DATA SHEET

SKY65094-360LF: 698 to 915 MHz Low-Noise Power Amplifier Driver

Applications

- 2.5G, 3G, 4G wireless infrastructure transceivers
- ISM band transmitters
- WCS fixed wireless
- 3GPP LTE

Features

- Wideband frequency range: 698 to 915 MHz
- Low Noise Figure: 3.2 dB
- High IIP3 up to +29 dBm
- Output P1dB = +25 dBm
- High gain: +17 dB
- Single DC supply: +5 V
- Enable voltage: +3.3 V
- On-chip bias circuit
- DFN (8-pin, 2 x 2 mm) package (MSL1, 260 °C per JEDEC J-STD-020)

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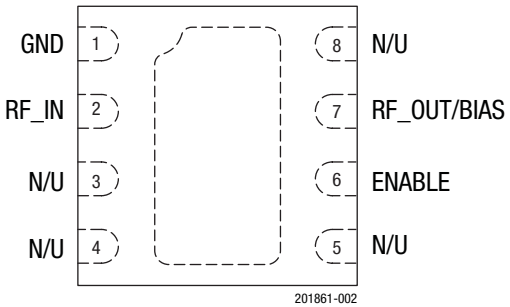


Figure 2. SKY65094-360LF Pinout (Top View)

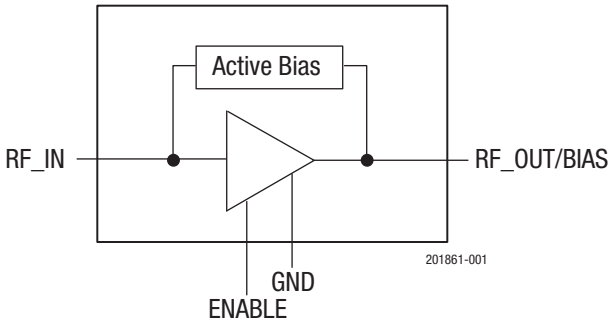


Figure 1. SKY65094-360LF Functional Block Diagram

Description

The Skyworks SKY65094-360LF is a high-performance, ultra-wideband power amplifier (PA) driver with superior output power, low noise, and linearity. The device provides excellent noise figure (NF) and high output power at 1 dB compression, which makes the SKY65094-360LF ideal for use in the driver stage of infrastructure transmit or receive chains.

The SKY65094-360LF uses low-cost surface-mount technology (SMT) in the form of an 8-pin, 2 x 2 mm Dual Flat No-Lead (DFN) package. A functional block diagram is provided in Figure 1, and the device package and pinout are shown in Figure 2. Signal pin assignments and functional pin descriptions are described in Table 1.

Table 1. SKY65094-360LF Signal Descriptions

Pin	Name	Description	Pin	Name	Description
1	GND	Ground	5	N/U	Not used (may be grounded)
2	RF_IN	RF input	6	ENABLE	PA enable
3	N/U	Not used (may be grounded)	7	RF_OUT/BIAS	RF output/bias voltage
4	N/U	Not used (may be grounded)	8	N/U	Not used (may be grounded)

Technical Description

The SKY65094-360LF is a single stage, low-noise PA that operates with a single 5 V power supply connected through an RF choke (inductor L1) to the output signal (pin 7). The bias current is set by the on-chip active bias composed of current mirror and reference voltage transistors, which allow excellent gain tracking over temperature and voltage variations. The device is externally RF matched using surface-mount components to facilitate operation over a frequency range of 824 to 849 MHz.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65094-360LF are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4 (general specifications), Table 5 (698 to 716 MHz), Table 6 (777 to 798 MHz), Table 7 (824 to 849 MHz), and Table 8 (880 to 915 MHz).

Typical performance characteristics of the SKY65094-360LF for the 824 to 849 MHz frequency range are illustrated in Figures 3 through 10.

Table 2. SKY65094-360LF Absolute Maximum Ratings[1]

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage	V_{CC}	-0.3	+6.0	V
RF input power	P_{IN}		+20	dBm
Supply current @ P1dB	I_{CC}		400	mA
Power dissipation @ P1dB	P_D		1.1	W
Power dissipation @ P_{IN} = -10 dBm	P_D		0.7	W
Operating case temperature	T_C	0	+95	°C
Extended operating temperature	T_{EXT}	-33	+95	°C
Storage temperature	T_{ST}	-55	+150	°C
Junction temperature	T_J		+150	°C
Thermal resistance	Θ_{JC}		35	°C/W

[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 values. 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. SKY65094-360LF Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Bias voltage	V_{CC}	4.75	5.00	5.25	V
Enable voltage	V_{EN}		3.3		V
Operating frequency	f	698		915	MHz

Table 4. SKY65094-360LF Electrical Characteristics: General

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Quiescent current	I_{CQ}	No RF		130	145	mA
Gain vs temperature			-0.01		+0.01	dB/°C
0.1 dB output compression point	OP0.1dB	Sweep input power	+19			dBm
Turn-on time		Pin = -10 dBm, Ven = 3.3 V		1		µs
Stability		P_{IN} = 0 dBm, over all operating temperatures	Unconditional			-

Table 5. SKY65094-360LF Electrical Characteristics: 698 to 716 MHz[1]
(V_{CC} = +5 V, T_C = 25 °C, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Frequency	f		698		716	MHz
Third order input intercept point	IIP3	P_{IN} = -10 dBm/tone, 5 MHz spacing		+26.5		dBm
Small signal gain	$\|S21\|$	P_{IN} = -30 dBm		16.5		dB
Input return loss	$\|S11\|$	P_{IN} = -30 dBm		21		dB
Output return loss	$\|S22\|$	P_{IN} = -30 dBm		6.8		dB
Noise figure	NF			3.3		dB
1 dB output compression point	OP1dB	Sweep input power		+22.7		dBm

[1] Performance is verified by characterization. Evaluation Board input trace loss up to DC blocking capacitor = 0.06 dB. Output trace loss up to DC blocking capacitor = 0.07 dB.

Table 6. SKY65094-360LF Electrical Characteristics: 777 to 798 MHz[1]
(V_{CC} = +5 V, T_C = 25 °C, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Frequency	f		777		798	MHz
Third order input intercept point	IIP3	P_{IN} = -10 dBm/tone, 5 MHz spacing		+28.8		dBm
Small signal gain	|S21|	P_{IN} = -30 dBm		17.0		dB
Input return loss	|S11|	P_{IN} = -30 dBm		21.5		dB
Output return loss	|S22|	P_{IN} = -30 dBm		10		dB
Noise figure	NF			3.0		dB
1 dB output compression point	OP1dB	Sweep input power		+23.2		dBm

1 Performance is verified by characterization. Evaluation Board input trace loss up to DC blocking capacitor = 0.08 dB. Output trace loss up to DC blocking capacitor = 0.10 dB.

Table 7. SKY65094-360LF Electrical Characteristics: 824 to 849 MHz, Tested to Production Screen Limits[1]
(V_{CC} = +5 V, V_{EN} = 3.3 V, T_C = 25 °C, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Frequency	f		824		849	MHz
Third order input intercept point	IIP3	P_{IN} = -10 dBm/tone, 5 MHz spacing	+27.5	+29.5		dBm
Small signal gain	|S21|	P_{IN} = -30 dBm	16	17	18	dB
Gain vs frequency			-0.25	+0.12	+0.25	dB/20 MHz
Input return loss	|S11|	P_{IN} = -30 dBm	15	23		dB
Output return loss	|S22|	P_{IN} = -30 dBm	10	15		dB
Noise figure	NF			3.2	4.0	dB
1 dB output compression point	OP1dB	Sweep input power	+24.5	+25.5		dBm

1 Performance is guaranteed only under the conditions listed in this table, and corresponds to the Bill of Materials in Table 8 for this frequency band. Evaluation Board input trace loss up to DC blocking capacitor = 0.09 dB. Output trace loss up to DC blocking capacitor = 0.10 dB.

Table 8. SKY65094-360LF Electrical Characteristics: 880 to 915 MHz[1]
(VCC = +5 V, T_C = 25 °C, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Frequency	f		880		915	MHz
Third order input intercept point	IIP3	P_{IN} = -10 dBm/tone, 5 MHz spacing		+30		dBm
Small signal gain	|S21|	P_{IN} = -30 dBm		16.8		dB
Input return loss	|S11|	P_{IN} = -30 dBm		20		dB
Output return loss	|S22|	P_{IN} = -30 dBm		14		dB
Noise figure	NF			3.0		dB
1 dB output compression point	OP1dB	Sweep input power		+25.5		dBm

1 Performance is verified by characterization. Evaluation Board input trace loss up to DC blocking capacitor = 0.09 dB. Output trace loss up to DC blocking capacitor = 0.10 dB.

Typical Performance Characteristics (824 to 849 MHz) (Based on BOM in Table 9)

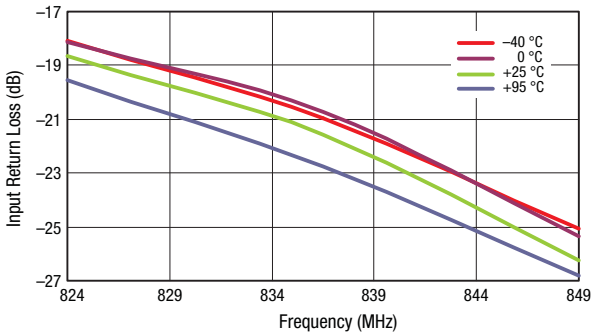


Figure 3. Input Return Loss vs Frequency Over Temperature

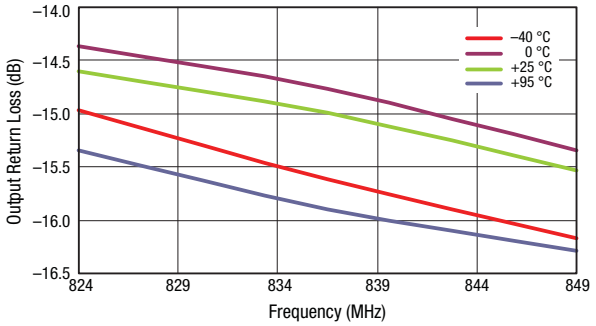


Figure 4. Output Return Loss vs Frequency Over Temperature

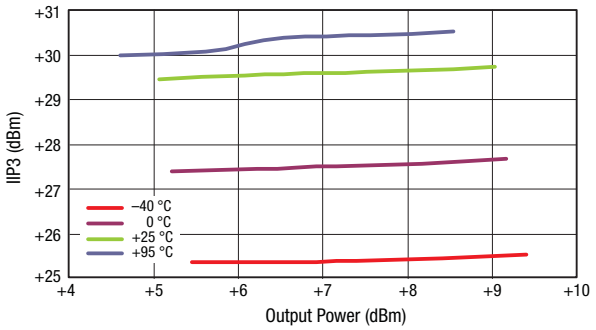


Figure 5. IIP3 vs Output Power Over Temperature

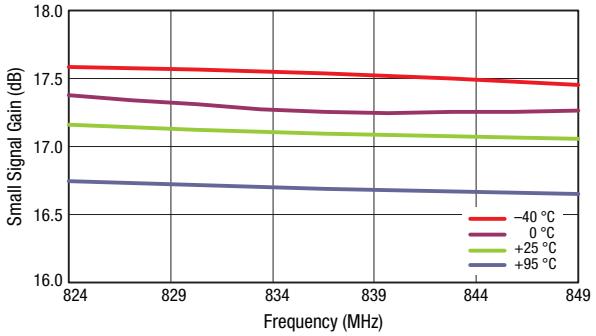


Figure 6. Small Signal Gain vs Frequency Over Temperature

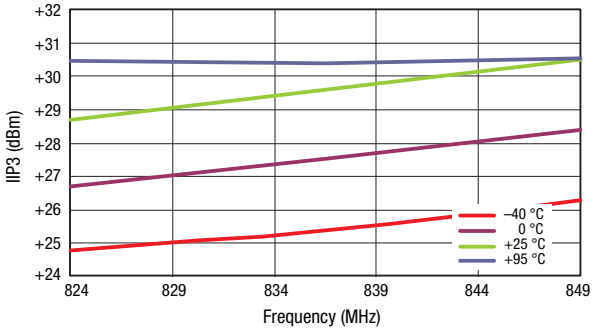


Figure 7. IIP3 vs Frequency Over Temperature

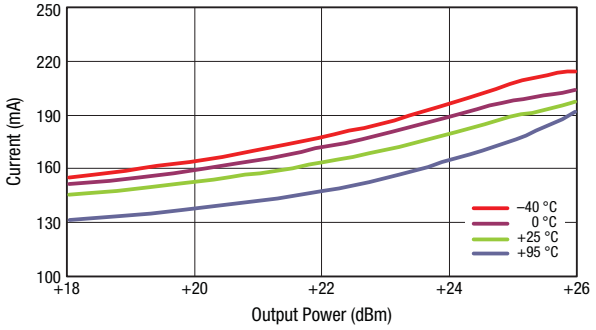


Figure 8. Current vs Output Power Over Temperature

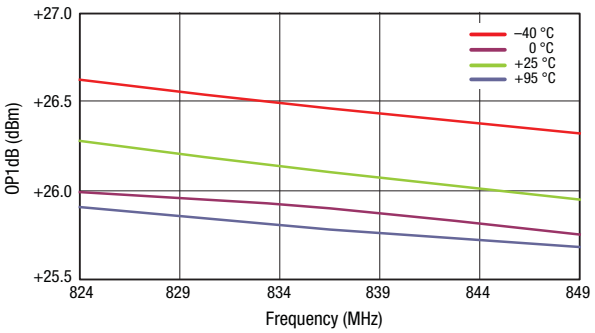


Figure 9. OP1dB vs Frequency Over Temperature

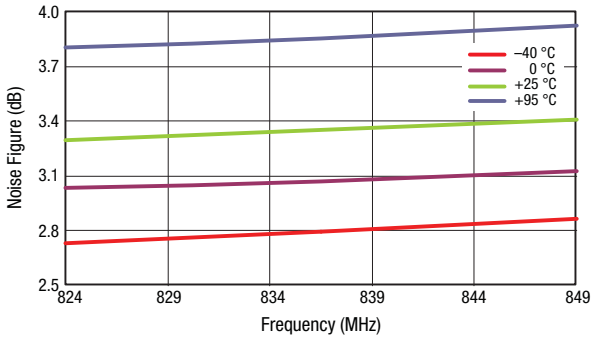


Figure 10. Noise Figure vs Ferquency Over Temperature

Evaluation Board Description

The Skyworks SKY65094-360LF Evaluation Board is used to test the performance of the SKY65094-360LF PA driver. An assembly drawing for the Evaluation Board is shown in Figure 1,1 and the layer detail is provided in Figure 12. The layer detail physical characteristics are noted in Figure 13.

Capacitor C10 provides DC bias decoupling for the output stage collector voltage. Pins 2 and 7 are the RF input and output signals, respectively. External DC blocking is required on the input and output, but can be implemented as part of the RF matching circuit. Pin 1 (GND) and the center ground pad provide the DC and RF ground.

Testing Procedure

Use the following procedure to set up the SKY65094-360LF Evaluation Board for testing:

1. Connect a 5.0 V supply to the VCC pin and 3.3 V to the ENABLE pin of the J3 header (see Evaluation Board assembly drawing in Figure 11 and schematic diagram in Figure 14). If available, enable the current limiting function of the power supply to 500 mA.
2. Connect a signal generator to the RF signal input port. Set it to the desired RF frequency at a power level of -15 dBm or less to the Evaluation Board but do NOT enable the RF signal.
3. Connect a spectrum analyzer to the RF signal output port.
4. Enable the power supply.
5. Enable the RF signal.
6. Take measurements.

***CAUTION**: If any of the output signals exceed the rated maximum values, the SKY65094-360LF Evaluation Board can be permanently damaged.*

Circuit Design Configurations

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

1. Paths to ground should be made as short as possible.
2. The ground pad of the SKY65094-360LF power amplifier 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 amplifier. As such, design the connection to the ground pad to dissipate the maximum wattage produced to the circuit board. Multiple vias to the grounding layer are required.

***NOTE:** Junction temperature (Tj) of the device increases with a poor connection to the slug and ground. This reduces the lifetime of the device.*

A suggested matching circuit is shown in Figure 14 with component values for the SKY65094-360LF Evaluation Board listed in Table 9.

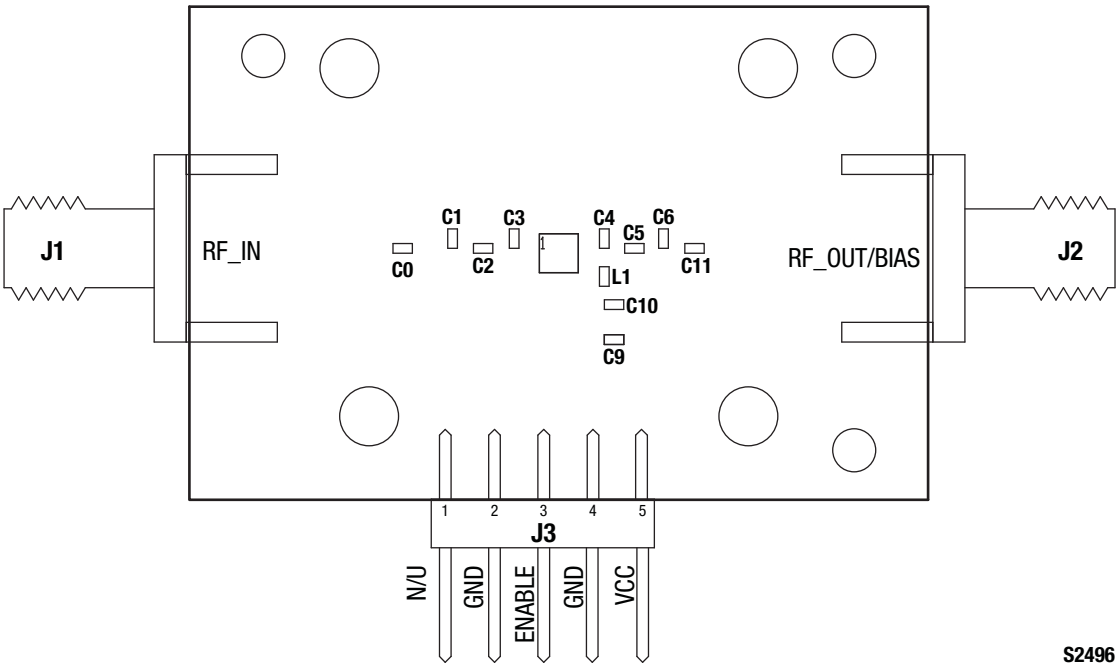
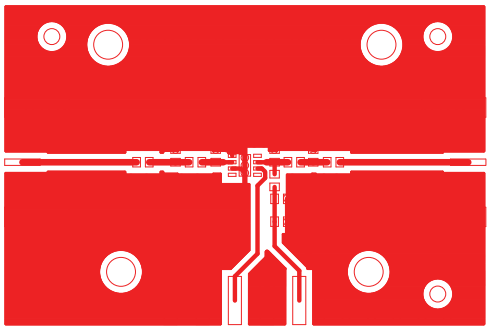
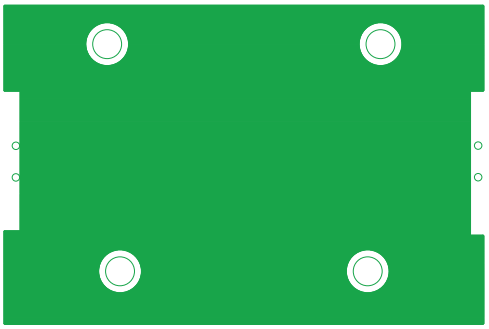


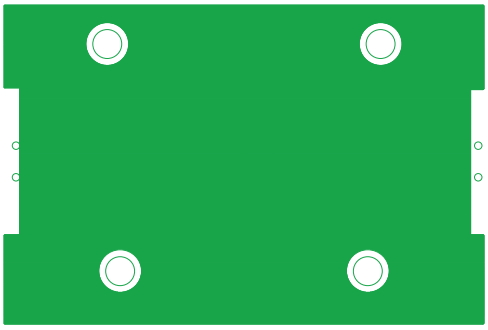
Figure 11. Evaluation Board Assembly Drawing



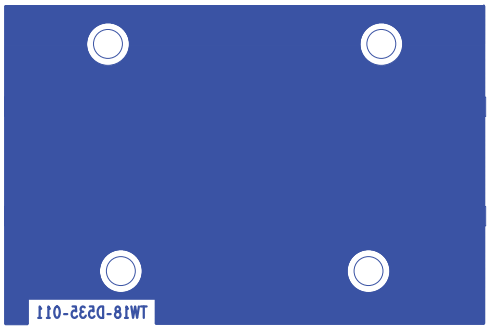
Layer 1: Top – Metal



Layer 2: Ground



Layer 3: Power Plane



Layer 4: Solid Ground Plane

S2497

Figure 12. Evaluation Board Layer Detail

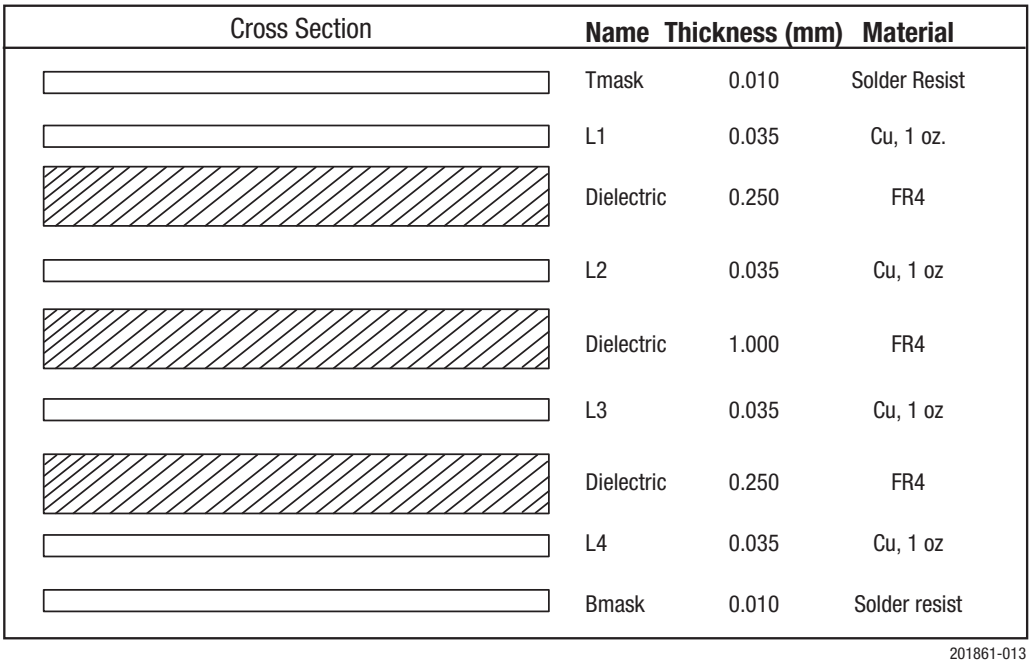


Figure 13. Layer Detail Physical Characteristics

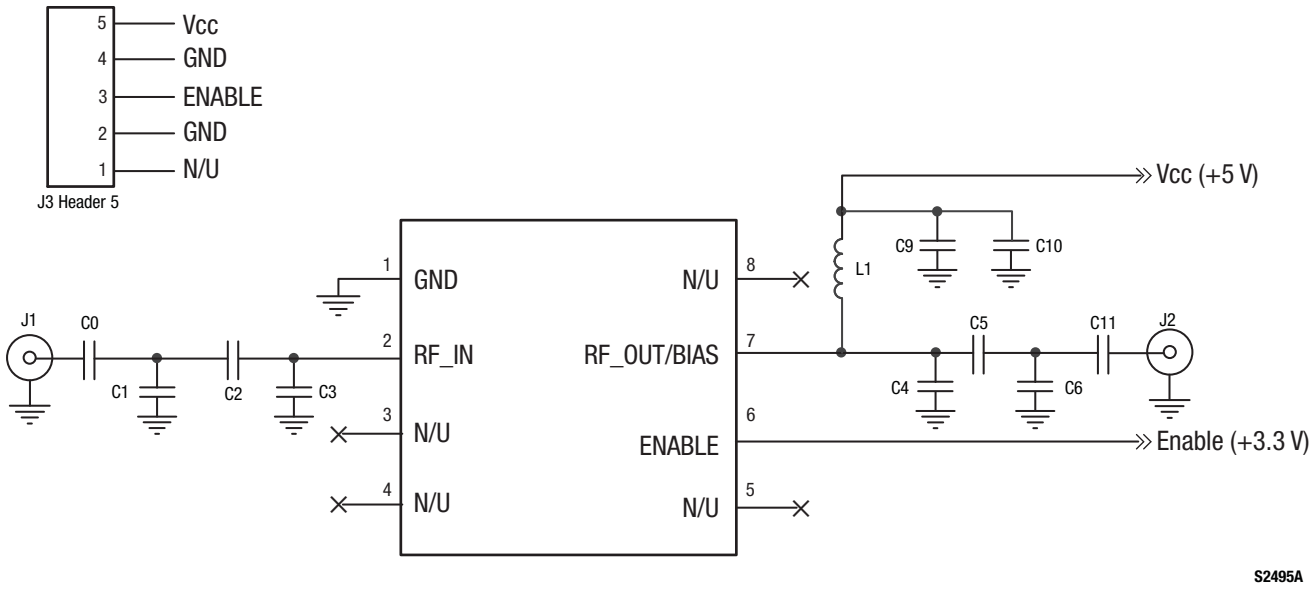


Figure 14. SKY65094-360LF Evaluation Board Schematic

Table 9. SKY65094-360LF (DFN Package) Evaluation Board Bill of Materials (1 of 2)

Component	Size	Value	Vendor	Vendor Part #
698 MHz to 716 MHz				
C0	0402	33 pF	Murata	GRM1555C1H330JZ01
C1	0402	4.7 nH	Murata	LQG15HS4N7S02
C2	0402	7.5 pF	Murata	GRM1555C1H7R5CB01
C3	0402	DNI	-	-
C4	0402	DNI	-	-
C5	0402	3.3 pF	Murata	GJM1555C1H3R3BB01B
C6	0402	12 nH	Murata	LQG15HS12NJ02
C9	1206	DNI	-	-
C10	0402	1 µF	Murata	GRM155R61A105KE15
C11	0402	33 pF	Murata	GRM1555C1H330JZ01
J1, J2		SMA Connector		615R54-021
J3		Connector, 5-pin header		615R31-040
L1	0402	18 nH	Murata	LQG15HS18NJ02
777 MHz to798 MHz				
C0	0402	33 pF	Murata	GRM1555C1H330JZ01
C1	0402	4.3 nH	Murata	LQG15HS4N3S02
C2	0402	7 pF	Murata	GRM615C0G070C50
C3	0402	DNI	-	-
C4	0402	DNI	-	-
C5	0402	4.7 pF	Murata	GJM1555C1H4R7BB01
C6	0402	12 nH	Murata	LQG15HS12NJ02
C9	1206	DNI	-	-
C10	0402	1 µF	Murata	GRM155R61A105KE15
C11	0402	33 pF	Murata	GRM1555C1H330JZ01
J1, J2		SMA Connector		615R54-021
J3		Connector, 5-pin header		615R31-040
L1	0402	18 nH	Murata	LQG15HS18NJ02

Table 9. SKY65094-360LF (DFN Package) Evaluation Board Bill of Materials (2 of 2)

Component	Size	Value	Vendor	Vendor Part #
824 MHz to 849 MHz				
C0	0402	33 pF	Murata	GRM1555C1H330JZ01
C1	0402	5.1 nH	Murata	LQG15HS5N1S02
C2	0402	6 pF	Murata	GJM1555C1H6R0BB01
C3	0402	DNI	-	-
C4	0402	DNI	-	-
C5	0402	8.2 pF	Murata	GJM1555C1H8R2CB01
C6	0402	12 nH	Murata	LQG15HS12NJ02
C9	1206	DNI	-	-
C10	0402	1 µF	Murata	GRM155R61A105KE15
C11	0402	33 pF	Murata	GRM1555C1H330JZ01
J1, J2		SMA Connector		615R54-021
J3		Connector, 5-pin header		615R31-040
L1	0402	18 nH	Murata	LQG15HS18NJ02
880 MHz to 915 MHz				
C0	0402	33 pF	Murata	GRM1555C1H330JZ01
C1	0402	4.7 nH	Murata	LQG15HS4N7S02
C2	0402	5.6 pF	Murata	GJM1555C1H5R6CB01
C3	0402	DNI	-	-
C4	0402	DNI	-	-
C5	0402	8.2 pF	Murata	GJM1555C1H8R2CB01
C6	0402	10 nH	Murata	LQG15H10NJ02
C9	1206	DNI	-	-
C10	0402	1 µF	Murata	GRM155R61A105KE15
C11	0402	33 pF	Murata	GRM1555C1H330JZ01
J1, J2		SMA Connector		615R54-021
J3		Connector, 5-pin header		615R31-040
L1	0402	18 nH	Murata	LQG15HS18NJ02

Package Dimensions

The PCB layout footprint for the SKY65094-360LF is shown in Figure 15. Typical part markings are shown in Figure 16. Package dimensions are shown in Figure 17, and tape and reel dimensions are provided in Figure 18.

Package and Handling Information

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 SKY65094-360LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering.

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.

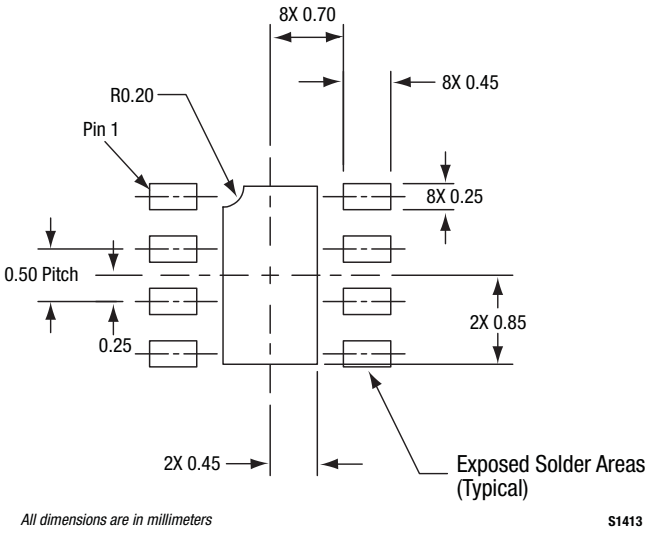


Figure 15. SKY65094-360LF PCB Layout Footprint

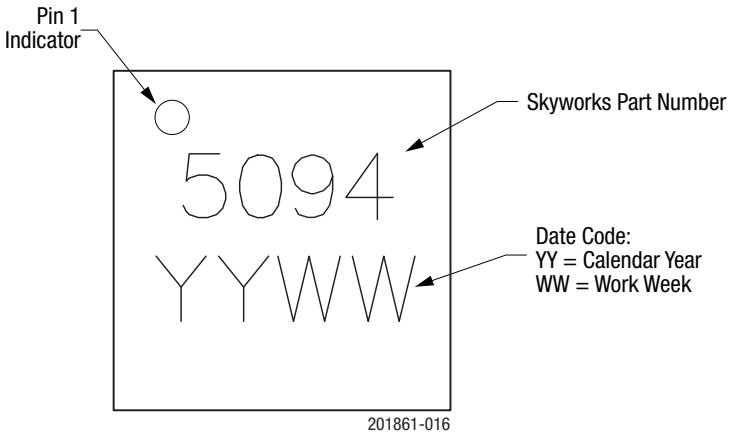
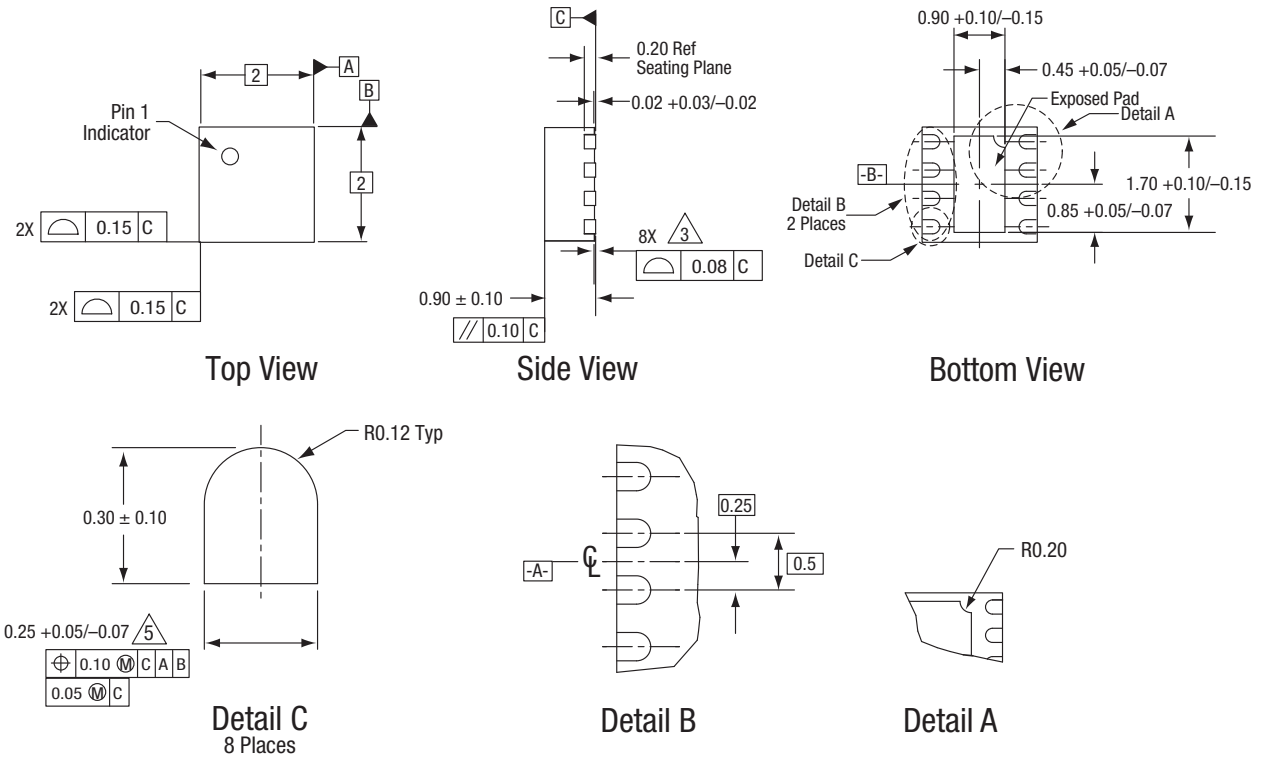


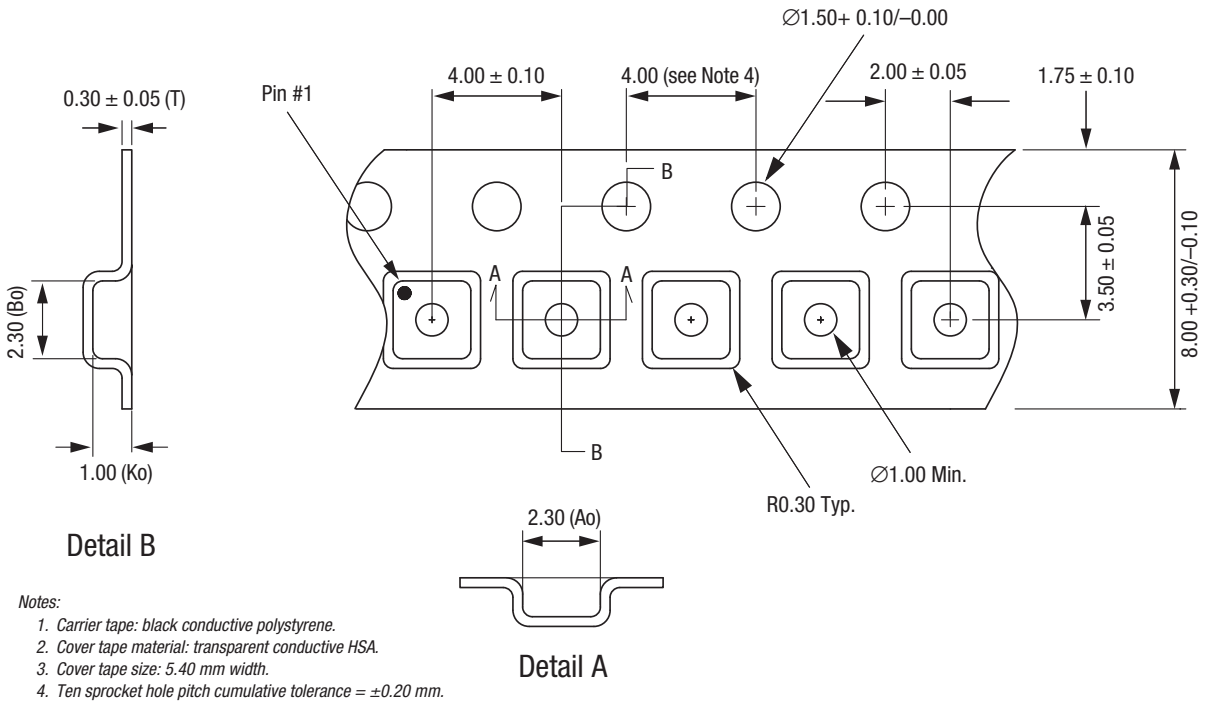
Figure 16. Typical Part Markings (Top View)



All measurements are in millimeters.
Dimensioning and tolerancing according to ASME Y14.5M-1994.
Coplanarity applies to the exposed heat sink slug as well as the terminals..
Plating requirement per source control drawing (SCD) 2504.
Dimension applies to metalized terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

201861-017

Figure 17. SKY65094-360LF Package Dimensions



Notes:

1. *Carrier tape: black conductive polystyrene.*
2. *Cover tape material: transparent conductive HSA.*
3. *Cover tape size: 5.40 mm width.*
4. *Ten sprocket hole pitch cumulative tolerance = ±0.20 mm.*
5. *ESD surface resistivity is ≤1 x 10^8 Ohms/square per EIA, JEDEC tape and reel specification.*
6. *Ao and Bo measurement point to be 0.30 mm from bottom pocket.*
7. *All measurements are in millimeters.*

201861-018

Figure 18. SKY65094-360LF Tape and Reel Dimensions

Ordering Information

Model Name	Ordering Part Number	Evaluation Board Part Number
SKY65094-360LF Low-Noise PA Driver	SKY65094-360LF	SKY65094-360EK1 (698 to 716MHz) SKY65094-360EK2 (777 to 798MHz) SKY65094-360EK3 (824 to 849MHz) SKY65094-360EK4 (880 to 915MHz)