DATA SHEET

SKY65099-360LF: 700 to 2700 MHz Broadband Linear Amplifier Driver

Applications

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

Features

- Wideband frequency range: 700 to 2700 MHz
- High OIP3 @ +8 dBm output power: +40 dBm
- Output P1dB = +24 dBm
- High gain
- Single DC supply: +5 V
- On-chip bias circuit
- DFN (8-pin, 2 x 2 mm) package (MSL1, 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.

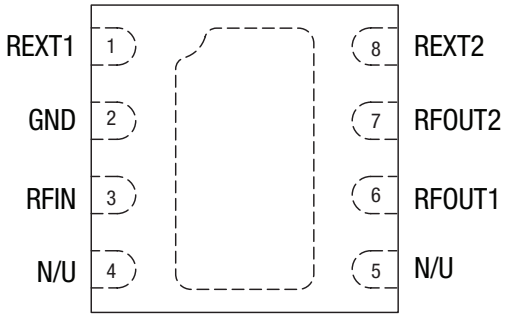


Figure 2. SKY65099-360LF Pinout (Top View)

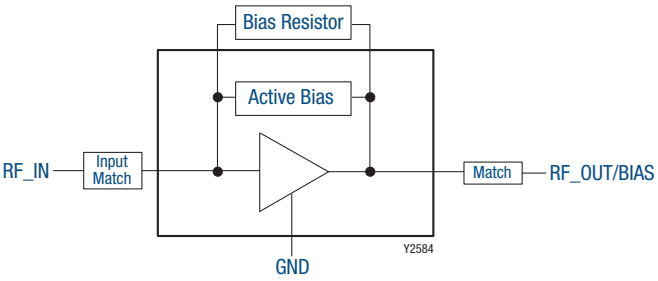


Figure 1. SKY65099-360LF Functional Block Diagram

Description

Skyworks SKY65099-360LF is a high performance, broadband power amplifier (PA) driver with superior output power and linearity. The device provides high output power at 1 dB compression, which makes the SKY65099-360LF ideal for use in the driver stage of infrastructure transmit or receive chains.

The SKY65099-360LF 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. SKY65099-360LF Signal Descriptions

Pin	Name	Description
1	REXT1	Pin 1 of external bias resistor
2	GND	Ground
3	RFIN	RF input port
4	N/U	Not used (may be grounded)
5	N/U	Not used (may be grounded)
6	RFOUT1	RF output port 1
7	RFOUT2	RF output port 2
8	REXT2	Pin 2 of external bias resistor

Technical Description

The SKY65099-360LF 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 700 to 2700 MHz.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY65099-360LF are provided in Table 2. The recommended operating conditions are specified in Table 3.

Electrical specifications are provided in Table 4 (720 to 840 MHz), Table 5 (2100 to 2200 MHz), and Table 6 (2500 to 2700 MHz).

Table 2. SKY65099-360LF Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Min	Max	Units
Supply voltage	V_{CC}	–0.3	+5.5	V
RF input power	P_{IN}		+10	dBm
Supply current @ P1dB	I_{CC}		400	mA
Power dissipation	P_{DISS}		0.9	W
Operating case temperature	T_C	–40	+85	°C
Storage temperature	T_{ST}	–55	+150	°C
Junction temperature (@ P1dB = –10 dBm)	T_J		+150	°C
Thermal resistance (@ P1dB = –10 dBm)	Θ_{JC}		85	°C/W
Electrostatic discharge: Charged Device Model (CDM), Class 4 Human Body Model (HBM), Class 1C Machine Model (MM), Class A	ESD		 1000 1500 50	 V V V

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 values. 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. SKY65099-360LF Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Units
Supply voltage	V_{CC}	4.75	5.00	5.25	V
Operating frequency	f	700		2700	MHz

Table 4. SKY65099-360LF Electrical Characteristics: 720 to 840 MHz (Note 1)
(V_{CC} = +5 V, T_C = 25 °C, f = 780 MHz, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		720		840	MHz
Quiescent current	I_{CQ}	No RF		88	105	mA
Third order output intercept point	OIP3	P_{OUT} = +8 dBm/tone, 1 MHz spacing	+39.5	+41.5		dBm
Small signal gain	|S21|	P_{IN} = –20 dBm	22	23		dB
Input return loss	|S11|	P_{IN} = –20 dBm	10	15		dB
Output return loss	|S22|	P_{IN} = –20 dBm	10	15		dB
1 dB output compression point	OP1dB	Sweep input power	+23	+24		dBm
Noise figure	NF			2.85	3.50	dB

Note 1: Performance is verified by characterization.

Table 5. SKY65099-360LF Electrical Characteristics: 2100 to 2200 MHz (Note 1)
(V_{CC} = +5 V, T_C = 25 °C, f = 2150 MHz, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		2100		2200	MHz
Quiescent current	I_{CQ}	No RF		88	105	mA
Third order output intercept point	OIP3	P_{OUT} = +8 dBm/tone, 1 MHz spacing	+40	+41		dBm
Small signal gain	|S21|	P_{IN} = –20 dBm	15.0	15.8		dB
Input return loss	|S11|	P_{IN} = –20 dBm	10.0	13.5		dB
Output return loss	|S22|	P_{IN} = –20 dBm	10	14		dB
1 dB output compression point	OP1dB	Sweep input power	+23	+24		dBm
Noise figure	NF			2.5	3.0	dB

Note 1: Performance is verified by characterization. Evaluation Board input trace loss up to DC blocking capacitors = 0.17 dB. Output trace loss up to DC blocking capacitors = 0.17 dB.

Table 6. SKY65099-360LF Electrical Characteristics: 2500 to 2700 MHz (Note 1)
(VCC = +5 V, Tc = 25 °C, f = 2600 MHz, CW, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
RBIAS = 82 Ω						
Frequency	f		2500		2700	MHz
Quiescent current	I_{CQ}	No RF		88	105	mA
Third Order Output Intercept Point	OIP3	P_{OUT} = +8 dBm/tone, 1 MHz spacing	+40.5	+41.3		dBm
Small signal gain	|S21|	P_{IN} = –20 dBm	13.8	14.5		dB
Input return loss	|S11|	P_{IN} = –20 dBm	10	18		dB
Output return loss	|S22|	P_{IN} = –20 dBm	10	18		dB
1 dB output compression point	OP1dB	Sweep input power	+23	+24		dBm
Noise Figure	NF			2.5	3.0	dB
RBIAS = 200 Ω						
Quiescent current	I_{CQ}	No RF, R_{BIAS} = 200 Ω		65		mA
Third order output intercept point	OIP3	P_{OUT} = 0 dBm/tone, 1 MHz spacing		+38.5		dBm
Small signal gain	|S21|	P_{IN} = –20 dBm		14		dB
Input return loss	|S11|	P_{IN} = –20 dBm		10		dB
Output return loss	|S22|	P_{IN} = –20 dBm		10		dB
1 dB output compression point	OP1dB	Sweep input power		+23		dBm

Note 1: Performance is verified by characterization. Evaluation Board input trace loss up to the DC blocking capacitors is 0.17 dB. Output trace loss up to the DC blocking capacitors is also 0.17 dB.

Evaluation Board Description

The Skyworks SKY65099-360LF Evaluation Board is used to test the performance of the SKY65099-360LF PA driver. A schematic of the Evaluation Board is shown in Figure 3. Table 7 lists the Bill of Materials (BOM) with component values for the Evaluation Board.

An assembly drawing for the Evaluation Board is shown in Figure 4, and the layer detail is provided in Figure 5. The layer detail phyiscal characteristics are shown in Figure 6.

Capacitor C10 provides DC decoupling, and C8 and C9 provide RF bypass for the PA. Pin 3 is the RF input port and pins 6 and 7 are the RF output ports.

External DC blocking is required on the input and output, but can be implemented as part of the RF matching circuit. Ground pin 2 and the center ground pad provide the DC and RF ground.

Testing Procedure

Use the following procedure to set up the SKY65099-360LF Evaluation Board for testing:

1. Connect a 5.0 V supply to the VCC pin of the J3 header (see Evaluation Board assembly drawing in Figure 4 and schematic diagram in Figure 3). 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.

Circuit Design Configurations

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

- Paths to ground should be made as short as possible.
- The ground pad of the SKY65099-360LF 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 ground pad and ground. This reduces the life of the device.*

CAUTION: *If any of the output signals exceed the rated maximum values, the SKY65099-360LF Evaluation Board can be permanently damaged.*

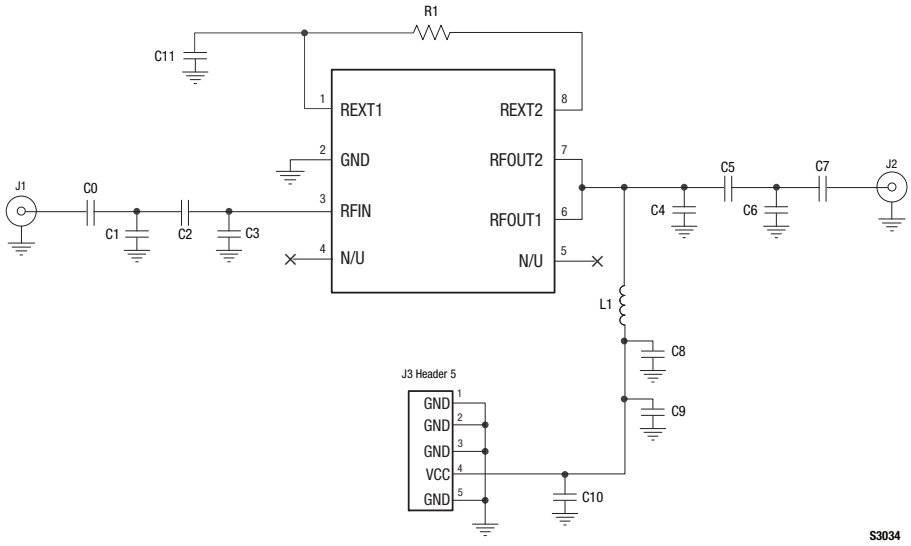


Figure 3. SKY65099-360LF Evaluation Board Schematic

Table 7. SKY65099-360LF (DFN Package) Evaluation Board Bill of Materials (1 of 2)

Component	Size	Value	Vendor	Vendor Part #
720 to 840 MHz (BOM 1)				
C0	0402	9 pF	Murata	GJM1555C1H9R0BB01
C1	0402	4.7 nH	Murata	LQG15HS4N7S02
C2	0402	6.2 pF	Murata	GJM1555C1H6R2BB01
C3	0402	1.5 pF	Murata	GJM1555C1H1R5BB01
C4	–	DNI	–	–
C5	0402	4.3 nH	Murata	LQG15HS4N3S02
C6	0402	1.3 pF	Murata	GJM1555C1H1R3BB01
C7	0402	68 pF	Murata	GRM1555C1H680JA01
C8	0402	82 pF	Murata	GRM1555C1H820JA01
C9	0402	4700 pF	Murata	GRM155R61H472KA01
C10	0603	1 µF	Murata	GRM155R61C105KA12
C11	–	DNI	–	–
L1	0402	36 nH	Murata	LQW15AN36NG00
R1	0402	51 Ω	Any vendor	–
2100 to 2200 MHz (BOM 2)				
C0	0402	27 pF	Murata	GRM1555C1H270JA01
C1	0402	2.0 nH	Murata	LQG15HS2N0J02
C2	0402	2.4 pF	Murata	GJM1555C1H2R4BB01
C3	0402	3.3 pF	Murata	GJM1555C1H3R3BB01
C4	0402	0.6 pF	Murata	GJM1555C1HR60WB01
C5	0402	2.7 nH	Murata	LQW15AN2N7G00
C6	0402	0.9 pF	Murata	GJM1555C1HR90WB01
C7	0402	68 pF	Murata	GRM1555C1H680JA01
C8	0402	82 pF	Murata	GRM1555C1H820JA01
C9	0402	4700 pF	Murata	GRM155R61H472KA01
C10	0603	1 µF	Murata	GRM155R61C105KA12
C11	0402	1.8 pF	Murata	GJM1555C1H1R8BB01
L1	0402	6.8 nH	Murata	LQW15AN6N8G00
R1	0402	56 Ω	Any vendor	–

Table 7. SKY65099-360LF (DFN Package) Evaluation Board Bill of Materials (2 of 2)

Component	Size	Value	Vendor	Vendor Part Number
2500 to 2700 MHz (BOM 3)				
C0	0402	20 pF	Murata	GRM1555C1H200JA01
C1	0402	8.2 nH	Murata	LQG15HS8N2J02
C2	0402	7.5 pF	Murata	GJM1555C1H7R5BB01
C3	0402	2.2 pF	Murata	GJM1555C1H2R2BB01
C4	0402	0.2 pF	Murata	GJM1555C1HR20WB01
C5	0402	1.2 nH	Murata	LQG15HS1N2S02
C6	0402	0.9 pF	Murata	GJM1555C1HR90WB01
C7	0402	68 pF	Murata	GRM1555C1H680JA01
C8	0402	82 pF	Murata	GRM1555C1H820JA01
C9	0402	4700 pF	Murata	GRM155R61H472KA01
C10	0603	1 μF	Murata	GRM155R61C105KA12
C11	0402	1.8 pF	Murata	GJM1555C1H1R5BB01
L1	0402	6.8 nH	Murata	LQW15AN6N8G00
R1	0402	82 Ω	Any vendor	–

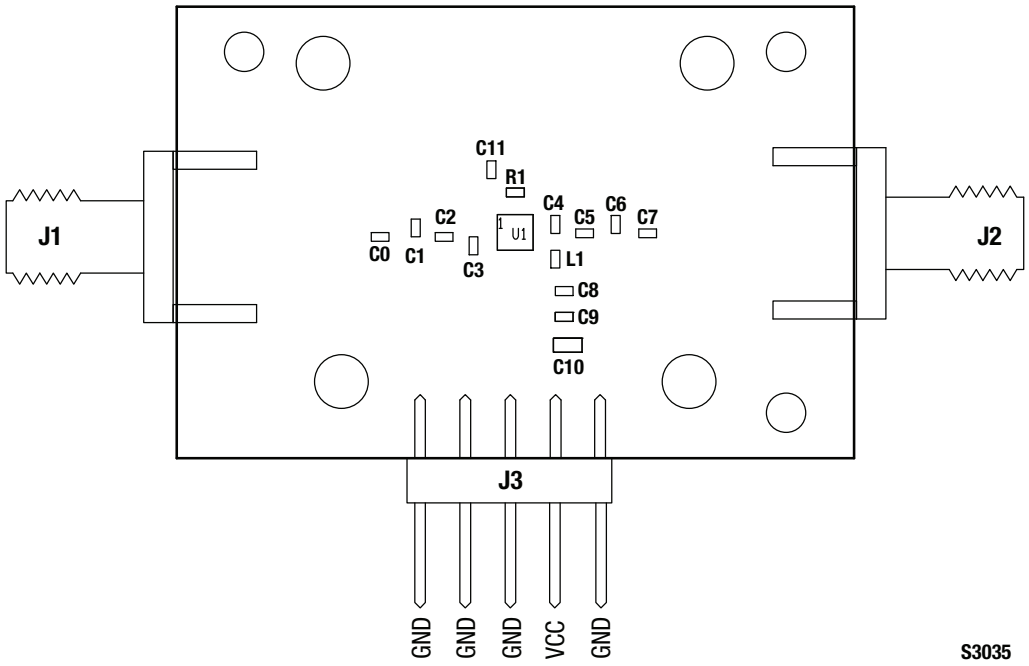
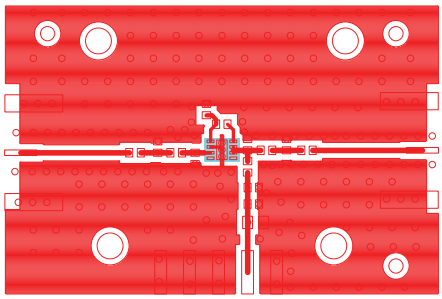
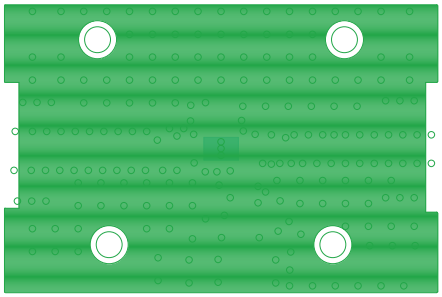


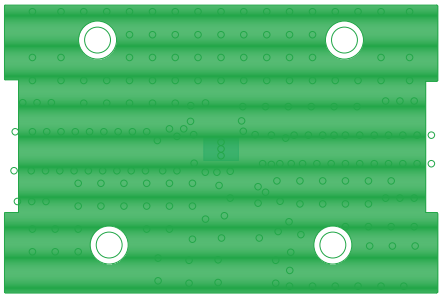
Figure 4. Evaluation Board Assembly Drawing



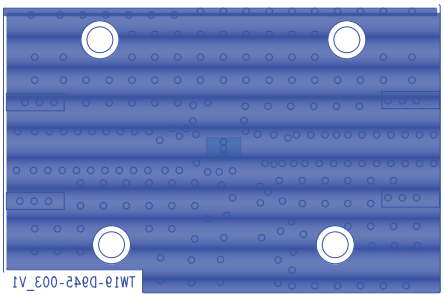
Layer 1: Signal Layer



Layer 2: Ground



Layer 3: Ground



Layer 4: Bottom Ground

S3258

Figure 5. Evaluation Board Layer Detail

50 Ω	Cross Section	Name	Thickness (mm)	Material
W = 0.500 mm		TMask	0.010	Solder Resist
		L1	0.035	Cu – 1 oz
		Dielectric	0.250	FR4
		L2	0.035	Cu – 1 oz
		Dielectric	1.000	FR4
		L3	0.035	Cu – 1 oz
		Dielectric	0.250	FR4
		L4	0.035	Cu – 1 oz
		BMask	0.010	Solder Resist

Y2583

Figure 6. SKY65099-360LF Layer Detail Physical Characteristics

Package Dimensions

The PCB layout footprint for the SKY65099-360LF is shown in Figure 7. Typical part markings are shown in Figure 8. Package dimensions are shown in Figure 9, and tape and reel dimensions are provided in Figure 10.

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 SKY65099-360LF is rated to Moisture Sensitivity Level 1 (MSL1) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *Solder Reflow Information*, document number 200164.

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.

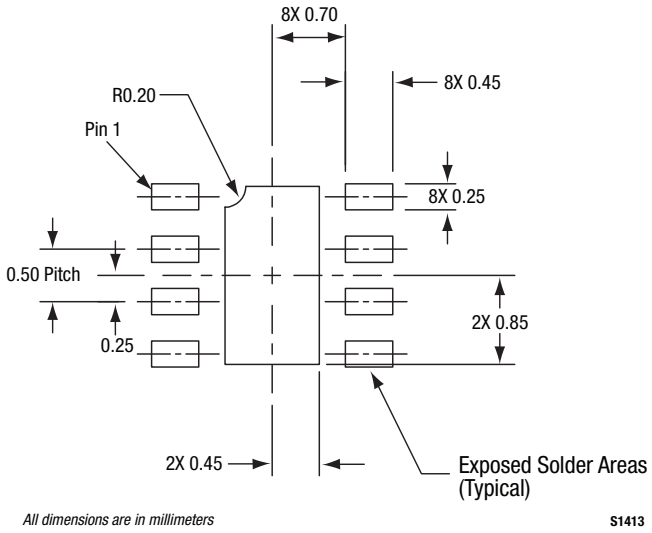


Figure 7. SKY65099-360LF PCB Layout Footprint

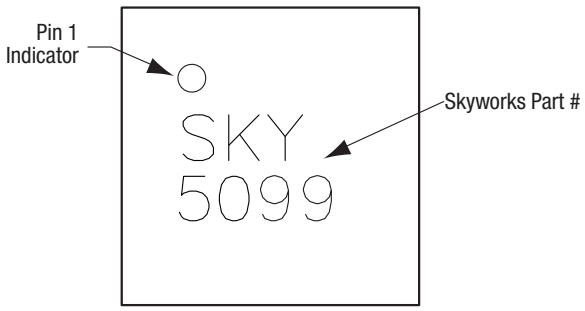
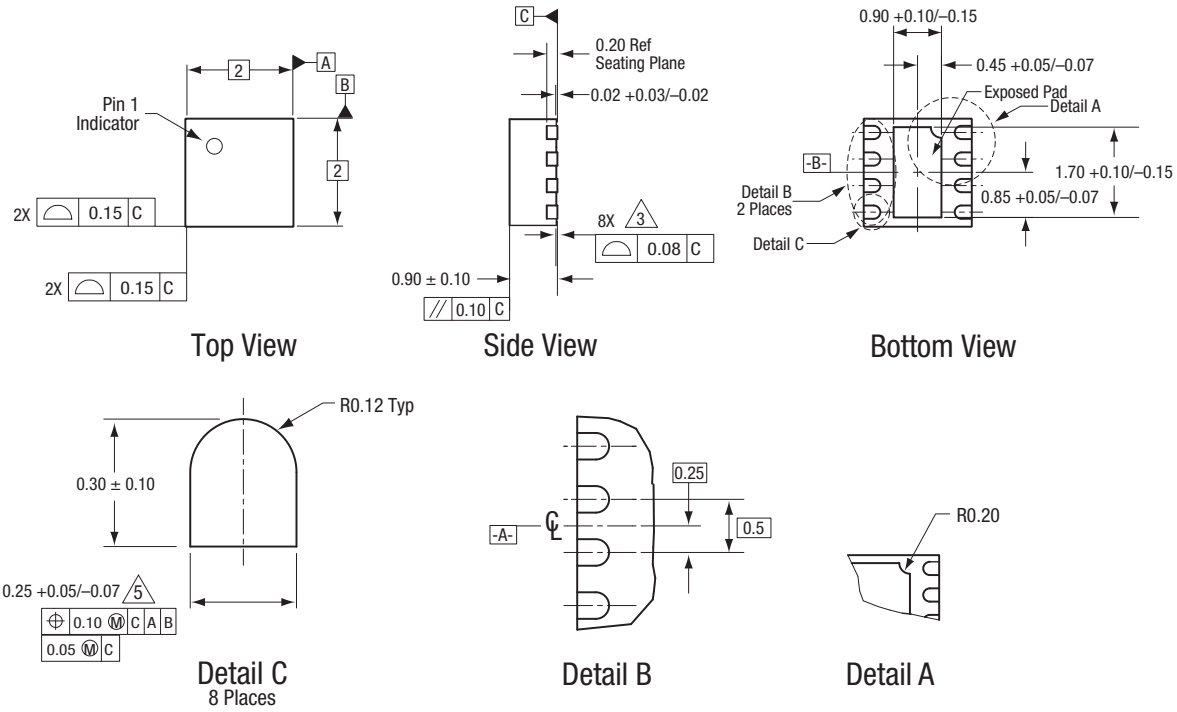


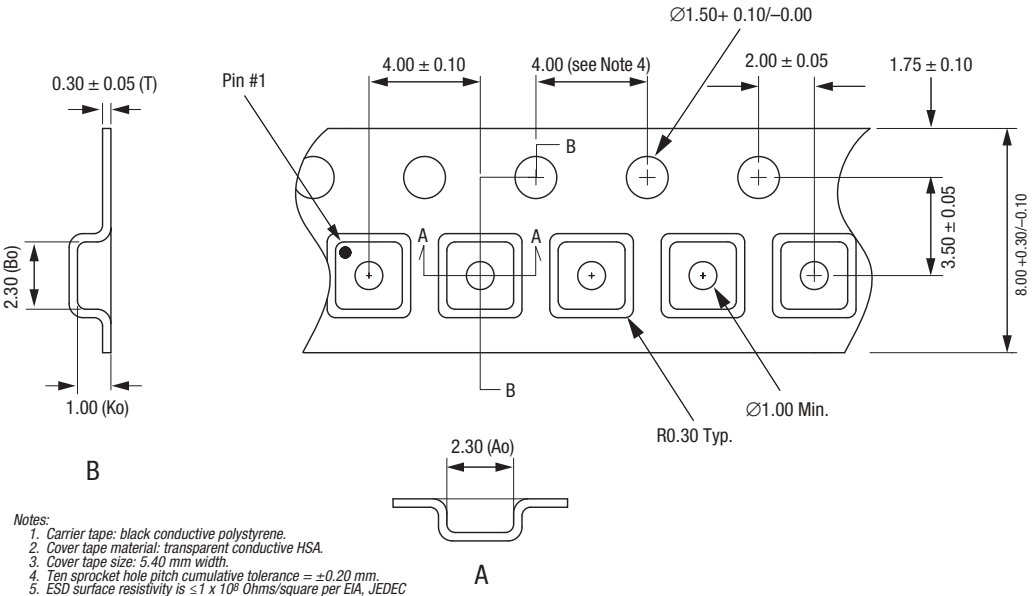
Figure 8. Typical Part Markings (Top View)



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.

S1415

Figure 9. SKY65099-360LF 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 10^6 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.*

S1601

Figure 10. SKY65099-360LF Tape and Reel Dimensions

Ordering Information

Model Name	Ordering Part Number	Evaluation Board Part Number
SKY65099-360LF Broadband Linear Amplifier Driver	SKY65099-360LF	TW19-D940