DATA SHEET

SKY65338-21: 450 to 470 MHz Transmit/Receive Front-End Module

Applications

- Tetra radio
- Remote metering
- GSM
- WLL transmitters

Features

- Transmit output power > +25 dBm
- High gain in transmit path: 32 dB
- High transmit/receive isolation > 30 dB
- Internal RF match and bias circuits
- All RF ports internally DC blocked
- Single DC supply = +3.6 V
- Small footprint, MCM (12-pin, 8 x 8 mm) SMT package (MSL3, 260 °C per JEDEC J-STD-020)

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 Skyworks SKY65338-21 is a high-efficiency front-end module (FEM) that incorporates a transmit and receive path, and an antenna transmit/receive (T/R) switch.

The transmit path consists of a high efficiency power amplifier (PA) followed by an harmonic filter for rejection of harmonic frequencies.

The PA is implemented using Skyworks high reliability heterojunction bipolar transistor (HBT) process and is Class AB biased to provide maximum efficiency with a low spurious output.

A high-linearity and high-isolation single-pole, double-throw (SPDT) switch is used at the common antenna interface between the transmit and receive paths. The receive path is a low insertion loss through-path with input and output ports internally matched to 50 Ω.

The device is mounted in a 12-pin, 8 x 8 mm Multi-Chip Module (MCM) surface-mount technology (SMT) package, which allows for a highly manufacturable, low-cost solution.

A block diagram of the SKY65338-21 is shown in Figure 1. The device package and pinout for the 12-pin MCM are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

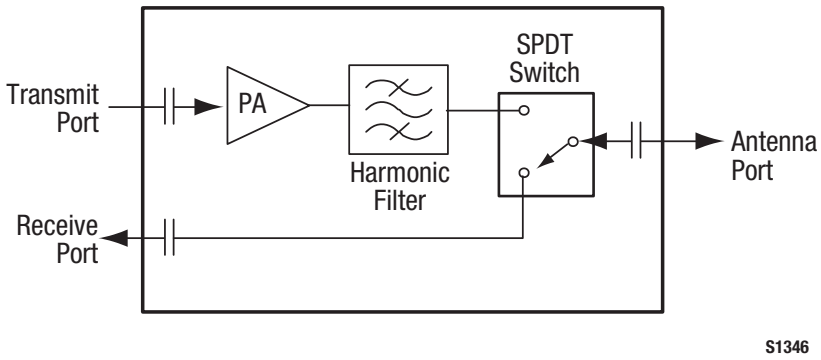


Figure 1. SKY65338-21 Block Diagram

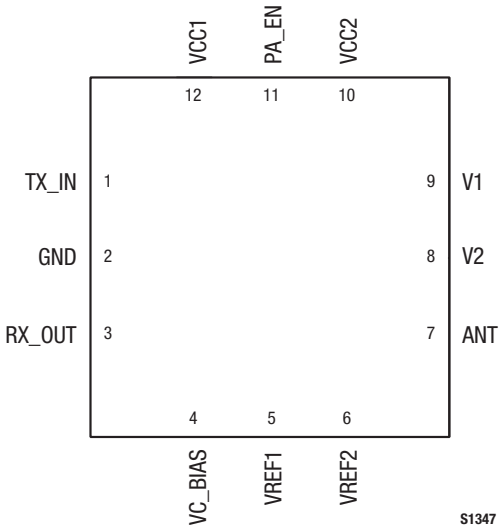


Figure 2. SKY65338-21 Pinout (Top View)

Table 1. SKY65338-21 Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	TX_IN	Transmit RF input	7	ANT	Antenna
2	GND	Ground	8	V2	Switch logic (see Table 1)
3	RX_OUT	Receive RF output	9	V1	Switch logic (see Table 1)
4	VC_BIAS	+3.6 V DC supply	10	VCC2	+3.6 V DC supply
5	VREF1	+3.6 V DC supply	11	PA_EN	PA enable switch (On = 2.5-3.6 V; Off = 0-0.2 V)
6	VREF2	+3.6 V DC supply	12	VCC1	+3.6 V DC supply

Technical Description

The SKY65338-21 provides input and output amplifier stages, and is internally matched for optimum efficiency. An active bias circuit provides the input and output stages with excellent gain tracking over temperature and voltage variations. The module operates with positive DC voltages, and maintains high efficiency and good linearity. The nominal operating voltage is 3.6 V for maximum power, but the device can be operated at slightly lower voltages for other mobile applications.

The SKY65338-21 is internally matched for optimum linearity and efficiency. The input and output stages are independently supplied using the VCC1 and VCC2 supply lines (pins 12 and 10, respectively). The bias reference voltages for stages 1 and 2 are supplied using common lines VREF1 and VREF2 (pins 5 and 6, respectively). The DC control voltage that sets the bias for stages 1 and 2 is supplied by the VC_BIAS signal, pin 4.

Operational Modes

The module's receive and transmit modes are configured using the V1 and V2 control signals (pins 9 and 8, respectively). The transmit path provides an harmonic filter and high efficiency PA. The receive path provides a low loss <1 dB bypass between the antenna port and the receive port.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65338-21 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4.

Typical performance characteristics of the SKY65338-21 are illustrated in Figures 3 through 10. The state of the SKY65338-21 is determiend by the logic provided in Table 5.

Table 2. SKY65338-21 Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	VCC		4.4	V
Input power	P_{IN}		+5	dBm
Supply current	I_{CC}		800	mA
Case operating temperature	T_C	–40	+85	°C
Storage temperature	T_{ST}	–65	+125	°C
Junction temperature	T_J		150	°C

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.

***ESD HANDLING**: 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 when handling or transporting. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD handling precautions should be used at all times.*

Table 3. SKY65338-21 Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Supply voltage	VCC1, VCC2, VREF1, VREF2, VC_BIAS	3.0	3.6	4.0	V
Case operating temperature	T_C	–40		+85	°C
Storage temperature	T_{ST}	–55		+125	°C

Table 4. SKY65338-21 Electrical Specifications[1]
(Frequency = 460 MHz, VCC1 = VCC2 = VREF1 = VREF2 = VC_BIAS = 3.6 V, Tc = +25 °C, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Operating frequency range	f		450		470	MHz
Transmit path small signal gain	G	CW, P_{IN} = –30 dBm	30	32		dB
Transmit saturated output power	P_{SAT}	CW, P_{IN} = –4 dBm	+25	+27		dBm
Transmit path noise figure	NF			5.5	6.5	dB
Transmit path harmonics (2^{nd} to 10^{th})	Pf2 to Pf10	CW, P_{OUT} = +25 dBm	55			dBc
Power-added efficiency	PAE	CW, P_{OUT} = +27 dBm	30	36		%
Receive path insertion loss	R_{X_LOSS}			0.6	1.0	dB
Transmit/receive path isolation	I_{SOL}	CW	27	30		dB
Input return loss	S11		15	19		dB
Output return loss	S22		9	14		dB
Quiescent current	I_Q	No RF		45	55	mA
Operating current	I_{OP}	P_{OUT} = +25 dBm		315	350	mA
Leakage current	I_{LEAK}	No RF input, module in standby mode		2		µA
Maximum VSWR for stable operation	$VSWR_{MAX}$	CW			8:1	–

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.

Typical Performance Characteristics
(Vcc = 3.6 V, Tc = 25 °C, Unless Otherwise Noted)

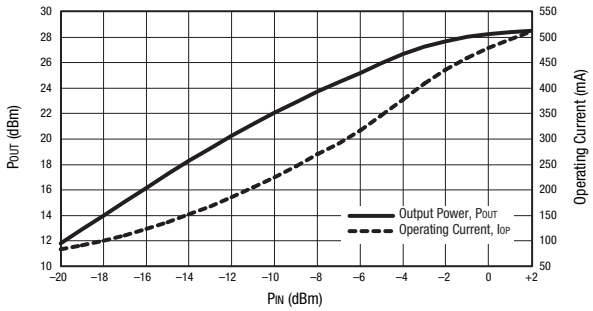


Figure 3. Output Power and Operating Current vs Input Power Voltage

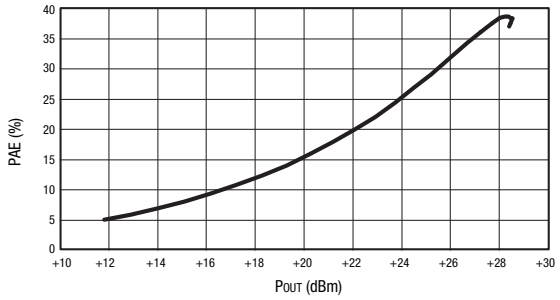


Figure 4. Power-Added Efficiency vs Output Power

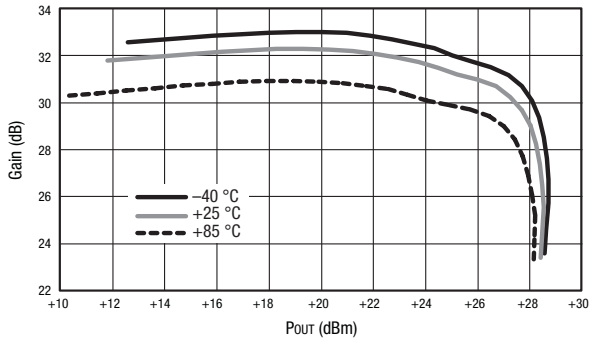


Figure 5. Gain vs Output Power Over Temperature

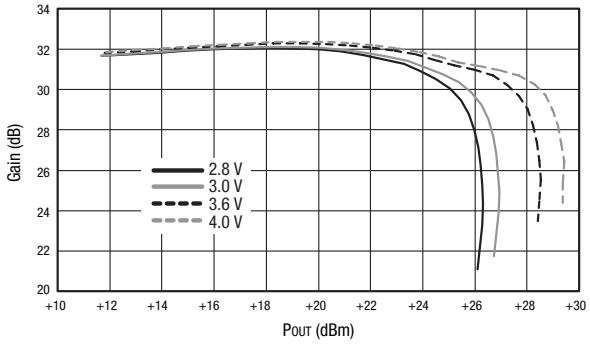


Figure 6. Gain vs Output Power Over Supply Voltage

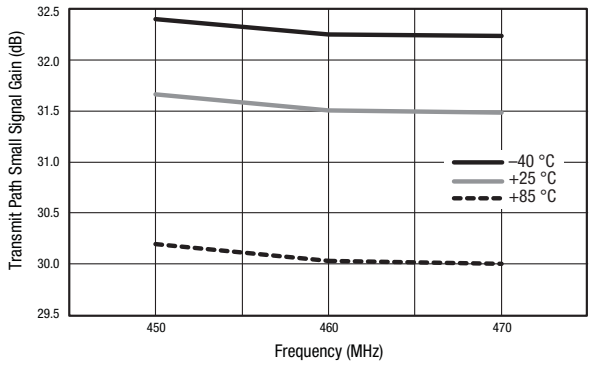


Figure 7. Gain vs Frequency Over Temperature

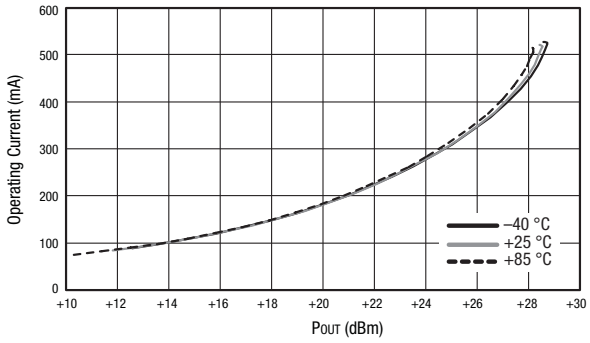


Figure 8. Operating Current vs Output Power Over Temperature

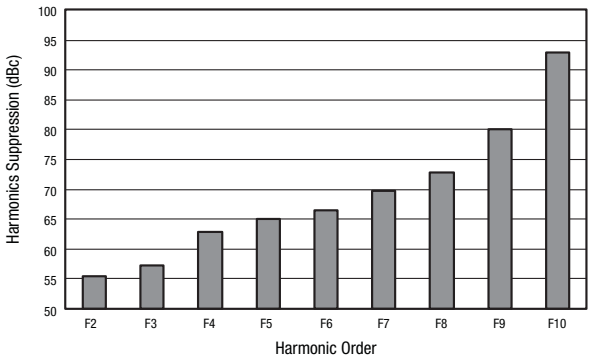


Figure 9. Harmonics

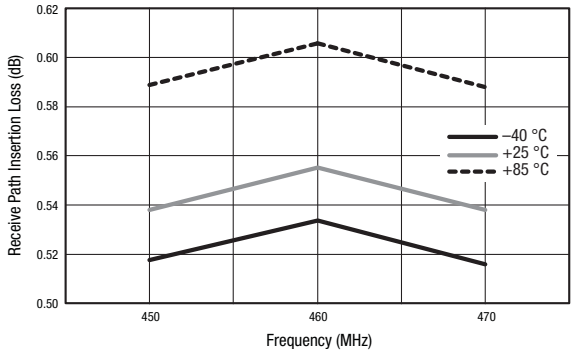


Figure 10. Receive Insertion Loss vs Frequency Over Temperature

Table 5. SKY65338-21 SPDT Switch Control Logic[1]

Mode	V1 Signal (Pin 9)	V2 Signal (Pin 8)
Transmit	1	0
Receive	0	1

1 Logic level 0: 0 V to 0.2 V
Logic level 1: 2.0 V to 5.0 V

Evaluation Board Description

The SKY65338-21 Evaluation Board is used to test the performance of the SKY65338-21 FEM. The Evaluation Board schematic diagram is shown in Figure 11. An assembly drawing for the Evaluation Board is shown in Figure 12 and the layer detail is provided in Figure 13. The layer detail physical characteristics are noted in Figure 14. Table 6 provides the Bill of Materials (BOM) list for Evaluation Board components.

Circuit Design Considerations

The following design considerations are general in nature and must be followed regadless of final use or configuration:

- Paths to ground should be made as short as possible.
- The ground pad of the SKY65338-21 has special electrical and thermal grounding requirements. This pad is the main thermal conduit for heat dissipation. Since the circuit board acts as the heat sink, it must shunt as much heat as possible from the device. Therefore, design the connection to the ground pad to dissipate the maximum wattage produced by the circuit board. Multiple vias to the grounding layer are required.

NOTE: *A poor connection between the slug and ground increases junction temperature (TJ), which reduces the lifetime of the device.*

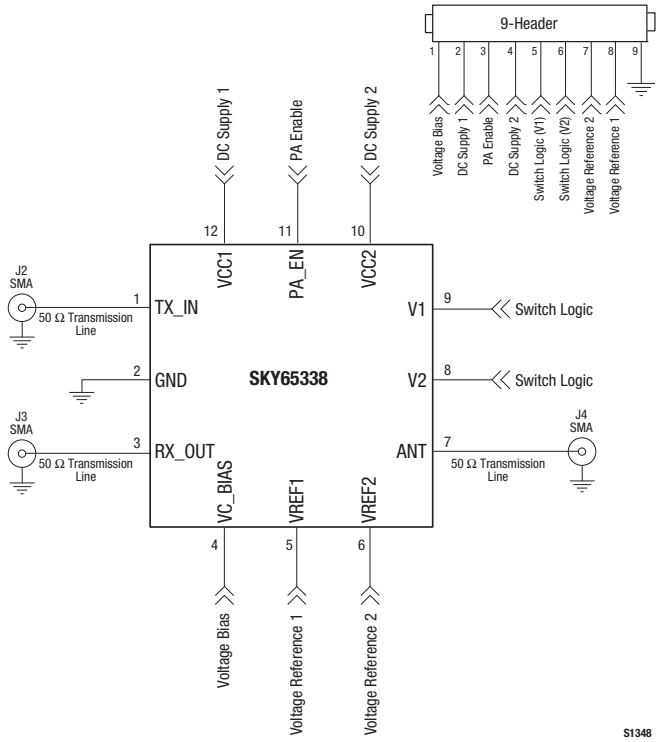


Figure 11. SKY65338-21 Evaluation Board Schematic

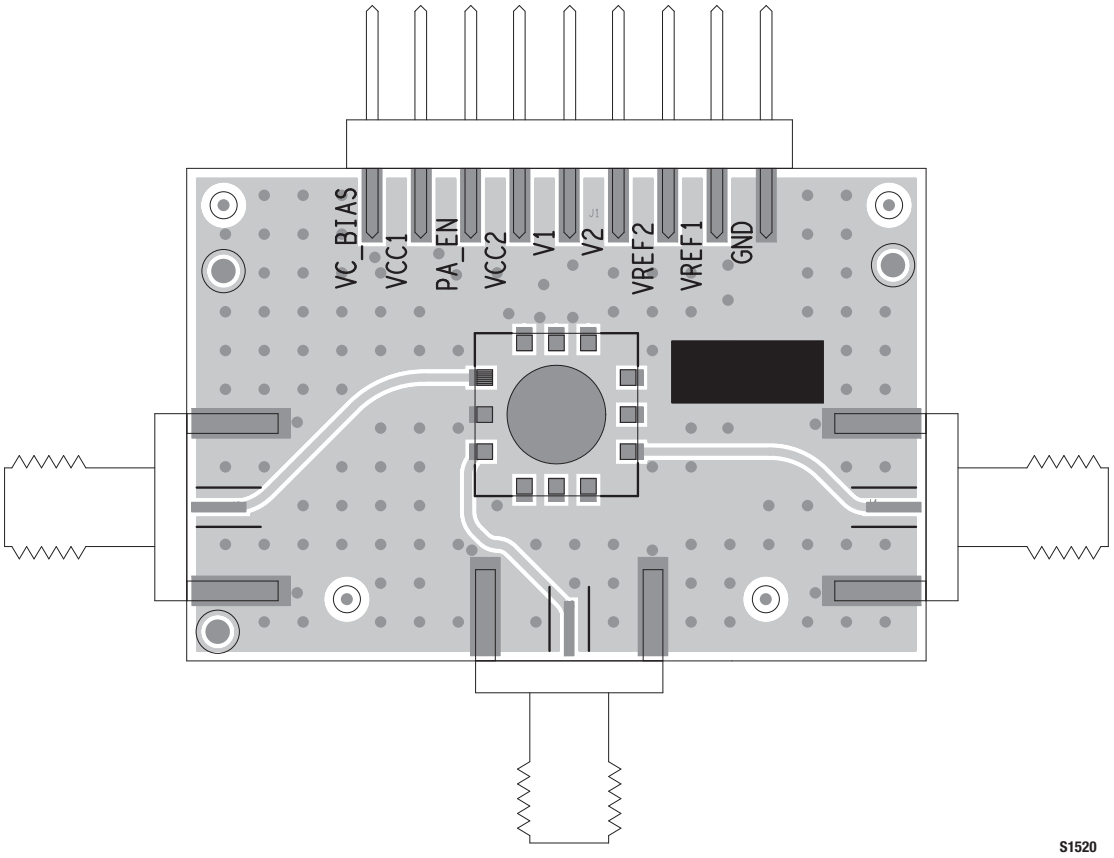
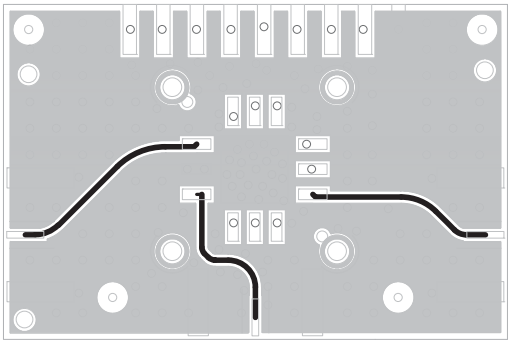
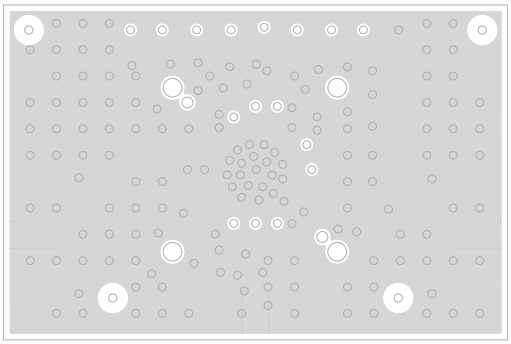


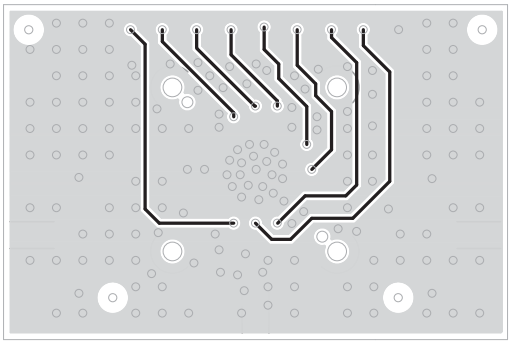
Figure 12. SKY65338-21 Evaluation Board Assembly Drawing



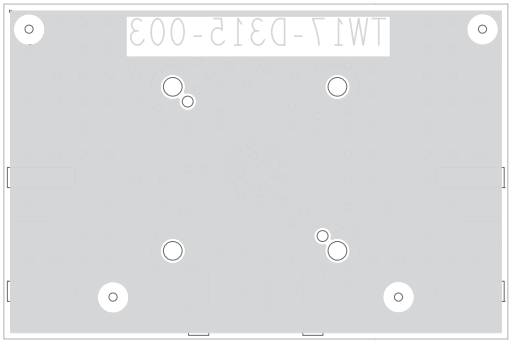
Layer 1: Top – Metal



Layer 2: Ground



Layer 3: Power Plane



Layer 4: Solid Ground Plane

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Figure 13. SKY65338-21 Evaluation Board Layer Detail

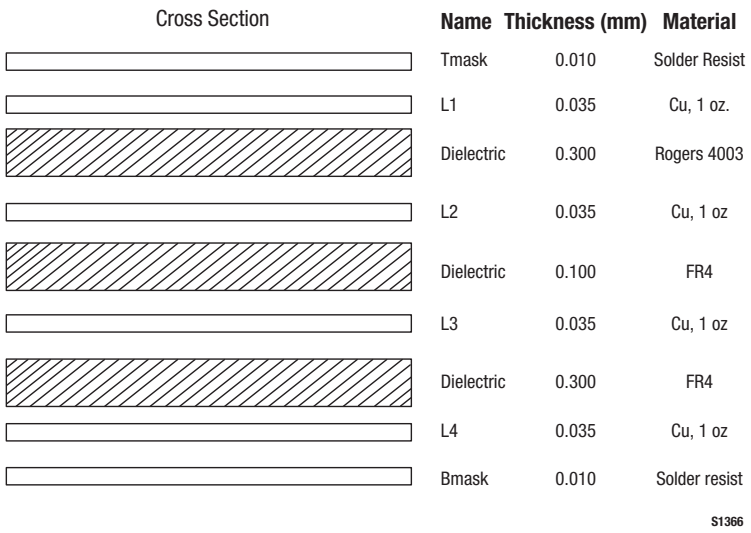


Figure 14. Layer Detail Physical Characteristics

Table 6. SKY65338-21 Evaluation Board Bill of Materials

Component	Quantity	Part Number
J2, J3, J4	3	615R54-021
SC1, SC2, SC3, SC4	4	92196A052
Backframe	1	1056-101

Package Dimensions

The phone board layout footprint for the SKY65338-21 is shown in Figure 15. Package dimensions are shown in Figure 16, and tape and reel dimensions are provided in Figure 17.

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 SKY65338-21 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 Skyworks Application Note, *PCB Design and 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. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.

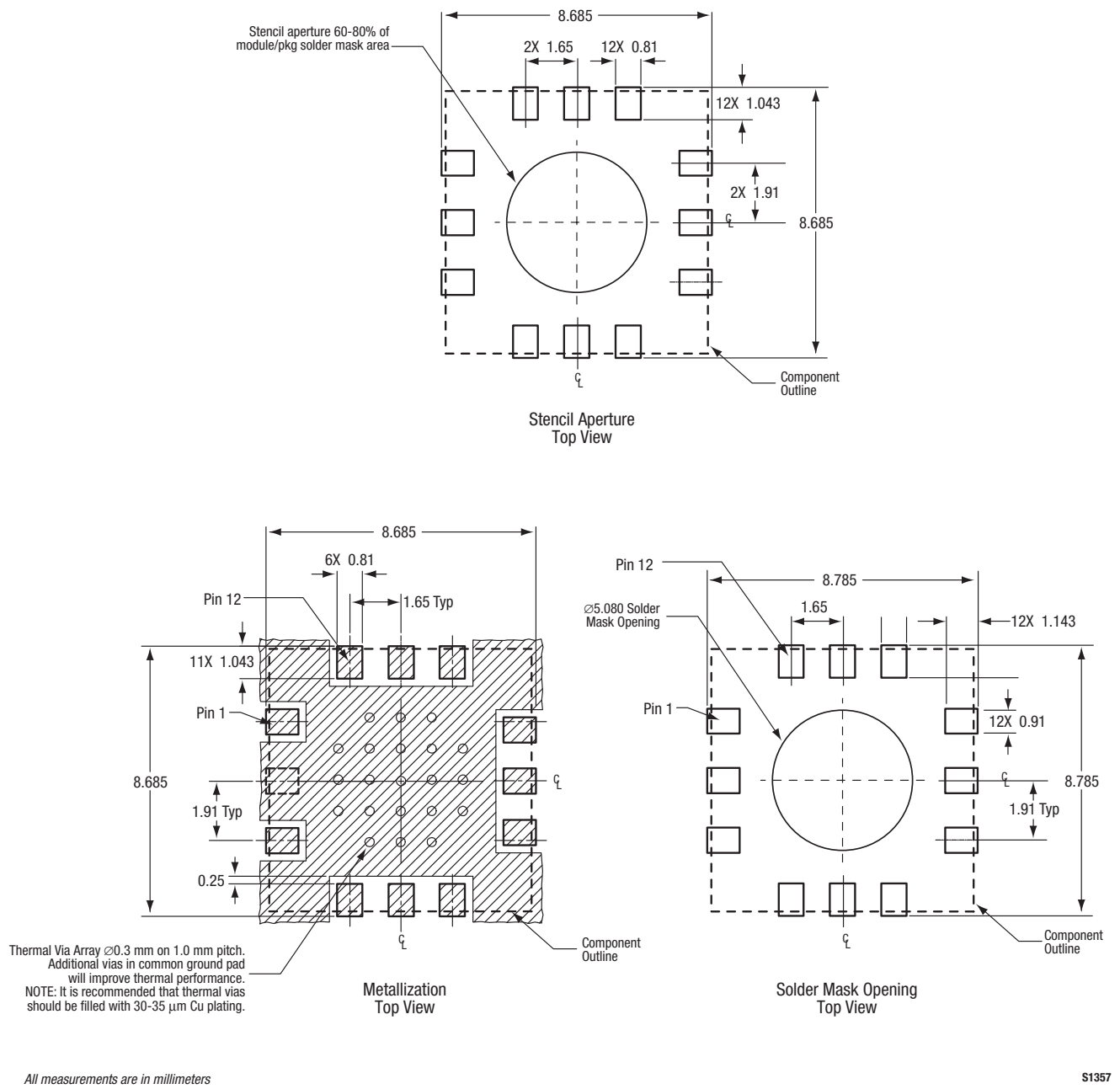
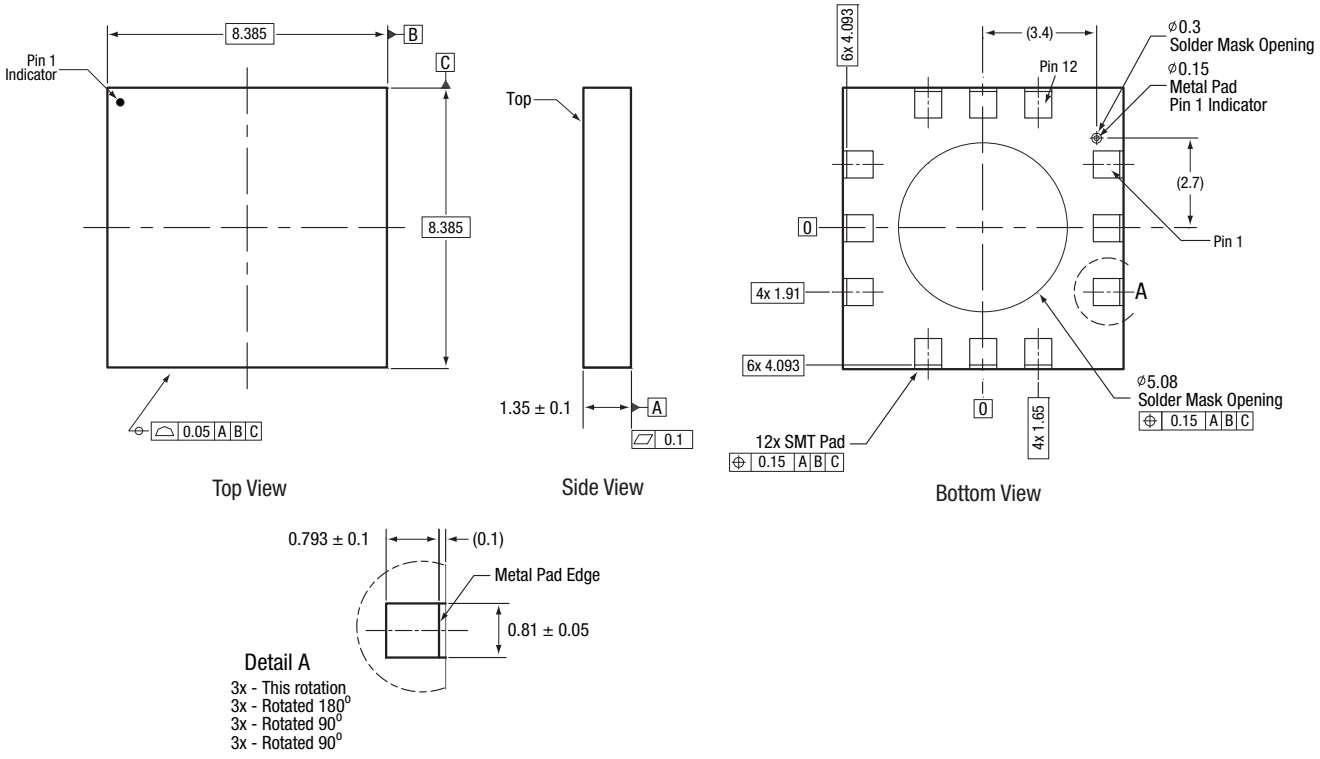


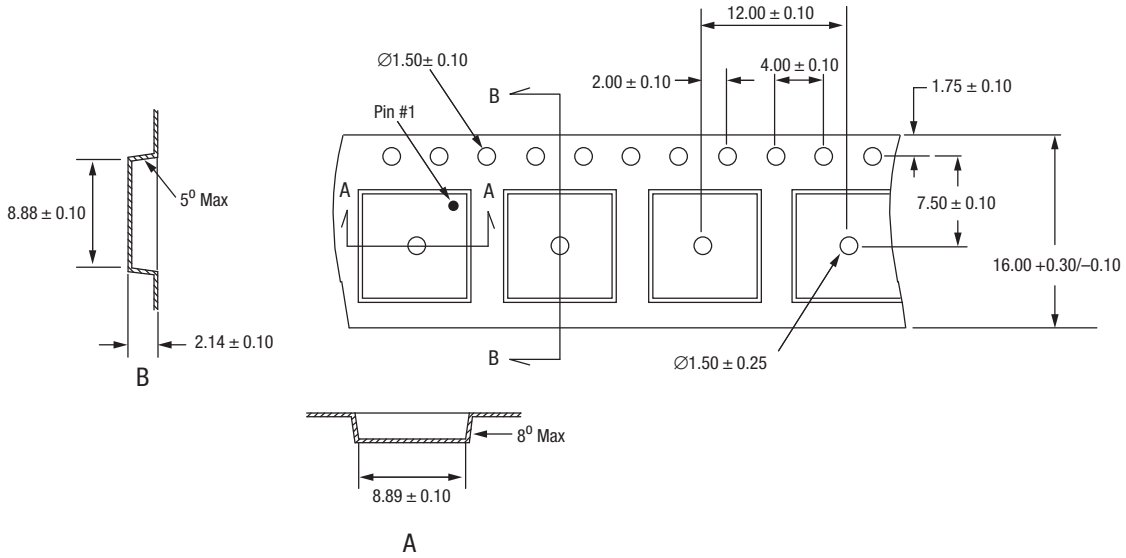
Figure 15. SKY65338-21 Phone Board Layout Footprint



Dimensioning and tolerancing according to ASME Y14.5M-1994.
All measurements are in millimeters

S1354

Figure 16. SKY65338-21 Package Dimensions



Notes:
1. *Carrier tape: black conductive poly carbonate or polystyrene.*
2. *Cover tape material: transparent conductive PSA.*
3. *Cover tape size: 13.3 mm width.*
4. *All measurements are in millimeters.*

S1252

Figure 17. SKY65338-21 Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number
SKY65338-21: 450 to 470 MHz Front-End Module	SKY65338-21 (Pb-free package)	SKY65338-21-EVB