DATA SHEET

SKY65162-70LF: 400-2700 MHz Linear Power Amplifier

Applications

- UHF television
- TETRA radios
- PCS, DCS, 2.5G, 3G, 4G handsets and infrastructure systems
- ISM band transmitters
- WCS fixed wireless
- 802.16 WiMAX
- 3GPP LTE

Features

- Wideband frequency range: 400 to 2700 MHz
- Low Noise Figure: 3.6 dB
- High OIP3
- OP1dB = +29.5 dBm @ 1960 MHz
- High gain: 24 dB
- On-chip bias circuit
- SOT-89 (4-pin, 2.4 x 4.5 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.

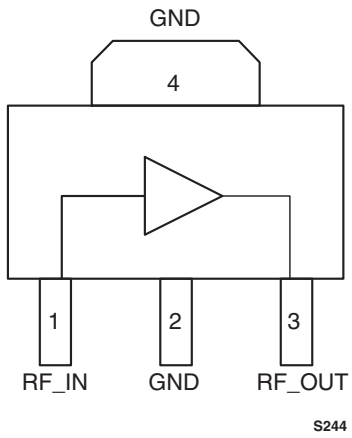


Figure 1. SKY65162-70LF Pinout – 4-Pin SOT Package (Top View)

Description

Skyworks SKY65162-70LF is a high performance, ultra-wideband Power Amplifier (PA) with superior output power, low noise, high linearity, and high efficiency. The device provides excellent linearity with a 1 dB Output Compression Point (OP1dB) of +29.5 dBm at 1960 MHz, making the SKY65162-70LF ideal for use in the driver stage of infrastructure transmit chains.

The SKY65162-70LF uses low-cost Surface-Mount Technology (SMT) in the form of a 4-pin, 2.4 x 4.5 mm Small Outline Transistor (SOT-89) package. The device package and pinout are shown in Figure 1 and a functional block diagram is provided in Figure 2.

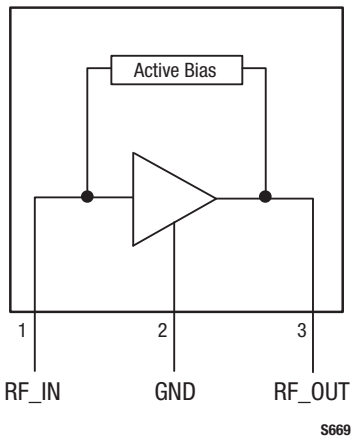


Figure 2. SKY65162-70LF Functional Block Diagram

Table 1. SKY65162-70LF Signal Descriptions

Pin	Name	Description
1	RF_IN	RF input
2	GND	Ground
3	RF_OUT	RF output
4	GND	Ground

Technical Description

The SKY65162-70LF is a single stage, linear PA that operates with a single 5 V power supply connected through an RF choke (inductor L2) to the output signal (pin 3). 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 400 to 2700 MHz.

Electrical and Mechanical Specifications

Signal pin assignments and functional pin descriptions are described in Table 1. The absolute maximum ratings of the SKY65162-70LF are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Tables 4 through 9.

Typical performance characteristics of the SKY65162-70LF are illustrated in Figures 3 through 17 (915 MHz), Figures 18 through 34 (1960 MHz), Figures 35 through 49 (2100 MHz), Figures 50 through 67 (2400 MHz), and Figures 68 through 71 (2600 MHz).

Table 2. SKY65162-70LF Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Supply voltage	VCC		6	V
RF output power	P_{OUT}		+30	dBm
Supply current	I_{CC}		400	mA
Operating case temperature	T_C	–40	+85	°C
Storage temperature	T_{ST}	–55	+125	°C
Junction temperature	T_J		+150	°C
Thermal resistance	Θ_{JC}		29	°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 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. SKY65162-70LF Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Units
Supply voltage	VCC	4.75	5.0	5.5	V
Operating frequency	f	400		2700	MHz
Operating case temperature	T_J	–40	+25	+85	°C

Table 4. SKY65162-70LF Electrical Characteristics (Note 1)
(VCC = +5 V, T_C = 25 °C, f = 430 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		400		470	MHz
Small signal gain	$\|S21\|$	Small signal	23.0	23.5		dB
Input return loss	$\|S11\|$	Small signal	14	17		dB
Output return loss	$\|S22\|$	Small signal	16	24		dB
3rd Order Output Intercept Point	OIP3	P_{OUT} = +10 dBm	+37	+40		dBm
Noise Figure	NF			10	12	dB
1 dB Output Compression Point	OP1dB	CW	+28	+29		dBm
Adjacent Channel Power Ratio	ACPR1	@ P_{OUT} = +14 dBm (CDMA 2000)		–61	–60	dBc
Quiescent current	I_{CQ}	No RF		188		mA

Note 1: Performance is verified by characterization.

Table 5. SKY65162-70LF Electrical Characteristics (Note 1)
(VCC = +5 V, T_C = 25 °C, f = 915 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		869		960	MHz
Small signal gain	|S21|	Small signal	19.5	20.0		dB
Input return loss	|S11|	Small signal	21	29		dB
Output return loss	|S22|	Small signal	9	10		dB
3rd Order Output Intercept Point	OIP3	P_{OUT} = +10 dBm	+40	+42		dBm
Noise Figure	NF			4.0	4.5	dB
1 dB Output Compression Point	OP1dB	CW	+28.0	+28.5		dBm
Saturated output power	P_{SAT}	V_{CC} = 5 V V_{CC} = 4 V		+30.5 +29.0		dBm dBm
Operational current	I_{OP}	@ P1dB = +28.8 dBm		306		mA
Quiescent current	I_{CQ}	No RF		188		mA

Note 1: Performance is verified by characterization.

Typical Performance Characteristics

(VCC = +5 V, Tc = 25 °C, f = 915 MHz, Unless Otherwise Noted)

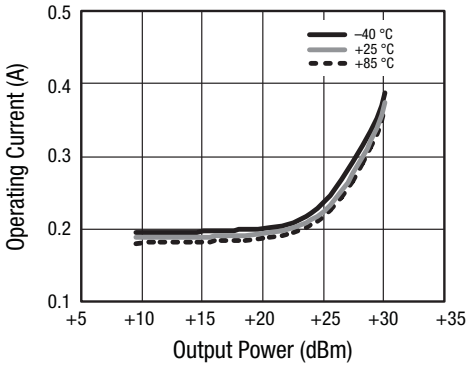


Figure 3. Operating Current vs Output Power Over Temperature

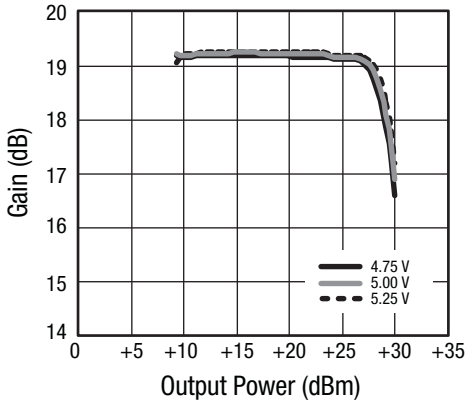


Figure 4. Gain vs Output Power Over Voltage

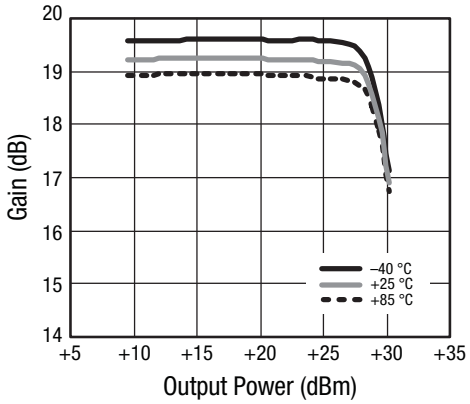


Figure 5. Gain vs Output Power Over Temperature

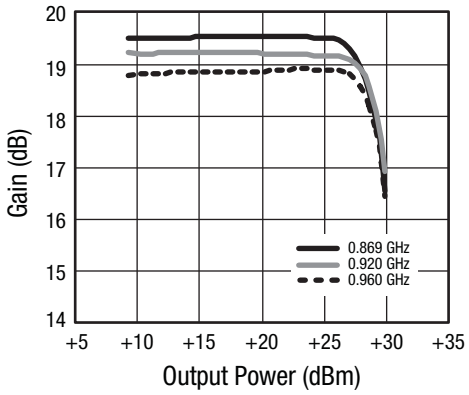


Figure 6. Gain vs Output Power Over Frequency

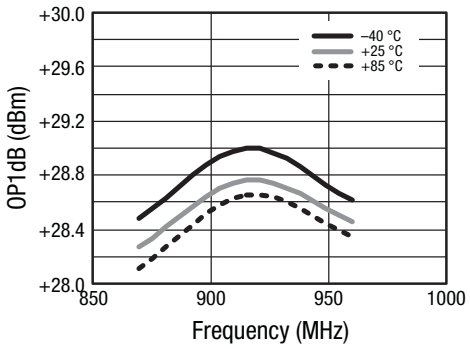


Figure 7. OP1dB vs Frequency Over Temperature

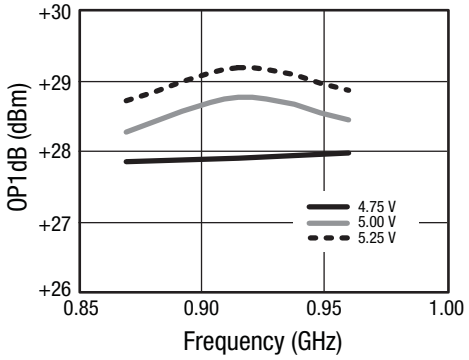


Figure 8. OP1dB vs Frequency Over Voltage

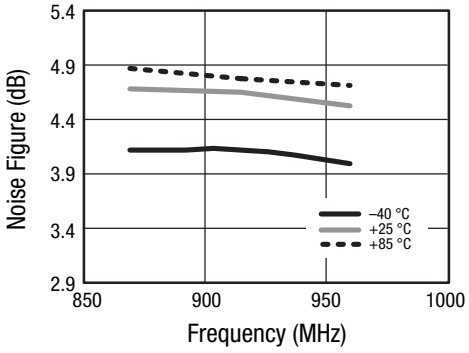


Figure 9. Noise Figure vs Frequency Over Temperature

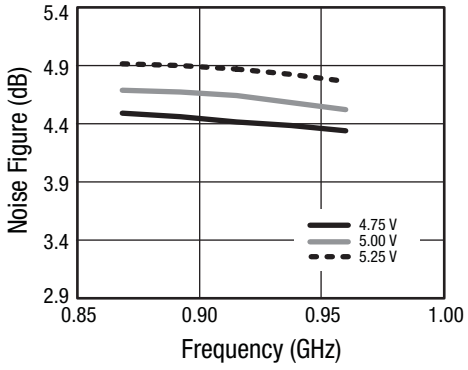


Figure 10. Noise Figure vs Frequency Over Voltage

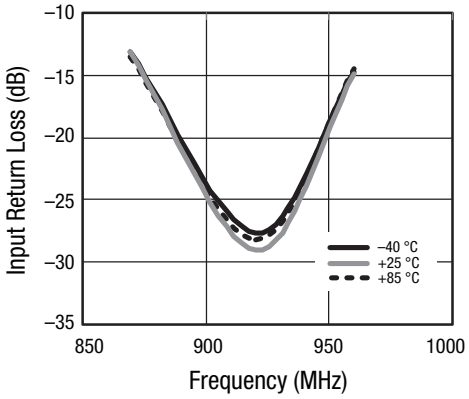


Figure 11. Input Return Loss vs Frequency Over Temperature

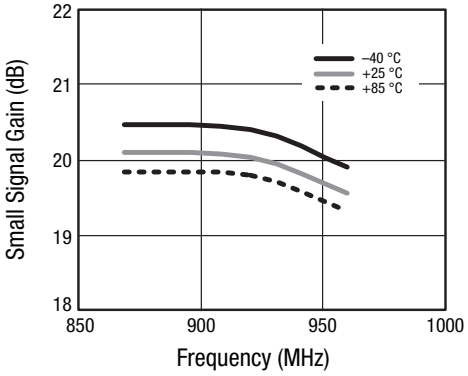


Figure 12. Small Signal Gain vs Frequency Over Temperature

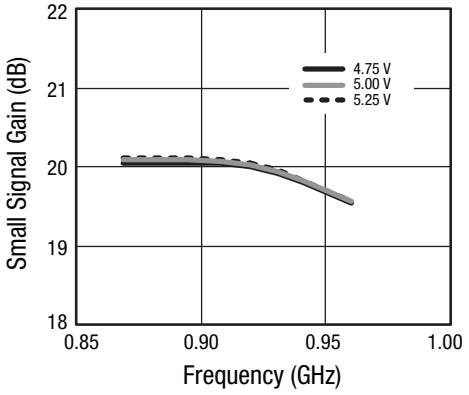


Figure 13. Small Signal Gain vs Frequency Over Voltage

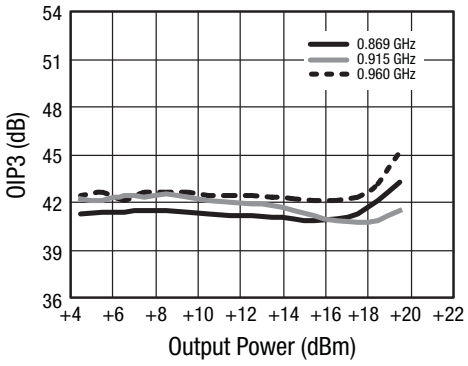


Figure 14. OIP3 vs Output Power Over Frequency

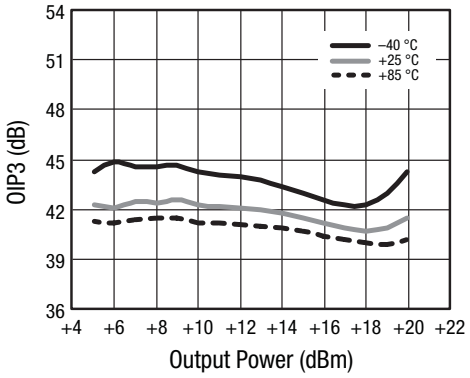


Figure 15. OIP3 vs Output Power Over Temperature

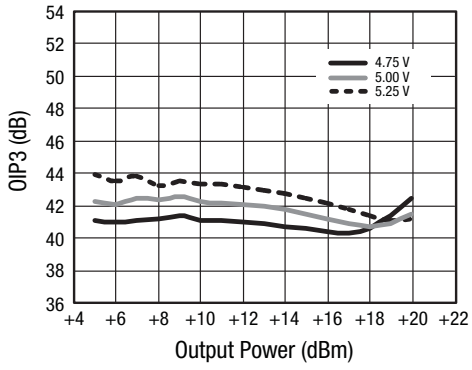


Figure 16. OIP3 vs Output Power Over Voltage

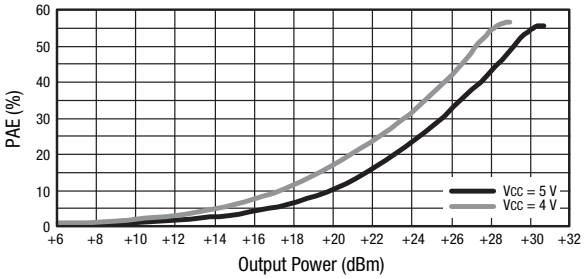


Figure 17. Output Power vs PAE Over Voltage

Table 6. SKY65162-70LF Electrical Characteristics (Note 1)
(VCC = +5 V, Tc = 25 °C, f = 1960 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		1930		1990	MHz
Small signal gain	|S21|	Small signal	14.5	15.0		dB
Input return loss	|S11|	Small signal	17	20		dB
Output return loss	|S22|	Small signal	15	20		dB
1 dB Output Compression Point	OP1dB	CW	+29.0	+29.5		dBm
3rd Order Output Intercept Point	OIP3	P_{OUT} = +10 dBm	+42	+43		dBm
Noise Figure	NF			3.8	4.5	dB
Operational current	I_{OP}	@ P1dB = +30.2 dBm		390	400	mA
Quiescent current	I_{CQ}	No RF		188	210	mA

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

Typical Performance Characteristics

(VCC = +5 V, Tc = 25 °C, f = 1960 MHz, Unless Otherwise Noted)

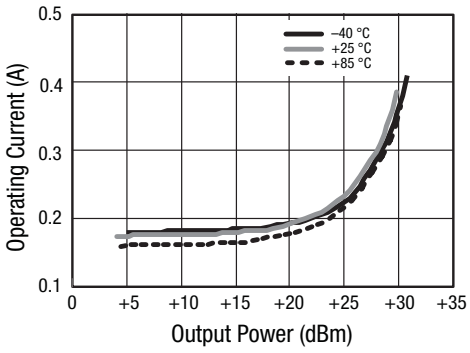


Figure 18. Operating Current vs Output Power Over Temperature

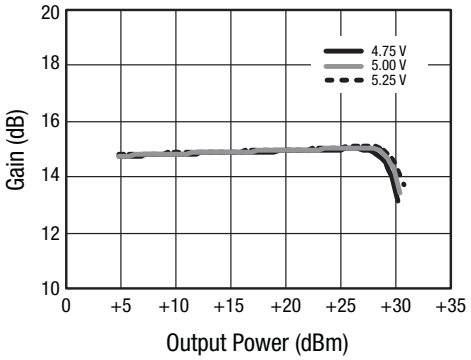


Figure 19. Gain vs Output Power Over Voltage

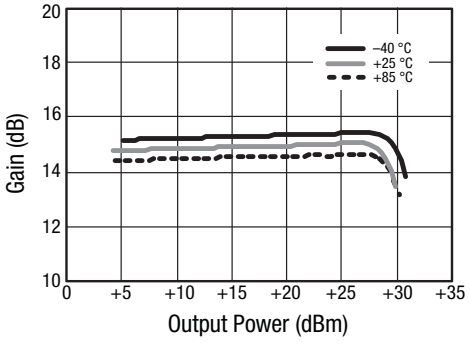


Figure 20. Gain vs Output Power Over Temperature

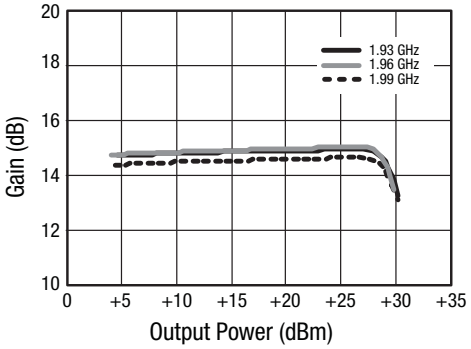


Figure 21. Gain vs Output Power Over Frequency

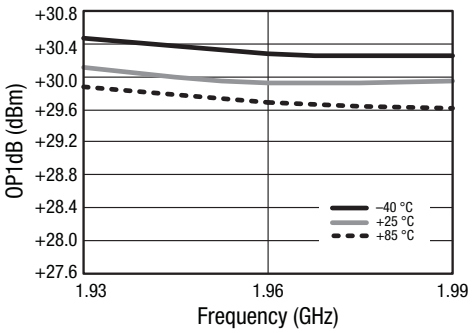


Figure 22. OP1dB vs Frequency Over Temperature

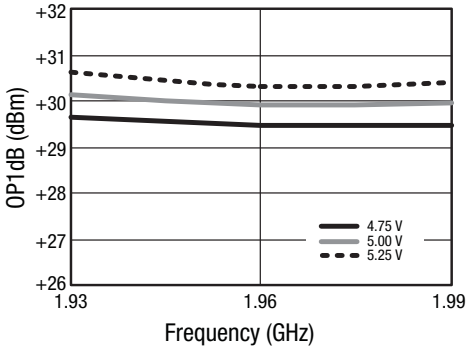


Figure 23. OP1dB vs Frequency Over Voltage

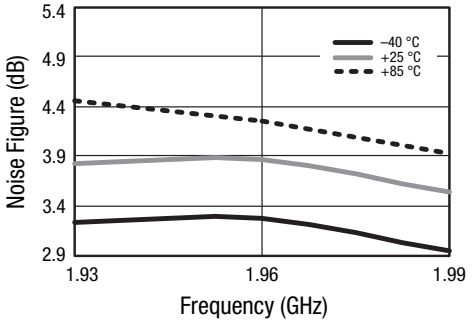


Figure 24. Noise Figure vs Frequency Over Temperature

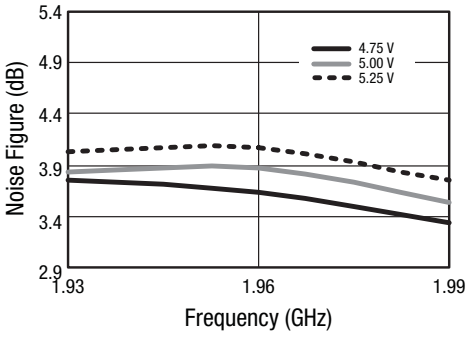


Figure 25. Noise Figure vs Frequency Over Voltage

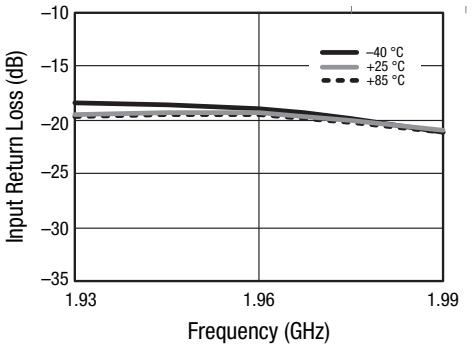


Figure 26. Input Return Loss vs Frequency Over Temperature

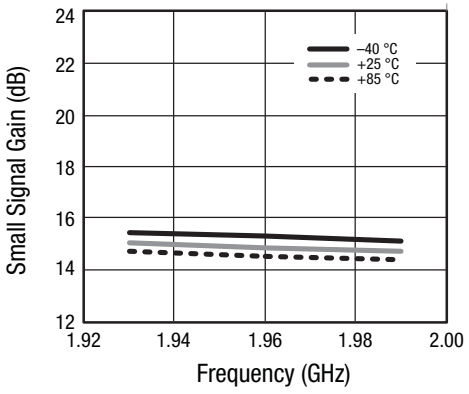


Figure 27. Small Signal Gain vs Frequency Over Temperature

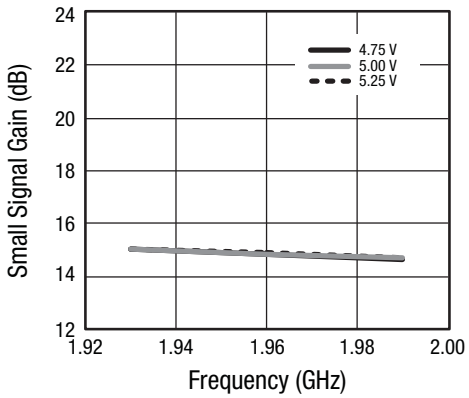


Figure 28. Small Signal Gain vs Frequency Over Voltage

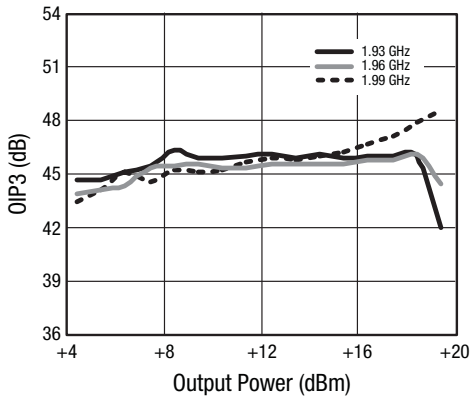


Figure 29. OIP3 vs Output Power Over Frequency

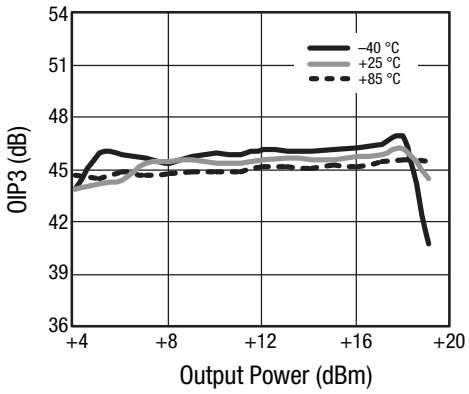


Figure 30. OIP3 vs Output Power Over Temperature

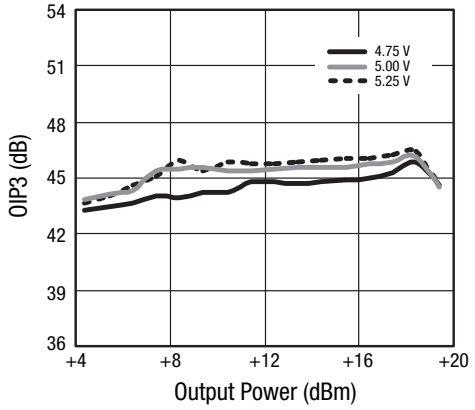


Figure 31. OIP3 vs Output Power Over Voltage

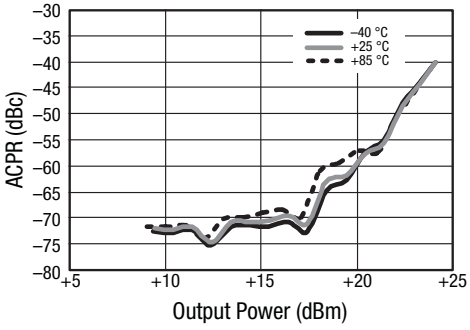


Figure 32. ACPR vs Output Power Over Temperature

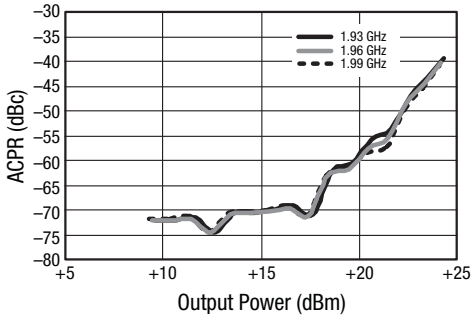


Figure 33. ACPR vs Output Power Over Frequency

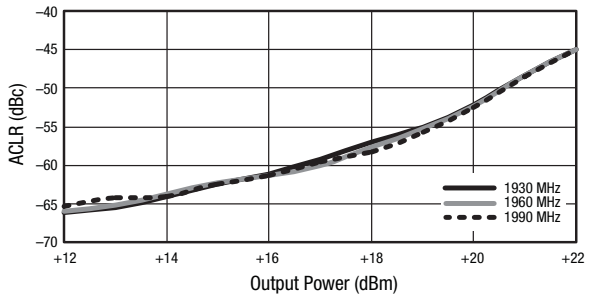


Figure 34. ACLR vs Output Power Over Frequency (WCDMA 3GPP, Test Model 1, 64 DPCH)

Table 7. SKY65162-70LF Electrical Characteristics (Note 1) (VCC = +5 V, Tc = 25 °C, f = 2100 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		2110		2170	MHz
Small signal gain	|S21|	Small signal	14.0	14.3		dB
Input return loss	|S11|	Small signal	10	17		dB
Output return loss	|S22|	Small signal	10	20		dB
1 dB Output Compression Point	OP1dB	CW	+28.5	+29.0		dBm
3rd Order Output Intercept Point	OIP3	P_{OUT} = +10 dBm	+42.0	+43.5		dBm
Noise Figure	NF			4.6	5.0	dB
Operational current	I_{OP}	@ P1dB = +29.5 dBm		375	400	mA
Quiescent current	I_{CQ}	No RF		188		mA

Note 1: Performance is verified by characterization.

Typical Performance Characteristics

(VCC = +5 V, Tc = 25 °C, f = 2100 MHz, Unless Otherwise Noted)

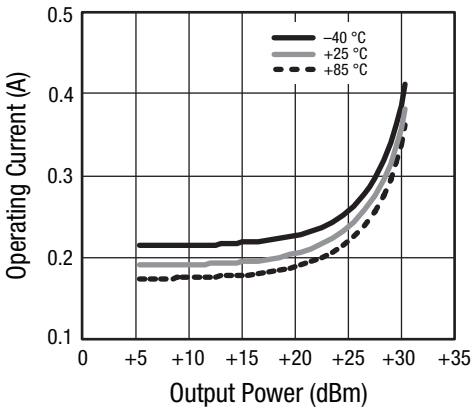


Figure 35. Operating Current vs Output Power Over Temperature

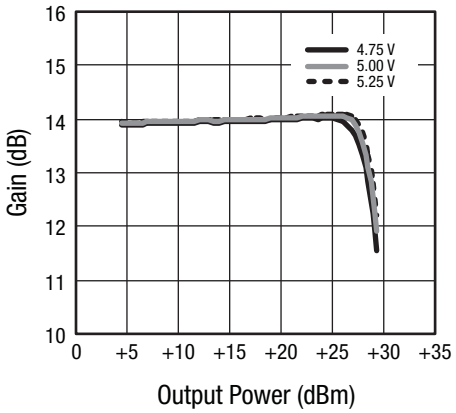


Figure 36. Gain vs Output Power Over Voltage

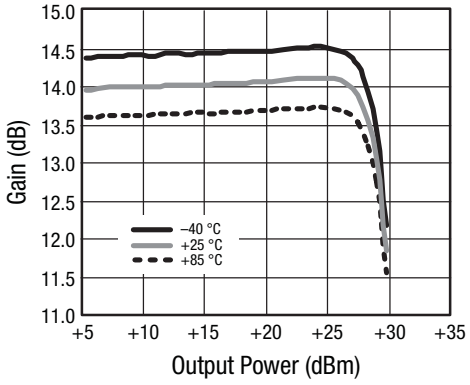


Figure 37. Gain vs Output Power Over Temperature

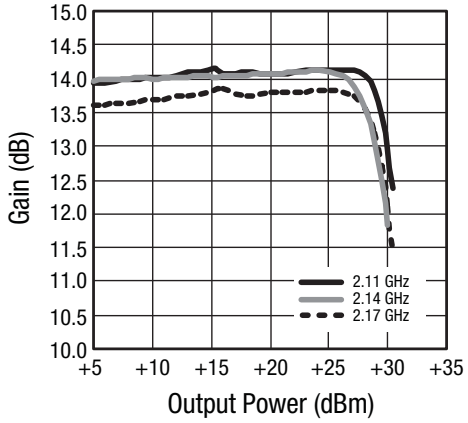


Figure 38. Gain vs Output Power Over Frequency

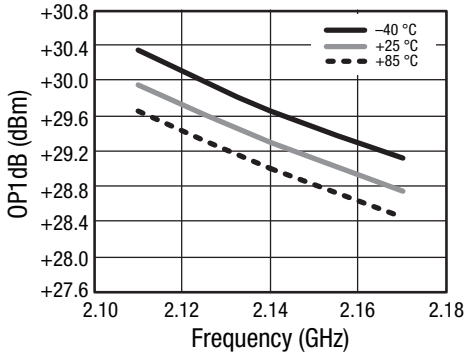


Figure 39. OP1dB vs Frequency Over Temperature

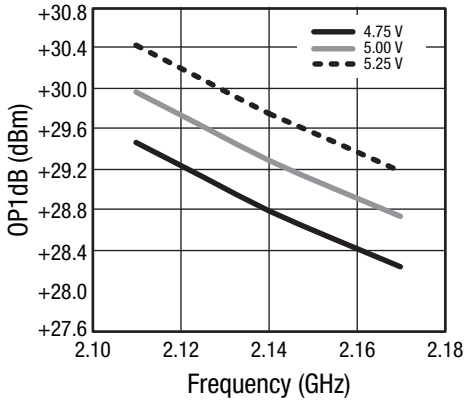


Figure 40. OP1dB vs Frequency Over Voltage

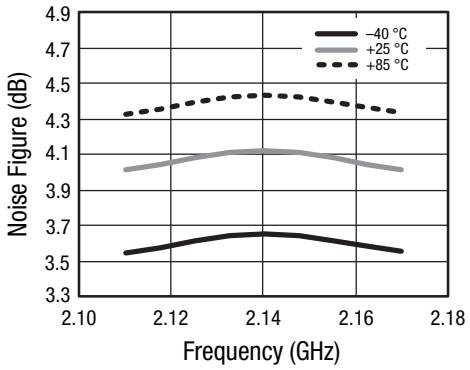


Figure 41. Noise Figure vs Frequency Over Temperature

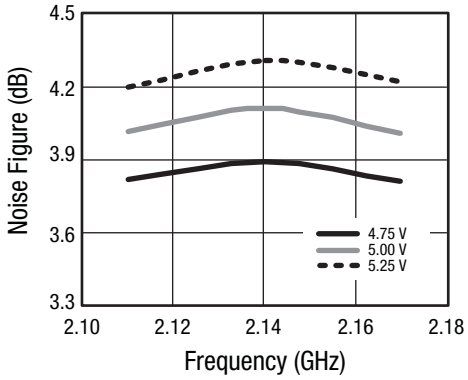


Figure 42. Noise Figure vs Frequency Over Voltage

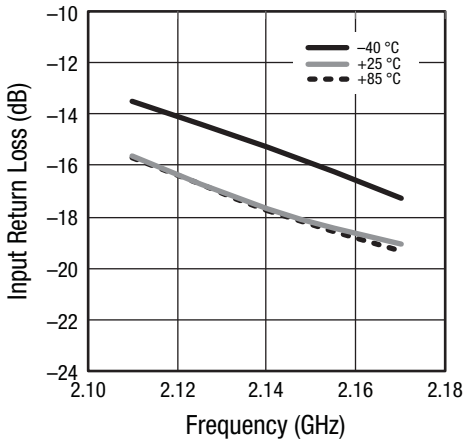


Figure 43. Input Return Loss vs Frequency Over Temperature

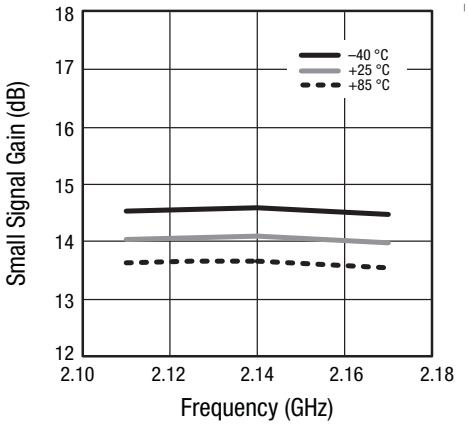


Figure 44. Small Signal Gain vs Frequency Over Temperature

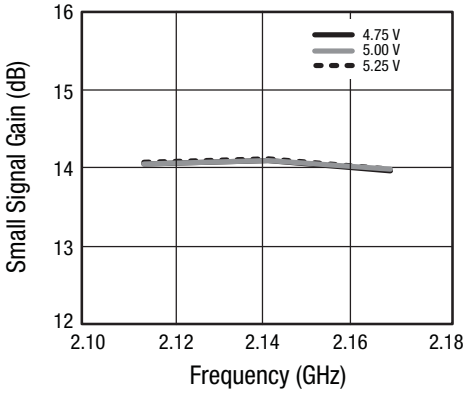


Figure 45. Small Signal Gain vs Frequency Over Voltage

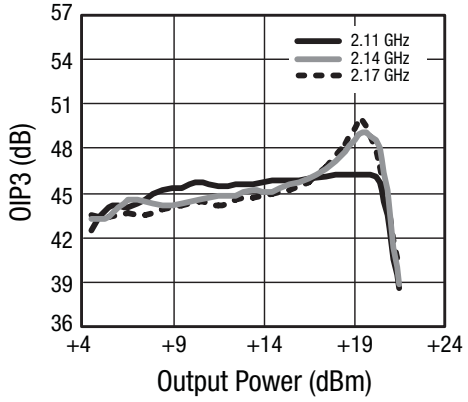


Figure 46. OIP3 vs Output Power Over Frequency

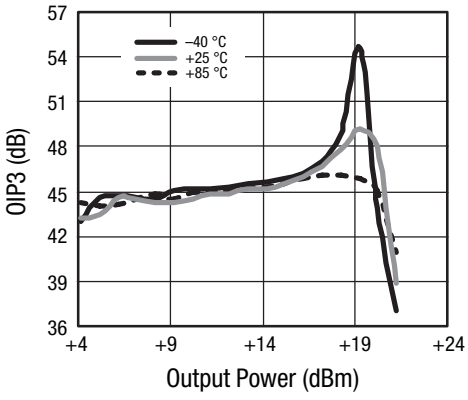


Figure 47. OIP3 vs Output Power Over Temperature

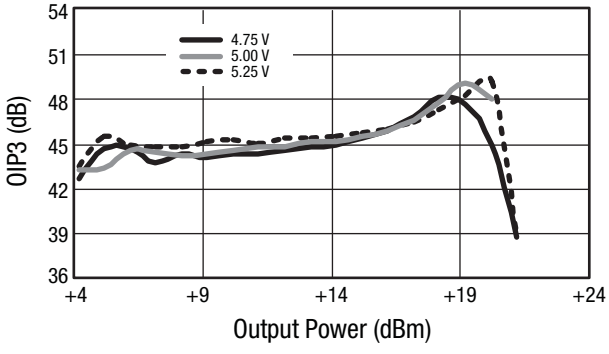


Figure 48. OIP3 vs Output Power Over Voltage

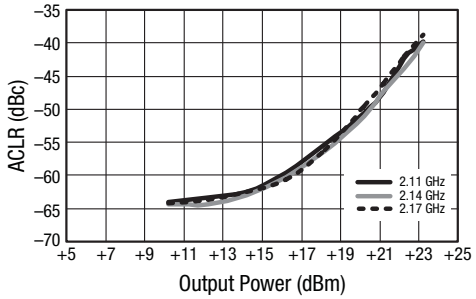


Figure 49. ACLR vs Output Power Over Frequency

Table 8. SKY65162-70LF Electrical Characteristics (Note 1)
(VCC = +5 V, TC = 25 °C, f = 2400 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		2300		2500	MHz
Small signal gain	|S21|	Small signal	12.5	13.0		dB
Input return loss	|S11|	Small signal	17	20		dB
Output return loss	|S22|	Small signal	15	20		dB
Reverse transmission loss	|S12|	Small signal	17	21		dB
1 dB Output Compression Point	OP1dB	CW	+29.0	+29.5		dBm
3rd Order Output Intercept Point	OIP3		+44	+45		dBm
Output power	POUT	802.11g, 64 QAM, 54 Mbps, 3% EVM		+22		dBm
Noise Figure	NF			4.4	5.0	dB
Operational current	IOP	@ P1dB = +30 dBm		401	480	mA
Quiescent current	ICQ	No RF		188		mA

Note 1: Performance is verified by characterization.

Typical Performance Characteristics

(VCC = +5 V, TC = 25 °C, f = 2400 MHz, Unless Otherwise Noted)

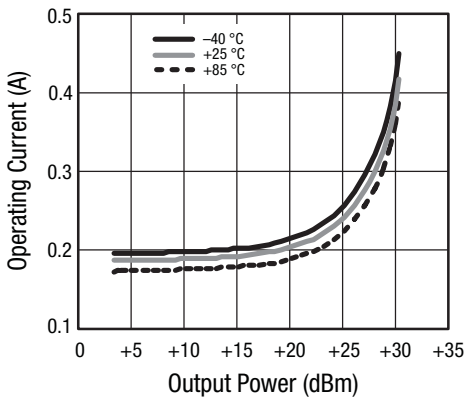


Figure 50. Operating Current vs Output Power Over Temperature

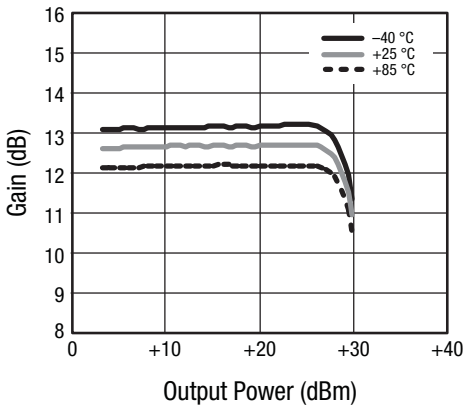


Figure 51. Gain vs Output Power Over Temperature

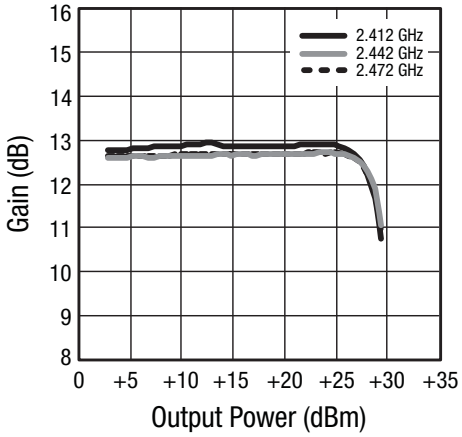


Figure 52. Gain vs Output Power Over Frequency

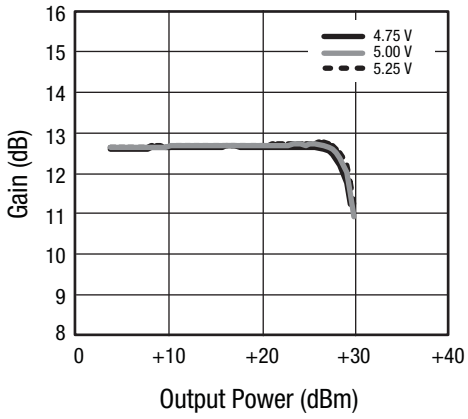


Figure 53. Gain vs Output Power Over Voltage

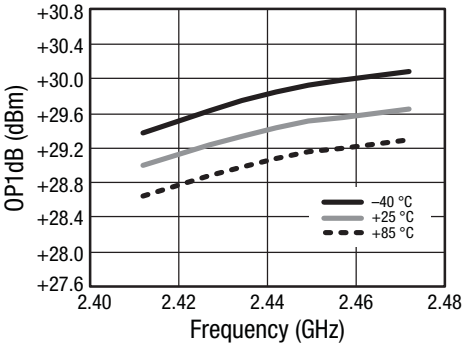


Figure 54. OP1dB vs Frequency Over Temperature

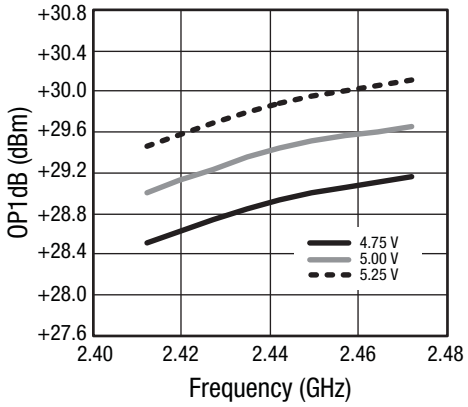


Figure 55. OP1dB vs Frequency Over Voltage

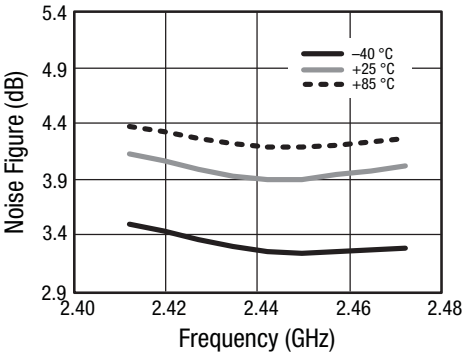


Figure 56. Noise Figure vs Frequency Over Temperature

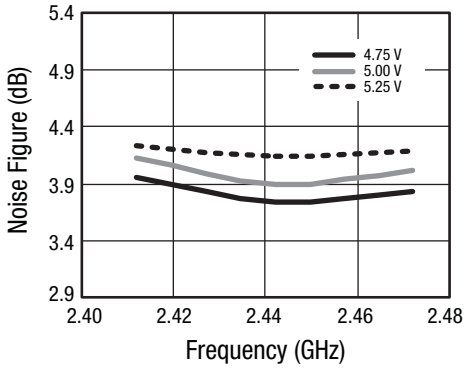


Figure 57. Noise Figure vs Frequency Over Voltage

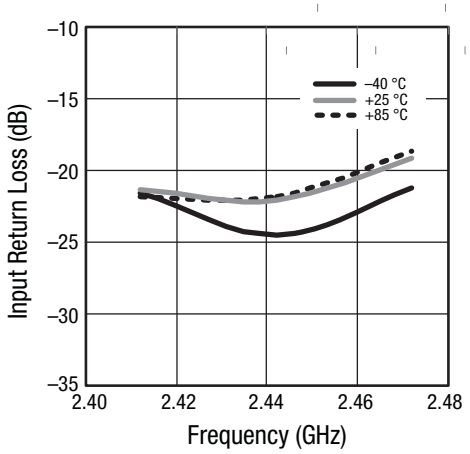


Figure 58. Input Return Loss vs Frequency Over Temperature

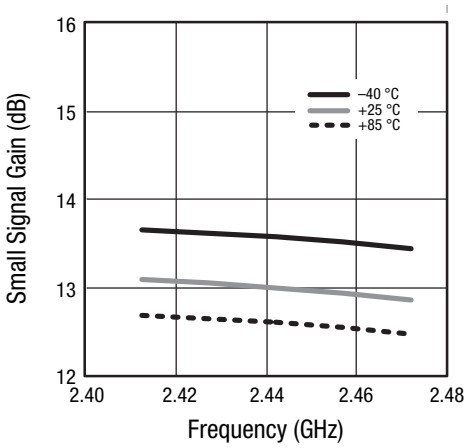


Figure 59. Small Signal Gain vs Frequency Over Temperature

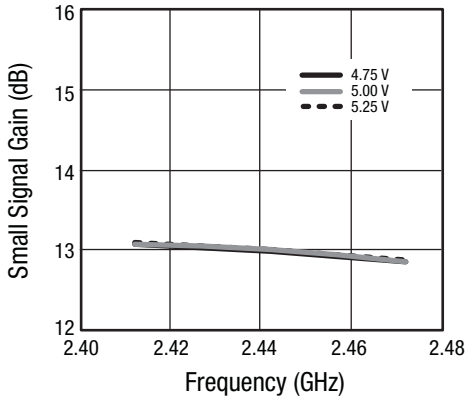


Figure 60. Small Signal Gain vs Frequency Over Voltage

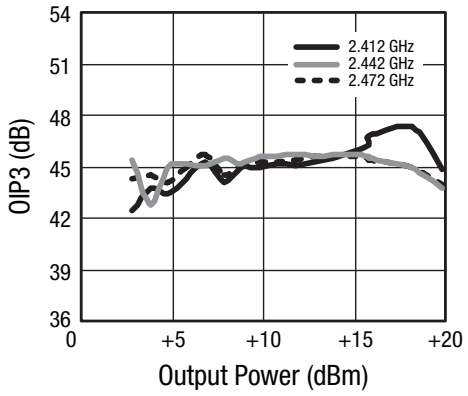


Figure 61. OIP3 vs Output Power Over Frequency

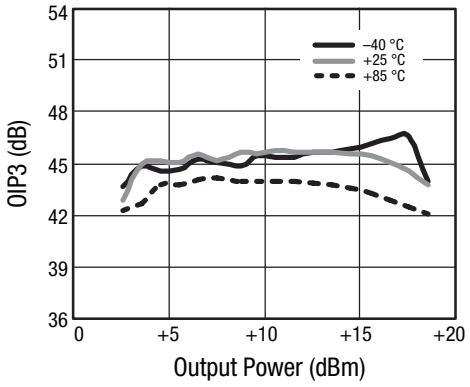


Figure 62. OIP3 vs Output Power Over Temperature

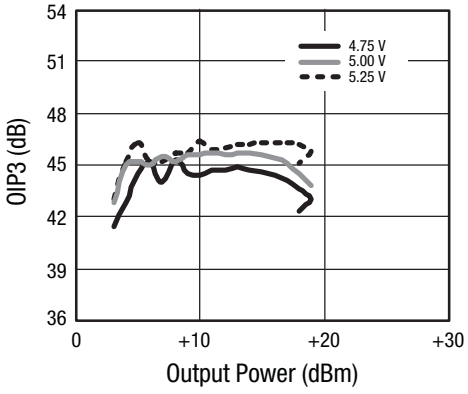


Figure 63. OIP3 vs Output Power Over Voltage

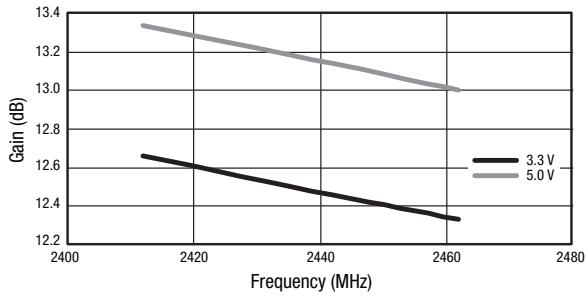


Figure 64. Gain vs Frequency Over Voltage (802.11g, 64 QAM, 54 Mbps, OFDM)

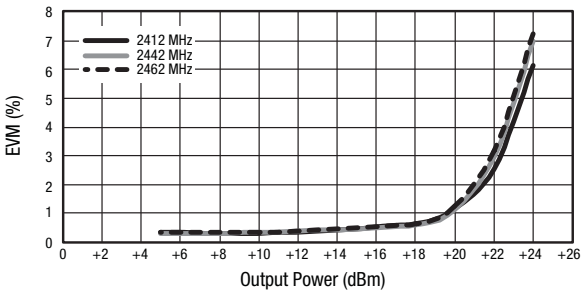


Figure 65. EVM vs Output Power Over Frequency (802.11g, 64 QAM, 54 Mbps, OFDM)

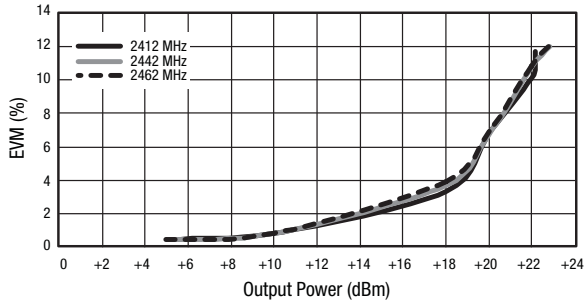


Figure 66. EVM vs Output Power Over Frequency (802.11g, 64 QAM, 54 Mbps, OFDM, V_{CC} = 3.3 V)

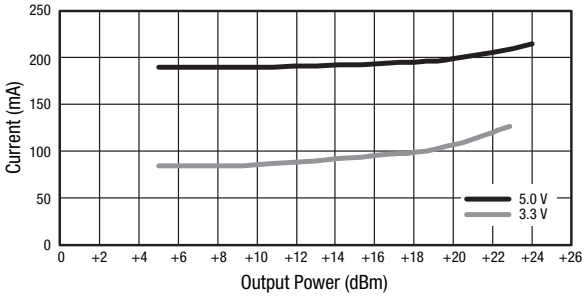


Figure 67. Operating Current vs Output Power Over Voltage (802.11g, 64 QAM, 54 Mbps, OFDM)

Table 9. SKY65162-70LF Electrical Characteristics (Note 1)
(VCC = +5 V, Tc = 25 °C, f = 2600 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Conditions	Min	Typical	Max	Units
Frequency	f		2500	2600	2700	MHz
Small signal gain	|S21|	Small signal		12.7		dB
Input return loss	|S11|	Small signal		17		dB
Output return loss	|S22|	Small signal		22		dB
Reverse transmission loss	|S12|	Small signal		25		dB
1 dB Output Compression Point	OP1dB	CW		+29.6		dBm
Saturated output power	P_{SAT}			+30.4		dBm
Saturation current	I_{SAT}	@ P_{SAT} = +30.4 dBm		428		mA
3rd Order Output Intercept Point	OIP3	P_{OUT} = +5 dBm		+44		dBm
Noise Figure	NF			3.8		dB
Operational current	I_{OP}	@ P1dB = +29.6 dBm		330		mA
Quiescent current	I_{CQ}	No RF		188		mA

Note 1: Performance is verified by characterization.

Typical Performance Characteristics

(VCC = +5 V, Tc = 25 °C, f = 2600 MHz, Unless Otherwise Noted)

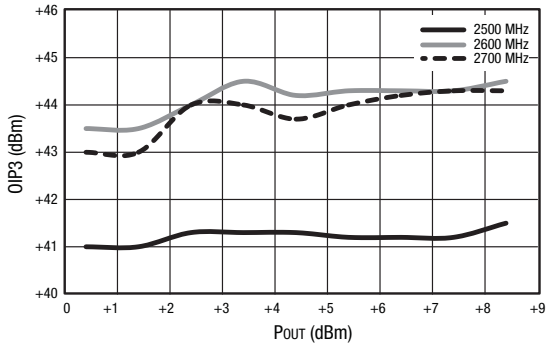


Figure 68. OIP3 vs P_{OUT} @ 2700 MHz

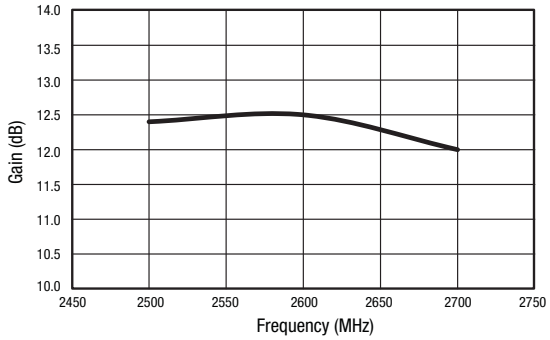


Figure 69. Gain vs Frequency @ 2600 MHz

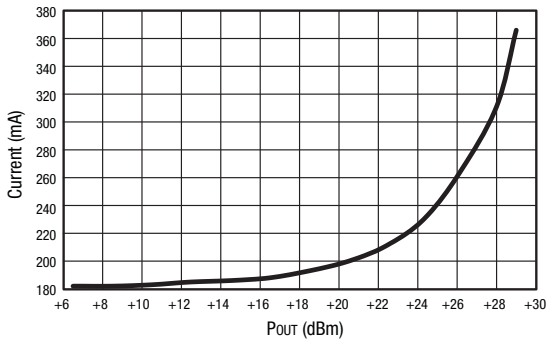


Figure 70. Current vs P_{OUT} @ 2600 MHz

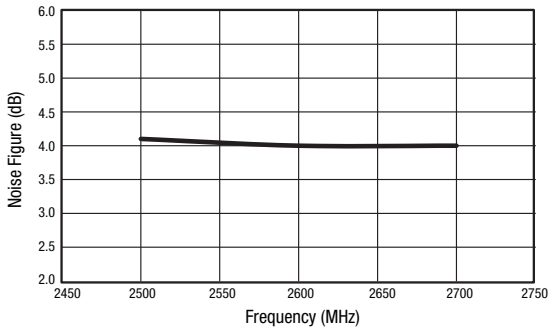


Figure 71. Noise Figure vs Frequency @ 2600 MHz

Evaluation Board Description

The Skyworks SKY65162-70LF Evaluation Board is used to test the performance of the SKY65162-70LF PA driver. An assembly drawing for the Evaluation Board is shown in Figure 72 and the layer detail is provided in Figure 73. The layer detail physical characteristics are noted in Figure 74.

Capacitors C7, C8, and C9 provide DC bias decoupling for VCC. Pins 1 and 3 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 2 and the package backside metal, pin 4, are ground pins that provide the DC and RF ground, respectively.

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 SKY65162-70LF 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 75. Component values for the SKY65162-70LF Evaluation Board are shown in Table 10.

Testing Procedure

Use the following procedure to set up the SKY65162-70LF Evaluation Board for testing:

1. Connect a 5.0 V supply to VCC. If available, enable the current limiting function of the power supply to 400 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 SKY65162-70LF Evaluation Board can be permanently damaged.*

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 SKY65162-70LF 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.

Package Dimensions

Package dimensions for the 4-pin SOT-89 are shown in Figure 76, and tape and reel dimensions are provided in Figure 77.

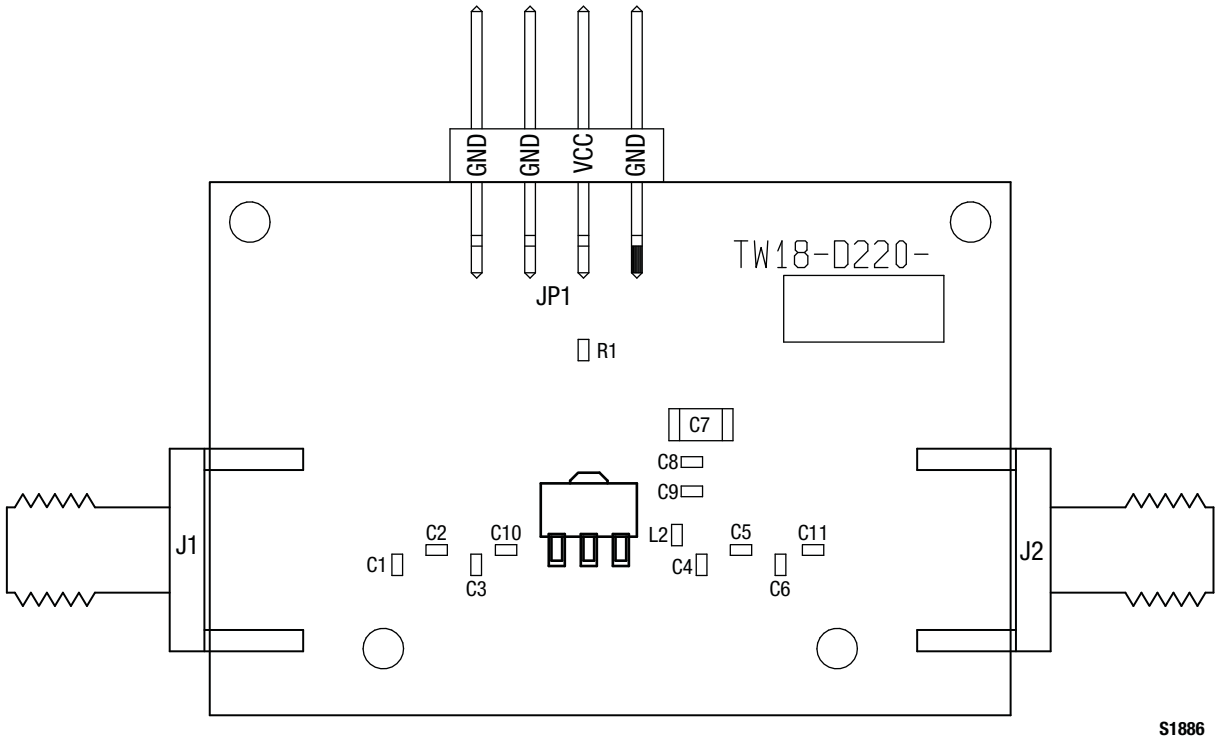
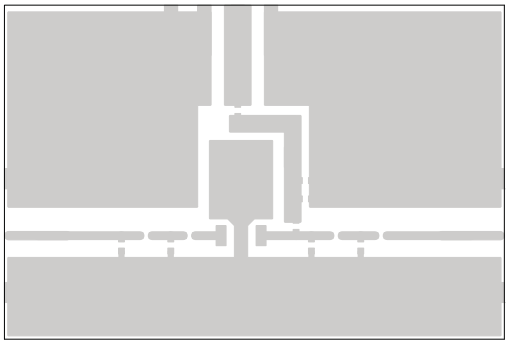
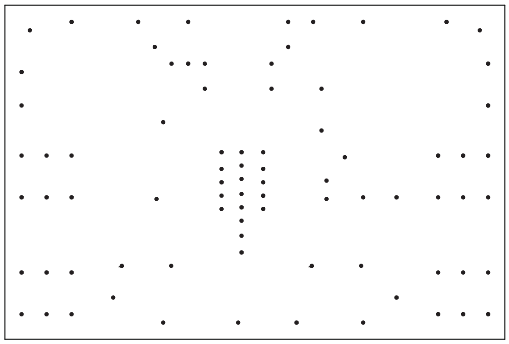


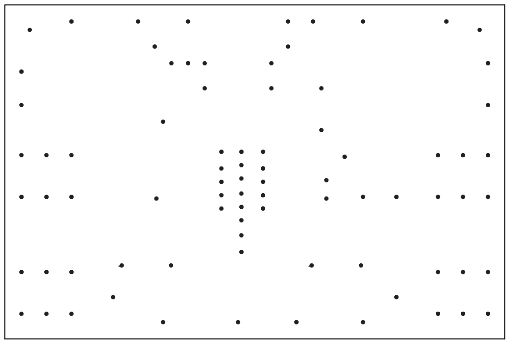
Figure 73. Evaluation Board Assembly Drawing



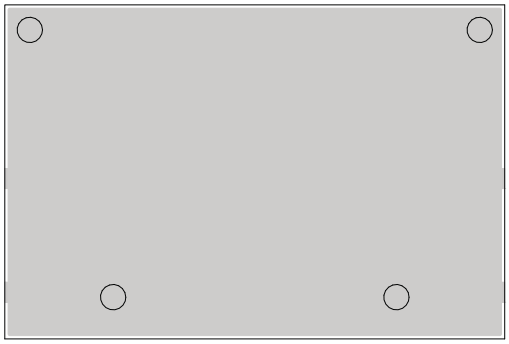
Layer 1: Top – Metal



Layer 2: Ground



Layer 3: Ground



Layer 4: Solid Ground Plane

S2056

Figure 74. Evaluation Board Layer Detail

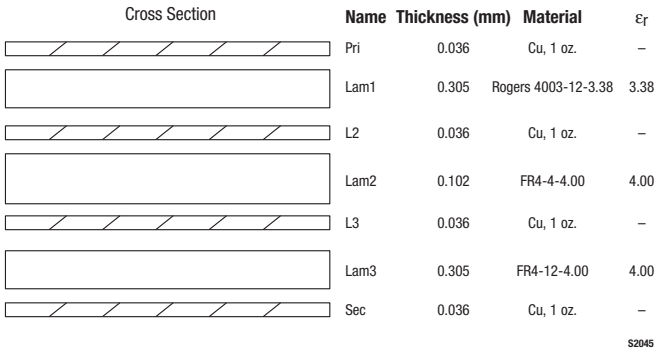


Figure 75. Layer Detail Physical Characteristics

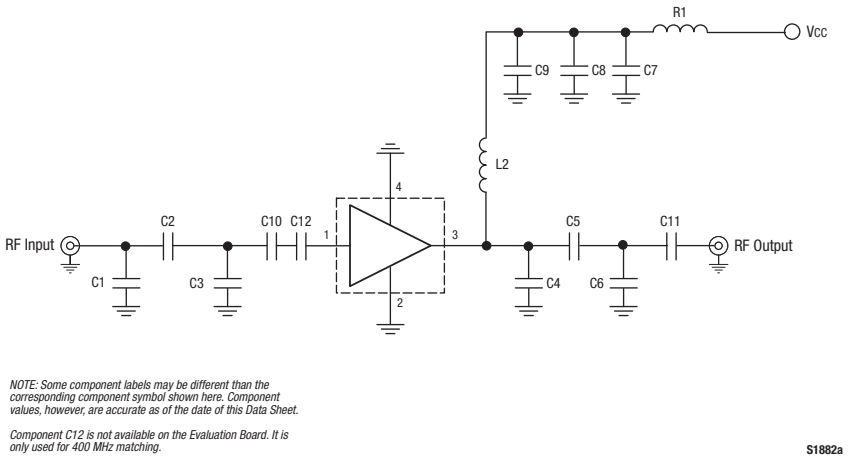


Figure 76. SKY65162-70LF Evaluation Board Schematic

Table 10. SKY65162-70LF (SOT-89 Package) Evaluation Board Bill of Materials

Component	Size	Value					
		400 MHz	915 MHz	1960 MHz	2100 MHz	2400 MHz	2600 MHz
C1	0402	8.2 pF	4.3 nH	DNI	DNI	DNI	DNI
C2	0402	30 pF	4.3 pF	1.3 pF	1.0 pF	0.8 pF	0.8 pF
C3	0402	DNI	DNI	1.3 pF	0.8 pF	0.7 pF	0.3 pF
C4	0402	DNI	DNI	2.7 pF	1.8 pF	1.5 pF	0.9 pF
C5	0402	20 pF	3.9 nH	4.7 pF	3.0 pF	1.5 pF	1.0 pF
C6	0402	8.2 nH	2.4 pF	DNI	DNI	DNI	DNI
C7	0805	1.0 µF	1.0 µF	1.0 µF	1.0 µF	1.0 µF	1.0 µF
C8	0402	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF	1000 pF
C9	0402	DNI	DNI	DNI	DNI	DNI	DNI
C10	0402	10 nH	1.5 Ω	0 Ω	0 Ω	0 Ω	0 Ω
C11	0402	0 Ω	3.6 pF	0 Ω	0 Ω	0 Ω	0 Ω
C12	0402	10 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω
L2	0402	36 nH	8.7 nH	8.7 nH	8.7 nH	8.7 nH	8.7 nH
R1	0402	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω	0 Ω

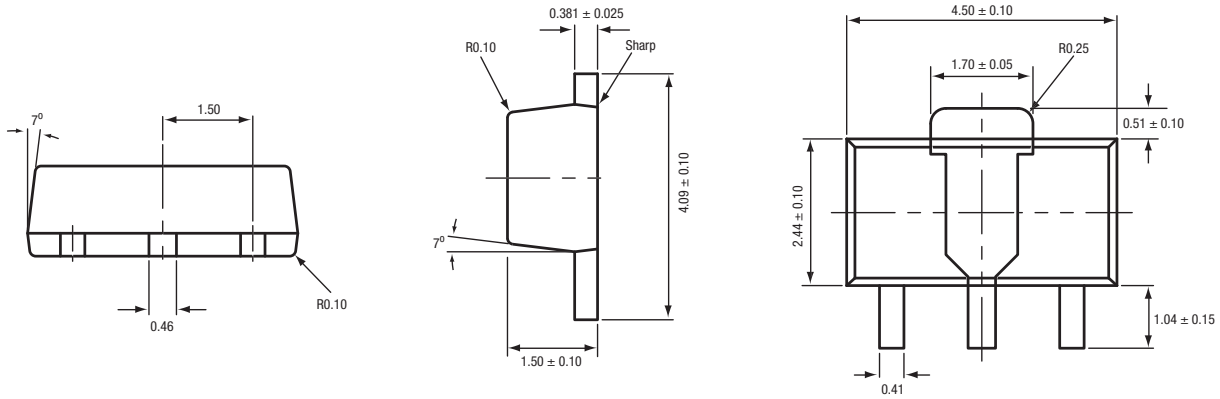
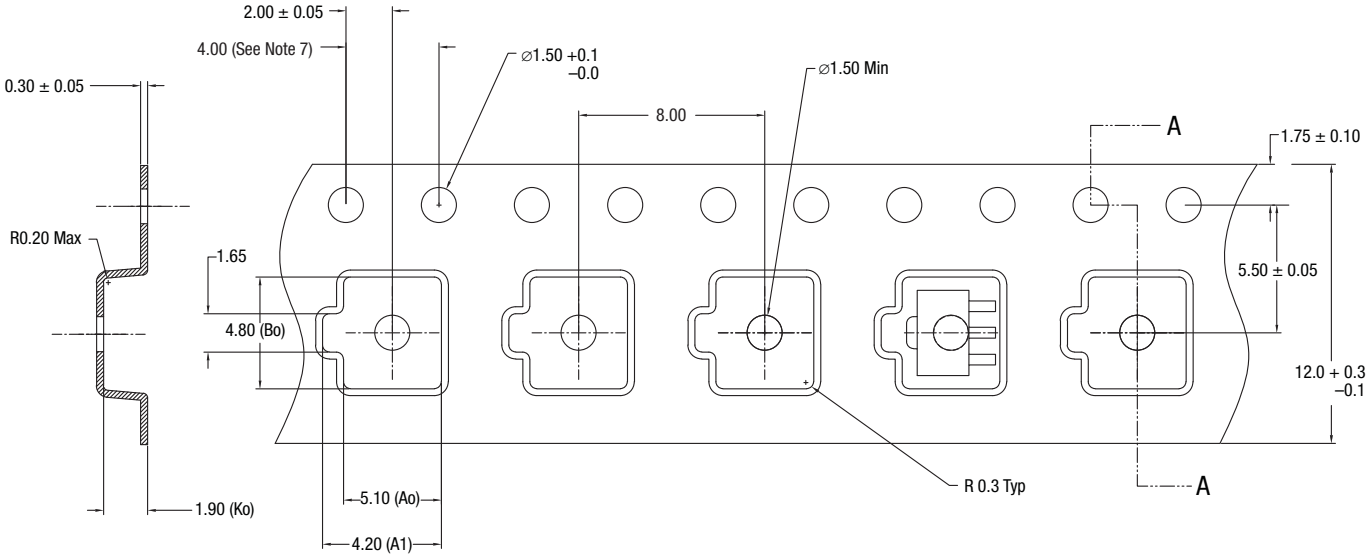


Figure 77. SKY65162-70LF (4-Pin SOT-89) Package Dimensions



Notes:

1. *Carrier tapes must meet all requirements of Skyworks GP01-D233 procurement spec for tape and reel shipping.*
2. *Carrier tape material: black conductive polycarbonate or polystyrene.*
3. *Cover tape material: transparent conductive PSA. Cover tape size: 9.2 mm width.*
4. *Typical ESD surface resistivity must meet all ESD requirements of Skyworks specified in GP01-D233.*
5. *Ao and Bo measurement point to be 0.30 mm from bottom pocket.*
6. *All measurements are in millimeters.*
7. *10-sprocket hole pitch cumulative tolerance 0.2 mm.*

200953-100

Figure 78. SKY65162-70LF Tape and Reel Dimensions

Ordering Information

Model Name	Ordering Part Number	Evaluation Board Part Number
SKY65162-70LF Linear PA	SKY65162-70LF	TW18-D220