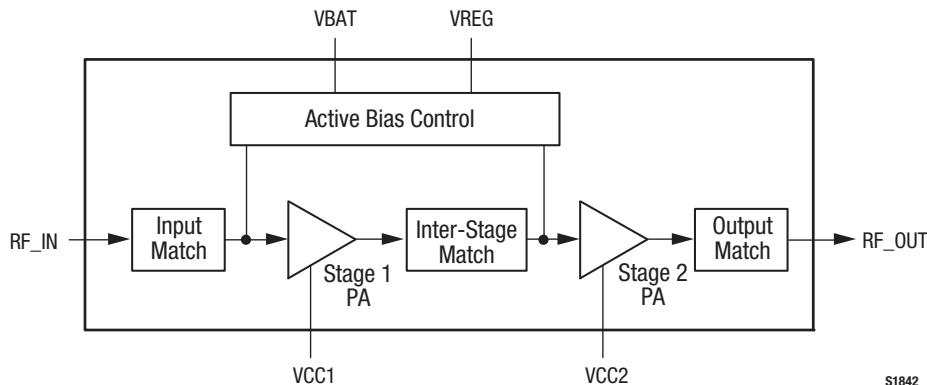
The PA contains all the active bias and RF matching circuits, which makes it easy to integrate into 50 Ω RF systems. The internal input and output match are optimized for efficiency and high power performance into a 50 Ω load.

Primary bias to the SKY65160-11 is supplied directly from a single cell Li-ion or other suitable battery with a nominal output of 3.6 V. No external supply-side switch is needed since typical “off” leakage is a few microamperes with full primary voltage supplied by the battery.

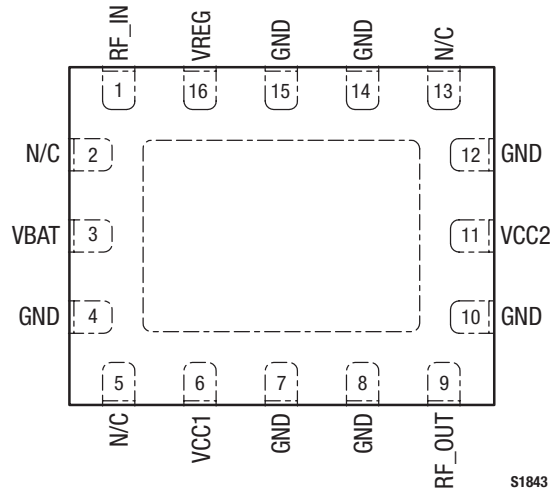
The SKY65160-11 is fabricated using Skyworks high reliability GaAs Heterojunction Bipolar Transistor (HBT) process, which allows for single supply operation while maintaining high efficiency and good linearity. The device is provided in an 8 x 10 mm, 16-pin Multi-Chip Module (MCM) package.

A functional block diagram is shown in Figure 1. The pin configuration and package are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

 Skyworks Pb-free products are compliant with all applicable legislation. For additional information, refer to *Skyworks Definition of Lead (Pb)-Free*, document number SQ04-0073.



**Figure 1. SKY65160-11 Block Diagram**



**Figure 2. SKY65160-11 Pinout – 16-Pin MCM (Top View)**

**Table 1. SKY65160-11 Signal Descriptions**

Pin #	Name	Description	Pin #	Name	Description
1	RF_IN	RF input to PA	9	RF_OUT	RF output of PA
2	N/C	No connection	10	GND	Ground
3	VBAT	Supply voltage for bias circuit, +3.6 V	11	VCC2	Supply voltage to 2 <sup>nd</sup> amplifier, +3.6 V
4	GND	Ground	12	GND	Ground
5	N/C	No connection	13	N/C	No connection
6	VCC1	Supply voltage to 1 <sup>st</sup> amplifier, +3.6 V	14	GND	Ground
7	GND	Ground	15	GND	Ground
8	GND	Ground	16	VREG	PA enable control signal (on = +3.6 V, off = 0 V)

**Electrical and Mechanical Specifications**

The absolute maximum ratings of the SKY65160-11 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

Performance characteristics for the SKY65160-11 are illustrated in Figures 3 through 9.

**Table 2. SKY65160-11 Absolute Maximum Ratings**

Parameter	Symbol	Minimum	Typical	Maximum	Units
RF output power	P <sub>OUT</sub>			+37	dBm
Supply voltage (VCC1, VCC2, VBAT, VREG)	V <sub>CC</sub>			5.1	V
Supply current	I <sub>CC</sub>			2500	mA
Operating temperature	T <sub>OP</sub>	-40		+85	°C
Storage temperature	T <sub>STG</sub>	-65		+125	°C
Junction temperature	T <sub>J</sub>			150	°C
Thermal resistance	Θ <sub>JC</sub>			18	°C/W

**Note:** 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.

**Table 3. SKY65160-11 Recommended Operating Conditions**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Operating frequency	f	350		470	MHz
Supply voltage (VCC1, VCC2)	V <sub>CC</sub>	3.2	3.6	4.0	V
Bias voltage	V <sub>BAT</sub>	3.2	3.6	4.0	V
Enable voltage:	V <sub>REG</sub>				
On state		2.7	3.6	4.0	V
Off state		0		0.5	V
Operating temperature	T <sub>OP</sub>	-40	+25	+85	°C

**Table 4. SKY65160-11 Electrical Specifications (1 of 2) (Note 1)**

(V<sub>BAT</sub> = V<sub>CC1</sub> = V<sub>CC2</sub> = V<sub>REG</sub> = 3.6 V; f = 350 MHz, 410 MHz, and 470 MHz; T<sub>OP</sub> = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
1 dB Output Compression Point	OP1dB	CW	+33.0	+34.0		dBm
Saturated output power	P <sub>SAT</sub>	CW, input power = +5 dBm	+35.8	+36.5		dBm
Small signal gain	G <sub>SMALL_SIGNAL</sub>	CW, input power = -5 dBm	34.3	35.5		dB
Large signal gain	G <sub>LARGE_SIGNAL</sub>	P <sub>OUT</sub> = +32.8 dBm	33.9	37.2	40.0	dB
Noise Figure	NF			6.5	7.0	dB
Quiescent current	I <sub>Q</sub>	No RF input		300		mA
Operating current @ P1dB	I <sub>1DB</sub>	P <sub>OUT</sub> = +33 dBm		2000		mA
Operating current @ P <sub>SAT</sub>	I <sub>SAT</sub>	CW, input power = +5 dBm		2500		mA
PAE @ P <sub>SAT</sub>	PAE <sub>PSAT</sub>	TETRA-correlated CW measurements, input power = +5 dBm	45	48		%
PAE @ P <sub>OUT</sub> = +32.8 dBm	PAE+32.8DBM	TETRA-correlated CW measurements	34	36		%

**Table 4. SKY65160-11 Electrical Specifications (2 of 2) (Note 1)**

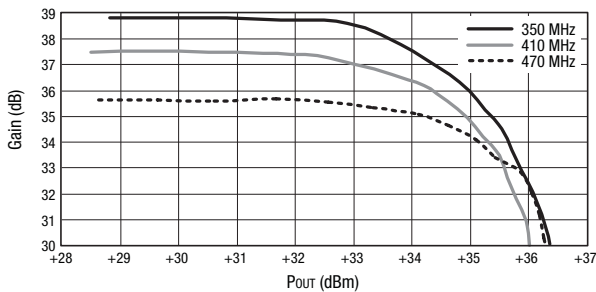
(VBAT = VCC1 = VCC2 = VREG = 3.6 V; f = 350 MHz, 410 MHz, and 470 MHz; T<sub>OP</sub> = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Input return loss	IS11I	Input power = -15 dBm	11	14		dB
Output return loss	IS22I	Input power = -15 dBm		12		dB
VSWR for stable operation	VSWR	CW			8:1	-
Leakage current	I <sub>LEAK</sub>	No RF input, VREG = 0 V		0.5	1.0	μA

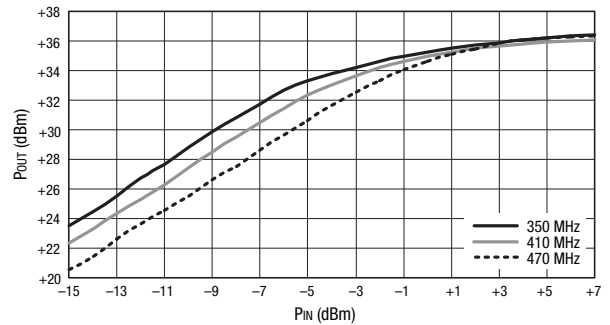
**Note 1:** Performance is guaranteed only under the conditions listed in this Table.

### Typical Performance Characteristics

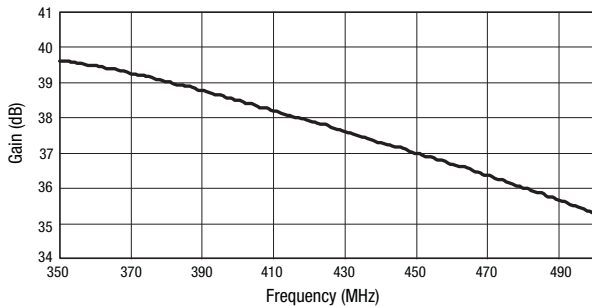
(VBAT = VCC1 = VCC2 = VREG = 3.6 V, f = 410 MHz, T<sub>OP</sub> = +25 °C, Unless Otherwise Noted)



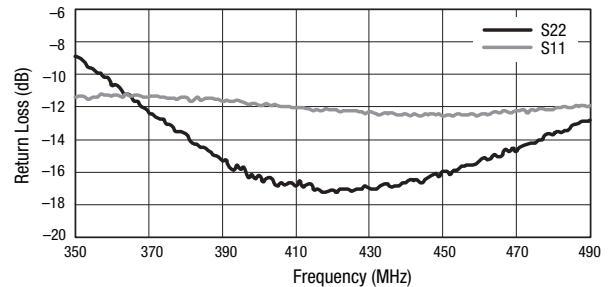
**Figure 3. Gain vs. Output Power Over Frequency**



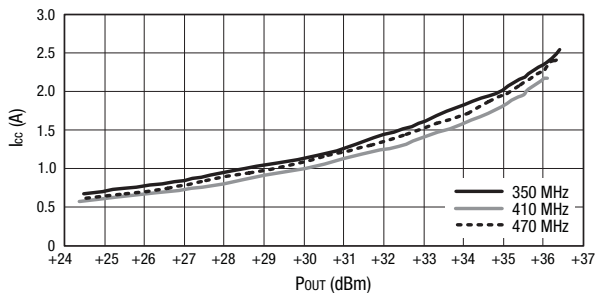
**Figure 4. Input Power vs Output Power Over Frequency**



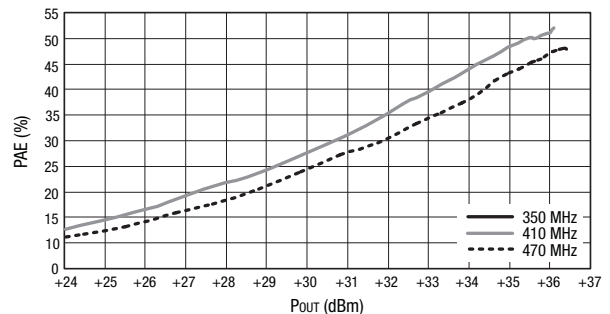
**Figure 5. Gain vs Frequency**



**Figure 6. Input and Output Return Loss vs Frequency**



**Figure 7. Total Operating Current vs Output Power Over Frequency**



**Figure 8. PAE vs Output Power Over Frequency**

## Evaluation Board Description

The SKY65160-11 Evaluation Board is used to test the performance of the SKY65160-11 LNA. An assembly drawing for the Evaluation Board is shown in Figure 9 and the layer detail is provided in Figure 10. The layer detail physical characteristics are noted in Figure 11. A schematic diagram of the SKY65160-11 Evaluation Board is shown in Figure 12.

Input and output trace lengths have been minimized to reduce losses. All surface mount components are 0402-sized to reduce component parasitics. The use of 0603 or larger components is not recommended. Component spacing has also been minimized. The board is provisioned with two RF connectors and a DC launch.

It is very important to place multiple ground vias as close to shunt components as possible. This ensures proper grounding and circuit performance.

Board material is 10 mil thick VT47 FR4 with 1 oz. copper cladding. RF input and output traces are 50  $\Omega$ .

## Evaluation Board Test Procedure

- Step 1: Connect RF test equipment to amplifier input/output SMA connectors.
- Step 2: Connect DC ground.
- Step 3: Connect VBAT, VCC1, VCC2, and VREG to a +3.6 V supply with a current limit of 3 A. Verify that the board draws approximately 290 mA.
- Step 4: Apply a low RF signal (e.g., -30 dBm) or noise source.

## Package Dimensions

The PCB layout footprint for the SKY65160-11 is provided in Figure 13. Package dimensions for the 16-pin MCM are shown in Figure 14, and tape and reel dimensions are provided in Figure 15.

## 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 SKY65160-11 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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.

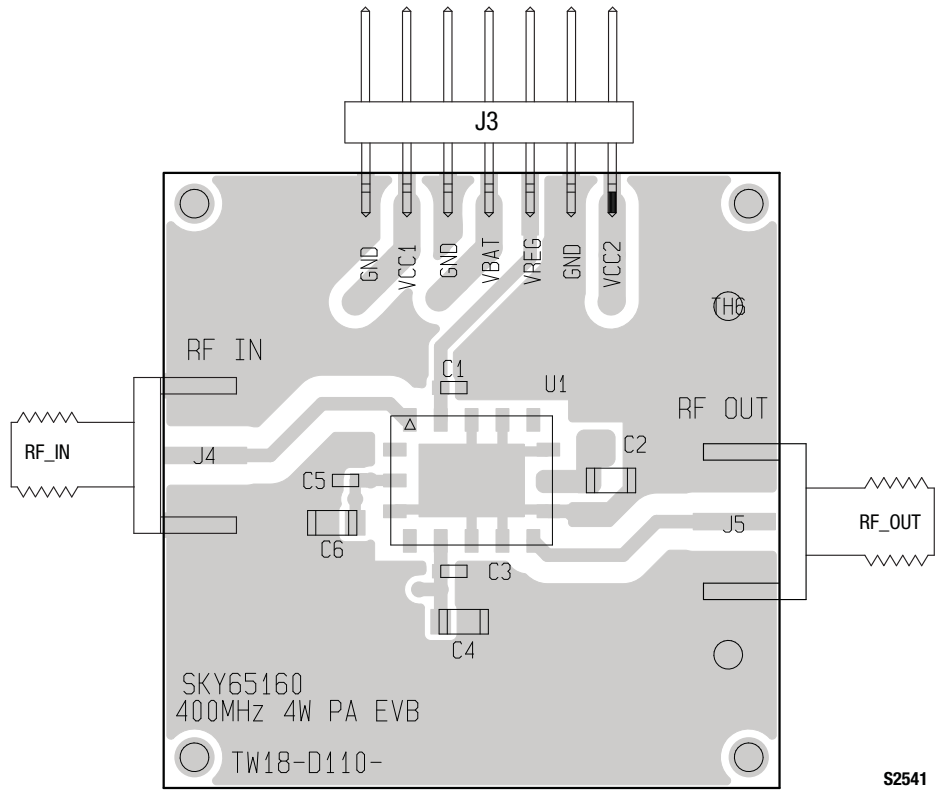
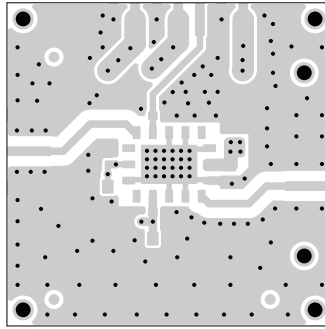
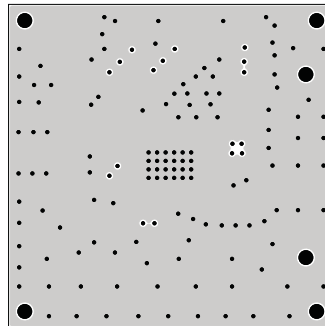


Figure 9. SKY65160-11 Evaluation Board Assembly Diagram

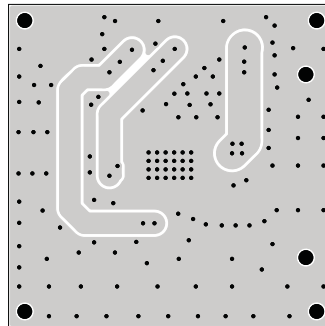
S2541



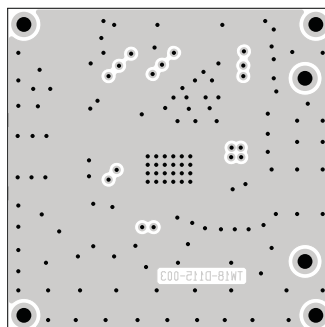
Layer 1: Top – Metal



Layer 2: Ground



Layer 3: Power Plane



Layer 4: Solid Ground Plane

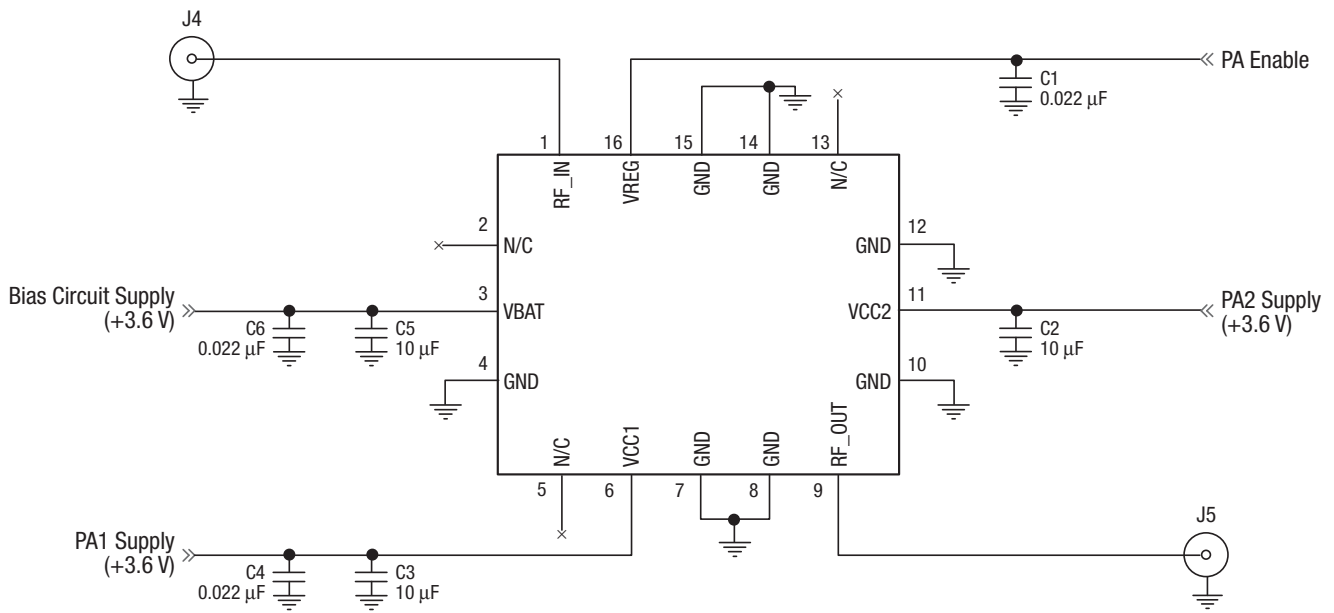
S1844

**Figure 10. SKY65160-11 Evaluation Board Layer Detail**

Cross Section	Name	Thickness (mm)	Material	$\epsilon_r$
	Pri	0.025	Cu	-
	Die1	0.400	Rogers 4003	-
	L2	0.025	Cu	-
	Die2	0.600	FR4	4.0
	L3	0.025	Cu	-
	Die3	0.400	FR4	4.0
	Sec	0.025	Cu	-

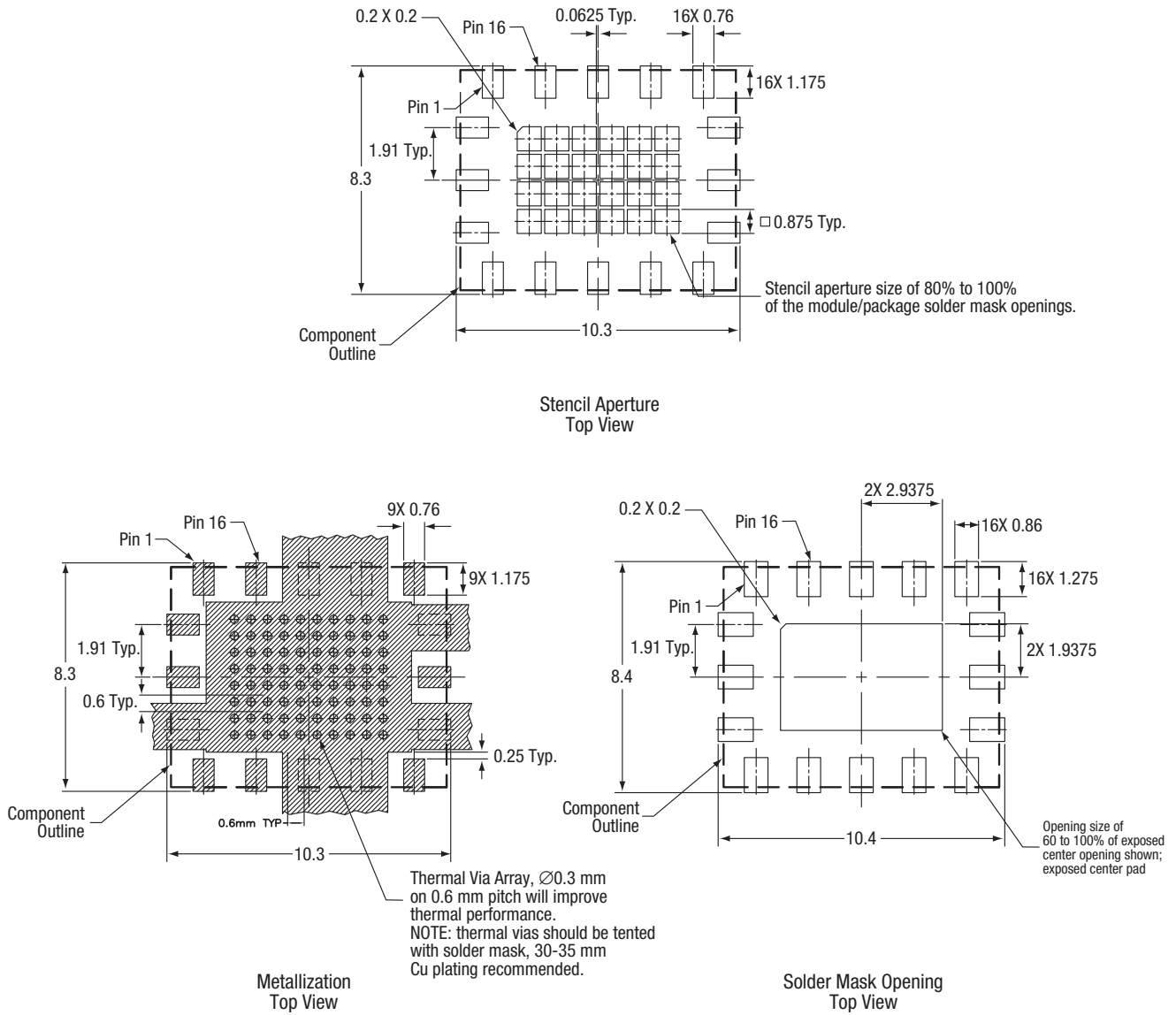
S2540

Figure 11. Layer Detail Physical Characteristics



S1845

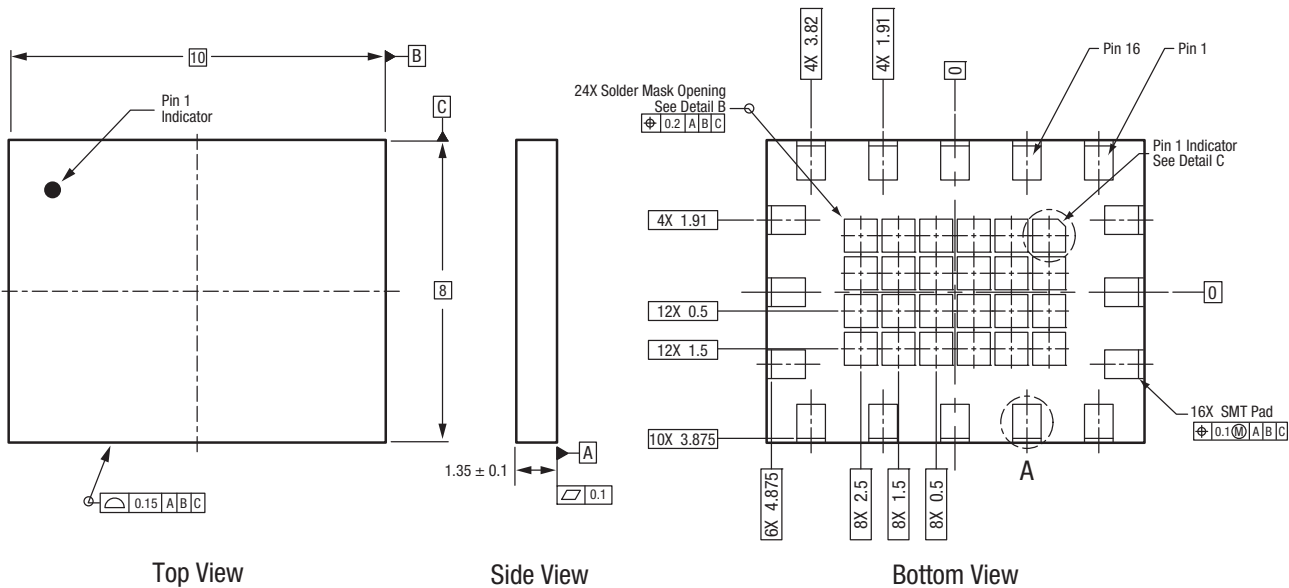
Figure 12. SKY65160-11 Evaluation Board Schematic



All dimensions are in millimeters

S2565

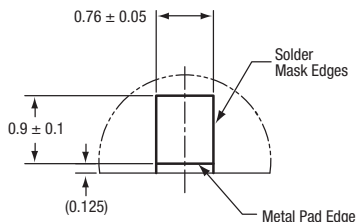
**Figure 13. SKY65160-11 PCB Layout Footprint**



Top View

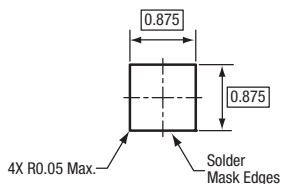
Side View

Bottom View



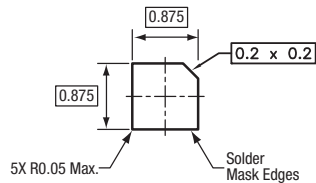
Detail A  
Pad  
Scale: 2X

5X This rotation  
5X Rotated 180°  
3X Rotated 90° CW  
3X Rotated 90° CCW



Detail B  
Scale: 2X

23X This rotation



Detail C  
Scale: 2X

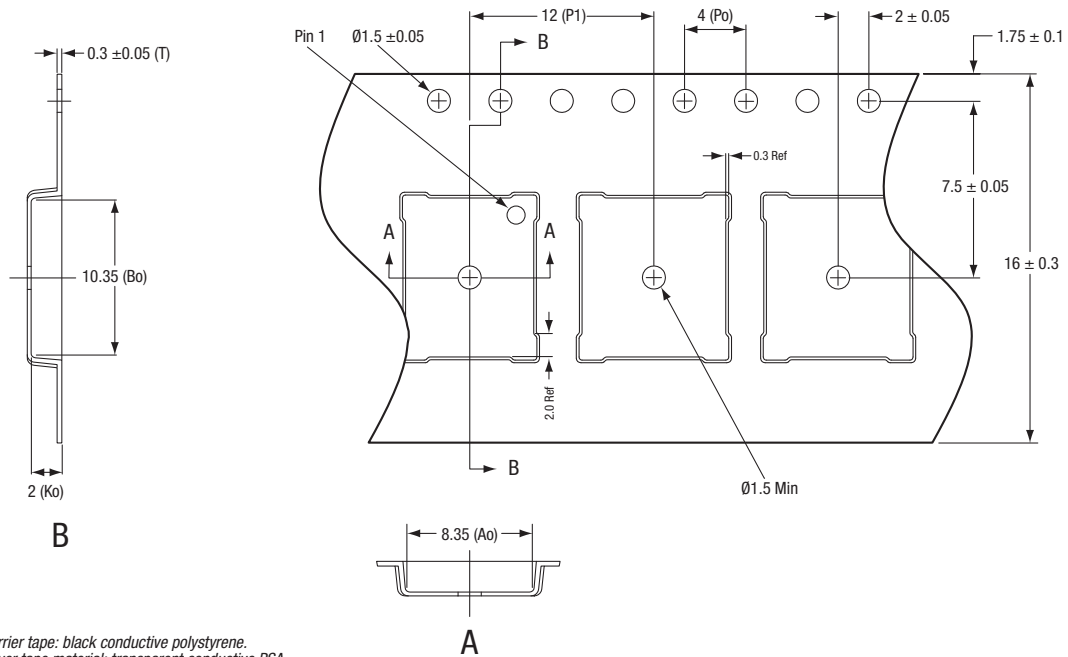
1X This rotation

All measurements are in millimeters.

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

S1623b

Figure 14. SKY65160-11 16-Pin MCM Package Dimensions



Notes:

1. Carrier tape: black conductive polystyrene.
2. Cover tape material: transparent conductive PSA.
3. Cover tape size: 13.3 mm width.
4. Po/P1, 10 pitches cumulative tolerance on tape  $\pm 0.20$  mm.
5. Ao and Bo measurement point to be 0.3 mm from bottom pocket.
6. All measurements are in millimeters.

S1625

Figure 15. SKY65160-11 Tape and Reel Dimensions

**Ordering Information**

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY65160-11 High Power PA	SKY65160-11	TW18-D110-003

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