SKYWORKS®
BREAKTHROUGH SIMPLICITY



Linear Products

2008

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0001











Skyworks Solutions

Skyworks Solutions, Inc. is an innovator of high-performance analog and mixed-signal semiconductors enabling mobile connectivity. The company's power amplifiers, front-end modules and direct conversion transceivers are at the heart of many of today's leading-edge multimedia handsets. Leveraging core technologies, Skyworks also offers a diverse portfolio of linear products that support automotive, broadband, cellular infrastructure, industrial and medical applications.

Headquartered in Woburn, Massachusetts, USA, Skyworks is worldwide with engineering, manufacturing, sales and service facilities throughout Asia, Europe and North America.

New products are continually being introduced at Skyworks. For the latest information, visit our Web site at **www.skyworksinc.com**. For additional information, please contact your local sales office or email us at **sales@skyworksinc.com**.

The Skyworks Advantage

- Broad multimode radio and precision analog product portfolio
- Market leadership in key product segments
- Solutions for all air interface standards, including CDMA2000, GSM/GPRS/EDGE, WCDMA, WLAN and WiMAX
- Engagements with a diverse set of top-tier customers
- Analog, RF and mixed-signal design capabilities
- Access to all key process technologies: GaAs HBT, PHEMT, BiCMOS, SiGe, CMOS and RF CMOS
- World-class manufacturing capabilities and scale
- Unparalleled level of customer service and technical support
- Commitment to technology innovation





INDEX

Selection Guide

Amplifiers

Attenuators

Diodes

Directional Couplers/Detectors

Filters

Hybrids

Infrastructure RF Subsystems

Intera™ Front-End Modules (WLAN)

MIS Silicon Chip Capacitors

Mixers/Demodulators

Modulators

Phase Shifters

PLLs/Synthesizers/VCOs

Power Dividers/Combiners

Receivers

Switches

Technical Ceramics
These products are produced by Trans-Tech
(a wholly owned subsidiary of Skyworks Solutions, Inc.)

Data Sheets

Reference Material

Solder Reflow

Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation

Suggested PCB Land Pattern

Quality/Reliability

Waffle Pack Chip Carrier Handling/ Opening Procedure

Linear Products Application Notes

Part Number Index

Skyworks Sales Representatives

Skyworks Distributors

Skyworks Sales Offices

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0003

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0004

SELECTION GUIDE

Amplifiers
Attenuators
Diodes
Directional Couplers/Detectors
Filters
Hybrids
Infrastructure RF Subsystems
Intera™ Front-End Modules (WLAN)
MIS Silicon Chip Capacitors
Mixers/Demodulators
Modulators
Phase Shifters
PLLs/Synthesizers/VCOs
Power Dividers/Combiners
Receivers
Switches
Technical Ceramics
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Tin/lead (SnPb) packaging is not recommended for new designs.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0005

AMPLIFIERS

Wireless Infrastructure High Gain Linear PA Modules

Part Number	Frequency (MHz)	Voltage (V)	P_{OUT} (dBm)	Gain (dB)	Test Frequency	Quiescent Current (mA)	NF (dB)	OIP3 (dBm)	Package (mm)
SKY65120	2110–2170	5	33.5	24.6	2140	447	8.4	48	20-pin MCM 6 x 6
SKY65124	1960–1990	5	25.0	24	1960	550	6.0	45	20-pin MCM 6 x 6

Wireless Infrastructure Ultralinear PA Drivers

Part Number	Frequency (MHz)	Test Frequency (MHz)	Gain Typ. (dB)	V_{CC} (V)	$P_{1\ dB}$ (dBm)	Package (mm)
SKY65004-21	250–2700	1960	16 @ 5 V	3 or 5	25 @ 5 V	3-pin MCM 4 x 4
SKY65008-21	250–2700	1960	20	3.3	21	3-pin MCM 4 x 4
SKY65009-70LF	250–2500	1960	12 @ 5 V	3 or 5	27 @ 5 V	4-pin SOT-89
SKY65028-70LF	250–2700	1960	16 @ 5 V	3 or 5	25 @ 5 V	4-pin SOT-89

Wireless Infrastructure PA/PA Driver Amplifiers

Part Number	Frequency (GHz)	Gain Typ. (dB)	Quiescent Current Typ. (mA)	V_{CC} (V)	OIP3 (dBm)	$P_{1\ dB}$ (dBm)	PAE (%) @ $P_{1\ dB}$	Package (mm)
SKY65112-84LF	0.4–2.3	18 @ 940 MHz	260	5	39	27	22	SOIC-8 Exposed Paddle
SKY65113-84LF	0.4–2.3	20 @ 940 MHz	450	5	40	30	39	SOIC-8 Exposed Paddle

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0006

AMPLIFIERS

Power Amplifiers for WLAN and ISM

Part Number	Frequency Range (GHz)	Gain Typ. (dB)	$P_{1\ dB}$ (dBm)	OIP3 (dBm)	PAE (%)	V_{CC} (V)	Quiescent Current Typ. (mA)	Package (mm)
SKY65006	2.40–2.50	27.5	23.9	–	–	3.3	50	QFN-16 3 x 3
SKY65131	2.40–2.50	26.0	28.0	–	38	3.3	150	MCM-16 4 x 4
SKY65132	2.40–2.50	33.0	30.0	–	29	3.3	330	MCM-20 6 x 6
SKY65135-21	2.40–2.50	33.0	33.0	42	34	5.0	400	MCM-20 6 x 6
SKY65116	0.39–0.50	35.0	32.5	43	42	3.6	330	MCM-12 8 x 8
SKY65111-348LF	0.60 –1.10	40.0	29.5	36	50	3.5	250	QFN-16 3 x 3
SKY65146	0.806–0.849	38.7	35.0	37	50	3.5	329	MCM-28 10 x 14

General-Purpose Amplifiers

Part Number	Frequency Range (GHz)	Test Frequency (MHz)	Gain Typ. (dB)	$P_{1\ dB}$ (dBm)	OIP3 (dBm)	Operating Current Typ. (mA)	Noise Figure Typ. (dB)	Package (mm)
SKY65013–70LF	LF–7	2	12.5	12.5	29	40	5.5	SOT-89
SKY65014-70LF	LF–6	2	16.0	18.0	36	70	4.8	SOT-89
SKY65015-70LF	LF–6	2	18.0	17.0	35	70	4.2	SOT-89
SKY65016-70LF	LF–3	2	20.0	14.0	27	40	4.8	SOT-89
SKY65017-70LF	LF–6	2	20.0	20.0	35	100	4.5	SOT-89
SKY65013-92LF	LF–12	2	12.5	12.5	29	40	5.8	SC-88
SKY65014-92LF	LF–9	2	15.0	18.0	36	70	5.4	SC-88
SKY65015-92LF	LF–6	2	18.0	18.0	35	70	4.8	SC-88
SKY65016-92LF	LF–3	2	20.0	14.0	27	40	5.4	SC-88
SKY65013-214LF	LF–6	2	11.5	12.5	29	40	5.4	Plastic Micro-X
SKY65014-214LF	LF–6	2	13.5	18.0	36	70	4.6	Plastic Micro-X
SKY65015-214LF	LF–6	2	16.0	18.0	24	70	5.2	Plastic Micro-X
SKY65016-214LF	LF–3	2	19.0	14.0	20	40	6.5	Plastic Micro-X

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0007

ATTENUATORS

Low Frequency 6 GHz Plastic Packaged Digital Attenuators

Part Number	Frequency[1] (GHz)	Control Bits/ Interface Parallel/Serial	Attenuation Range (dB)	Typ. $P_{1\ dB}$ (dBm)	LSB Attenuation (dB)	Typ. IP3 (dBm)	Typ. IL (dB)	Package (mm)
AA103-72LF	LF–2.5	1/P	10.0	20	10.0	41	0.3–0.4	SOT-5
AA116-72LF	LF–2.0	1/P	15.0	20	15.0	41	0.35–0.4	SOT-5
AA104-73LF	LF–2.5	1/P	32.0	21	32.0	41	0.8–1.0	SOT-6
SKY12324-73LF	0.5–3.0	2/P	12.0	30	4.0	43	0.9–1.3	SOT-6
SKY12325-350LF	0.5–6.0	3/P	7.0	27	1.0	47	0.7–1.3	QFN-16 3 x 3
AA100-59LF	0.75–2.0	3/P	28.0	20	4.0	32	1.8	MSOP-8
AA105-86LF	0.5–3.0	4/P	15.0	24	1.0	49	1.5–2.7	MSOP-10
AA210-25LF	LF–2.0	4/P	15.0	28	1.0	48	0.9–2.1	SOIC-16
AA226-87LF	0.5–2.5	4/P	15.0	25	1.0	49	1.3–2.3	TSSOP-16
AA264-87LF	0.5–2.0	4/P	30.0	15	2.0	36	1.6–1.8	TSSOP-16
AA102-80LF	0.5–2.5	5/P	15.5	24	0.5	42	1.9–3.2	SSOP-16
AA106-86LF	0.5–2.0	5/P	15.5	21	0.5	41	2.0–3.0	MSOP-10
AA107-310LF	LF–2.0	5/S	15.5	24	0.5	44	1.4–1.72	QFN 5 x 5
SKY12322-86LF	0.5–4.0	5/P	15.5	27	0.5	45	1.4–3.0	MSOP-10
SKY12328-350LF	0.5–4.0	5/P	15.5	30	0.5	–	1.1–2.3	QFN-16 3 x 3
AA101-80LF	0.5–2.5	5/P	31.0	21	1.0	41	2.0–2.9	SSOP-16
AA109-310LF	0.5–2.5	5/S	31.0	21	1.0	41	2.0–3.1	QFN 5x5
AA110-85LF	DC–2.0	5/P	31.0	22	1.0	40	1.4–2.2	SSOP-20
AA117-85LF	DC–2.0	5/P	31.0	22	1.0	40	1.4–22	SSOP-20
AA260-85LF	LF–2.0	5/P	31.0	25	1.0	42	1.4–2.0	SSOP-20
SKY12323-303LF	0.5–3.0	5/P	31.0	30	1.0	48	1.4–2.3	MSOP-10EP
AA113-310LF	LF–1.0	6/P	31.5	29	0.5	48	1.5–1.8	QFN-32 5 x 5
SKY12332-310LF	LF–1.0	6/P	31.5	29	0.5	48	1.5–1.8	QFN-32 5 x 5

1. LF = low frequency 300 kHz.

Innovation to Go™ Select products (indicated in blue/bold) are now available for purchase online.

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0008

ATTENUATORS

DC–6 GHz Plastic Packaged Variable Voltage Attenuators—FET-Based

Part Number	Frequency (GHz)	Description	Insertion Loss Range (dB) Typ.	Attenuation Range (dB) Typ.	IP3 > 0.5 GHz (dBm) Typ.	Package (mm)
AV103-12LF	0.5–2.5	Single, 5 V CTL High Speed	2.5–3.2	35	12	SOIC-8
AV104-12LF	0.5–2.5	Single, 5 V CTL High IP3	2.5–3.5	25	20	SOIC-8
AV105-12LF	0.5–2.5	Single, 5 V CTL	2.7–3.5	35	15	SOIC-8
AV109-73LF	0.8–1.0	Single, 3 V CTL Rev. Transfer	3.3–3.5	32	15	SOT-6
AV110-73LF	1.7–2.5	Single, 3 V CTL Rev. Transfer	3.5–3.8	32–27	12	SOT-6
SKY12146-321LF	3.2–3.8	20 dB Single CTL	1.5–1.6	32–20	20	QFN-12 3 x 3 Surface Mount

DC–6 GHz Plastic Packaged Variable Voltage Attenuators—PIN Diode-Based

Part Number	Frequency (GHz)	Description	Insertion Loss Range (dB) Typ.	Attenuation Range (dB) Typ.	IP3 > 0.5 GHz (dBm) Typ.	Package
AV101-12LF	0.8–1.0	HIP3™ Variable Attenuator	1	20	50	SOIC-8
AV102-12LF	1.7–2.0	HIP3™ Variable Attenuator	1	20	50	SOIC-8
AV111-12LF	0.8–1.0	HIP3™ Variable Attenuator	1	30	40	SOIC-8
AV113-12LF	2.1–2.3	HIP3™ Variable Attenuator	1	21	40	SOIC-8

Part Number	Frequency (MHz)	Description	Insertion Loss Range (dB) Max.	Attenuation Range @ 10 V (dB) Min.	Attenuation Range @ 12 V (dB) Min.	IP3 (dBm) Typ.	Control Voltage Range (V) Typ.	Package
SKY12143-315 Pb	869–894 925–960	Voltage Variable Attenuator	1.5	18–22	23	43	0–12	LGA Surface Mount
SKY12144-315 Pb	1805–1870 1930–1990	Voltage Variable Attenuator	1.5	18–22	23	32	0–12	LGA Surface Mount
SKY12145-315 Pb	2110–2170	Voltage Variable Attenuator	1.5	18–22	23	43	0–12	LGA Surface Mount

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0009

ATTENUATORS

DC–40 GHz Fixed Attenuator Pads

Part Number	Nominal Attenuation (dB)	Attenuation Tolerance @ DC (dB)	Attenuation Flatness		
			DC–12 GHz (dB)	DC–26.5 GHz (dB)	DC–40 GHz (dB)
ATN3580-01	1	±0.15	±0.2	±0.50	±1
ATN3580-02	2	±0.15	±0.2	±0.50	±1
ATN3580-03	3	±0.25	±0.2	±0.50	±1
ATN3580-04	4	±0.25	±0.2	±0.50	±1
ATN3580-05	5	±0.25	±0.2	±0.50	±1
ATN3580-06	6	±0.25	±0.4	±0.60	±1
ATN3580-07	7	±0.25	±0.4	±0.60	±1
ATN3580-08	8	±0.35	±0.4	±0.60	±1
ATN3580-09	9	±0.35	±0.4	±0.60	±1
ATN3580-10	10	±0.35	±0.4	±0.60	±1
ATN3580-12	12	±0.50	±0.4	±0.60	±1
ATN3580-15	15	±0.50	±0.4	±0.60	±1
ATN3580-20	20	±1.10	±1.0	±2.00	±4
ATN3580-30	30	±1.60	±1.0	±2.00	±4
ATN3580-40	40	±1.60	±1.0	±2.00	±4

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0010

DIRECTIONAL COUPLERS

Part Number	Frequency (GHz)	Insertion Loss (dB) Typ.	Isolation (dB) Typ.	Input VSWR Typ.	Output VSWR Typ.	Coupling (dB) Typ.	Coupled Port VSWR Typ.	Package
DC08-73LF	0.81–0.96	0.45	22	1.05:1	1.05:1	15.0	1.2:1	SOT-6
DC09-73LF	0.81–0.96	0.20	30	1.1:1	1.1:1	19.8	1.1:1	SOT-6
DC15-73LF	1.42–1.66	0.20	34	1.1:1	1.1:1	18.4	1.1:1	SOT-6
DC16-73LF	1.42–1.99	0.30	24	1.1:1	1.1:1	15.0	1.1:1	SOT-6
DC18-73LF	1.71–1.99	0.20	38	1.1:1	1.1:1	18.8	1.2:1	SOT-6
DC25-73LF	2.30–2.60	0.20	33	1.1:1	1.1:1	17.2	1.3:1	SOT-6

DIRECTIONAL DETECTORS

Part Number	Frequency (GHz)	Insertion Loss (dB) Typ.	Directivity (dB)	Input VSWR Typ.	Output VSWR Typ.	Directed Output Voltage (dBm)	Package
DD02-999LF	0.65–3.0	0.2	2	1.1:1	1.1:1	80 mV @ 900 MHz 160 mV @ 1800 MHz	SC-88

SAMPLING PHASE DETECTORS

Part Number	Typ. Microwave Signal Drive Level (dBm)	Barrier	Schottky Diode			Typ. Capacitor C_C (pF)	Step Recovery Diode		
			V_F @ 1 mA (mV)	Max. R_T @ 5 mA (Ω)	Typ. C_J @ 0 V (pF)		Typ. C_J @ 6 V (pF)	Typ. T_I (ns)	Typ. T_T (ps)
SPD1101-111	-3 to 0	Low	270–350	24	0.10	0.5	0.25	10	70
SPD1102-111	0 to 3	Medium	370–550	24	0.10	0.5	0.25	10	70
SPD1103-111	3 to 13	High	600–700	24	0.10	0.5	0.25	10	70

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0011

FILTERS

BAW Filters

Part Number	Pass Band Frequency (GHz)	Pass Band Insertion Loss Typ. (dB)	Pass Band Return Loss Typ. (dB)	Attenuation- Lower Stop Band (dB)	Lower Stop Band Frequency (GHz)	Attenuation- Upper Stop Band (dB)	Package (mm)
SKY33100-360LF	2.402–2.472	2	10	14	2.4835	14	QFN 16L 2 x 2

Programmable Filters

Part Number	Lowest Cutoff Frequency (MHz)	Highest Cutoff Frequency (MHz)	Program Method	Corner Accuracy (%)	Max. Pass Band Ripple (dB)	Max. Group Delay Variation (ns)	Gain (dBv)	Supply Current (mA)	Supply Voltage (V)	Package (mm)
SKY73201-364LF	1	28	SPI	1	0.5	35	0 or 6	32	3.3	QFN 32L 5 x 5
SKY73202-364LF	1	28	SPI	1	0.5	35	0 or 6	60	3.3	QFN 32L 5 x 5

HYBRID COUPLERS

90-Degree Hybrid Couplers

Part Number	Frequency (GHz)	Insertion Loss (dB) Typ.	Isolation (dB) Typ.	Input VSWR Typ.	Output VSWR Typ.	Amplitude Balance (Degrees) Typ.	Phase Balance (dB) Typ.	Package
HY86-12LF	0.82–0.90	0.40	30	1.15:1	1.15:1	±0.5	±1	SOIC-8
HY92-12LF	0.88–0.96	0.40	25	1.1:1	1.1:1	±0.5	±1	SOIC-8
HY17-12LF	1.71–1.88	0.50	20	1.2:1	1.2:1	±0.5	±1	SOIC-8
HY19-12LF	1.85–1.99	0.50	20	1.3:1	1.3:1	±0.5	±1	SOIC-8
HY22-73LF	2.10–2.30	0.55	23	1.2:1	1.2:1	±0.4	±2	SOT-6

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0012

INFRASTRUCTURE RF SUBSYSTEMS

High Gain Linear PA Modules

Part Number	Frequency (MHz)	Voltage (V)	P_{OUT} (dBm)	Gain (dB)	Test Frequency	Quiescent Current (mA)	NF (dB)	OIP3 (dBm)	Package (mm)
SKY65120	2110–2170	5	33.5	24.6	2140	447	8.4	48	20-pin MCM 6 x 6
SKY65124	1960–1990	5	25.0	24	1960	550	6.0	45	20-pin MCM 6 x 6

Ultralinear PA Drivers

Part Number	Frequency (MHz)	Test Frequency (MHz)	Gain Typ. (dB)	V_{CC} (V)	$P_{1\ dB}$ (dBm)	Package (mm)
SKY65004-21	250–2700	1960	16 @ 5 V	3 or 5	25 @ 5 V	3-pin MCM 4 x 4
SKY65008-21	250–2700	1960	20	3.3	21	3-pin MCM 4 x 4
SKY65009-70LF	250–2500	1960	12 @ 5 V	3 or 5	27 @ 5 V	4-pin SOT-89
SKY65028-70LF	250–2700	1960	16 @ 5 V	3 or 5	25 @ 5 V	4-pin SOT-89

Dual Fractional-N Synthesizers

Part Number	Main Synthesizer Frequency (MHz)	Auxiliary Synthesizer Frequency (MHz)	Main Synthesizer Phase Noise (dBc/Hz)	Supply Voltage (V)	Package (mm)
SKY72300-21	100–2100	100–500	-91 @ 1800 MHz	2.7–3.3	28-pin EP-TSSOP 9.7 x 6.4
SKY74038-21	100–2600	1–800	-85 @ 2500 MHz	2.6–3.6	20-pin TSSOP 6.5 x 4.4
SKY72300-362	100–2100	100–500	-91 @ 1800 MHz	2.7–3.3	24-pin QFN 4 x 4
SKY72302-21	400–6100	100–1000	-80 @ 6100 MHz	2.7–3.3	28-pin EP-TSSOP 9.7 x 6.4
SKY72301-22	100–1000	100–500	-96 @ 950 MHz	2.7–3.3	28-pin EP-TSSOP 9.7 x 6.4

Innovation to Go™ Select products (indicated in blue/bold) are now available for purchase online.

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0013

INFRASTRUCTURE RF SUBSYSTEMS

Single Fractional-N Synthesizers

Part Number	Operating Frequency (MHz)	Phase Noise dBc/Hz	Supply Voltage (V)	Package (mm)
SKY72310-362	100–2100	-91 @ 1800 MHz	2.7–3.3	24-pin QFN 4 x 4

High-Performance VCO/Synthesizers

Part Number	RF Output Frequency Range (MHz)	Output Power (dBm)	Phase Noise @ 200 kHz (dBc/Hz)	Phase Noise @ 800 kHz (dBc/Hz)	Phase Setting Time (µS)	Current Consumption (mA)	Supply Voltage (V)	Package (mm)
SKY73100	865–960	0	-127	-148	300	120	5	38-pin MCM 9 x 12
SKY73120	890–960	0	-124	-144	–	26	3	28-pin MCM 6 x 6
SKY73101	1800–1990	-10	-112	-139	300	120	5	38-pin MCM 9 x 12
SKY73103	1460–1665	-10	-121	-144	300	120	5	38-pin MCM 9 x 12
SKY73112	750–850	0	-132	-152	300	120	5	38-pin MCM 9 x 12

Direct Quadrature Demodulator and Direct Conversion Mixer

Part Number	RF Input Frequency Range (MHz)	IF Input Frequency Range (MHz)	Voltage (V)	IIP2 (dBm)	IIP3 (dBm)	Voltage Conversion Gain (dB)	Package (mm)
SKY73013	4900–5925	DC–100	3.3	28	0	24.5	16-pin QFN 4 x 4
SKY73012	400–3900	DC–250	3	60 @ 900MHz	29 @ 900MHz	1 @ 900MHz	32-pin RFLGA 5 x 5
SKY73009	400–3000	DC–250	3	60 @ 900MHz	27 @ 900MHz	2 @ 900MHz	32-pin RFLGA 5 x 5
SKY73001	2–3500	DC–100	3	67 @ 900MHz	27 @ 900MHz	-3.5 @ 900MHz	32-pin RFLGA 5 x 5

Direct Quadrature Modulator

Part Number	RF Output Frequency Range (MHz)	Broad Band Noise Floor (dBm/Hz)	ACPR (dBc)	Package (mm)
SKY73010-21	300–2500	<-153	72	16-pin RFLGA 4 x 4

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0014

INTERA™ FRONT-END WLAN MODULES

Front-End Modules for WLAN

Part Number	Frequency (GHz)	Description	802.11 WLAN Standard	Typ. P_{OUT} @ 2.5% EVM (dBm)	Typ. Current @ V_{CC} = 3.3 V (mA)	Typ. Tx Gain (dB)	Architecture	Antenna Ports	Package (mm)
SKY65225-11	2.4–2.5 4.9–5.85	WLAN 802.11n 2 x 2 MIMO Front-End Module	b,g,n a,n	19 16	190 180	24 25	Two Full Dual-Band Tx/Rx Chains	2	MCM 10 x 14 x 0.9
SKY65227-11	2.4–2.5	WLAN 802.11n 2 x 2 MIMO Single-Band Front-End Module	b,g,n	19	190	25	Two Full 2 GHz Tx/Rx Chains	2	MCM 10 x 14 x 0.9
SKY65228-11	4.9–5.85	WLAN 802.11n 2 x 2 MIMO Single-Band Front-End Module	a,n	16	180	25	Two Full 5 GHz Tx/Rx Chains	2	MCM 10 x 14 x 0.9
SKY65230-11	2.4–2.5 4.9–5.85	WLAN 802.11n 2 x 2 MIMO Front-End Module with 3 Antenna Ports	b,g,n a,n	19 16	190 180	25 24	Two Full Dual-Band Tx/Rx Chains	3	MCM 10 x 14 x 0.9
SKY65241-11	2.4–2.5 4.9–5.85	WLAN 801.11a,b,g Dual-Band Front-End Module	a b g	16 21 18	190 210 180	25 26 26	One Complete Dual-Band Tx/Rx Chain	1	Laminate 5 x 5 x 0.9
SKY65243-11	2.4–2.5 4.9–5.85	WLAN 801.11a,b,g Dual-Band Front-End Module	a b g	16 21 18	190 210 180	25 26 26	One Complete Dual-Band Tx/Rx Chain	2	Laminate 5 x 5 x 0.9
SKY65249-11	2.4–2.5	WLAN 802.11b,g Front-End Module	b g	21 18	210 180	26 26	One single-band Tx/Rx chain	2	Laminate 4 x 4 x 0.9
SKY65256-11	2.4–2.5 4.9–5.85	WLAN 801.11a,b,g Dual-Band Front-End Module	a b g	16 21 18	190 210 180	25 26 26	One Complete Dual-Band Tx/Rx Chain	1	Laminate 5 x 6 x 0.9

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0015

MIS SILICON CHIP CAPACITORS

Part Number	Capacitance Value (pF) ± 20%	Size (mils)
SC00080912	0.8	12 x 12
SC00120912	1.2	12 x 12
SC00180912	1.8	12 x 12
SC00260912	2.6	12 x 12
SC00380912	3.8	12 x 12
SC00560912	5.6	12 x 12
SC00680912	6.8	12 x 12
SC00821518	8.2	18 x 18
SC01000710	10	10 x 10
SC01500912	15	12 x 12
SC02201518	22	18 x 18
SC03301518	33	18 x 18
SC04701518	47	18 x 18
SC06801518	68	18 x 18
SC10002430	100	30 x 30
SC33303440	333	40 x 40
SC50004450	500	50 x 50
SC99906068	1000	68 x 68

MIXERS/DEMODULATORS

Diversity Mixers/Downconverters

Part Number	RF Frequency (MHz)	IF Frequency (MHz)	Gain (dB)	IIP3 (dBm)	OIP3 (dBm)	$I_{P1\ dB}$ (dBm)	NF (dB)	Package (mm)
SKY73020	700–1000	50–250	7.0	27	34.0	16.5	10.2	36-pin MCM 6 x 6
SKY73025-11	2300–2700	50–500	8.6	23.5	32.1	12.3	9.8	36-pin MCM 6 x 6
SKY73021	1700–2200	40–300	6.0	26	32.0	17.0	9.6	36-pin MCM 6 x 6
SKY73023-11	1700–2200	40–300	9.7	25.7	35.4	13.6	9.5	36-pin MCM 6 x 6
SKY73022-11	700–1000	40–300	9.4	25.3	34.7	13.3	9.0	36-pin MCM 6 x 6

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0016

SWITCHES

Low Frequency—6 GHz Plastic Packaged and Chip—Control FET and SPST

Part Number	Frequency(1) (GHz)	Typ. IL Series (dB)	Typ. IL Shunt (dB)	Typ. Isolation Series (dB)	Typ. Isolation Shunt (dB)	Control Bits	Package (mm)
AF002C1-39LF	LF–2.5	0.50	0.10	25	12	1	SOT-23
AF002C4-39LF	LF–2.5	0.25	0.25	6	9	1	SOT-23
SKY13282-334	LF–2.5	0.35	0.40	6	7	1	LGA-6 1.5 x 1.2

Part Number	Frequency(1) (GHz)	Typ. IL (dB)	Typ Isol. (dB)	Typ. IIP3 (dBm)	Typ. $IP_{1\ dB}$ (dBm)	Absorptive/ Reflective	Package
AS130-73LF	0–2.5	0.75-1.0	53-24	44	25	A/R	SOT-6
AS156-73LF	0.5–2.5	0.65-0.75	45-15	43	18	R	SOT-6
AS165-59LF	0.5–2.5	0.7-1.2	45-38	45	28	A/R	MSOP-8

Low Frequency—6 GHz Plastic Packaged and Chip—SPDT

Part Number	Frequency(1) (GHz)	Typ. IL (dB)	Typ Isol. (dB)	Typ. IIP3 (dBm)	Typ. $IP_{1\ dB}$ (dBm)	Absorptive/ Reflective	Package (mm)
AS188-92LF	LF–2.0	0.35–0.55	26–17	50	33	R	SC-88
AS002R2-12LF	LF–2.5	0.4–0.8	42–20	46	24	R	SOIC-8
AS169-73LF	LF–2.5	0.3–0.4	25–24	48	30	R	SOT-6
AS183-92LF	LF–2.5	0.3–0.55	20–13	48	30	R	SC-88
AS216-339LF	LF–2.5	0.7–1.0	34–20	63	40	R	SOIC-8EP
AS338-12LF	LF–2.5	0.5–1.2	46–26	46	28	R	SOIC-8
AW002R2-12LF	LF–2.5	0.7–1.0	37–22	63	35	R	SOIC-8
SKY13270-92LF	0.1–2.5	0.3–0.55	30–17		37 for 0.1 dB	R	SC-88
SKY13278-313LF	0.1–2.5	0.4–0.55	32–18	–	40 for 0.1 dB	R	QFN-6 2 x 3
AS193-73LF	0.1–2.5	0.3–0.55	30–17	–	37	R	SOT-6
SKY13290-313LF	0.5–2.5	0.4–0.55	26–18	–	40.5 for 0.1 dB	R	QFN-6 2 x 3
AS176-59LF	LF–3.0	0.7–0.9	55–27	41	–	R	MSOP-8
AS177-86LF	LF–3.0	0.7–0.9	55–40	41	21	R	MSOP-10
AS179-92LF	LF–3.0	0.3–0.4	25–23	48	30	R	SC-88
AS179-000	0.3–3.0	0.3–0.35	25–22	48	30	R	Chip
AS213-92LF	0.1–3.0	0.3–0.5	27–19	40	27	R	SC-88
AS214-92LF	0.1–3.0	0.3–0.4	30–25	40	20	R	SC-88
AS222-92LF	0.1–3.0	0.35–0.5	27–18	44	20	R	SC-88

1. LF = low frequency 300 kHz.

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0017

SWITCHES

Low Frequency—6 GHz Plastic Packaged and Chip—SPDT (Continued)

Part Number	Frequency(1) (GHz)	Typ. IL (dB)	Typ Isol. (dB)	Typ. IIP3 (dBm)	Typ. $IP_{1\ dB}$ (dBm)	Absorptive/ Reflective	Package (mm)
AS215-92LF	0.5–3.0	0.5–0.75	28–20	40	20	R	SC-88
AS211-334	LF–4.0	0.3–0.60	26–22	50	34	R	LGA-6 1.5 x 1.2
AS186-302LF	LF–4.0	0.8–1.00	55–40	27	17	A	MSOP-8
AS191-73LF	0.1–4.0	0.5–0.70	27–18	–	35	R	SOT-6
SKY13299-321LF	0.1–4.0	0.3-0.65	30–29	–	38.5 for 0.1 dB	R	QFN 12-Lead 3 x 3
AS196-307LF	LF–6.0	0.9–1.60	55–30	30	17	A	LPCC 4 x 4
AS229-350LF	LF–6.0	0.8–1.80	55–25	46	24	A	QFN-16 3 x 3
AS230-348LF	LF–6.0	0.8–1.20	30–15	63	40	R	QFN-16 3 x 3
SKY13274-349LF	LF–6.0	0.5–0.80	25–17	46	25 for 0.1 dB	A/R	QFN-8
AS225-313LF	0.1–6.0	0.5–0.60	21–20	52	30	R	QFN-6
SKY13268-344LF	0.3–3.0	0.3–0.40	25–23	43	30	R	SOT-666
SKY13286-359LF	0.1–6.0	0.8–1.50	62–42	46	30	A	QFN-16 4 x 4
SKY13276-334	0.1–6.0	0.6–0.70	21–20	52	30	R	LGA-6 1.5 x 1.2
AS200-313LF	5.0–6.0	1.3	30	–	33	R	QFN-6 2 x 3
SKY13306-313LF	0.1–6.0	0.4–0.55	26–18	–	40.5 for 0.1 dB	R	QFN-6 2 x 3

Low Frequency—6 GHz Plastic Packaged and Chip—Multiport

Part Number	Frequency(1) (GHz)	Description (Absorptive/ Reflective)	Typ. IL (dB)	Typ Isol. (dB)	Typ. IIP3 (dBm)	Typ. $IP_{1\ dB}$ (dBm)	Package (mm)
AS172-73LF	LF–2.0	DPDT (R)	0.3–0.95	25–13	50	34	SOT-6
AS218-321LF	LF–6.0	DPDT (R)	1.2–1.6	28–19	47	33	QFN-12
AS236-321LF	LF–6.0	DPDT (R)	0.95–1.15	22–15	56	34	QFN-12
SKY13267-321LF	2.4–6.0	DPDT (R)	0.7–0.9	32–20	49	–	QFN-12
AS202-321LF	LF–2.0	SP3T (R)	0.55–0.8	28–25	–	–	QFN-12
AS227-321LF	LF–2.0	SP3T (R)	0.45–0.7	32–20	63	–	QFN-12
SKY13277-355LF	0.5–2.5	SP3T (A)	0.9–1.2	62–55	43	30	QFN 5 x 5
AS219-321LF	0.1–2.6	SP3T (R)	0.35–0.8	26–14	–	35	QFN-12
SKY13251-349LF	LF–3.0	SP3T (R)	0.35–0.6	29–15	46	25	QFN-8
SKY13296-340LF	0.02–2.5	SP4T (A)	0.4–0.7	40–26	40	18	QFN-20 4 x 4
AS221-306LF	0.1–2.5	SP4T (R)	0.6–1.1	34–22	55	–	QFN-16 4 x 4
AS204-80LF	LF–3.0	SP4T (A)	0.4–0.9	45–25	40	26	SSOP-16
AS195-306LF	0.1–2.0	SP5T (R)	0.5–1.0	35–23	55	–	MLF-16
SKY13309-370LF	LF–3.0	–	0.5–0.6	25	–	–	QFN 2 x 2 x 0.6

1. LF = low frequency 300 kHz.

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0018

SWITCHES

Low Frequency—2.5 GHz Plastic Packaged 4 x 2—LNB/DBS Switch Matrix

Part Number	Frequency (GHz)	Typ. IL (dB)	Typ Isol. (dB)	Typ. $IP_{1\ dB}$ (dBm)	Absorptive/Reflective	Package (mm)
SKY13264-340LF	0.25–2.15	7.5–8.5	40–33	15	R	QFN-20 4 x 4
SKY13272-340LF	0.25–2.15	7.5–8.5	40–31	15	A	QFN-20 4 x 4
SKY13292-365LF	0.25–2.15	7.5–9.0	40–30	15	R	QFN-20 4 x 4

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0019

DATA SHEETS

Amplifiers
Attenuators
Diodes
Directional Couplers/Detectors
Filters
Hybrids
Infrastructure RF Subsystems
Intera™ Front-End Modules (WLAN)
MIS Silicon Chip Capacitors
Mixers/Demodulators
Modulators
Phase Shifters
PLLs/Synthesizers/VCOs
Power Dividers/Combiners
Receivers
Switches
Technical Ceramics
These products are produced by Trans-Tech
(a wholly owned subsidiary of Skyworks Solutions, Inc.)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0020

PRELIMINARY DATA SHEET

SKY65112-84LF: Linear Power Amplifier Driver, 0.5 W 400–2300 MHz

Features

- Wideband: 400–2300 MHz
- High linearity: OIP3 > 39 dBm; $P_{1\ dB}$ > 27 dBm @ 940 MHz
- High gain > 18 dB
- Single DC supply: 5 V
- Low-cost SMT, lead (Pb)-free package, RoHS-compliant

Applications

- UHF TV broadcast
- TETRA radio
- GSM/CDMA/EDGE 450/750/850/900MHz bands
- DCS, PCS, W-CDMA, UMTS

Description

Skyworks SKY65112 is a high performance power amplifier with superior linearity and output power. The device is fabricated using Skyworks high-reliability Heterojunction Bipolar Transistor (HBT) technology. The device utilizes low-cost, industry-standard, thermally enhanced SOIC-8 lead (Pb)-free, RoHS-compliant packaging.

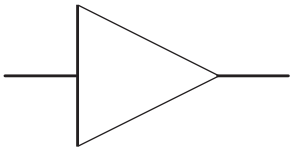
The SKY65112 incorporates on-chip active bias which achieves excellent gain tracking over temperature and voltage variations.

The SKY65112 is designed for ultrahigh linearity and wideband operation, making it a cost effective building block for many transceiver applications.

The SKY65112 is rated for operation from -40 to +85 °C. It operates from a 5 V power supply voltage.

An evaluation board is available upon request.

Functional Block Diagram



NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0021

Electrical Specifications

T_A = 25 °C, V_{CC} = 5 V, I_{CCQ} = 260 mA, Z_O = 50 Ω, as measured in the evaluation board, unless otherwise noted

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operational bandwidth			440		460	MHz
Total power-added efficiency	PAE	@ $P_{1\ dB}$		27		%
Gain	$\|S_{21}\|$			22		dB
Output $P_{1\ dB}$	$OP_{1\ dB}$		26.5		dBm	
Output IP3	OIP3	@ 14 dBm P_{OUT}/Tone, 1 MHz Spacing		34		dBm
Second harmonic		P_{OUT} @ 450 MHz = 10 dBm		-40		dBc
Third harmonic		P_{OUT} @ 450 MHz = 10 dBm		-86		dBc
Supply current	I_{CCQ}			260		mA
Reference current	I_{REF}			2		mA
Operational bandwidth			920		960	MHz
Total power-added efficiency	PAE	@ $P_{1\ dB}$		22		%
Gain	$\|S_{21}\|$			18		dB
Output $P_{1\ dB}$	$OP_{1\ dB}$			27.2		dBm
Output IP3	OIP3	@ 14 dBm P_{OUT}/Tone, 1 MHz Spacing		39		dBm
Second harmonic		P_{OUT} @ 940 MHz = 10 dBm		-65		dBc
Third harmonic		P_{OUT} @ 940 MHz = 10 dBm		-90		dBc
Supply current	I_{CCQ}			260		mA
Reference current	I_{REF}			2		mA
Operational bandwidth			1930		1990	MHz
Total power-added efficiency	PAE	@ $P_{1\ dB}$		38		%
Gain	$\|S_{21}\|$			15.1		dB
Output $P_{1\ dB}$	$OP_{1\ dB}$			30		dBm
Output IP3	OIP3	@ 14 dBm P_{OUT}/Tone, 1 MHz Spacing		39		dBm
Second harmonic		P_{OUT} @ 1.96 GHz = 10 dBm		-58		dBc
Third harmonic		P_{OUT} @ 1.96 GHz = 10 dBm		-79		dBc
CDMA (IS95) channel power		@ -50 dBc ACPR, 1960 MHz		22		dBm
Supply current	I_{CCQ}			260		mA
Reference current	I_{REF}			2		mA
Operational bandwidth			2110		2170	MHz
Total power-added efficiency	PAE	@ $P_{1\ dB}$		38		%
Gain	$\|S_{21}\|$			15.5		dB
Output $P_{1\ dB}$	$OP_{1\ dB}$			29		dBm
Output IP3	OIP3	@ 14 dBm P_{OUT}/Tone, 1 MHz Spacing		37		dBm
Second harmonic		P_{OUT} @ 2.14 GHz = 10 dBm		-55		dBc
Third harmonic		P_{OUT} @ 2.14 GHz = 10 dBm		-72		dBc
W-CDMA channel power		@ -45 dBc ACLR, 2140 MHz		20		dBm
Supply current	I_{CCQ}			260		mA
Reference current	I_{REF}			2		mA

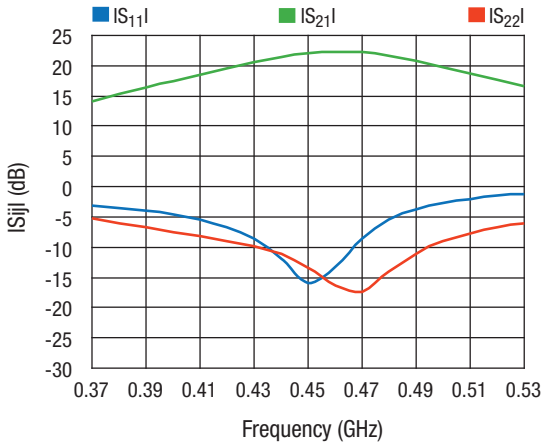
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0022

Recommended Operating Conditions

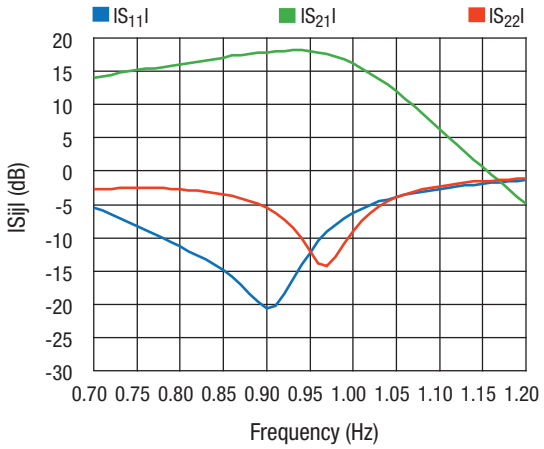
Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		5		V
Reference current	I_{REF}		2		mA
Reference voltage	V_{REF}		5		V
Operating frequency		400		2300	MHz
Supply current	I_{CCQ}		260		mA
Junction temperature	T_J			150	°C

Typical Performance Data

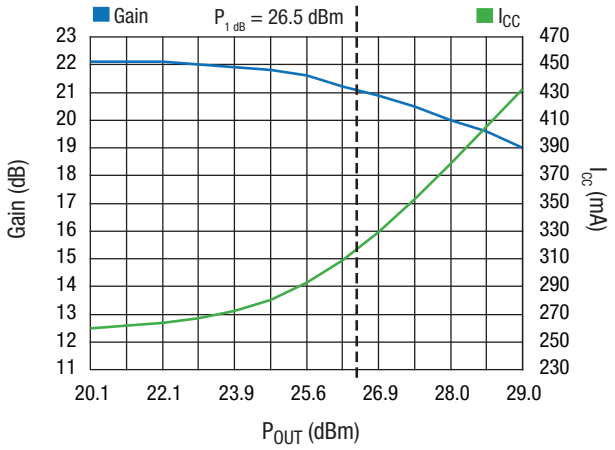
T_A = 25 °C, V_{CC} = 5 V, I_{CCQ} = 260 mA, Z_O = 50 Ω, unless otherwise noted



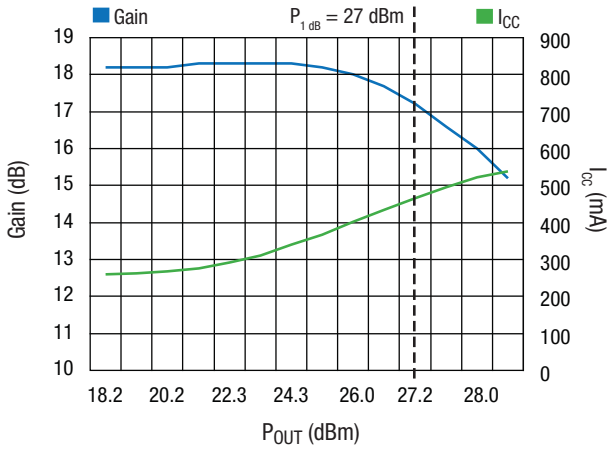
SKY65112 Tuned for 450 MHz
V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA



SKY65112 Tuned for 940 MHz
V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA

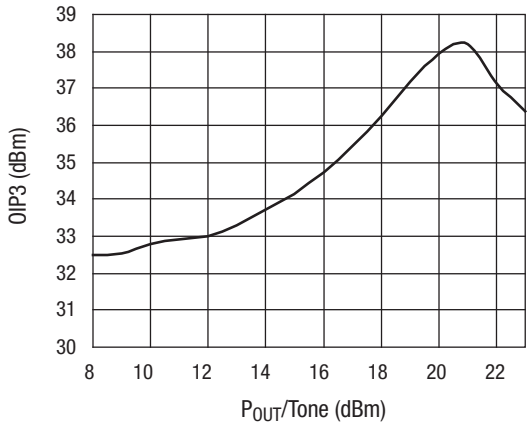


SKY65112 Gain, I_{CC} vs. P_{OUT}
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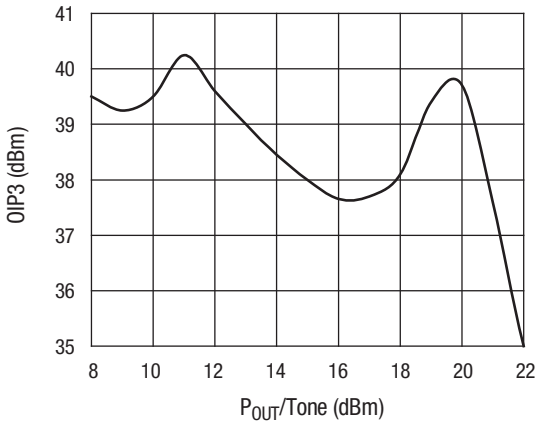


SKY65112 Gain, I_{CC} vs. P_{OUT}
V_{CC} = 5 V, V_{REF} = 5.1 V, I_{CCQ} = 260 mA, F = 940 MHz

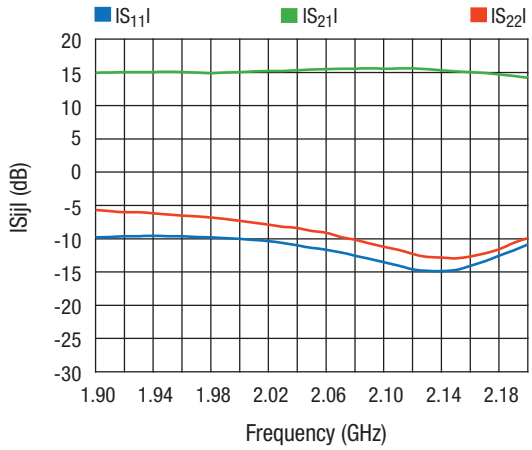
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0023



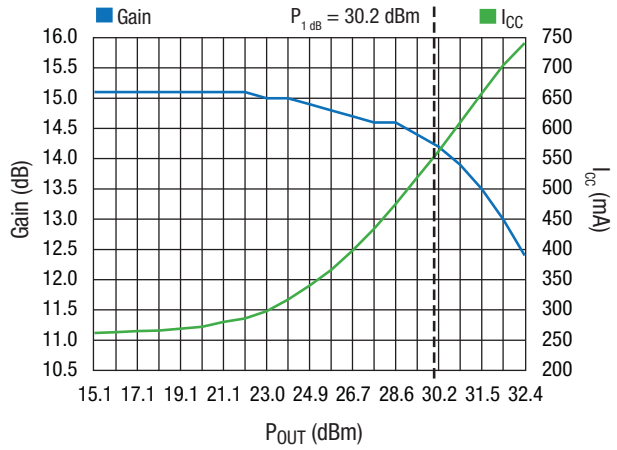
SKY65112 OIP3, V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA, F = 450 MHz, Tone Spacing = 1 MHz



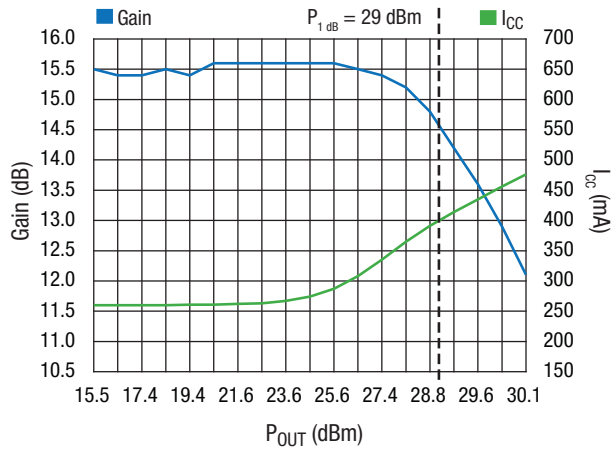
SKY65112 OIP3, V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA, F = 940 MHz, Tone Spacing = 1 MHz



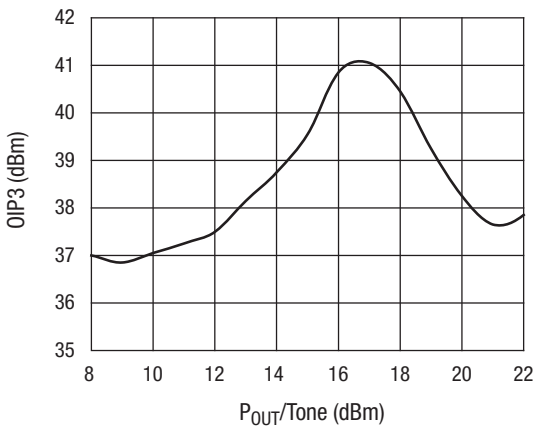
SKY65112 Tuned for 1960–2140 MHz V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA



SKY65112 Gain, I_{CC} vs. P_{OUT} V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA, F = 1960 MHz

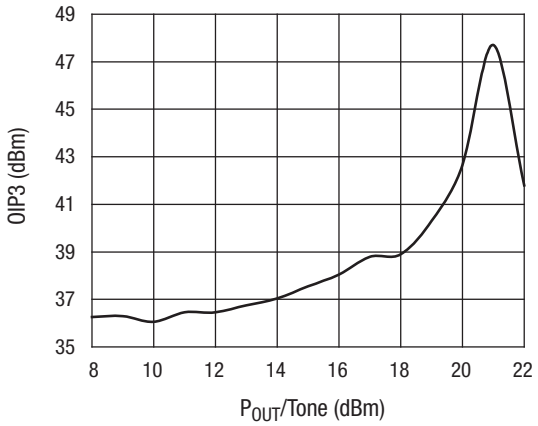


SKY65112 Gain, I_{CC} vs. P_{OUT} V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA, F = 2140 MHz

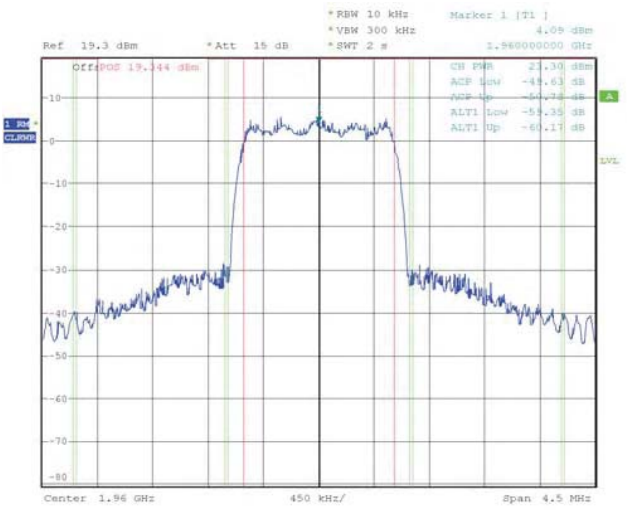


SKY65112 OIP3, V_{CC} = 5 V, I_{CCQ} = 260 mA, V_{REF} = 5 V, F = 1960 MHz, Tone Spacing = 1 MHz

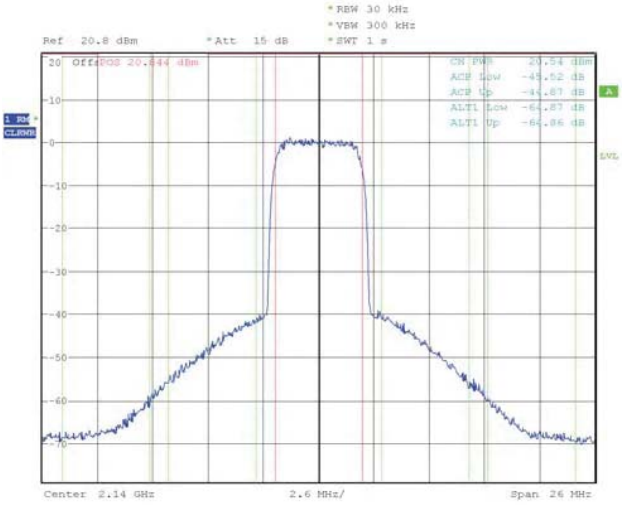
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0024



SKY65112 OIP3, V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA, F = 2140 MHz, Tone Spacing = 1 MHz



SKY65112 IS-95, F = 1960 MHz
V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA,
Clock freq 9.8304 MHz



SKY65112 3GPP WCDMA, F = 2140 MHz
QPSK 45° Offset, Filter Root Cosine,
Roll-off Factor 0.22, Symbol Rate 3.84 Msym/s
V_{CC} = 5 V, V_{REF} = 5 V, I_{CCQ} = 260 mA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0025

Absolute Maximum Ratings

Characteristic	Value
RF input power (P_{IN})	22 dBm
Supply voltage (V_{CC})	8 V
Reference current (I_{REF})	10 mA
Total supply current (I_{CC} + I_{REF})	500 mA
Power dissipation (P_{DISS})	2 W
Case operating temperature[1] (T_C)	-40 to +85 °C
Storage temperature (T_{ST})	-50 to +150 °C
Junction temperature (T_J)	-50 to +150 °C
Thermal resistance (θ_{JC})	42 °C/W

1. Case temperature is defined as the temperature of the surface of the exposed paddle where it is soldered to the printed circuit board ground. This surface must be connected via the lowest possible thermal impedance to an adequate heatsink.

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Technical Description

The SKY65112 is a single stage linear amplifier. The device should be externally matched for optimum gain and linearity using external passive components on the input and on the output ports. These external components allow the amplifier to be optimized for the desired operating frequency.

The RF input is internally connected to pins 2, 3 and 4 via different lengths of bond wire. The inductances produced by these bond wires can be utilized in the impedance matching circuit on the amplifier's input port.

The RF output is internally connected to pins 6 and 7 for current sharing. Both of these pins should be connected externally to the same printed circuit board trace.

The SKY65112 contains a bias circuit for optimum temperature tracking performance. An external resistor is used to set the bias current level. The value of this resistor can be selected to set the amplifier operational mode to Class A, B, or AB, allowing for optimization of linearity and efficiency.

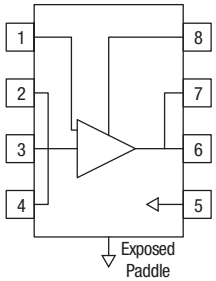
Package and Handling Information

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.

Please refer to Skyworks solder reflow application note, available at www.skyworksinc.com, for instructions on mounting the SKY65112 to a printed circuit board.

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.

Pin Out



Pin Descriptions

Pin No.	Name	Descriptions
1	V_{REF}	Reference voltage input
2, 3, 4	RF_In	RF input
5	GND	Ground
6, 7	RF_Out	RF output
8	V_{CC}	Supply voltage
Backside	GND	Exposed paddle package ground

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0026

Evaluation Board

The SKY65112 Evaluation Board is used to test the performance of the SKY65112 power amplifier driver. Schematic diagrams for evaluation circuits, optimized for output third order intercept (OIP3) are shown below. Evaluation board schematics and bills of materials are shown for GSM operation at 940 MHz and also for DCS/UMTS/CDMA operation near 2 GHz. The mounting footprint for the SKY65112 is shown in the mounting footprint schematic.

The evaluation board also contains a probe fixture section which makes it possible to conveniently measure scattering parameters with ground-signal-ground probes and a vector network analyzer, directly at the input and output pins of the package. Scattering parameters measured in this fixture are available upon request.

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 exposed paddle ground pad of the SKY65112 power amplifier has special electrical and thermal grounding requirements. This paddle 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 power produced to the circuit board. Multiple vias to the grounding layer are required.

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

3. External bypass capacitors are required on the V_{CC} line and on pins 1.
4. Bias resistors R_2 and R_4 and the voltage applied to V_{REF} determine the reference current, I_{REF}, into pin 1. This current controls the supply current through the amplifier stage.

A suggested matching circuit is shown in the evaluation board schematic.

Test Procedure

Use the following procedure to set up the SKY65112 Evaluation Board for testing. Refer to the mounting footprint schematic for guidance:

1. Connect a 5 V supply to V_{CC}. If available, enable the current limiting function of the power supply to 520 mA.
2. Connect a positive supply to V_{REF}.
3. 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.
4. Connect a spectrum analyzer to the RF signal output port.
5. Enable the power supply.
6. Adjust V_{REF} to set supply current (I_{CCQ}) to 260 mA
7. Enable the RF signal.
8. Take measurements.

CAUTION: *If any of the input signals exceed the rated maximum values, the SKY65112 Evaluation Board can be permanently damaged.*

Recommended Solder Reflow Profiles

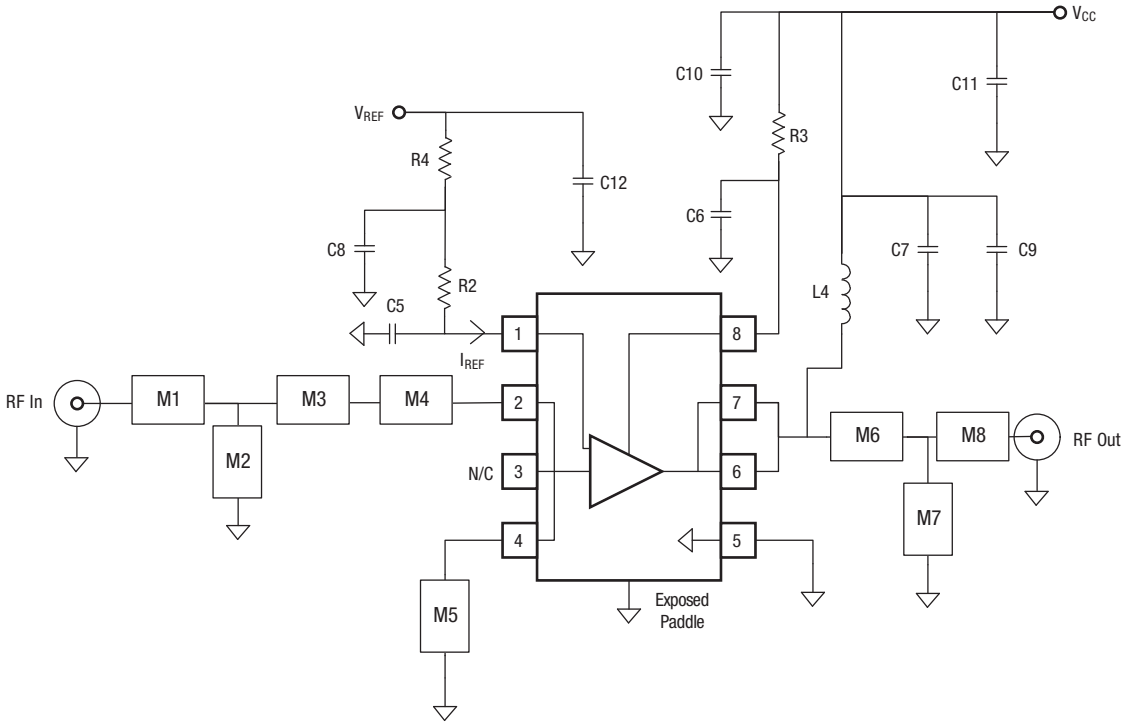
Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0027

Evaluation Board Schematic

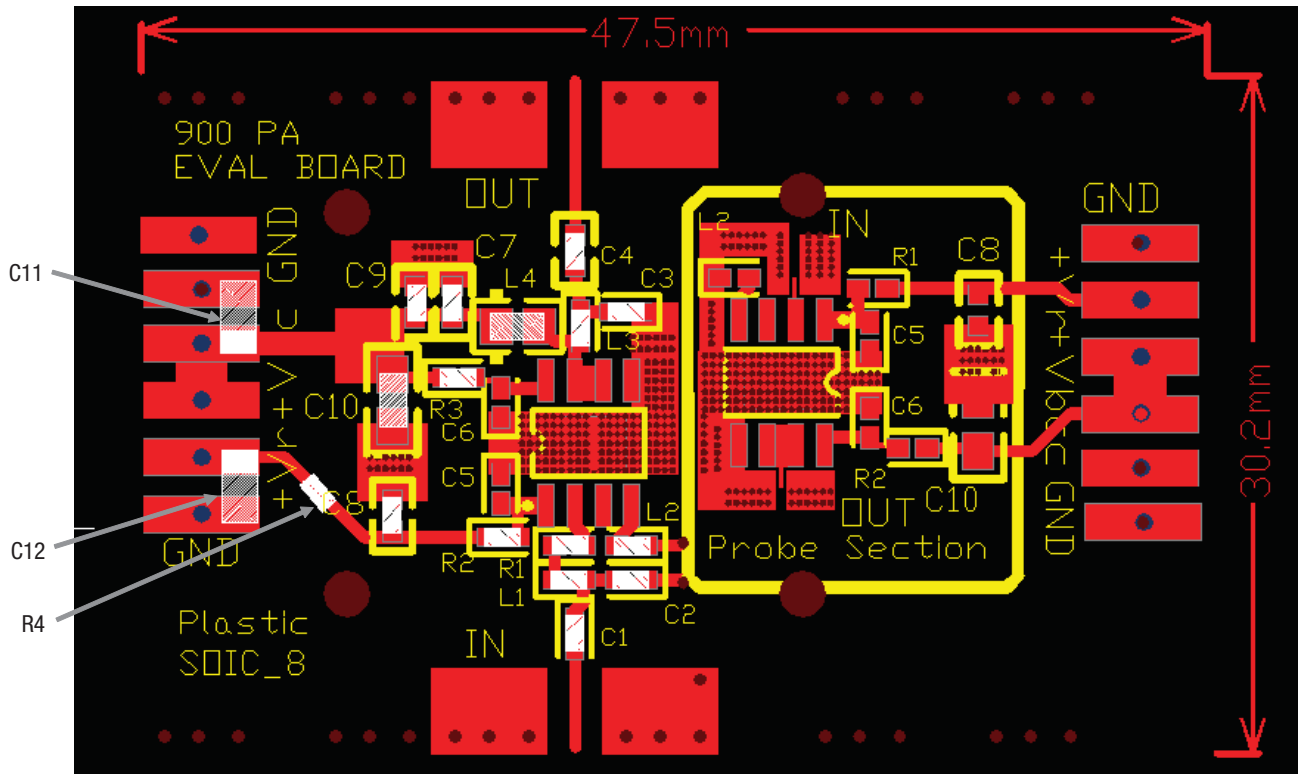


Evaluation Board Component Values vs. Frequency

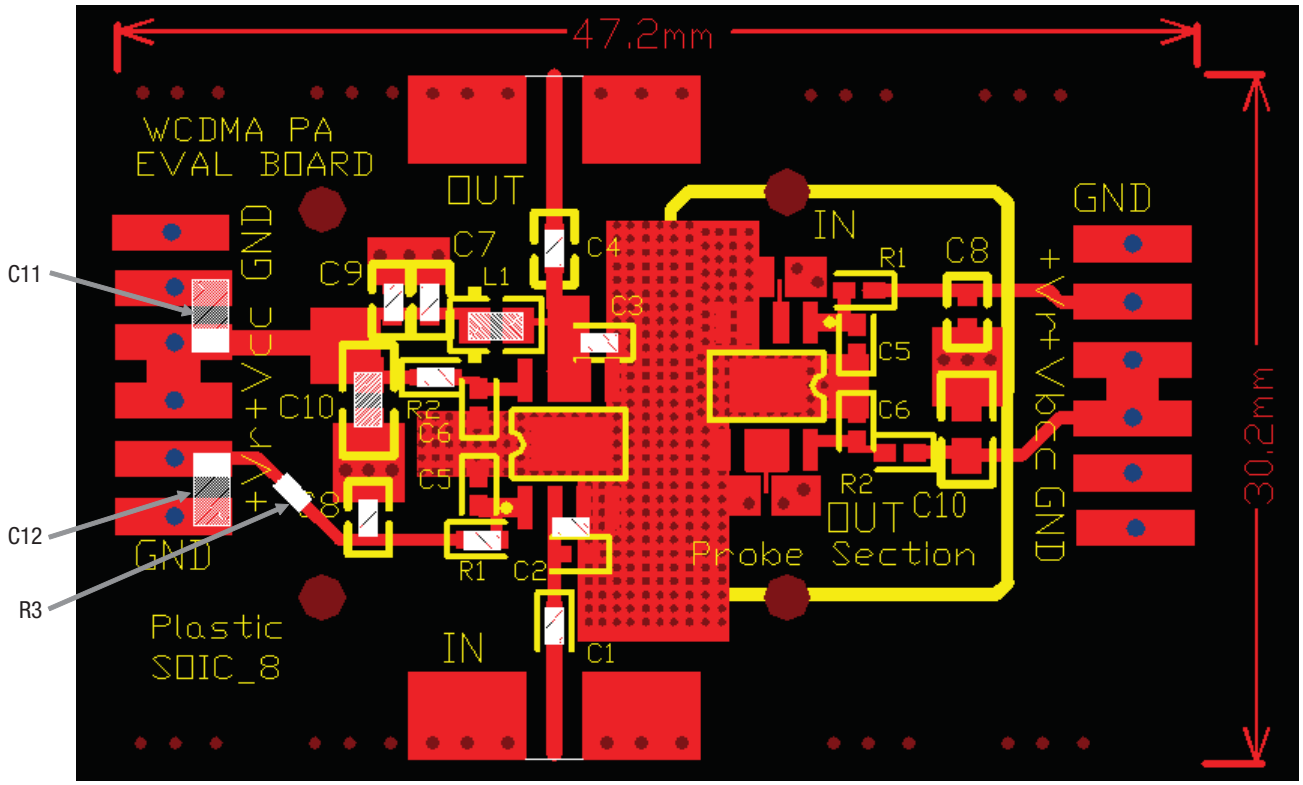
Component	450 MHz	940 MHz	1960 MHz	2140 MHz
R1	NA	NA	51 Ω	51 Ω
R2	51 Ω	51 Ω	51 Ω	51 Ω
R3	51 Ω	51 Ω	1.2 kΩ	1.2 kΩ
R4	1.2 kΩ	1.2 kΩ	NA	NA
L4	82 nH (0805)	82 nH (0805)	47 nH (0603)	47 nH (0603)
C5	NA	NA	NA	NA
C6	NA	NA	NA	NA
C7	100 pF	22 pF	10 pF	10 pF
C8	2.2 µF	0.1 µF	0.1 µF	0.1 µF
C9	2.2 µF	0.1 µF	0.1 µF	0.1 µF
C10	10 µF	2.2 µF	2.2 µF	2.2 µF
C11	10 µF	4 µF	4 µF	4 µF
C12	10 µF	4 µF	4 µF	4 µF
M1	33 nH	10 nH	100 pF	100 pF
M2	4.7 pF	2.2 pF	2.2 pF	2.2 pF
M3	10 nH	15 nH	NA	NA
M4	10 Ω	0 Ω	NA	NA
M5	5.6 nH	1 nH	NA	NA
M6	27 pF	1.5 nH	NA	NA
M7	5.6 nH	10 pF	3.9 pF	3.9 pF
M8	1000 pF	100 pF	100 pF	100 pF

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0028

Test Board Assembly 450, 940 MHz

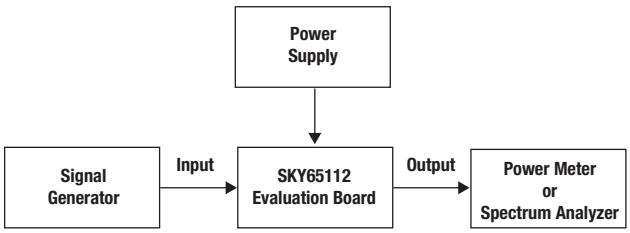


Test Board Assembly 1960, 2140 MHz

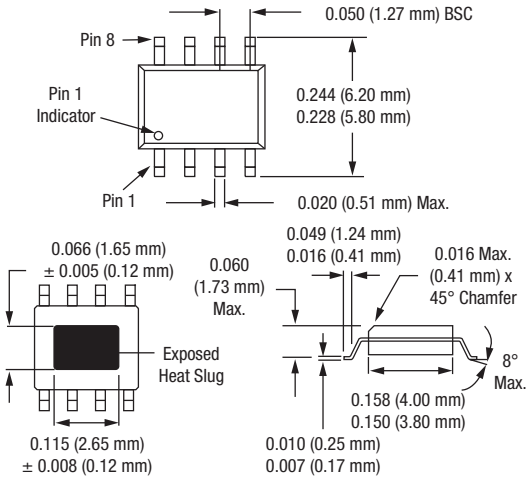


EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0029

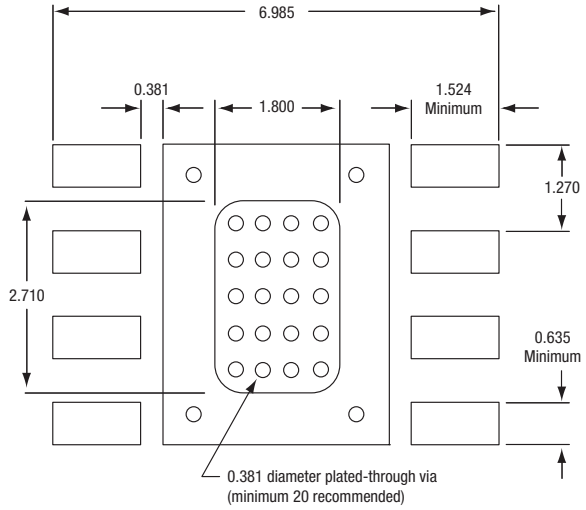
Evaluation Board Test Configuration



SOIC-8



Mounting Footprint



Dimensions in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0030

PRELIMINARY DATA SHEET

SKY73201-364LF, SKY73202-364LF: Programmable 1–28 MHz 6th Order Low Pass Filters

Applications

- High performance direct conversion receivers
- Software defined radio baseband
- High definition television tuners
- Medical imaging
- Flexible anti-aliasing and reconstruction filters

Features

- 6th order Butterworth low pass filter
- Exceptionally high dynamic range
- Auto-calibrated with 20 or 40 MHz clock reference
- Programmable in 1 MHz steps from 1–28 MHz
- Single or dual channel configuration
- Serial bus control
- 5 x 5 mm QFN package
- Lead (Pb)-free, RoHS-compliant, and Green MSL-3 @ 260 °C per JEDEC J-STD-020

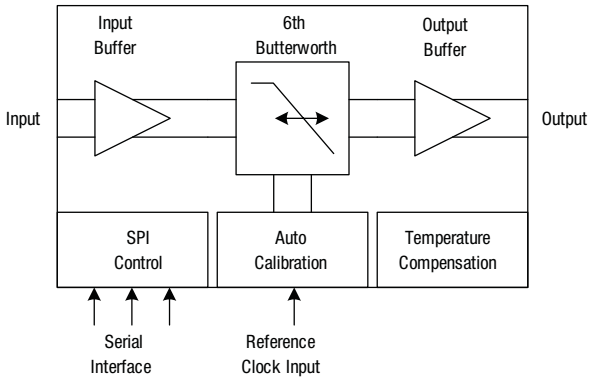
Description

The SKY73201-364LF and SKY73202-364LF are high-performance, programmable, monolithic, clock-referenced low-pass filters. They are configured as a 6th order Butterworth to provide extremely high stop-band isolation while maximizing pass-band flatness and minimizing group delay distortion. The cutoff frequency is programmable in 1 MHz steps, from 1–28 MHz, via the 3-wire Serial Peripheral Interface (SPI). Nearly ideal Butterworth performance is maintained over temperature and process via a proprietary internal cal bration circuit which derives its timing accuracy from a 20 or 40 MHz reference clock.

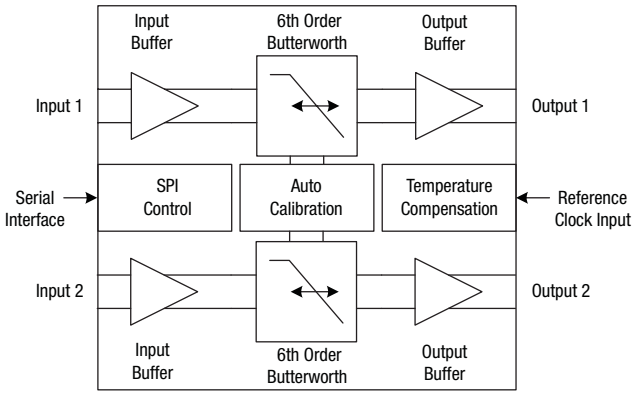
Additionally, the SKY73201-364LF and SKY73202-364LF offer excellent linearity and input noise level (83 dB SNR at 1 MHz corner setting), making them suitable for extremely high-dynamic range applications such as adjacent channel rejection filters in direct conversion receivers. The I/O interface is completely differential, but may also be used single-ended, and on-chip input/output drivers allow easy integration between modern system components such as mixers, data converters, and variable gain amplifiers.

The dual configuration of SKY73202-364LF offers the convenience of having two channels (such as the I and Q in vector demodulation) with closely matched characteristics that track each other. Both filters are programmed to the same settings by the common SPI interface.

SKY73201-364LF Functional Block Diagram



SKY73202-364LF Functional Block Diagram



NEW

Skyworks Green™ products are lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, and are free from antimony trioxide and brominated flame retardants.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0031

Operating Characteristics

V_{DD} = 3.3 V, T = 25 °C, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
DC operating conditions						
Supply voltage			3	3.3	3.6	V
DC current	SKY73201-364LF SKY73202-364LF			32 59		mA mA
Signal performance						
Lowpass filter corner	6-pole Butterworth		1		28	MHz
Lowpass filter step size				1		MHz
Lowpass corner accuracy	Using an accurate 20 or 40 MHz clock reference			1	5	%
Lowpass rejection	Suppression at 2 X (3 dB cutoff frequency)			35		dB
Ultimate rejection level	Measured differentially			80		dB
Lowpass ripple	10 kHz to 0.8 X (3 dB cutoff frequency)				0.5	dB
Lowpass group delay variation(2)	For 10 MHz setting; Over 10 kHz to 0.8 X (3 dB cutoff frequency)				35	ns
Isolation	Between channel 1 and channel 2 (SKY73202-364LF) measured differentially			60		dB
Interface specifications						
Gain	Selectable(1)		0	6		dBv
Input load	Differential		10k, 2			Ω, pF
Input-referred noise	At 6 dB gain setting			25		nV/√Hz
Input common mode voltage range			0.8		2.5	
Input 1dB compression	0 dB gain setting		1.2			V D_{PP}
Input SNR	At 1 MHz corner setting		80	83		dB
Output drive capability(3)	Differential		1000	5000		Ω
Output load capacitance					15	pF
Common mode voltage			1.55	1.65	1.7	V
Output linear signal swing	1 dB compression level; differential		1.2	2.0		V D_{PP}

1. Gain in dBV = $20\log_{10}$ (V_{OUT_RMS}/V_{IN_RMS}), independent of impedance.
2. Group delay scales inverse-linearly with cutoff frequency; average group delay variation = 350 ns/Cutoff_in_MHz
3. You may drive a 50 + 50 Ω load but the voltage gain may be reduced and the signal-linearity may be affected. The overall filter shape should be preserved.
4. The reference clock signal needs to have a duty cycle of 50%.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0032

Absolute Maximum Ratings

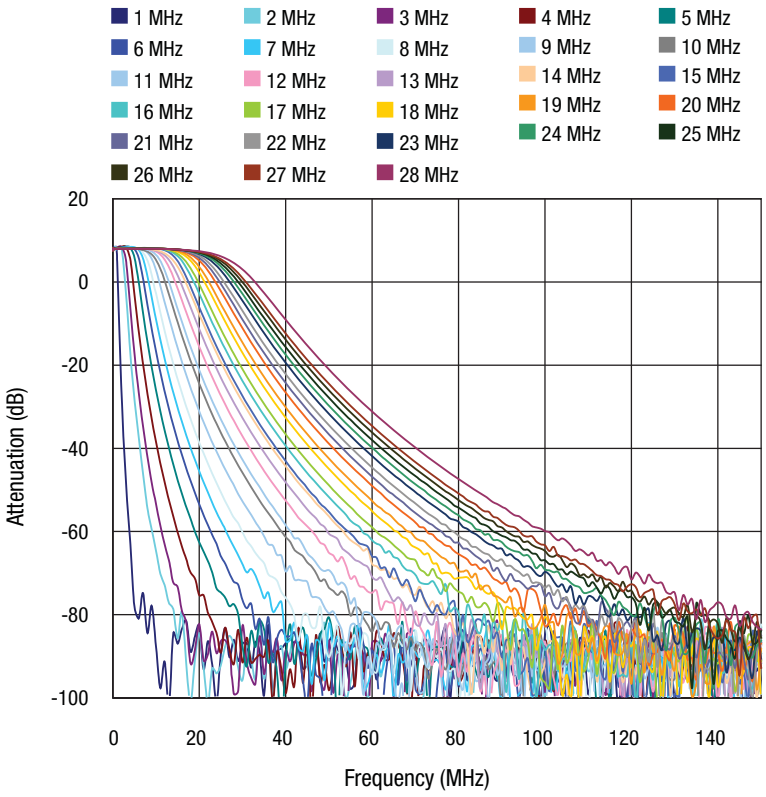
Characteristic	Value
Supply voltage	4.5 V
Supply current	100 mA
Signal input level	3 V_{PP}
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +85 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

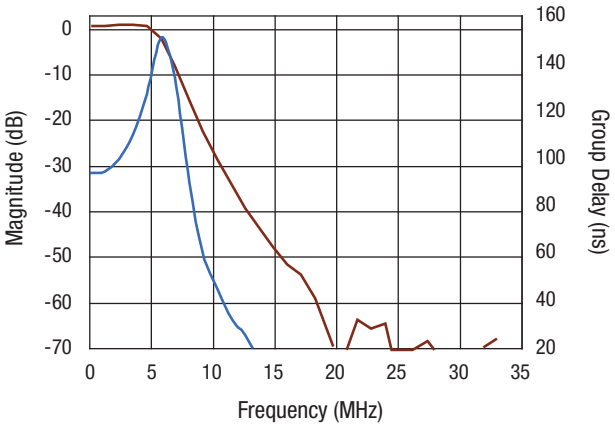
Typical Performance Data

V_{DD} = 3.3 V, T = 25 °C, unless otherwise noted

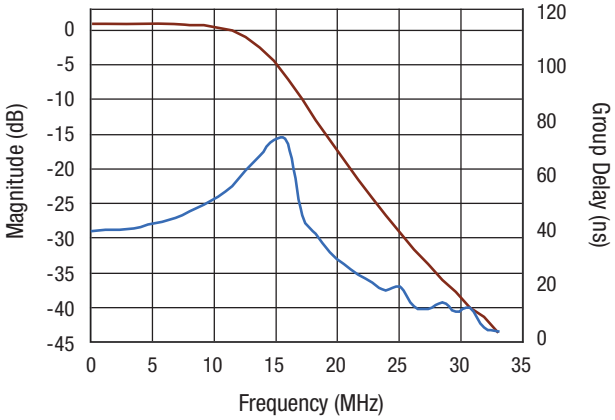


Programmable Filter Amplitude Response

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0033

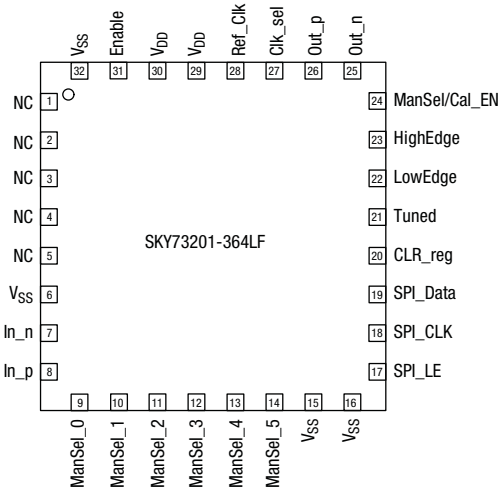


Filter Response with 3 dB Cutoff Tuned to 8 MHz



Filter Response with 3 dB Cutoff Tuned to 14 MHz

SKY73201-364LF Pin Out Diagram



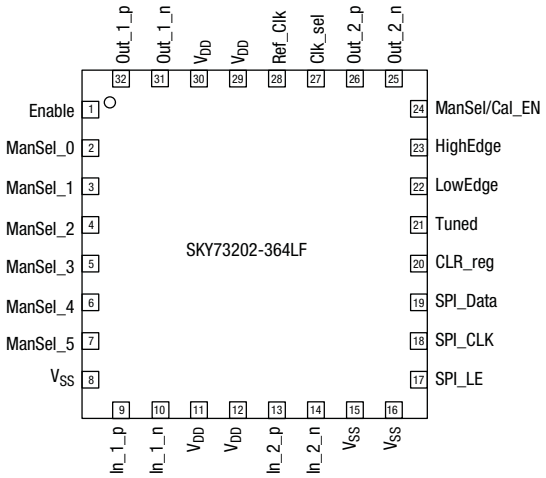
SKY73201-364LF Pin Descriptions

Pin #	Name	Description
1	N/C	No connection
2	N/C	No connection
3	N/C	No connection
4	N/C	No connection
5	N/C	No connection
6	V_{SS}	Ground
7	In_n	Filter input -
8	In_p	Filter input +
9	ManSel_0	Connect to GND in auto tuning mode(1)
10	ManSel_1	Connect to GND in auto tuning mode(1)
11	ManSel_2	Connect to GND in auto tuning mode(1)
12	ManSel_3	Connect to GND in auto tuning mode(1)
13	ManSel_4	Connect to GND in auto tuning mode(1)
14	ManSel_5	Connect to GND in auto tuning mode(1)
15	V_{SS}	Ground
16	V_{SS}	Ground
17	SPI_LE	SPI latch enable (see timing diagram)
18	SPI_CLK	SPI clock Input
19	SPI_DATA	SPI serial data (bi-directional I/O)
20	CLR_reg	Normally set LOW; set HIGH to clear all registers to zero
21	Tuned	Filter tuned indication; HIGH when filter is settled
22	LowEdge	No connect (filter settle error indicator, debug only)
23	HighEdge	No connect (filter settle error indicator, debug only)
24	ManSel/Cal_EN	Manual mode enable/ calibration enable; it is set HIGH for manual mode(1). In automatic mode, it is normally LOW but needs to be toggled HIGH then LOW to start/reset the AutoCal circuit (see timing diagram)
25	Out_n	Filter output -
26	Out_p	Filter output +
27	Clk_sel	Reference clock select; connect to V_{DD} if Ref_Clk is 40 MHz, connect to V_{SS} if Ref_Clk is 20 MHz
28	Ref_Clk	Reference clock; selectable 20 or 40 MHz (needed during calibration only)
29	V_{DD}	Power supply (+3.3 V_{DC})
30	V_{DD}	Power supply (+3.3 V_{DC})
31	ENABLE	Chip enable; chip is enabled when HIGH (V_{DD}), standby mode when LOW (V_{SS})
32	V_{SS}	Ground (GND)
Paddle		Must be connected via lowest possible impedance to ground for proper electrical and thermal performance

1. The manual select pins are for manual fine tuning of the filter corner frequency. Normally these inputs are grounded since tuning is performed by the automatic calibration circuit operating with the reference clock. If the "ManSel" pin (24) is set high, then pins 9-14 would be active to perform fine tuning by the user (but in this case auto cal would not be operational and the filter would not be clock referenced).

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0034

SKY73202-364LF Pin Out Diagram



SKY73202-364LF Pin Descriptions

Pin #	Name	Description
1	ENABLE	Chip enable; chip is enabled when HIGH (V_{DD}), standby mode when LOW (V_{SS})
2	ManSel_0	Connect to GND in auto tuning mode[1]
3	ManSel_1	Connect to GND in auto tuning mode[1]
4	ManSel_2	Connect to GND in auto tuning mode[1]
5	ManSel_3	Connect to GND in auto tuning mode[1]
6	ManSel_4	Connect to GND in auto tuning mode[1]
7	ManSel_5	Connect to GND in auto tuning mode[1]
8	V_{SS}	Ground
9	In_1_p	Filter No. 1 input +
10	In_1_n	Filter No. 1 input -
11	V_{DD}	Power supply (+3.3 V_{DC})
12	V_{DD}	Power supply (+3.3 V_{DC})
13	In_2_p	Filter No. 2 input +
14	In_2_n	Filter No. 2 input -
15	VSS	Ground
16	VSS	Ground
17	SPI_LE	SPI latch enable (see timing diagram)
18	SPI_CLK	SPI clock Input
19	SPI_DATA	SPI serial data (bi-directional I/O)
20	CLR_reg	Normally set LOW; set HIGH to clear all registers to zero
21	Tuned	Filter tuned indication; HIGH when filter is settled
22	LowEdge	No connect (filter settle error indicator, debug only)
23	HighEdge	No connect (filter settle error indicator, debug only)
24	ManSel/Cal_EN	Manual mode enable/ calibration enable; it is set HIGH for manual mode[1]. In automatic mode, it is normally LOW but needs to be toggled HIGH then LOW to start/reset the AutoCal circuit (see timing diagram)
25	Out_2_n	Filter No. 2 output -
26	Out_2_p	Filter No. 2 output +
27	Clk_sel	Reference clock select; connect to V_{DD} if Ref_Clk is 40 MHz, connect to V_{SS} if Ref_Clk is 20 MHz
28	Ref_Clk	Reference clock; selectable 20 or 40 MHz (needed during calibration only)
29	V_{DD}	Power supply (+3.3 V_{DC})
30	V_{DD}	Power supply (+3.3 V_{DC})
31	Out_1_n	Filter No. 1 output -
32	Out_1_p	Filter No. 1 output +
Paddle		Must be connected via lowest possible impedance to ground for proper electrical and thermal performance

1. The manual select pins are for manual fine tuning of the filter corner frequency. Normally these inputs are grounded since tuning is performed by the automatic calibration circuit operating with the reference clock. If the "ManSel" pin (24) is set high, then pins 2–7 would be active to perform fine tuning by the user (but in this case auto cal would not be operational and the filter would not be clock referenced).

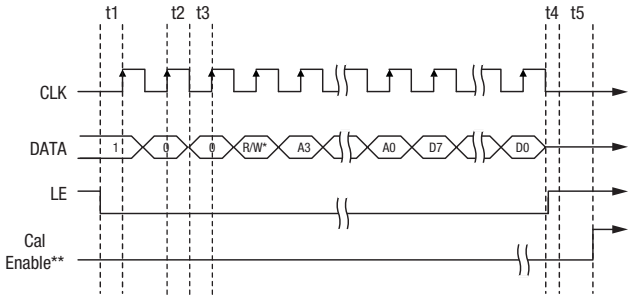
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0035

Serial I/O Interface and Programming Information

Serial Interface (CLK, DATA, LE, CE):

The main control interface is a three-wire bidirectional serial interface. The three write-controls are CLK, DATA_IN and LE. LE is asserted by a rising edge—this allows two modes of operation (see Figure 1).

The serial interface operates as slowly as DC, and as fast as 100 Mbps. The Data signal is latched at each CLK rising edge. The minimum setup time for any control is 5 ns from the CLK rising edge. There are 16 registers, each register containing 8 bits. Figure 1 depicts the timing diagram.



*R/W bit sets direction of data line for serial readback; Read = 0, Write = 1.
**Cal enable line is toggled after all registers are written.
Register readback is optional and is not required in normal application.

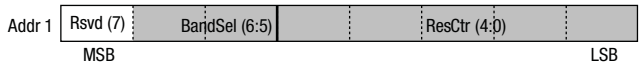
Figure 1. SPI Register Configuration Input Timing Diagram

Parameter	Description	Min	Unit
T1	LE to DATA setup time	5	ns
T2	DATA_IN to CLK hold time	5	ns
T3	DATA_IN to CLK setup time	5	ns
T4	LE Width	10	ns
T5	Calibration enable	10	ns

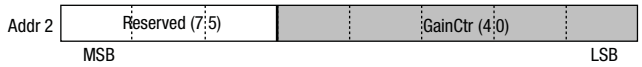
SPI Register Map Detail



ResDacCtr (7:3)	See filter programming table (Address 0 column)
ResSkewCtr (2:0)	See filter programming table (Address 0 column)



Reserved (7)	Set to zeros
BandSel (6:5)	See filter programming table (Address 1 column)
ResCtr (2:0)	See filter programming table (Address 1 column)



Reserved (7)	Set to zero
	See filter programming table (Address 2 column)
GainCtr (4:0)	See filter programming table; Sets filter gain=2*(GainCtr/ResCtr)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0036

6 dB Gain Configuration Register Lookup Table

3 dB Cutoff (MHz)	Address 0 (Hex)	Address 1 (Hex)	Address 2 (Hex)
1	0F	01	01
2	17	02	02
3	1F	03	03
4	27	04	04
5	2F	05	05
6	37	06	06
7	3F	07	07
8	47	08	08
9	4F	09	09
10	57	0A	0A
11	64	0C	0C
12	6C	0D	0D
13	75	0E	0E
14	7D	0F	0F
15	80	10	10
16	88	11	11
17	90	12	12
18	A4	14	14
19	AC	15	15
20	B5	16	16
21	BD	17	17
22	C5	18	18
23	CD	19	19
24	DC	1A	1A
25	E4	1B	1B
26	EC	1C	1C
27	F4	1D	1D
28	F0	1E	1E
660 kHz (uncalibrated)	10	62	02
330 kHz (uncalibrated)	08	61	01

0 dB Gain Configuration Register Lookup Table

3 dB Cutoff (MHz)	Address 0 (Hex)	Address 1 (Hex)	Address 2 (Hex)
1	0F	01	tbd
2	17	02	01
3	1F	03	tbd
4	27	04	02
5	2F	05	tbd
6	37	06	03
7	3F	07	tbd
8	47	08	04
9	4F	09	04
10	57	0A	05
11	64	0C	06
12	6C	0D	07
13	75	0E	07
14	7D	0F	08
15	80	10	08
16	88	11	08
17	90	12	09
18	A4	14	0A
19	AC	15	0B
20	B5	16	0B
21	BD	17	0C
22	C5	18	0C
23	CD	19	0D
24	DC	1A	0D
25	E4	1B	0E
26	EC	1C	0E
27	F4	1D	0F
28	F0	1E	0F
660 kHz (uncalibrated)	10	62	01
330 kHz (uncalibrated)	TBD	TBD	TBD

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0037

SKY73201-364LF/SKY73202-364LF Example Code

Bit 0	SPI_CLK
Bit 1	SPI_DATA
Bit 2	SPI_LE
Bit 3	CLR_Reg

C Code Listing

```
/* this is the SPI write function */
/* all variables are global  8-bit, unsigned */

void spi_write(void)
{
 PORTA &= ~0x08; /* drop clear_reg */
 PORTA &= ~0x04; /* drop Latch Enable */
 for (k=0; k<length; k++)
  {
   for(j=0; j<8; j++)
      {
      for(cphase=0; cphase<2;cphase++)
        {
       out_word=0;
       out_word= ((((( _BV(7-j)&spi_word[k]))&&1)<<1) | cphase) ;
       /*  _BV(n) is equivalent to (1<<n)  */
       PORTA=out_word;
         }
      }
  }
 PORTA &= ~0x01;  /*drop Clock*/
  for(r=0; r<254; r++)
   {
   dummy=r+1;
   }
 PORTA |= 0x04;  /*Raise Latch Enable*/
 }

void write_registers(void)
{
length=2;
spi_word[0]=0x90;   /*address 0 */
spi_word[1]=0x10;
spi_write();

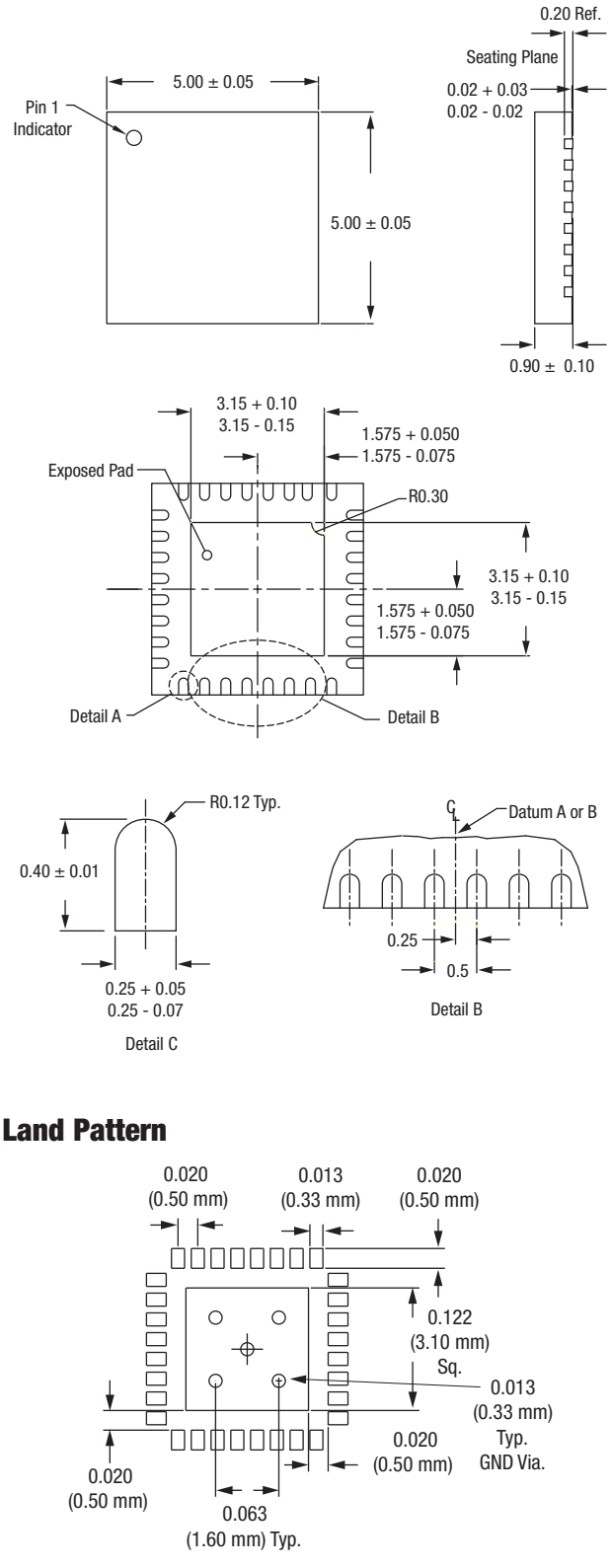
spi_word[0]=0x91;  /*address 1 */
spi_word[1]=0x04;
spi_write();

spi_word[0]=0x92;   /*address 2 */
spi_word[1]=0x24 ;
spi_write();

}

int main (void)
{
Write_registers();
}
```

QFN 5 x 5 (-364)

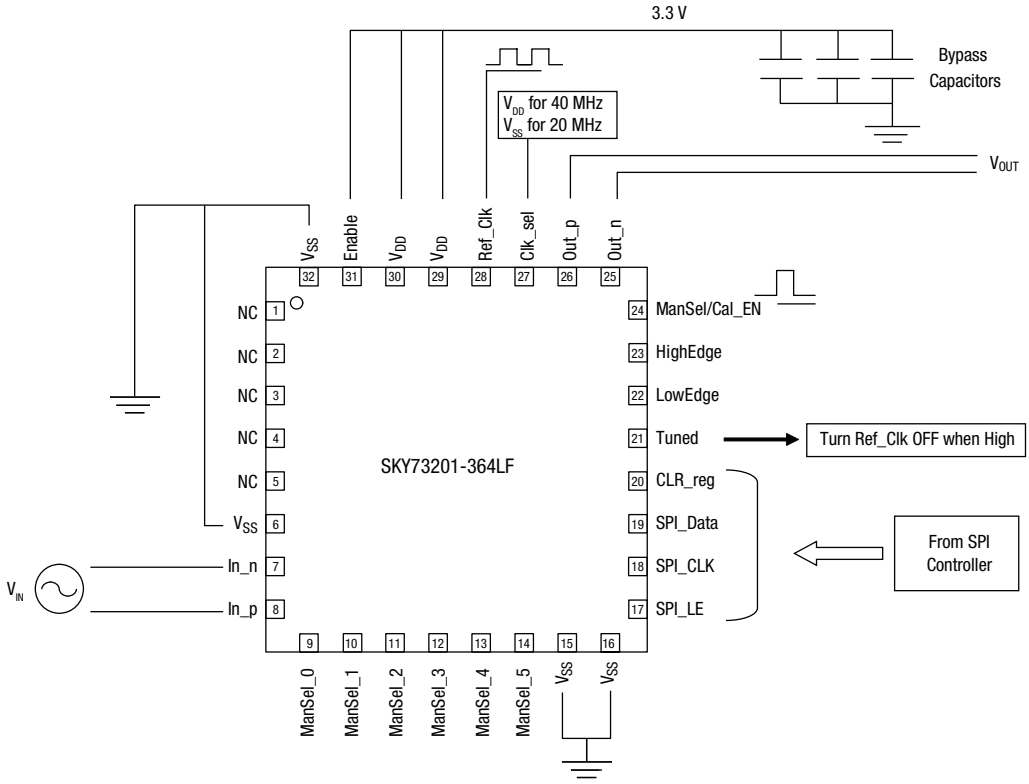


Land Pattern

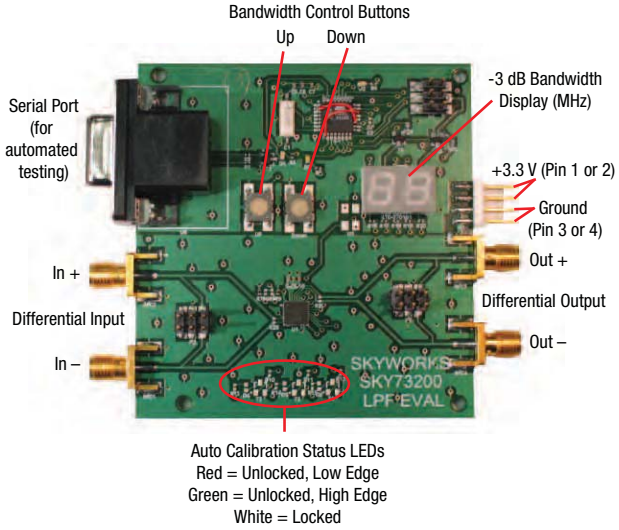
QFN 32-Lead 5 x 5 mm (-310, -364)
Surface Mount Land Pattern

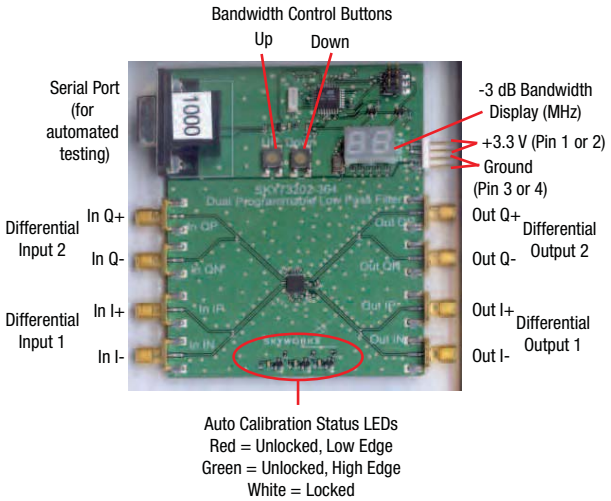
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0038

Basic Application Diagram



Evaluation Board (With On-Board Micro-Controller)





EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0039

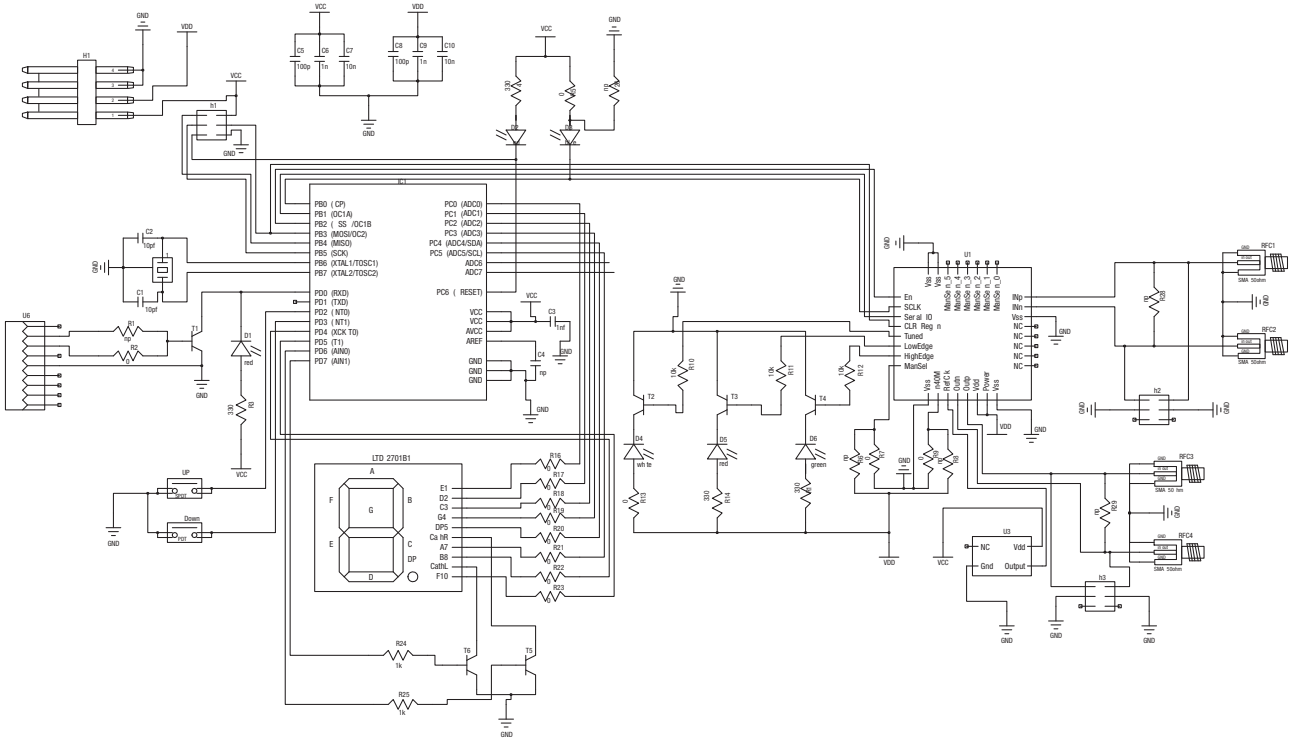
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

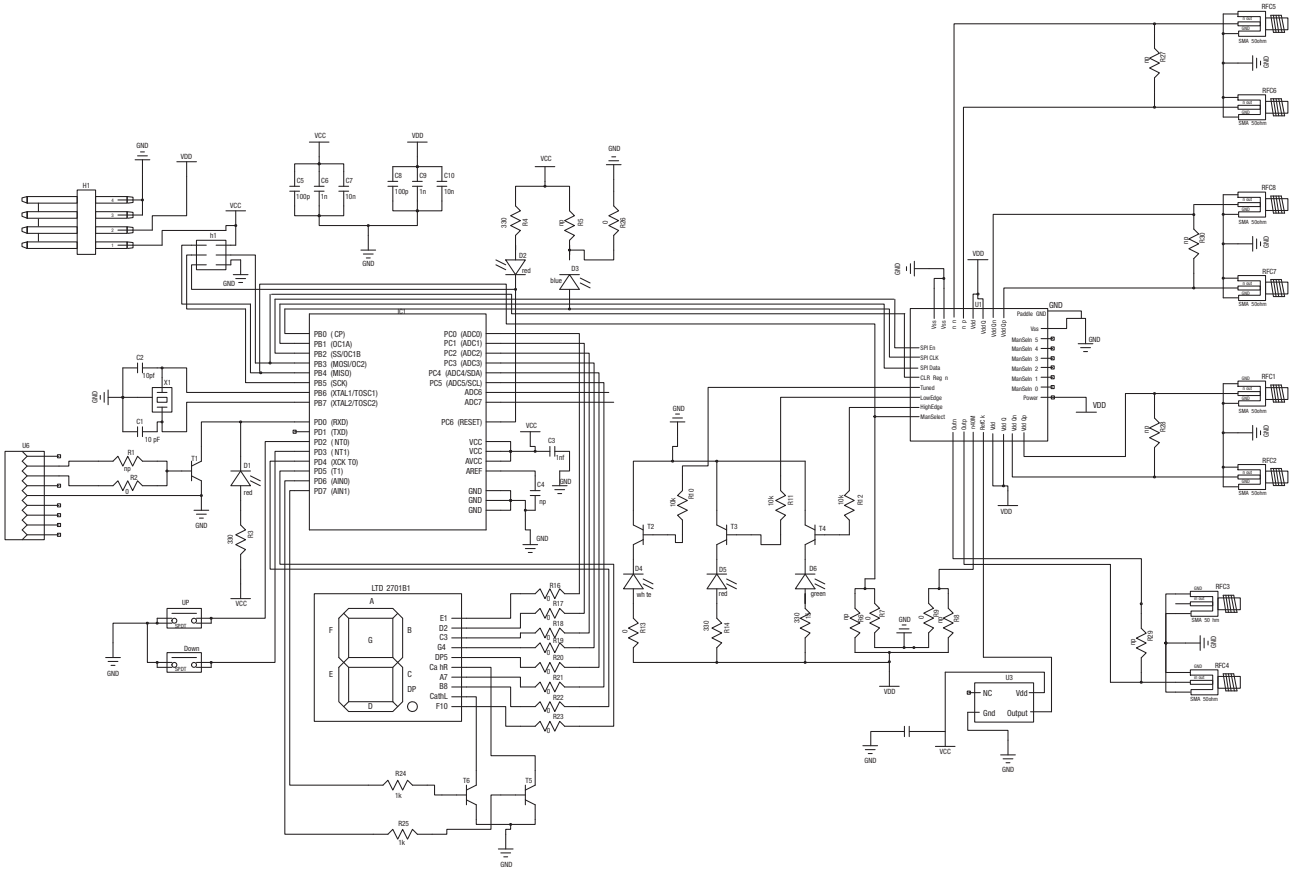
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

SKY73201-364LF Evaluation Circuit Schematic

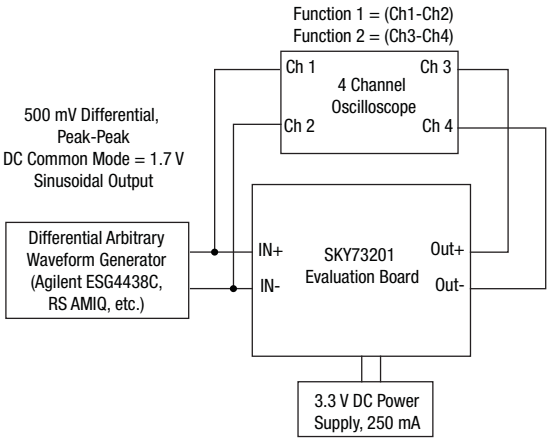


EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0040

SKY73202-364LF Evaluation Circuit Schematic

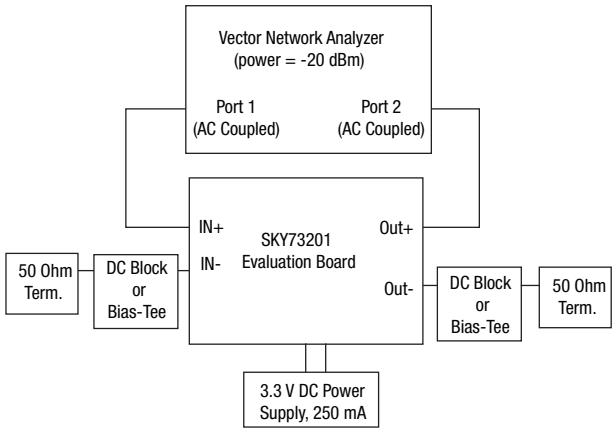


Fully Differential Test Configuration



Single-Ended Test Configuration

This set-up uses conventional RF test equipment (RF signal generator and spectrum analyzer may be used instead of VNA).



Note: DC blocks and terminations are placed on unused differential ports.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0041

Application Notes

Demonstration Board Operating Instructions

1) Connect 3.3 V power supply to 4 pin edge connector. Pins 1 and 2 (the top two pins) are shorted together and are both 3.3 V. Pins 3 and 4 (the bottom two pins) are ground. Normal current consumption is about 70 mA (includes the microcontroller, TCXO, and LEDs)
2) The LED display should display "- -". Press "UP" or "DOWN" button to set a filter state. The LED display shows the frequency in MHz. The three LEDs on the very button of the board indicate the filter's internal auto calibration status. Since the 300 kHz and 600 kHz states are not clock referenced, the red LED should light. The white LED will light for all other states.
3) Apply either a differential or a single-ended input waveform (as shown above), and observe the result at the output. Differential waveforms should be about 500 mV differential peak-to-peak with a common mode DC offset of about 1.7 V. Single-ended waveforms should be AC-coupled (using a DC block or bias-tee), where the unused input/output ports are AC coupled to a termination (usually 50 Ω). Arbitrary waveform generators, function generators, oscilloscopes, spectrum analyzers, and vector network analyzers are all acceptable test instruments.

Optimizing Performance on Demonstration Boards

On the demonstration boards, a microcontroller and a reference clock and a frequency readout are provided for convenience in programming the device. In the current sample demonstration boards, the reference clock and the microcontroller clock are active continuously. In applications demanding high signal purity, various methods are used to reduce the possibility of clock noise adding to the signal chain. To test the device without the reference clock and the other active circuits such as the microcontroller and the display, the following procedure is recommended:

1) Un-short the top two pins of the dc power connector (there is a piece of wire soldered across these two pins on the PCB),
2) Connect two separate 3.3 V supplies to these two pins—the top pin powers the microcontroller and the clock; the second pin is for the filter,
3) Set the filter to the desired cut-off setting (the white LED indicates that the filter is tuned),
4) Disable the power supply connected to the top pin—this will disable the microcontroller and the clock, but the filter will hold the correct state,
5) In this configuration, any possible spurs due to clock signals will not interfere with the measurements.

Programming and Calibration Procedure and Intervals

Register configuration time: This operation may take up to 50 SPI clock cycles to complete (the SPI clock may be up to 100 MHz).

Automatic calibration: After the registers have been written, the Cal_EN line is toggled (i.e. raised high and then low). The auto cal starts when the signal goes from high to low.

During this process, the (20 MHz) reference clock needs to be present to provide the timing information. The calibration process may take up to 50 reference clock cycles. When calibration is complete, the "Tuned" pin will go high, indicating that the calibration is complete. After this point, the reference clock is not needed and may be gated off. This is preferred in applications where possible spurs related to the clock and its harmonics may cause undesired degradation of the signal.

For devices used in the auto tuning mode, the ManSel_0 through ManSel_5 pins should be grounded (not left floating).

Set-up time: As an approximate example of total set-up time, if the SPI clock is also selected to be 20 MHz, then the entire filter corner set & cal procedure may take up to 5 µs (corresponding to 50 + 50 = 100 clock cycles).

Manual calibration: After the registers are configured, the device may also be calibrated (fine-tuned) manually through the use of the ManSel pins. In the manual tuning mode (which is activated by setting the ManSel pin high), the ManSel_0 through ManSel_5 pins are connected to the controller. For more details on this mode of operation, please consult Skyworks.

General Layout Recommendations:

1) Keep all analog traces differential (equal length, no ground in between)
2) Place a lot of vias on the outside of the differential pairs (but not between the differential lines)
3) Route all other traces perpendicularly across the differential pair, and never between the analog lines and their ground reference
4) Locate all decoupling caps as close to the device as possible, place many ground vias on the caps
5) Place as many ground vias under the filter paddle as possible.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0042

Reference Clock Selection

For best filter corner accuracy, a clock that is crystal-based (as opposed to ceramic), with an accuracy better than 1000 ppm over temperature, aging, and process is recommended. The clock input to the SKY73202-364LF/SKY73202-364LF is CMOS logic (threshold approx. 1.7 V) so most clocks that operate on a 3.3 V supply should be compatible. In addition, the duty cycle of the clock affects filter corner accuracy. The closer the duty cycle is to 50%, the more accurate the filter corner setting.

Output Drive Capability

The SKY73202-364LF and SKY73202-364LF have op-amp based output drivers, whose effective source impedance is in the few 10s of Ω range. While it is intended to drive a high impedance data converter or a PGA, it can also drive a 100 Ω differential load (or a 50 Ω single-ended load). Please note that the gain values that are specified in the data sheet are based on specified (high) input and output impedances. If a low impedance output load is used, the gain will be slightly lower than specified.

Filter Gain Setting

The SKY73201-364LF allows a certain amount of adjustment over its gain in addition to the ability to set the 3-dB cut-off frequency for fine-tuning the filter gain.

The gain may be controlled by setting five of the bits (bits 4, 3, 2, 1, 0) in Address2 of the register map. Then the gain is a linear ratio expressed in terms of the values set by these bits and those in Address1 that are used to set the filter cut-off:

$$\text{Gain} = 2 \bullet \frac{\text{Address2<4:0>}}{\text{Address1<4:0>}} = 2 \bullet \frac{\text{SPI\_bits<20:16>}}{\text{SPI\_bits<12:08>}}$$

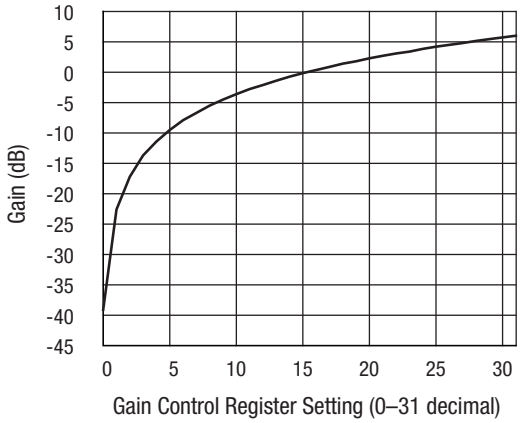
Note: For the linear gain calculation, please use the decimal equivalents of the binary representations in the above ratio.

The configuration procedure would typically involve determining the appropriate values for the desired corner frequency (from register configuration tables) and then modifying the bits in address2 for the desired gain and then writing the final sequence into the SKY73201-364LF through the SPI port.

Example (For a 14 MHz filter cutoff setting):

Gain	Address0	Address1	Address2
6 dB	7D	0F	0E
3 dB	7D	0F	0B
0 dB	7D	0F	08

As an example, the effect of the gain control bit settings (in Address 2<4:0> of the register map) at the 28 MHz corner setting is shown in the plot below (The 0 setting corresponds to open circuit and all 1's setting corresponds to maximum gain.)



SKY73201-364LF Gain vs. Register Setting

Input and Output Interface and Common Mode Voltage

At the input, the common mode voltage needs to be supplied by the previous device interfacing into the filter. At the output, the filter biases itself to a common mode voltage that is half of the Vcc. (e.g. 3.3/2 = 1.65 V. The output common mode setting is independent from the input. But the differential mode will pass through the filter (amplified, if it is set to have gain).

The device can drive a minimum of 1 kΩ (500 Ω each arm). This accommodates a majority of data converters in the market.

If the device immediately before the programmable filter has a different common mode voltage (e.g. 3.5 V from a 5 V device), then a matching network may be used to convert the 3.5 V offset to 1.65 V. This may be done with two series resistors into the + and – arms and a shunt resistor between the two. (Shunt resistor value of the order of 1 kΩ). You should be careful about the values of the resistors so as not to add extra noise at the input and degrade the input referred noise of the device. (The input referred noise is specified assuming 1–2 kΩ input loading resistors.)

Single-Ended to Differential Configuration

To use the programmable filter with a single input signal and a differential output signal, simply apply the single ended input signal to one of the input ports and apply a DC midpoint voltage (equal to the average level of the signal) to the other input port.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0043

Interfacing to the SKY73201-364LF and SKY73202-364LF Filters

Figure 1 shows a simplified schematic of the inputs to the SKY73201-364LF filter. The input stage is a 2-stage op-amp with bipolar input, which implies that the preceding stage must supply base current and a common-mode voltage. We suggest a common-mode base voltage of 1.65 V be applied to the inputs. Any external resistance in series with pins 7 and 8 will reduce the gain of the filter. (The same recommendations apply to the inputs of the SKY73202-364LF filter.)

Figure 2 shows a simplified schematic of the output buffer of the SKY73201-364LF. The device generates a common-mode voltage of 1.65 V at the output and the output buffers are designed to drive a minimum of 5 kΩ impedance. If the device is loaded with a resistance lower than 5 kΩ, it will cause loss in signal swing, which may reduce the gain and affect the signal-linearity. (The same recommendations apply to the SKY73202-364LF filter.)

If the stage following the SKY73201-364LF or SKY73202-364LF requires a common-mode voltage that is lower or higher than 1.65 V, the new common-mode voltage can be established by simple resistive-division. Figure 3 shows a simple application circuit in which the SKY73201-364LF filter is used to drive a 1.8 V data converter with an input common mode voltage of 0.9 V. It is important to design adequate supply bypassing by means of bypassing capacitors as any noise coupled into the device may affect the corner frequency accuracy. The exact values of the bypass capacitors will depend on the application environment.

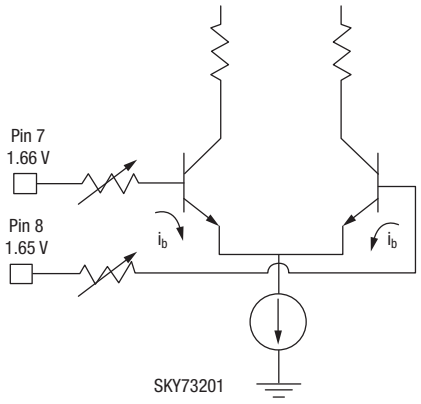


Figure 1. Simplified Schematic of Input

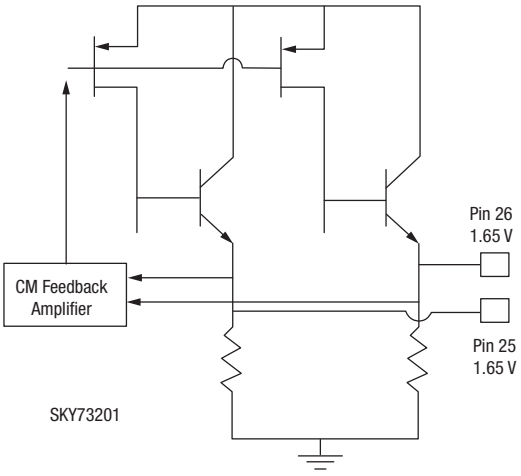


Figure 2. Simplified Schematic of the Filter Output

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0044

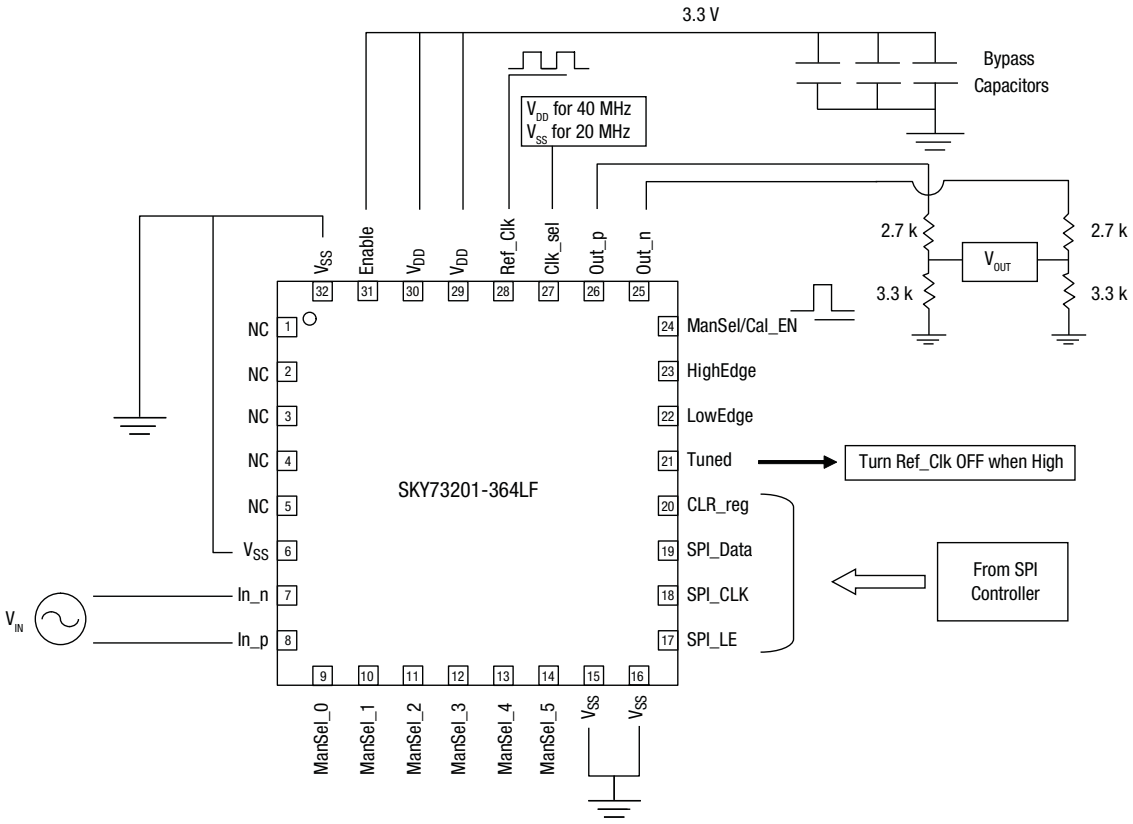


Figure 3. SKY73201-364LF Application Circuit with 0.9 V Output Common-mode Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0045

DATA SHEET

HY86-12, HY86-12LF: 90-Degree Hybrid 0.82–0.90 GHz

Features

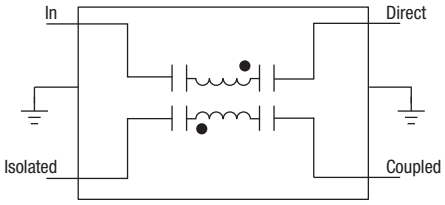
- Low cost
- Low profile
- Small SOIC-8 package
- Available on tape and reel
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The HY86-12 is a 90-degree hybrid tuned for the 0.82–0.90 GHz band. The monolithic circuitry is 100% passive and offers low loss, high isolation and exceptional phase/amplitude balance. It is available in the SOIC-8 surface mount package.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Block Diagram



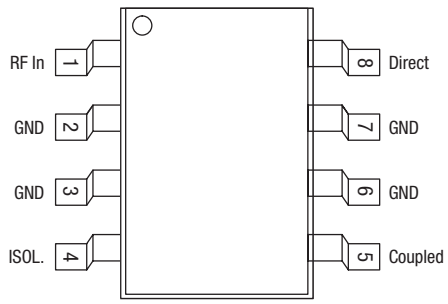
Electrical Specifications at 25 °C

Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Frequency		0.82		0.9	GHz
Insertion loss[1]			0.4	0.5	dB
Isolation		25	30		dB
VSWR all ports			1.15:1	1.2:1	
Amplitude balance			±0.5	±0.8	dB
Phase balance			±1	±2	Deg.

1. Less 3 dB power split.

Pin Out



The Pin Out diagram shows the HY86-12 configured for a Divider/Coupler with Pin 1 as the input port and a 50 Ω termination to be placed at Pin 3. Since the HY86-12 is symmetric, any nonground pin may be used as the input port. The following table shows the possible pin connection combinations for the HY86-12 used as a divider/coupler:

Input	Termination	Direct	Coupled
Pin 1	Pin 4	Pin 8	Pin 5
Pin 4	Pin 1	Pin 5	Pin 8
Pin 5	Pin 8	Pin 4	Pin 1
Pin 8	Pin 5	Pin 1	Pin 4

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0046

DATA SHEET

SKY65227-11: WLAN 802.11n Single Band 2.4 GHz MIMO Intera™ Front-End Module

Features

- Two full 2.4 GHz transmit/receive chains
- PCIe, miniPCI, Cardbus and Access Point applications
- Backward-compatible with 802.11b/g standards
- Pin compatible with SKY65225-11 (2.4 GHz)
- P_{OUT} @ 2.5% EVM: 19 dBm (-11b); 19 dBm (-11g)
- Gain matching: < 1.0 dB
- Internal voltage regulation
- Single 3.0–3.6 V power supply
- Temperature-compensated PA bias networks and directional power detection
- Separate digital controls for each PA
- Package size: 10 x 14 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant MSL-3 @ 250 °C per JEDEC J-STD-020

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

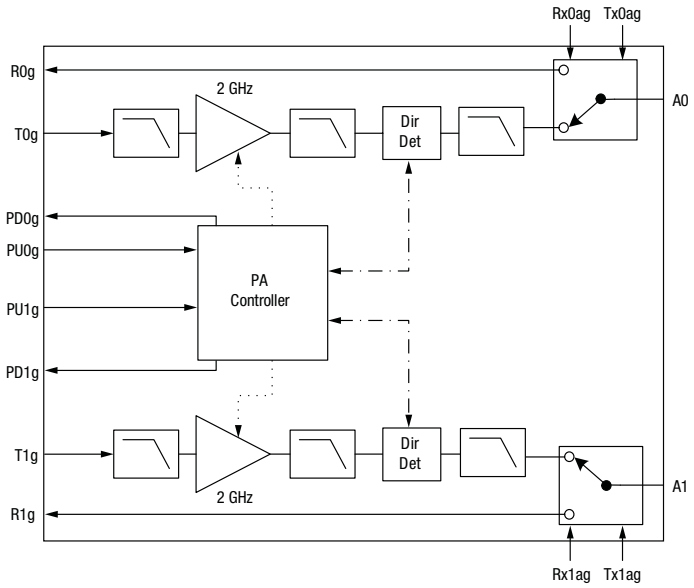
Description

The SKY65227-11 Intera nFEM contains two complete 2.4 GHz transmit/receive chains in one compact RF front-end module optimized for single band 2.4 GHz MIMO (multiple in—multiple out) operation, in compliance with the 802.11n draft standard. The SKY65227-11 includes two 2 GHz PAs with integrated input filtering for 3–4 GHz rejection, and temperature-compensated, directional power detector with 20 dB dynamic range. Also included are low loss, high rejection GaAs harmonic filters and T/R switches which provide high linearity in all transmit paths and low loss in all receive paths.

The SKY65227-11 Intera nFEM achieves outstanding gain matching which is a critical requirement for MIMO operation. This is accomplished though mirrored layout symmetry.

The SKY65227-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 140 mm^2. This FEM is designed as a pin to pin compatible version of the SKY65225-11 for 2.4 GHz only.

Functional Block Diagram



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0047

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC}		-0.3		5.5	V
PU0g, PU1g	PU		-0.3		5.5	V
T0g,T1g	RFin				10	dBm
Operating temperature range	T_{OP}		0		85	ºC
Storage temperature range	T_{STO}		-65		125	ºC\
Moisture sensitivity level	MSL-3				250	°C
Thermal resistance	θ_{JC}				55	°C/W

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		3	3.3	3.6	V
Operating Temperature	T_{OP}		0	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current, T0g or T1g	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, PU0g or PU1g = 3.3 V PU0a or PU1a = 0 V		190		mA
Total 802.11g Tx quiescent current, T0g or T1g	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current, T0g or T1g	I_{CC}-b	P_{OUT} = 18 dBm, 11 Mbps CCK PU0g or PU1g = 3.3 V PU0a or PU1a = 0 V		190		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic high voltage for PU0g, PU1g, (Tx On)			2		V_{CC}	V
Logic low voltage for PU0g, PU1g, (Tx Off)			0		0.5	V
Input current logic high voltage for PU0g, PU1g				100	200	µA
Input current logic low voltage for PU0g,PU1g				0.2		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0048

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	V_{CTL}_on		3	3.3	3.6	V
Control voltage - OFF state	V_{CTL}_off		0		0.2	V
Control current - ON state	I_{CTL}_on	RF ON		10	75	uA
Control current - ON state	I_{CTL}_on	RF OFF		2	20	uA

Mode Control Voltage Table (V)

Mode	V_{CC}	PU0g	Rx0g	Tx0g	PU1g	Rx1G	Tx1g
Sleep	3.3	0	0	0	0	0	0
T0g - ANT0	3.3	3.3	0	3.3	0	0	0
R0g - ANT0	3.3	0	3.3	0	0	0	0
T1g - ANT1	3.3	0	0	0	3.3	0	3.3
R1g - ANT1	3.3	0	0	0	0	3.3	0
802.11n Operation							
T0g - ANT0 & T1g - ANT1	3.3	3.3	0	3.3	3.3	0	3.3
R0g - ANT0 & R1g - ANT1	0 or 3.3	0	3.3	0	0	3.3	0

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0049

802.11b,g Transmit Specifications (Tx Chain 0, Tx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		19		dBm
Compliant output power - b	P_{OUT}_b	11 Mbps CCK		19		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\|S_{21}\|$			25		dB
Small signal gain variation over frequency band	$\Delta\|S_{21}\|$			1	2.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\|S_{21}\|$ - M	Compared frequency by frequency		1		dB
Gain, 3.2–3.3 GHz	$\|S_{21}\|$ - 3.2			-2	3	dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output			500	ns
Input return loss	$\|S_{11}\|$	T0g or T1g		-10		dB
Output return loss	$\|S_{22}\|$	A0 or A1		-8		dB
Isolation between T0g and A1	ISO-A1	CW power into T0g and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1g and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications (Rx Chain 0, Rx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables & Tx control voltages = 0 V. Rx0ag or Rx1ag = 3.3 V. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\|S_{21}\|$			1.5	2.0	dB
Input/output	$\|S_{11}\|$, $\|S_{22}\|$	R0g or R1g, A0 or A1		-15		dB
Insertion loss delta	$\|\Delta S_{21}\|$	A0 to R0g and A1 to R1g			0.5	dB
Ant. isolation	ANT_ISO	A0 to R0g and A1 to R1g		25		dB
TR isolation	TR_ISO	Transmit A0 or A1, measure R0g or R1g		24		dB

802.11b,g Power Detector Specification

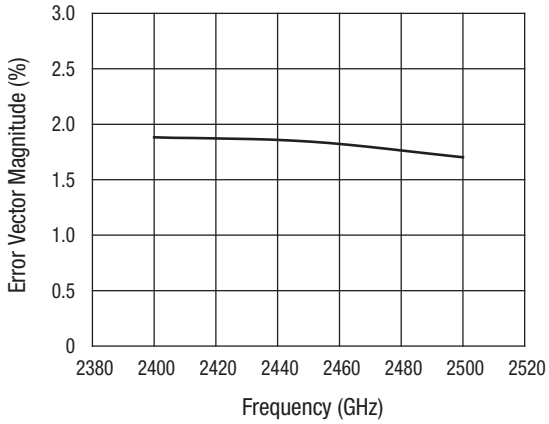
Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PU0g and Tx0ag or PU1g and Tx1ag = 3.3 V. RX0ag or RX1ag = 0 V. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		1		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF			0.85		0.95	V
Output voltage, 20 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

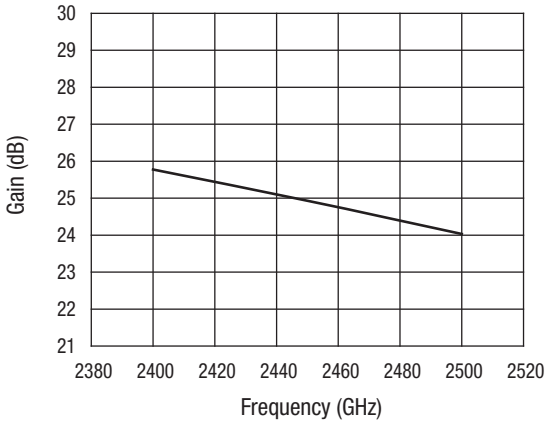
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0050

Typical Performance Data (2.4–2.5 GHz)

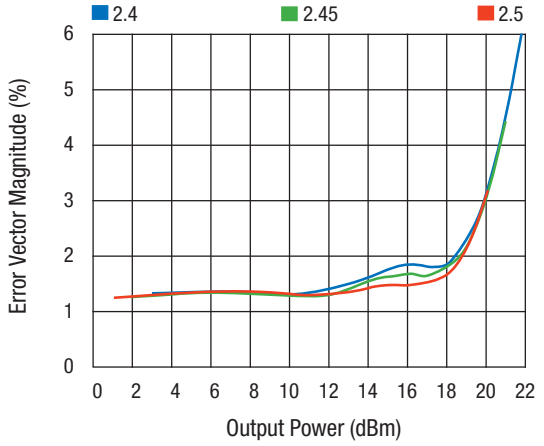
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_O = 50 Ω, unless otherwise noted



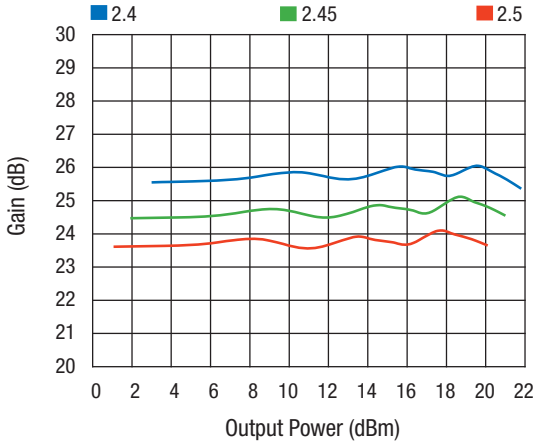
EVM vs. Frequency



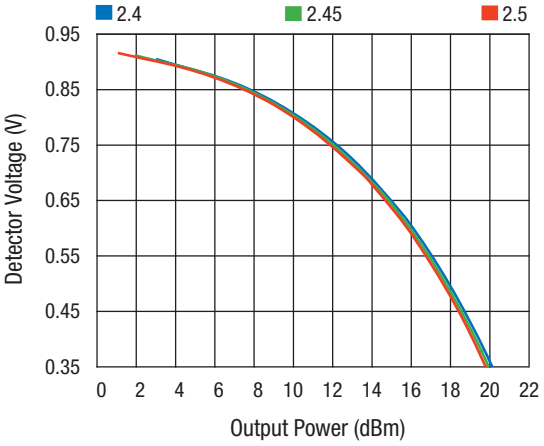
Gain vs. Frequency



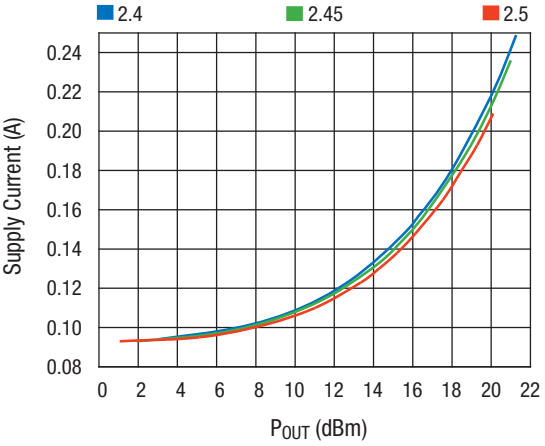
EVM vs. Output Power



Gain vs. Output Power



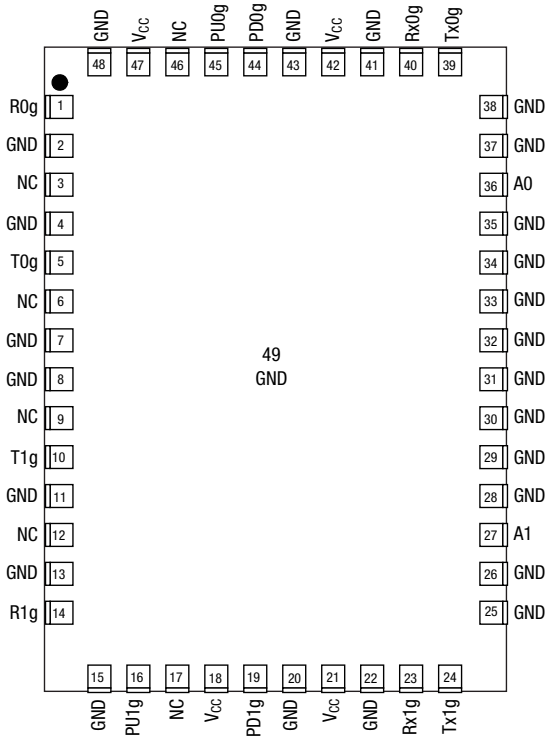
Detector Voltage vs. Output Power



Supply Current vs. Output Power

EX-1042
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0051

Pin Out

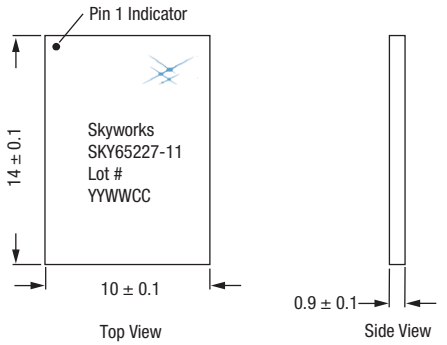


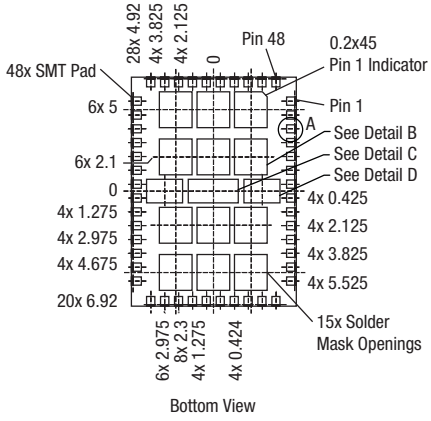
Pin Descriptions

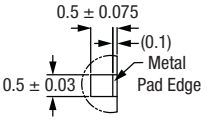
Pin #	Pin Name	Description	EVB Label
1	R0g	Receiver output	R0g
2	GND	Ground	GND
3	NC	No connection	R0a
4	GND	Ground	GND
5	T0g	Transmitter input	T0g
6	NC	No connection	T0a
7	GND	Ground	GND
8	GND	Ground	GND
9	NC	No connection	T1a
10	T1g	Transmitter input	T1g
11	GND	Ground	GND
12	NC	No connection	R1a
13	GND	Ground	GND
14	R1g	Receiver output	R1g
15	GND	Ground	GND
16	PU1g	Power amplifier enable input	VEN1g
17	NC	No connection	VEN1a
18	V_{CC}	3.3 V	None. Tied to Pin 47
19	PD1g	Power detector output voltage from PA1	VD1ag
20	GND	Ground	GND
21	V_{CC}	3.3 V	None
22	GND	Ground	GND
23	RX1g	Switch control input	Rx1ag
24	TX1g	Switch control input	Tx1ag
25	GND	Ground	GND
26	GND	Ground	GND
27	A1	Antenna 1	A1
28	GND	Ground	GND
29	GND	Ground	GND
30	GND	Ground	GND
31	GND	Ground	GND
32	GND	Ground	GND
33	GND	Ground	GND
34	GND	Ground	GND
35	GND	Ground	GND
36	A0	Antenna 0	A0
37	GND	Ground	GND
38	GND	Ground	GND
39	Tx0g	Switch control input	TX0ag
40	Rx0g	Switch control input	RX0ag
41	GND	Ground	GND
42	V_{CC}	3.3 V	None
43	GND	Ground	GND
44	PD0g	Power detector output voltage from PA0	VD0ag
45	PU0g	Power amplifier enable input	VEN0g
46	NC	No connection	VEN0a
47	V_{CC}	3.3 V	V_{CC}
48	GND	Ground	GND
49	GND	Ground	GND

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0052

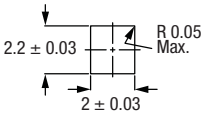
Package Outline



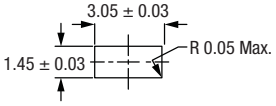




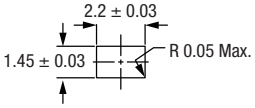
Detail A
Pad Scale: 2X
14X Rotated 180°
10X Rotated 90° CW
10X Rotated 90° CCW



Detail B
Scale: Full
12X



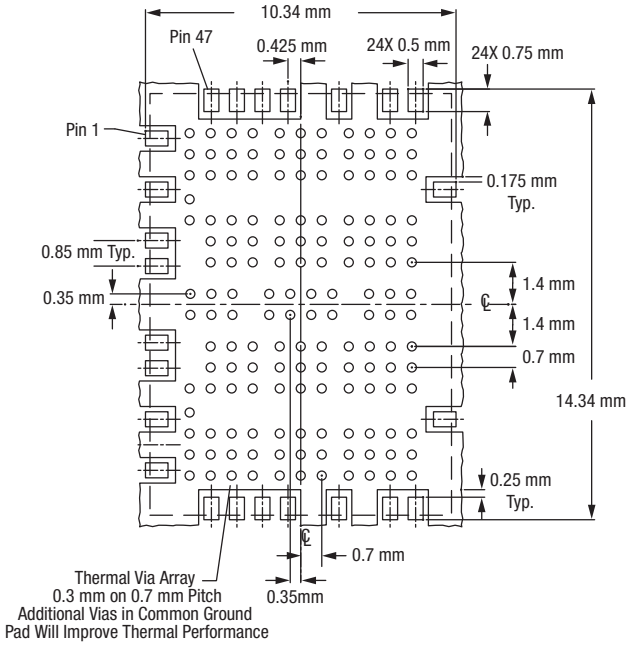
Detail C
Scale: Full



Detail D
Scale: Full
2X

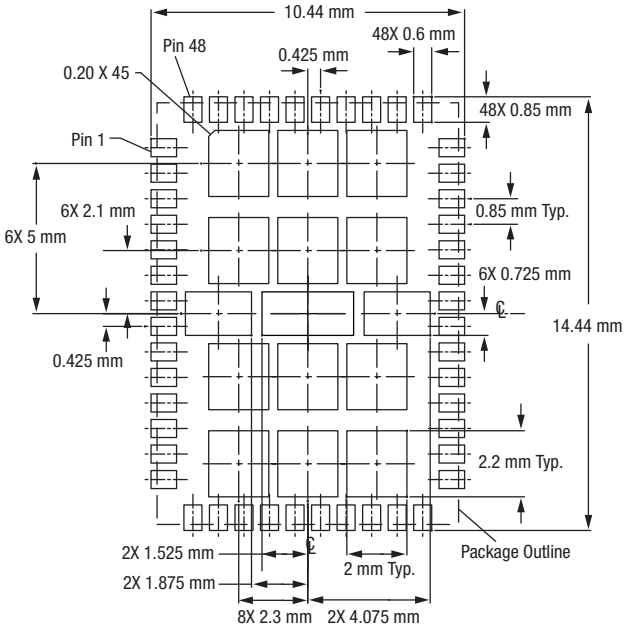
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0053

Recommended Footprint

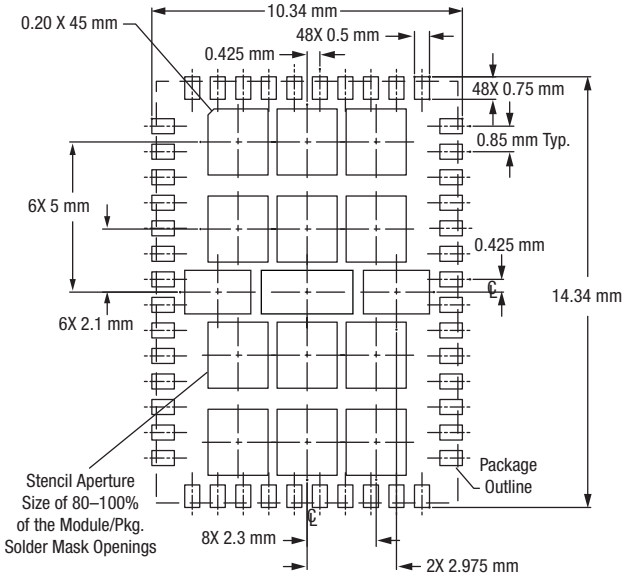


Thermal vias should be tented and filled with solder mask 30–35 µm copper plating recommended.

Solder Mask



Stencil Pattern



EX-1042
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0054

DATA SHEET

SKY65228-11: WLAN 802.11n Single Band 4.9–5.85 GHz MIMO Intera™ Front-End Module

Features

- Single band 4.9–5.85 GHz MIMO architecture
- Two full 4.9–5.85 GHz transmit/receive chains
- Backward-compatible with 802.11a standards
- Pin compatible with SKY65225-11 (4.9–5.85 GHz)
- P_{OUT} @ 2.5% EVM: 16 dBm (-11a)
- Gain matching: <2 dB
- Internal voltage regulation
- Single 3.0–3.6 V power supply
- Temperature-compensated PA bias networks
- Separate digital controls for each PA
- Temperature-compensated directional power detection
- Package size: 10 x 14 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant MSL-3 @ 250 °C per JEDEC J-STD-020

Description

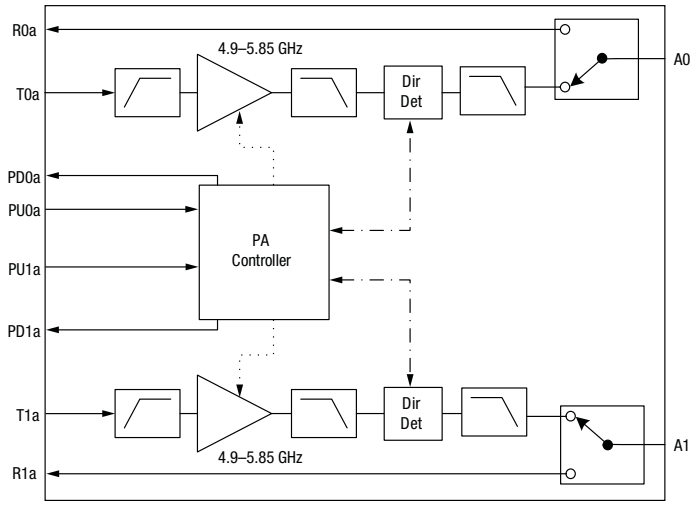
The SKY65228-11 Intera nFEM contains two complete 4.9–5.85 GHz transmit/receive chains in one compact RF front-end module optimized for single band 4.9–5.85 GHz MIMO (multiple in—multiple out) operation, in compliance with the 802.11n draft standard. The SKY65228-11 includes two 4.9–5.85 GHz PAs with integrated input filtering for 3–4 GHz rejection, and temperature-compensated, directional power detector with 20 dB dynamic range. Also included are low loss, high rejection GaAs harmonic filters and T/R switches which provide high linearity in all transmit paths and low loss in all receive paths.

The SKY65228-11 Intera nFEM achieves outstanding gain matching which is a critical requirement for MIMO operation. This is accomplished though mirrored layout symmetry.

The SKY65228-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 10 x 14 x 0.9 mm. This FEM is designed as a pin to pin compatible version of the SKY65225-11 for 4.9–5.85 GHz only.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



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Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC}		-0.3		5.5	V
PU0a, PU1a	PU		-0.3		5.5	V
T0a,T1a	RFin				10	dBm
Operating temperature range	T_{OP}		0		85	ºC
Storage temperature range	T_{STO}		-65		125	ºC
Moisture sensitivity level	MSL-3				250	°C
Thermal resistance	θ_{JC}				60	°C/W

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		3	3.3	3.6	V
Operating Temperature	T_{OP}		0	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11a Tx supply current, T0a or T1a	I_{CC}-a	P_{OUT} = 15 dBm, 54 Mbps OFDM, PU0g or PU1g = 0 V PU0a or PU1a = 3.3 V		180		mA
Total 802.11a Tx quiescent current, T0a or T1a	I_{CQ}-a	No RF		135		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic high voltage for PU0a, PU1a (Tx On)			2		V_{CC}	V
Logic low voltage for PU0a, PU1a (Tx Off)			0		0.5	V
Input current logic high voltage for PU0a, PU1a				100	200	µA
Input current logic low voltage for PU0a, PU1a				0.2		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0056

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	V_{CTL}_on		3	3.3	3.6	V
Control voltage - OFF state	V_{CTL}_off		0		0.2	V
Control current - ON state	I_{CTL}_on	RF ON		10	75	uA
Control current - ON state	I_{CTL}_on	RF OFF		2	20	uA

Mode Control Voltage Table (V)

Mode	V_{CC}	PU0a	Rx0a	Tx0a	PU1a	Rx1a	Tx1a
Sleep	3.3	0	0	0	0	0	0
T0a - ANT0	3.3	3.3	0	3.3	0	0	0
R0a - ANT0	3.3	0	3.3	0	0	0	0
T1a - ANT1	3.3	0	0	0	3.3	0	3.3
R1a - ANT1	3.3	0	0	0	0	3.3	0
802.11n Operation							
T0a - ANT0 & T1a - ANT1	3.3	3.3	0	3.3	3.3	0	3.3
R0a - ANT0 & R1a - ANT1	0 or 3.3	0	3.3	0	0	3.3	0

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0057

802.11a Transmit Specifications (Tx Chain 0, Tx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		16		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 7dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\lvert S_{21}\rvert$			24		dB
Small signal gain variation over any 20 MHz band	$\lvert \Delta S_{21}\rvert$				0.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\lvert S_{21}\rvert$ - M	Compared frequency by frequency		2		dB
Gain, 3.2–3.9 GHz	$\lvert S_{21}\rvert$ - 3.9			0		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	ns
Input return loss	$\lvert S_{11}\rvert$	T0a or T1a		-6		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-10		dB
Isolation between T0g and A1	ISO-A1	CW power into T0a and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1a and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications (Rx Chain 0, Rx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables & Tx control voltages = 0 V. Rx0ag or Rx1ag = 3.3 V. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\lvert S_{21}\rvert$			2.5	3	dB
Input return loss	$\lvert S_{11}\rvert$	R0g or R1g		-20		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-15		dB
Insertion loss delta	$\lvert \Delta S_{21}\rvert$	A0 to R0g and A1 to R1g			0.5	dB

802.11a Power Detector Specification

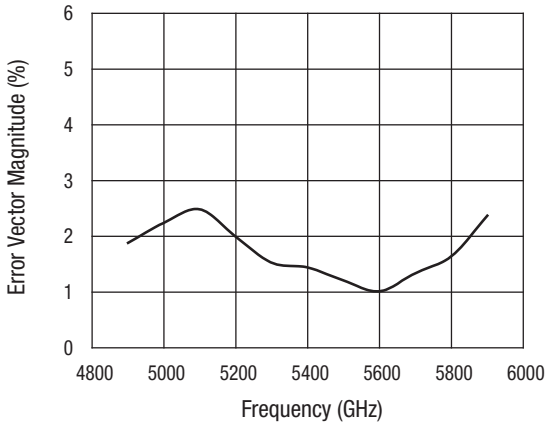
Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PU0a and Tx0ag or PU1a and Tx1ag = 3.3 V. RX0ag or RX1ag = 0 V. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc5	Over 3:1 VSWR		0.7		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF				0.90		V
Output voltage, 18 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

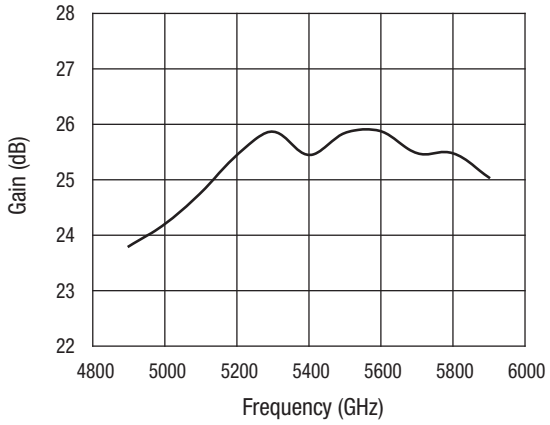
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0058

Typical Performance Data (4.9–5.85 GHz)

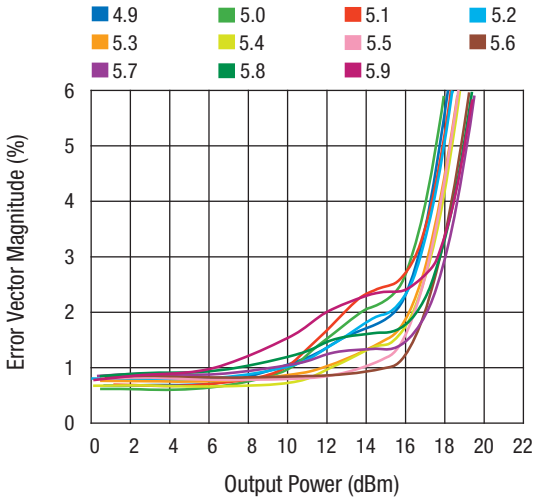
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_0 = 50 Ω, unless otherwise noted



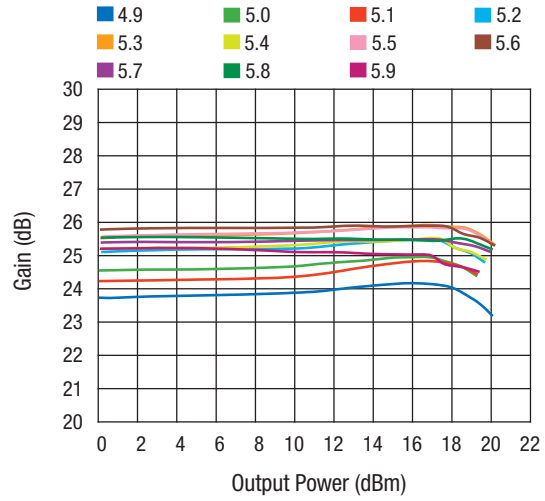
EVM vs. Frequency (P_{OUT} = 15 dBm)



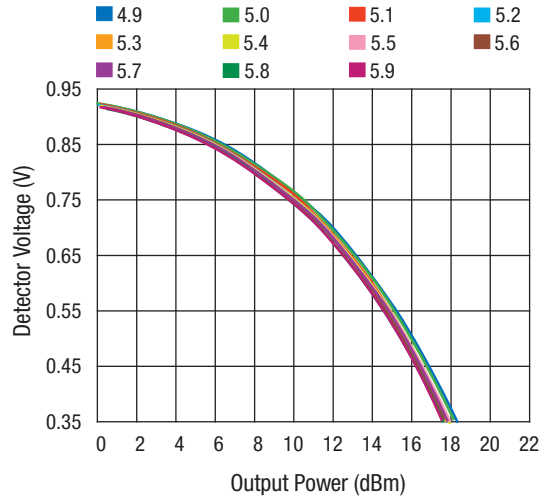
Gain vs. Frequency



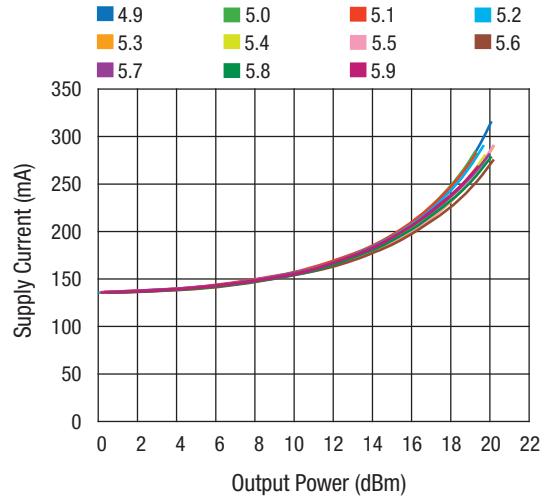
EVM vs. Output Power



Gain vs. Output Power



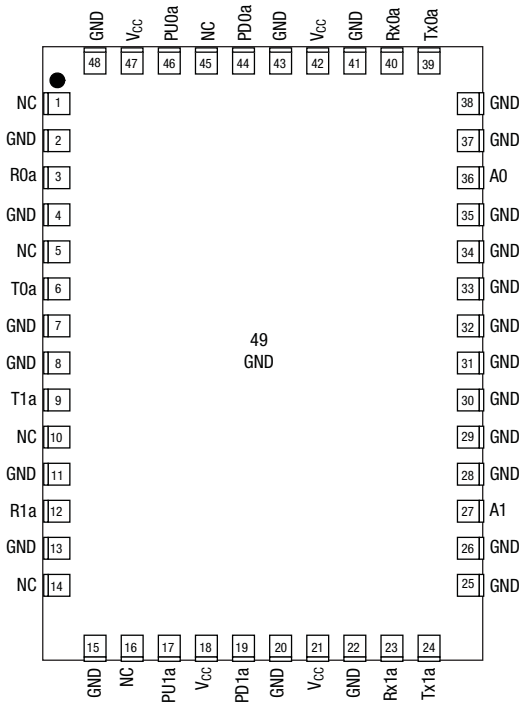
Detector Voltage vs. Output Power



Supply Current vs. Output Power

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0059

Pin Out

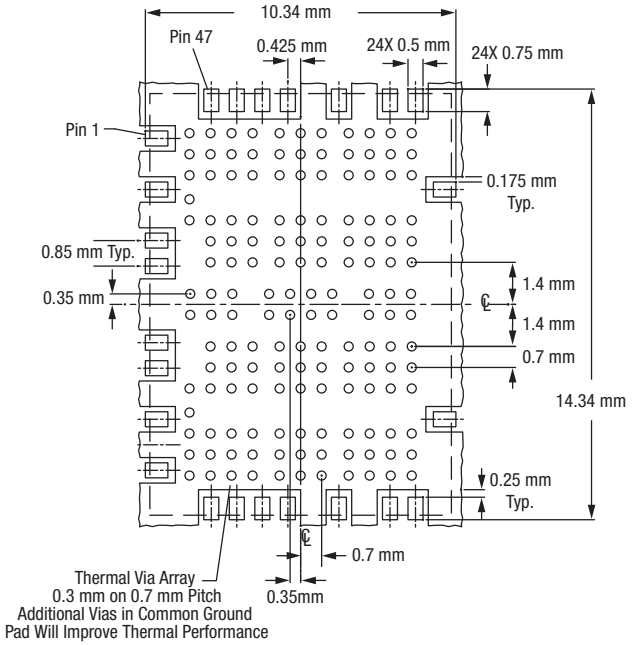


Pin Descriptions

Pin #	Pin Name	Description	EVB Label
1	NC	No connection	NC
2	GND	Ground	GND
3	R0a	Receiver output	R0a
4	GND	Ground	GND
5	NC	No connection	NC
6	T0a	Transmitter input	T0a
7	GND	Ground	GND
8	GND	Ground	GND
9	T1a	Transmitter input	T1a
10	NC	No connection	NC
11	GND	Ground	GND
12	R1a	Receiver output	R1a
13	GND	Ground	GND
14	NC	No connection	NC
15	GND	Ground	GND
16	NC	No connection	NC
17	PU1a	Power amplifier enable input	VEN1a
18	V_{CC}	3.3 V	None. Tied to Pin 47
19	PD1a	Power detector output voltage from PA1	VD1ag
20	GND	Ground	GND
21	V_{CC}	3.3 V	None. Tied to Pin 47
22	GND	Ground	GND
23	Rx1a	Switch control input	Rx1ag
24	Tx1a	Switch control input	Tx1ag
25	GND	Ground	GND
26	GND	Ground	GND
27	A1	Antenna 1	A1
28	GND	Ground	GND
29	GND	Ground	GND
30	GND	Ground	GND
31	GND	Ground	GND
32	GND	Ground	GND
33	GND	Ground	GND
34	GND	Ground	GND
35	GND	Ground	GND
36	A0	Antenna 0	A0
37	GND	Ground	GND
38	GND	Ground	GND
39	Tx0a	Switch control input	Tx0ag
40	Rx0a	Switch control input	Rx0ag
41	GND	Ground	GND
42	V_{CC}	3.3 V	None. Tied to Pin 47
43	GND	Ground	GND
44	PD0a	Power detector output voltage from PA0	VD0ag
45	NC	No connection	VEN0g
46	PU0a	Power amplifier enable input	VEN0a
47	V_{CC}	3.3 V	V_{CC}
48	GND	Ground	GND
49	GND	Ground	GND

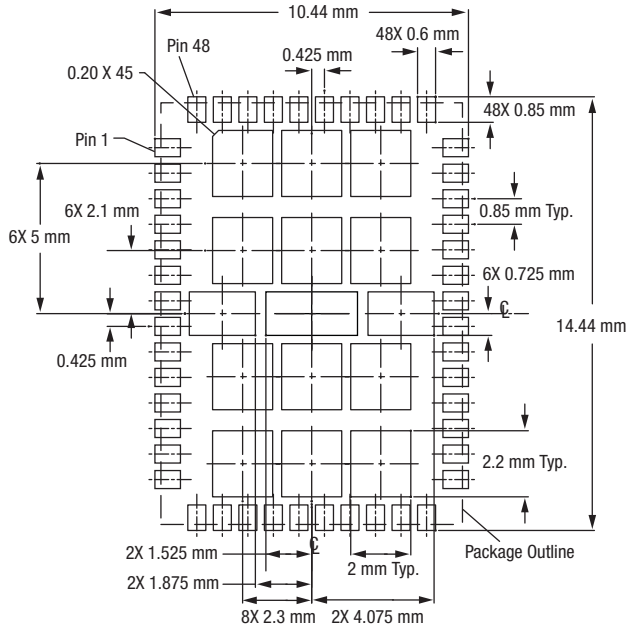
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0060

Recommended Footprint

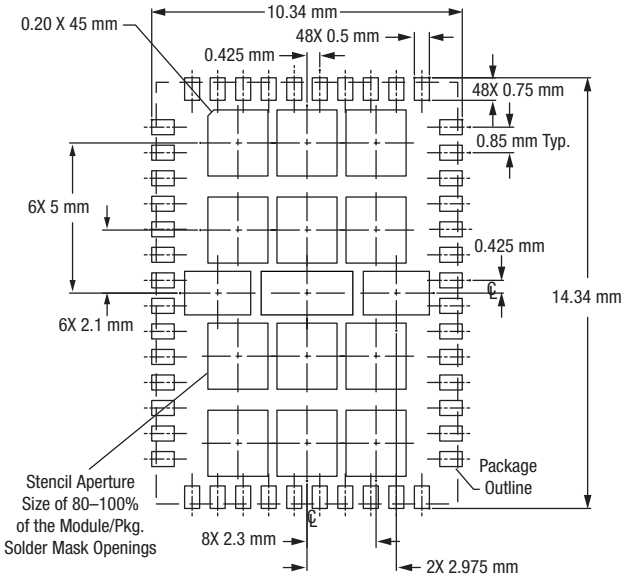


Thermal vias should be tented and filled with solder mask 30–35 µm copper plating recommended.

Solder Mask

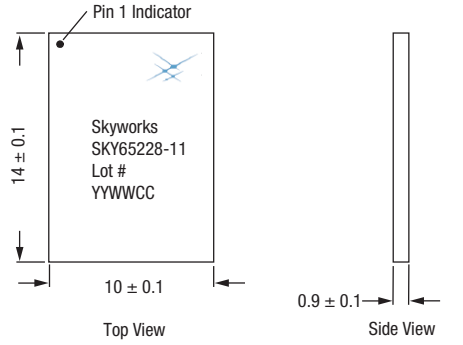


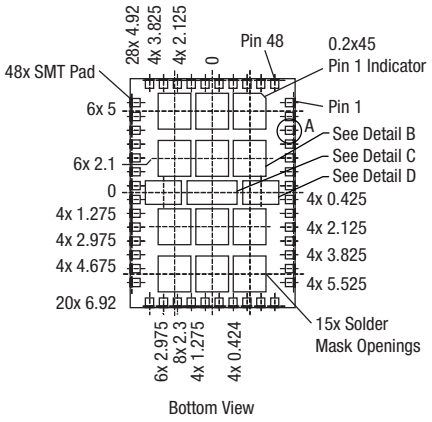
Stencil Pattern

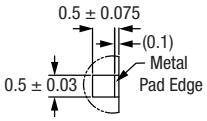


EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0061

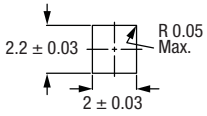
Package Outline



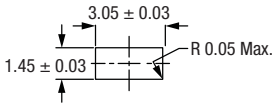




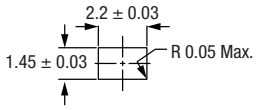
Detail A
Pad Scale: 2X
14X Rotated 180°
10X Rotated 90° CW
10X Rotated 90° CCW



Detail B
Scale: Full
12X



Detail C
Scale: Full



Detail D
Scale: Full
2X

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0062

DATA SHEET

SKY65230-11: WLAN 802.11n 2 x 2 MIMO Intera™ Front-End Module with 3 Antenna Ports

Features

- 2 x 2 MIMO architecture
- Two full dual-band transmit/receive chains
- 3rd antenna provides switch diversity on both chains
- Backward-compatible with 802.11a/b/g standards
- P_{OUT} @ 2.5% EVM: 16 dBm (-11a); 19 dBm (-11b); 19 dBm (-11g)
- Gain matching: <1.5 dB @ 2 GHz, < 2 dB @ 5 GHz
- Single 3.0–3.6 V power supply, internal voltage regulation
- Temperature-compensated PA bias networks and directional power detection
- Separate digital controls for each PA
- Package size: 10 x 14 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant MSL-3 @ 250 °C per JEDEC J-STD-020

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

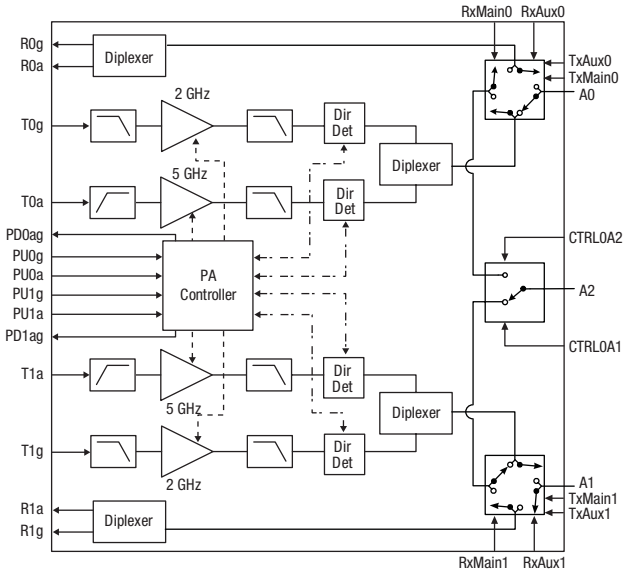
Description

The SKY65230-11 Intera nFEM combines two complete dual-band transmit/receive chains in one compact RF front end module optimized for 2 x 2 MIMO (multiple in—multiple out) operation, in compliance with the 802.11n draft standard. The SKY65230-11 includes two 5 GHz PAs and two 2 GHz PAs, each with integrated input filtering for 3–4 GHz rejection, and two temperature-compensated, directional power detectors with 20 dB dynamic range. Also included are low loss, high rejection GaAs diplexers and diversity switches which provide high linearity in all transmit paths and low loss in all receive paths. Additionally, a third antenna port is added to provide switch diversity capability on both chains. All RF ports are matched to 50 Ω.

The SKY65230-11 Intera nFEM achieves outstanding gain matching between both 2 GHz transmit paths and both 5 GHz transmit paths, which is a critical requirement for MIMO operation. This is accomplished though mirrored layout symmetry.

The SKY65230-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 140 mm^2. This tiny footprint enables more functionality in less printed circuit board space.

Functional Block Diagram



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0063

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC}		-0.3		5.5	V
PU0g, PU1g, PU0a, PU1a	PU		-0.3		5.5	V
T0g,T1g,T0a,T1a	RFin				10	dBm
Operating temperature range	T_{OP}		0		85	ºC
Storage temperature range	T_{STO}		-65		125	ºC
Moisture sensitivity level	MSL-3				250	°C
Thermal resistance	θ_{JC}				60	°C/W

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}		3	3.3	3.6	V
Operating Temperature	T_{OP}		0	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current, T0g or T1g	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, PU0g or PU1g = 3.3 V PU0a or PU1a = 0 V		190		mA
Total 802.11g Tx quiescent current, T0g or T1g	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current, T0g or T1g	I_{CC}-b	P_{OUT} = 18 dBm, 11 Mbps CCK PU0g or PU1g = 3.3 V PU0a or PU1a = 0 V		190		mA
Total 802.11a Tx supply current, T0a or T1a	I_{CC}-a	P_{OUT} = 15 dBm, 54 Mbps OFDM, PU0g or PU1g = 0 V PU0a or PU1a = 3.3 V		180		mA
Total 802.11a Tx quiescent current, T0g or T1g	I_{CQ}-a	No RF		135		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic high voltage for PU0g, PU1g, PU0a, PU1a (Tx On)			2		V_{CC}	V
Logic low voltage for PU0g, PU1g, PU0a, PU1a (Tx Off)			0		0.5	V
Input current logic high voltage for PU0g, PU1g, PU0a, PU1a				100	200	µA
Input current logic low voltage for PU0g, PU1g, PU0a, PU1a				0.2		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0064

PA Bias Control Line Truth Table

Control Pin	Logic Level = 1 (3 V)	Logic Level = 0 (0 V)
PU0g	g Band PA0 On	g Band PA0 Off
PU0a	a Band PA0 On	a Band PA0 Off
PU1g	g Band PA1 On	g Band PA1 Off
PU1a	a Band PA1 On	a Band PA1 Off

Switch Control Line Truth Tables

H = 3 V, L = 0 V, X = Don't Care

Path	RxMain0	TxMain0	RxAux0	TxAux0	Ctrl0A2	Ctrl1A2
A0-R0g	H	L	L	L	X	X
A0-R0a	H	L	L	L	X	X
A2-R0g	L	L	H	L	H	L
A2-R0a	L	L	H	L	H	L
A0-T0g	L	H	L	L	X	X
A0-T0a	L	H	L	L	X	X
A2-T0g	L	L	L	H	H	L
A2-T0a	L	L	L	H	H	L

Path	RxMain1	TxMain1	RxAux1	TxAux1	Ctrl0A2	Ctrl1A2
A1-R1g	H	L	L	L	X	X
A1-R1a	H	L	L	L	X	X
A2-R1g	L	L	H	L	L	H
A2-R1a	L	L	H	L	L	H
A1-T1g	L	H	L	L	X	X
A1-T1a	L	H	L	L	X	X
A2-T1g	L	L	L	H	L	H
A2-T1a	L	L	L	H	L	H

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0065

802.11b,g Transmit Specifications (Tx Chain 0, Tx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		19		dBm
Compliant output power - b	$P_{OUT_}$b	11 Mbps CCK		19		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\lvert S_{21}\rvert$			25		dB
Small signal gain variation over frequency band	$\lvert\Delta S_{21}\rvert$			1	2.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\lvert S_{21}\rvert$ - M	Compared frequency by frequency		1		dB
Gain, 3.2–3.3 GHz	$\lvert S_{21}\rvert$ - 3.2			-2		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	nS
Input return loss	$\lvert S_{11}\rvert$	T0g or T1g		-10		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-8		dB
Isolation between T0g and A1	ISO-A1	CW power into T0g and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1g and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications (Rx Chain 0, Rx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\lvert S_{21}\rvert$			1.5	2.0	dB
Input return loss	$\lvert S_{11}\rvert$	R0g or R1g		-20		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-15		dB
Insertion loss delta	$\lvert\Delta S_{21}\rvert$	A0 to R0g and A1 to R1g			0.5	dB

802.11b,g Power Detector Specification

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		1		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF			0.80		0.95	V
Output voltage, 20 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0066

802.11b,g Transmit Specifications (Tx Chain 2)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		18.5		dBm
Compliant output power - b	P_{OUT}_b	11 Mbps CCK		18.5		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22	25		dBm
Small signal gain	$\lvert S_{21}\rvert$			25		dB
Small signal gain variation over frequency band	$\lvert\Delta S_{21}\rvert$			1	2.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\lvert S_{21}\rvert$ - M	Compared frequency by frequency		1		dB
Gain, 3.2–3.3 GHz	$\lvert S_{21}\rvert$ - 3.2			-2		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-48	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	nS
Input return loss	$\lvert S_{11}\rvert$	T0g or T1g		-10		dB
Output return loss	$\lvert S_{22}\rvert$	A2		-8		dB
Isolation between T0g and A1	ISO-A1	CW power into T0g and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1g and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications (Rx Chain 2)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\lvert S_{21}\rvert$			1.8	2.5	dB
Input return loss	$\lvert S_{11}\rvert$	R0g or R1g		-20		dB
Output return loss	$\lvert S_{22}\rvert$	A2		-15		dB
Insertion loss delta	$\lvert\Delta S_{21}\rvert$	A2 to R0g and A2 to R1g			0.5	dB

802.11b,g Power Detector Specification

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		1		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF			0.80		0.95	V
Output voltage, 20 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0067

802.11a Transmit Specifications (Tx Chain 0, Tx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		16		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 7 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\lvert S_{21}\rvert$			24		dB
Small signal gain variation over any 20 MHz band	$\lvert \Delta S_{21}\rvert$				0.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\lvert S_{21}\rvert$ - M	Compared frequency by frequency		2		dB
Gain, 3.2–3.9 GHz	$\lvert S_{21}\rvert$ - 3.9			0		dB
Harmonics	2f, 3f	P_{OUT} = 15 dBm, OFDM542		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	nS
Input return loss	$\lvert S_{11}\rvert$	T0a or T1a		-6		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-10		dB
Isolation between T0g and A1	ISO-A1	CW power into T0a and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1a and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications (Rx Chain 0, Rx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\lvert S_{21}\rvert$			2.5	3	dB
Input return loss	$\lvert S_{11}\rvert$	R0g or R1g		-20		dB
Output return loss	$\lvert S_{22}\rvert$	A0 or A1		-15		dB
Insertion loss delta	$\lvert \Delta S_{21}\rvert$	A0 to R0g and A1 to R1g			0.5	dB

802.11a Power Detector Specification

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc5	Over 3:1 VSWR		0.7		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF			0.75		0.95	V
Output voltage, 18 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0068

802.11a Transmit Specifications (Tx Chain 2)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		15.5		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 7 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\lvert S_{21}\rvert$			24		dB
Small signal gain variation over any 20 MHz band	$\lvert \Delta S_{21}\rvert$				0.5	dB
Gain matching, T0g to A0 vs. T1g to A1	$\lvert S_{21}\rvert$ - M	Compared frequency by frequency		2		dB
Gain, 3.2–3.9 GHz	$\lvert S_{21}\rvert$ - 3.9			0		dB
Harmonics	2f, 3f	P_{OUT} = 15 dBm, OFDM542		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	nS
Input return loss	$\lvert S_{11}\rvert$	T0a or T1a		-6		dB
Output return loss	$\lvert S_{22}\rvert$	A2		-10		dB
Isolation between T0g and A1	ISO-A1	CW power into T0a and measure ratio of power at A0 to A1			-25	dBc
Isolation between T1g and A0	ISO-A0	CW power into T1a and measure ratio of power at A1 to A0			-25	dBc
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications (Rx Chain 2)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\lvert S_{21}\rvert$			3	3.5	dB
Input return loss	$\lvert S_{11}\rvert$	R0g or R1g		-20		dB
Output return loss	$\lvert S_{22}\rvert$	A2		-15		dB
Insertion loss delta	$\lvert \Delta S_{21}\rvert$	A2 to R0g and A2 to R1g			0.5	dB

802.11a Power Detector Specification

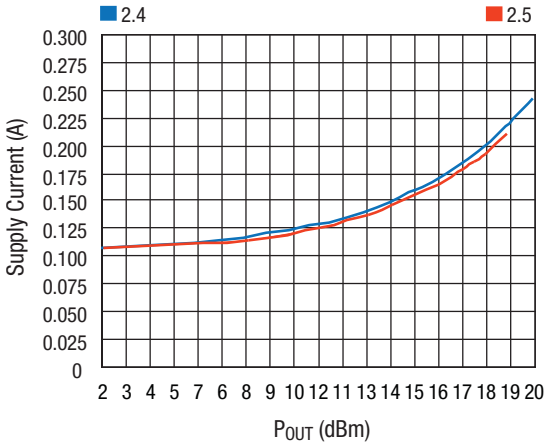
Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and switch control voltages set according to Truth Tables in this document. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Power detect range	PDR	A0 or A1	0		20	dBm
Power detector accuracy	PDacc5	Over 3:1 VSWR		0.7		dB
DC load impedance	Zload				3	kΩ
Output voltage, no RF			0.75		0.95	V
Output voltage, 18 dBm				0.35		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

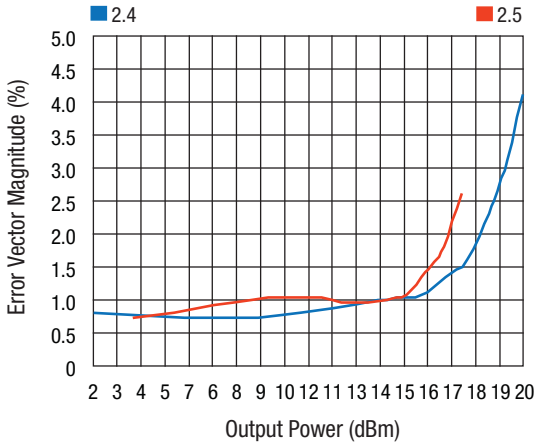
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0069

Typical Performance Data (2.4–2.5 GHz)

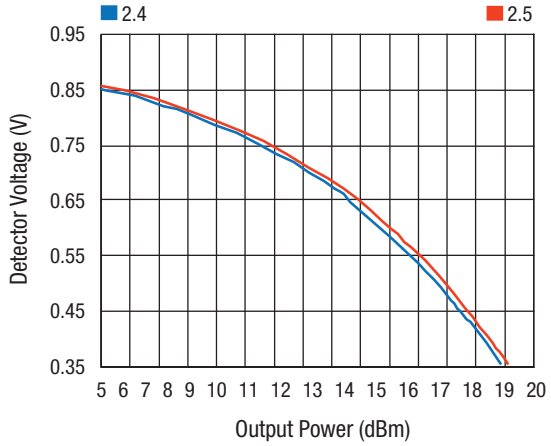
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_O = 50 Ω, unless otherwise noted



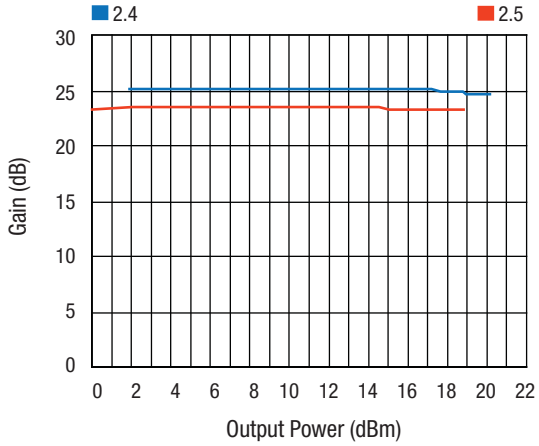
Supply Current vs. Output Power



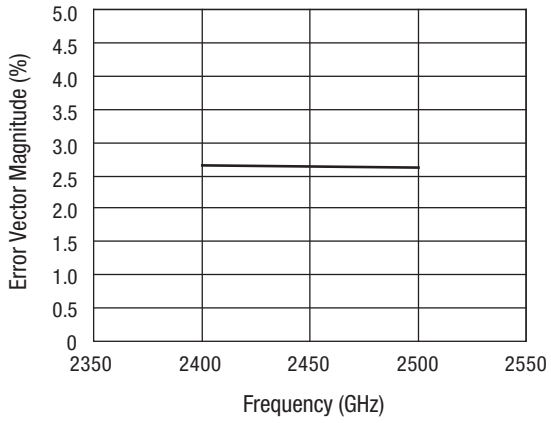
EVM vs. Output Power



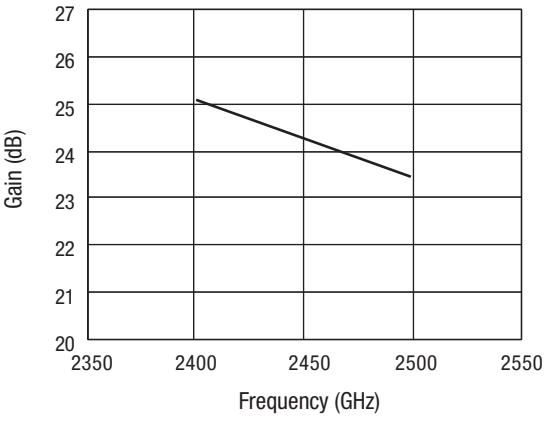
Detector Voltage vs. Output Power



Gain vs. Output Power



EVM vs. Frequency (P_{OUT} = 18 dBm)

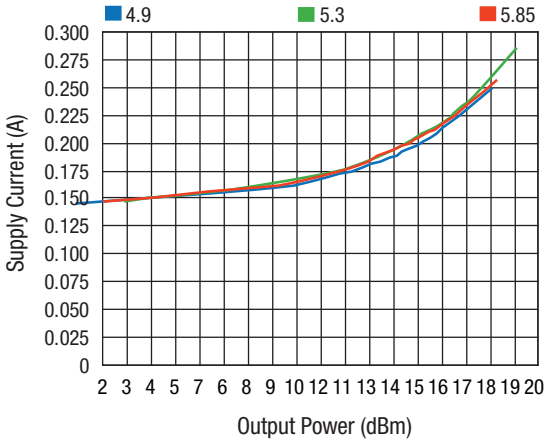


Gain vs. Frequency

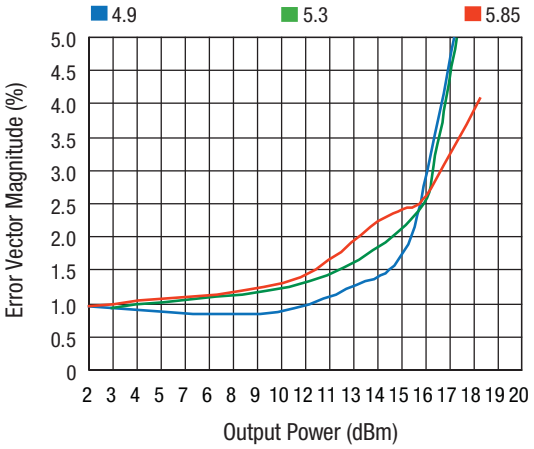
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0070

Typical Performance Data (4.9–5.85 GHz)

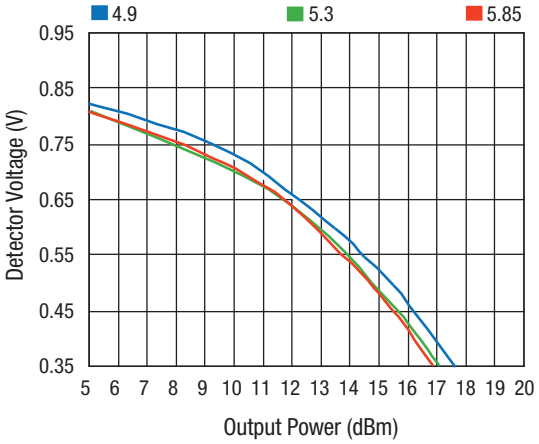
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_O = 50 Ω, unless otherwise noted



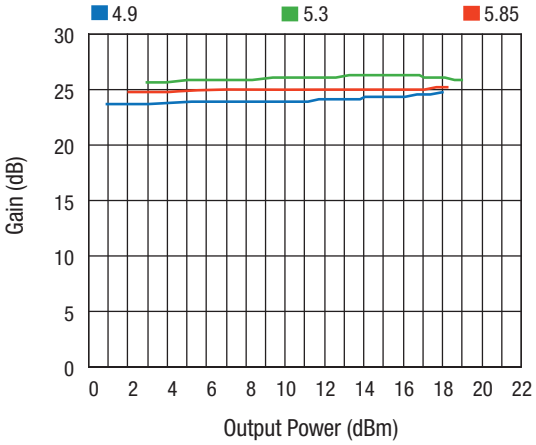
Supply Current vs. Output Power



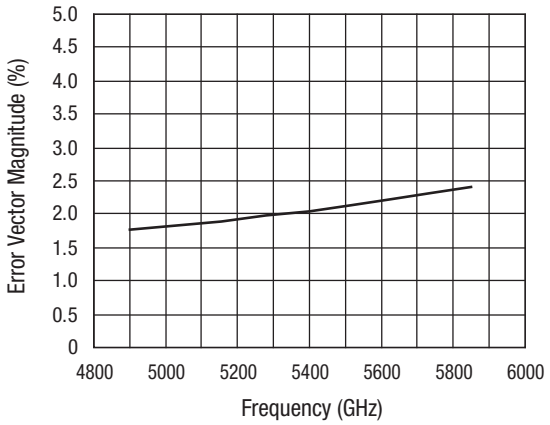
EVM vs. Output Power



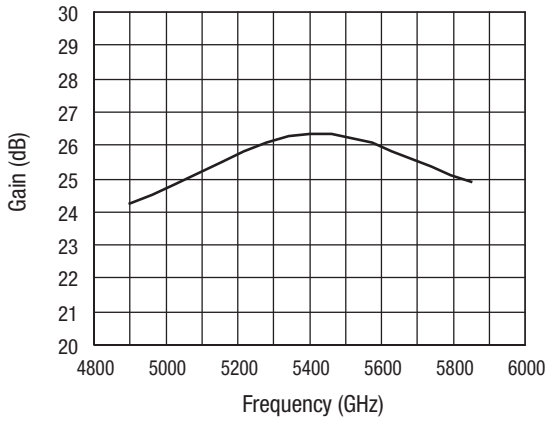
Detector Voltage vs. Output Power



Gain vs. Output Power



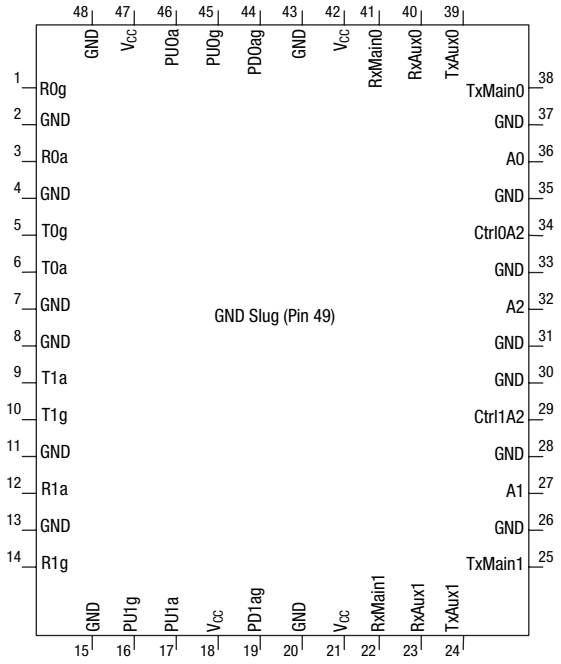
EVM vs. Frequency
@ P_{OUT} = 15 dBm



Gain vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0071

Module Pin Out

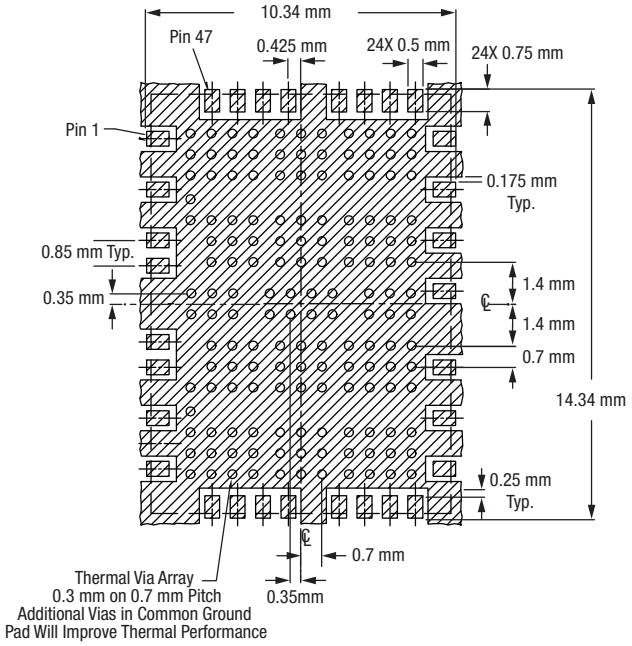


Pin Descriptions

Pin #	Name	Description
1	R0g	Receiver output
2	GND	Ground
3	R0a	Receiver output
4	GND	Ground
5	T0g	Transmitter input
6	T0a	Transmitter input
7	GND	Ground
8	GND	Ground
9	T1a	Transmitter input
10	T1g	Transmitter input
11	GND	Ground
12	R1a	Receiver output
13	GND	Ground
14	R1g	Receiver output
15	GND	Ground
16	PU1g	Power amp enable input
17	PU1a	Power amp enable input
18	V_{CC}	3.3 V
19	PD1ag	Power detector 1 output
20	GND	Ground
21	V_{CC}	3.3 V
22	RxMain1	Diversity switch control input
23	RxAux1	Diversity switch control input
24	TxAux1	Diversity switch control input
25	TxMain1	Diversity switch control input
26	GND	Ground
27	A1	Antenna 1
28	GND	Ground
29	Ctrl1A2	TR switch control input
30	GND	Ground
31	GND	Ground
32	A2	Antenna 2
33	GND	Ground
34	Ctrl0A2	TR switch control input
35	GND	Ground
36	A0	Antenna 0
37	GND	Ground
38	TxMain0	Diversity switch control input
39	TxAux0	Diversity switch control input
40	RxAux0	Diversity switch control input
41	RxMain0	Diversity switch control input
42	V_{CC}	3.3 V
43	GND	Ground
44	PD0ag	Power detector 0 output
45	PU0g	Power amp enable input
46	PU0a	Power amp enable input
47	V_{CC}	3.3 V
48	GND	Ground
49	GND	Ground

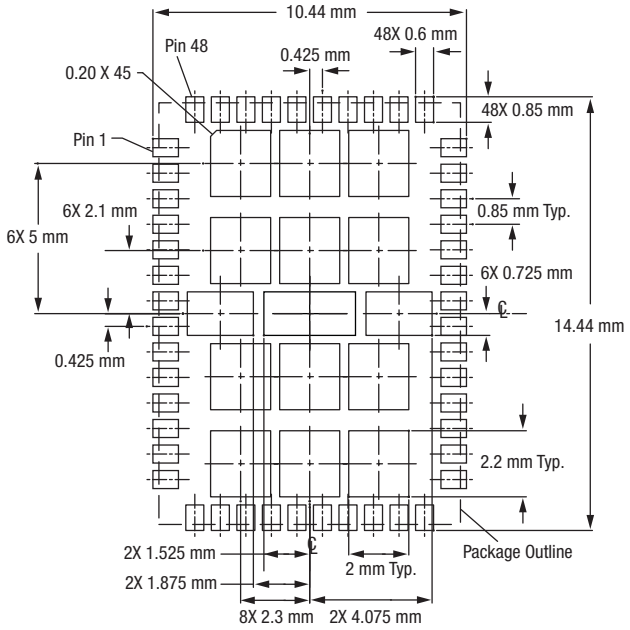
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0072

Recommended Footprint

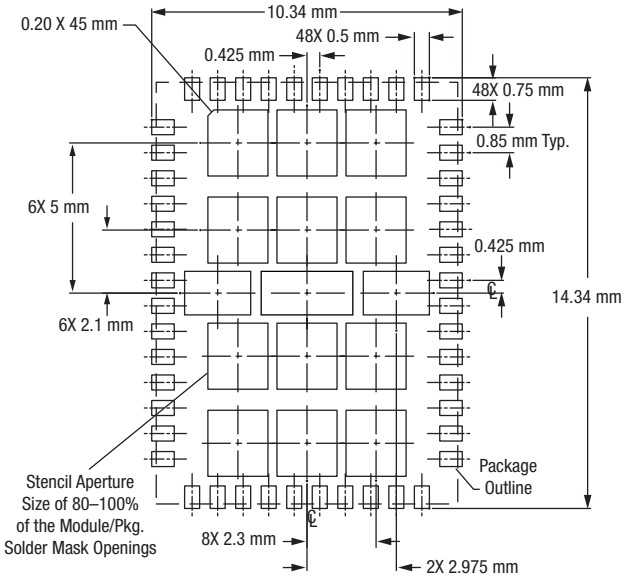


Thermal vias should be tented and filled with solder mask 30–35 µm copper plating recommended.

Solder Mask

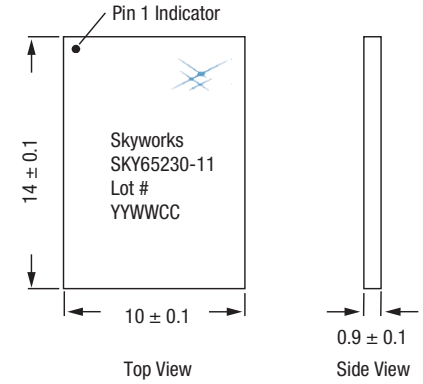


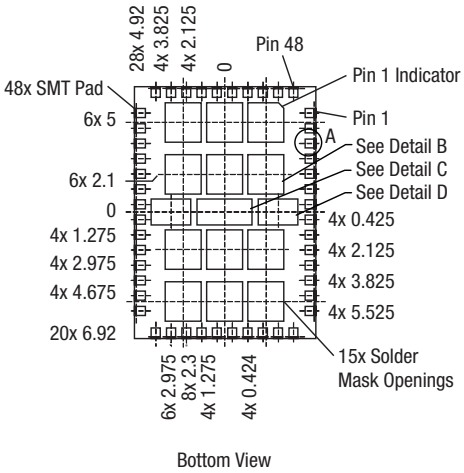
Stencil Pattern

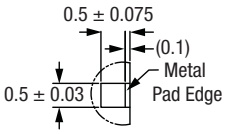


EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0073

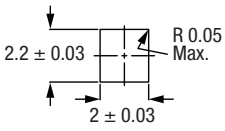
Package Outline



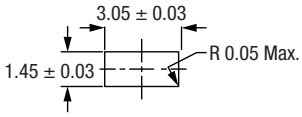




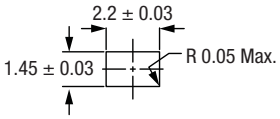
Detail A
Pad Scale: 2X
14X Rotated 180°
10X Rotated 90° CW
10X Rotated 90° CCW



Detail B
Scale: Full
12X



Detail C
Scale: Full



Detail D
Scale: Full
2X

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0074

PRELIMINARY DATA SHEET

SKY65241-12: WLAN 802.11a, b, g, n Dual-Band Intera™ Front-End Module Single Antenna

Features

- 2.4 to 2.5 GHz and 4.9 to 5.9 GHz operation
- Cardbus, mini PCI, PCIe and AP applications
- P_{OUT} @ 3.0% EVM (OFDM54): 16 dBm (a), 21 dBm (b), 18 dBm (g)
- Gain: 27 dB
- Integrated PA, filters, directional detector and SPDT switch
- Single supply voltage : 3.0 to 3.6 V
- Single antenna
- Small, ultra thin package 5 x 5 x 0.9 mm
- Lead (Pb)-free, RoHS-compliant, and halogen-free

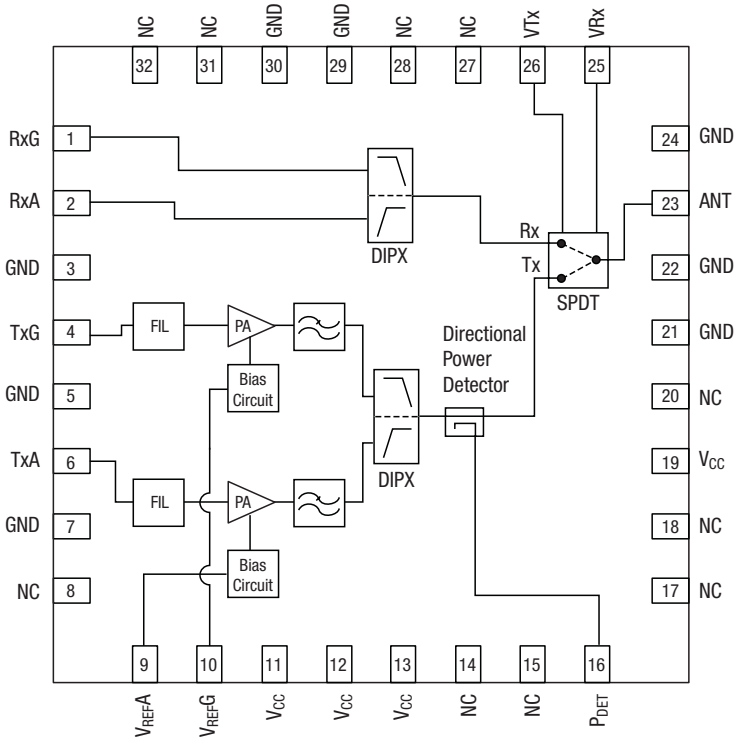
NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Description

The SKY65241-12 Intera FEM contains one complete dual-band transmit/receive chain in a compact RF front-end module. It includes one 5 GHz PA and one 2 GHz PA each with integrated input filtering for 3–4 GHz rejection, and temperature-compensated directional power detector with 20 dB dynamic range. Also included are low loss, high rejection diplexers and a SPDT TR switch which provides high linearity in transmit and low loss in receive paths. All RF ports are matched to 50 Ω.

The SKY65241-12 is packaged in a lead (Pb)-free, RoHS-compliant, and halogen-free laminate package, which measures 25 mm^2.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0075

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		-0.3		5.5	V
Reference voltage	$V_{REF}G$, $V_{REF}A$		-0.3		3.6	V
Supply current	I_{CC}				400	mA
Input power	TxG, TxA				10	dBm
Dissipated power	P_O			0.6	1.0	W
Thermal resistence	θ_{JC}				55	°C/W
Moisture sensitivity level	MSL-3				250	°C
Operating temperature range	T_{OP}		-20		85	ºC
Storage temperature range	T_{STO}		-65		150	ºC

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		3	3.3	3.6	V
Reference voltage	$V_{REF}G$		2.8	2.9	3.0	V
Operating temperature	T_{OP}		-10	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, $V_{REF}G$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}A$ = 0 V		180		mA
Total 802.11g Tx quiescent current	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current	I_{CC}-b	P_{OUT} = 20 dBm, 11 Mbps CCK $V_{REF}G$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}A$ = 0 V		210		mA
Total 802.11a Tx supply current, T0a or T1a	I_{CC}-a	P_{OUT} = 15 dBm, 54 Mbps OFDM, $V_{REF}A$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}G$ = 0 V		180		mA
Total 802.11a Tx quiescent current, T0g or T1g	I_{CQ}-a	No RF		135		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reference voltage high	$V_{REF}G$–H		2.8	2.9	3.0	V
Reference voltage low	$V_{REF}G$–L		0		0.3	V
Reference current high	$I_{REF}G$–H			5		mA
Reference current low	$I_{REF}G$–L			20		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0076

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	V_{CTL}_on		3	3.3	3.6	V
Control voltage - OFF state	V_{CTL}_off		0		0.2	V
Control current - ON state	I_{CTL}_on	RF ON		10	75	uA
Control current - ON state	I_{CTL}_on	RF OFF		2	20	uA

Truth Table

Mode	VRx	VTx
Rx-ANT	3.3	0
Tx-ANT	0	3.3
TxRx-ANT0	3.3	3.3

All other combinations undefined.

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0077

802.11b,g Transmit Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 3.0%		18		dBm
Compliant output power - b	P_{OUT}_b	11 Mbps CCK		21		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\|S_{21}\|$			27		dB
Small signal gain variation over frequency band	$\Delta\|S_{21}\|$			2		dB
Gain, 3.2–3.3 GHz	$\|S_{21}\|$ - 3.2			0		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 2 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50% of V_{CTL} to 90/10% RF output		1		µs
Input return loss	$\|S_{11}\|$	TxA or TxG		-10		dB
Output return loss	$\|S_{22}\|$	Ant		-8		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\|S_{21}\|$			1.1	1.6	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$	RxG–Ant		-15		dB
Antenna to Rx isolation		PA off, switch in Tx–Ant mode		23		dB

802.11b,g Power Detector Specification

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
P_{DET} load impedance				22.5		kΩ
P_{DET} output impedance					3	kΩ
Voltage limits		Over power range	0.1		1.1	V
Voltage range			0.3	0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0078

802.11a Transmit Specifications

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 3.0%		16		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 7 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\|S_{21}\|$			25		dB
Small signal gain variation over any 20 MHz band	$\Delta\|S_{21}\|$			2		dB
Gain matching, T0g to A0 vs. T1g to A1	$\|S_{21}\|$ - M	Compared frequency by frequency		2		dB
Gain, 3.2–3.9 GHz	$\|S_{21}\|$ - 3.9			0		dB
Harmonics	2f, 3f	P_{OUT} = 15 dBm, 6 Mbps, OFDM		-50	-42	dBm/MHz
Tx switching time	t_sw	50% of V_{CTL} to 90/10% RF output power level		0.5		µS
Input return loss	$\|S_{11}\|$	TxA or TxG		-6		dB
Output return loss	$\|S_{22}\|$	Ant		-10		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\|S_{21}\|$			2.5	3	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$	RxG –Ant		-15		dB
Antenna to Rx isolation	$\|S_{21}\|$	PA off, switch in Tx–Ant mode		22		dB

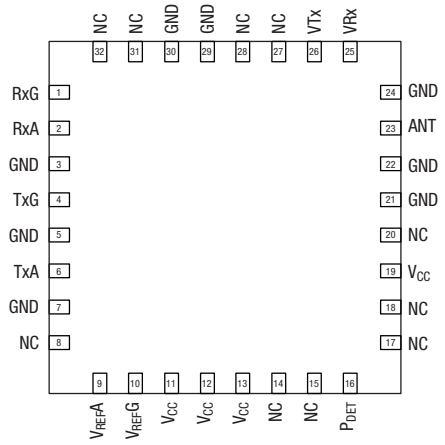
802.11a Power Detector Specification

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

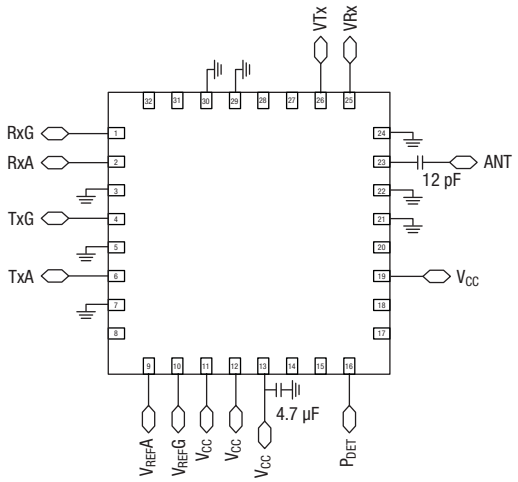
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
P_{DET} load impedance				22.5		kΩ
P_{DET} output impedance					3	kΩ
Voltage limits		Over power range	0.1		1.1	V
Voltage range			0.3	0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0079

Pin Out (Top View)



Application Circuit



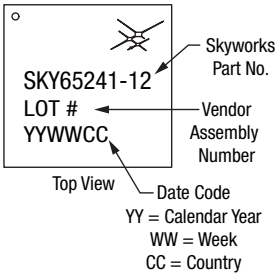
Pin Descriptions

Pin Number	Symbol	Description
1	RxG	Low-band receive output port. Internally matched to 50 Ω and DC blocked.
2	RxA	High-band receive output port. Internally matched to 50 Ω and DC blocked.
3	GND	Ground
4	TxG	Low-band transmit input port. Internally matched to 50 Ω and DC blocked.
5	GND	Ground
6	TxA	High-band transmit input port. Internally matched to 50 Ω and DC blocked.
7	GND	Ground
8	NC	No connection inside the module.
9	$V_{REF}A$	External reference voltage for the high-band PA.
10	$V_{REF}G$	External reference voltage for the low-band PA.
11	V_{CC}	Power supply 3.3 V, A band
12	V_{CC}	Power supply 3.3 V, A band
13	V_{CC}	Power supply 3.3 V, A band
14	NC	No connection inside the module.
15	NC	No connection inside the module.
16	P_{DET}	Directional power detector output.
17	NC	No connection inside the module.
18	NC	No connection inside the module.
19	V_{CC}	Power supply 3.3 V, G band
20	NC	No connection inside the module.
21	GND	Ground
22	GND	Ground
23	Ant	Antenna RF port. Internally matched to 50 Ω. External DC block cap required.
24	GND	Ground
25	VRx	Digital control input for SPDT switch
26	VTx	Digital control input for SPDT switch
27	NC	No connection inside the module.
28	NC	No connection inside the module.
29	GND	Ground
30	GND	Ground
31	NC	No connection inside the module.
32	NC	No connection inside the module.

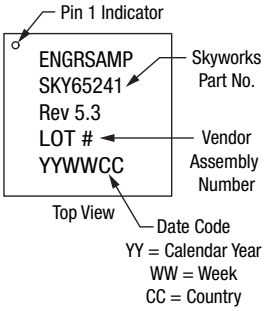
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0080

Branding Specifications

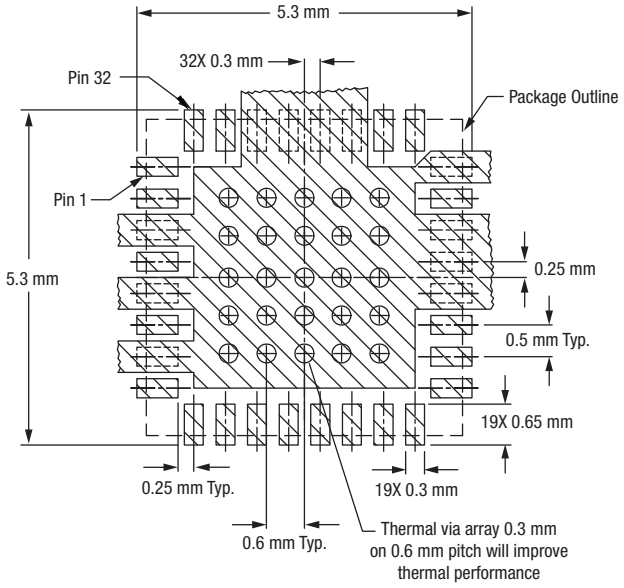
(Both Markings Perform the Same)



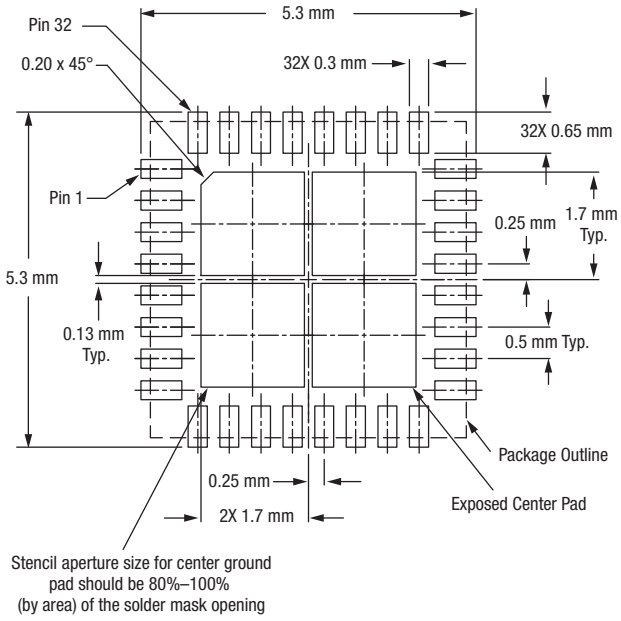
OR



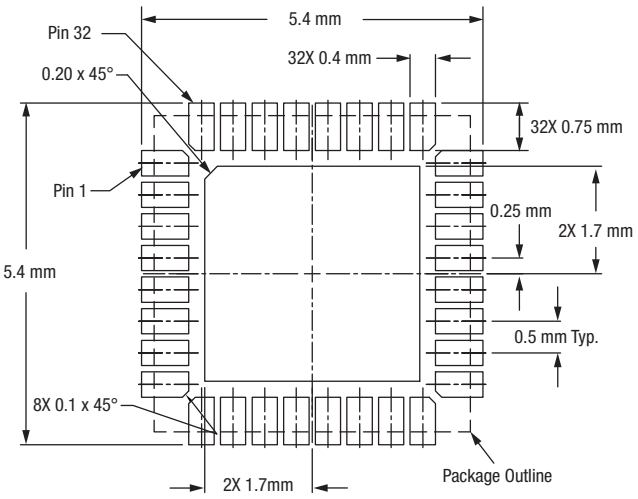
Recommended Footprint



Stencil Pattern

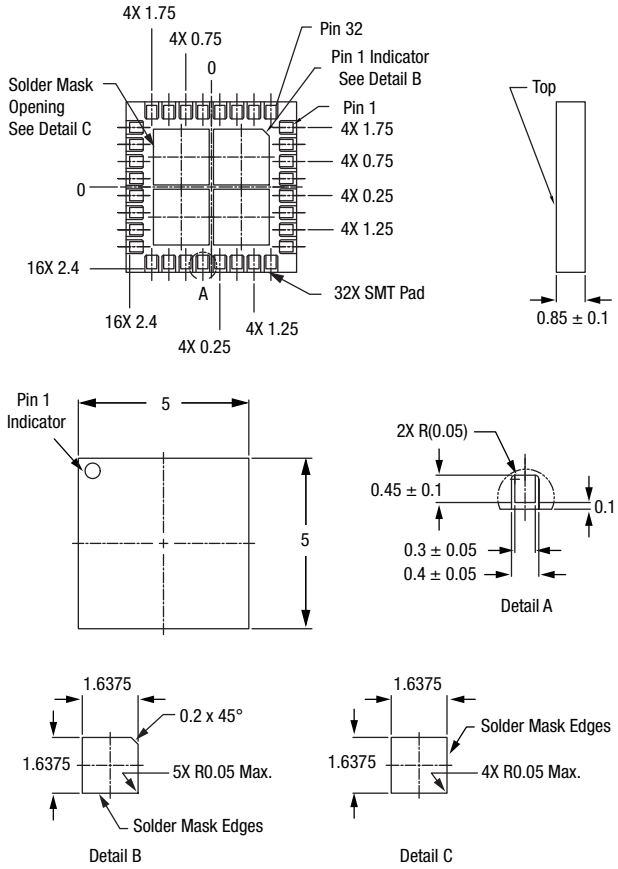


Solder Mask



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0081

Package Dimensions



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0082

ADVANCED DATA SHEET

SKY65243-11: WLAN 802.11a, b, g, n Dual-Band, Intera™ Front-End Module Dual Antennas

Features

- 2.4 to 2.5 GHz and 4.9 to 5.9 GHz Operation
- Cardbus, mini PCI, PCIe and AP applications
- P_{OUT} @ 3.0% EVM (OFDM54): 16 dBm (a), 21 dBm (b), 18 dBm (g)
- Gain: 27 dB
- Integrated PA, filters, directional detector and diversity switch
- Single supply voltage : 3.0 to 3.6 V
- Dual antennas
- Small, ultra thin package 5 x 5 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant

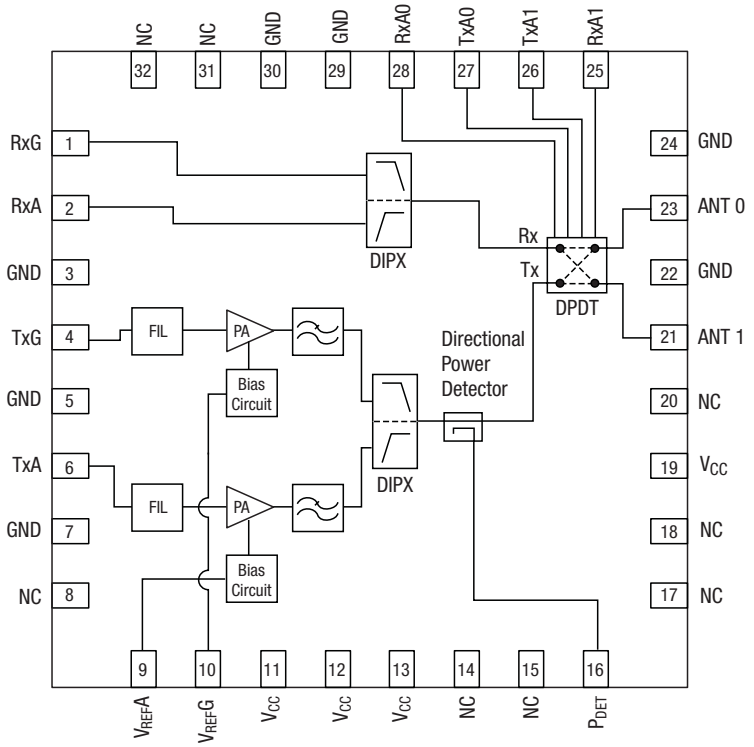
NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Description

The SKY65243-11 Intera FEM contains one complete dual-band transmit/receive chain in a compact RF front-end module. It includes one 5 GHz PA and one 2 GHz PA each with integrated input filtering for 3–4 GHz rejection, and temperature-compensated directional power detector with 20 dB dynamic range. Also included are low loss, high rejection diplexers and a diversity switch which provide high linearity in transmit and low loss in receive paths. All RF ports are matched to 50 Ω.

The SKY65243-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 25 mm^2.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0083

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		-0.3		5.5	V
Reference voltage	$V_{REF}G$, $V_{REF}A$		-0.3		3.6	V
Supply current	I_{CC}				400	mA
Input power	TxG, TxA				10	dBm
Dissipated power	P_O			0.6	1.0	W
Thermal resistence	θ_{JC}				55	°C/W
Moisture sensitivity level	MSL-3				250	°C
Operating temperature range	T_{OP}		-20		85	ºC
Storage temperature range	T_{STO}		-65		150	ºC

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		3	3.3	3.6	V
Reference voltage	$V_{REF}G$		2.8	2.9	3.0	V
Operating temperature	T_{OP}		-10	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, $V_{REF}G$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}A$ = 0 V		180		mA
Total 802.11g Tx quiescent current	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current	I_{CC}-b	P_{OUT} = 20 dBm, 11 Mbps CCK $V_{REF}G$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}A$ = 0 V		210		mA
Total 802.11a Tx supply current, T0a or T1a	I_{CC}-a	P_{OUT} = 15 dBm, 54 Mbps OFDM, $V_{REF}A$ = 2.9 V, V_{CC} = 3.3 V $V_{REF}G$ = 0 V		180		mA
Total 802.11a Tx quiescent current, T0g or T1g	I_{CQ}-a	No RF		135		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reference voltage high	$V_{REF}G$–H		2.8	2.9	3.0	V
Reference voltage low	$V_{REF}G$–L		0		0.3	V
Reference current high	$I_{REF}G$–H			5		mA
Reference current low	$I_{REF}G$–L			20		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0084

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	V_{CTL}_on		3	3.3	3.6	V
Control voltage - OFF state	V_{CTL}_off		0		0.2	V
Control current - ON state	I_{CTL}_on	RF ON		10	75	uA
Control current - ON state	I_{CTL}_on	RF OFF		2	20	uA

Truth Table

MODE	RxA0 (V)	RxA1 (V)	TxA0 (V)	TxA1 (V)	V_{CC} (V)
Rx-ANT0	3.3	0	0	0	3.3
Rx-ANT1	0	3.3	0	0	3.3
Tx-ANT0	0	0	3.3	0	3.3
Tx-ANT1	0	0	0	3.3	3.3
TxRx-ANT0	3.3	0	3.3	0	3.3

All other combinations undefined.

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0085

802.11b,g Transmit Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		18		dBm
Compliant output power - b	P_{OUT}_b	11 Mbps CCK		21		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\|S_{21}\|$			27		dB
Small signal gain variation over frequency band	$\Delta\|S_{21}\|$			2		dB
Gain, 3.2–3.3 GHz	$\|S_{21}\|$ - 3.2			0		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output		1		µs
Input return loss	$\|S_{11}\|$	TxA or TxG		-10		dB
Output return loss	$\|S_{22}\|$	Ant0 or Ant1		-8		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\|S_{21}\|$			1.1	1.6	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$	RxG, Ant 0, 1		-15		dB
Antenna to Rx isolation		PA off, switch in Tx–Ant0 (Ant1) mode		23		dB
Antenna to antenna isolation		Isolation between Ant0 and Ant1 parts Switch in any mode		19		dB

802.11b,g Power Detector Specification

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant 0 or Ant 1	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
P_{DET} load impedance				22.5		kΩ
P_{DET} output impedance					3	kΩ
Voltage limits		Over power range	0.1		1.1	V
Voltage range			0.3	0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 KΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0086

802.11a Transmit Specifications

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 3.0 %		16		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 7 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\|S_{21}\|$			25		dB
Small signal gain variation over any 20 MHz band	$\Delta\|S_{21}\|$			2		dB
Gain matching, T0g to A0 vs. T1g to A1	$\|S_{21}\|$ - M	Compared frequency by frequency		2		dB
Gain, 3.2–3.9 GHz	$\|S_{21}\|$ - 3.9			0		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level		0.5		µs
Input return loss	$\|S_{11}\|$	TxA or TxG		-6		dB
Output return loss	$\|S_{22}\|$	Ant 0 or Ant 1		-10		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\|S_{21}\|$			2.5	3	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$	RxG–Ant0, 1		-15		dB
Antenna to Rx isolation	$\|S_{21}\|$	PA off, switch in Tx-Ant0 (Ant1) mode		22		dB
Antenna to antenna isolation	$\Delta\|S_{21}\|$	Isolation between Ant0 and Ant1 paths. Switch in any mode.		19		dB

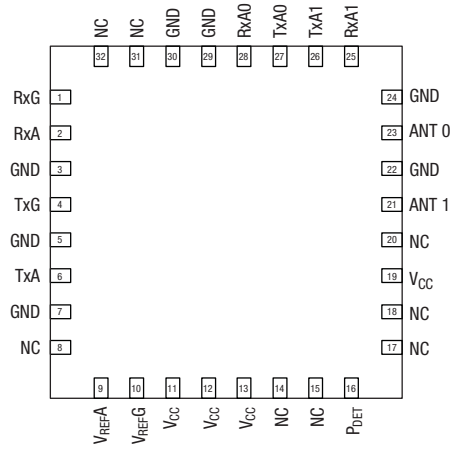
802.11a Power Detector Specification

Conditions: V_{CC} = 3.3 V, V_{REF}A = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

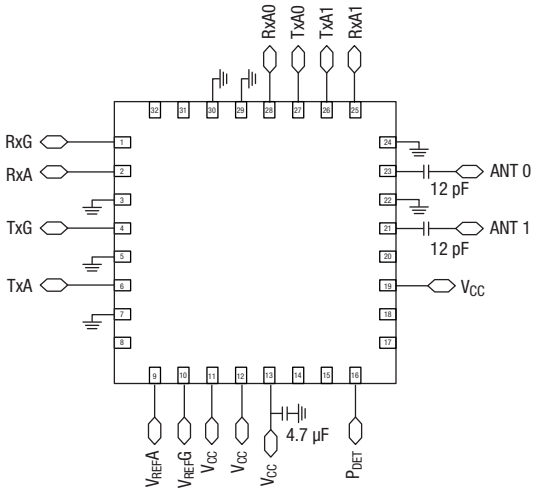
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant 0 or Ant 1	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
P_{DET} load impedance				22.5		kΩ
P_{DET} output impedance					3	kΩ
Voltage limits		Over power range	0.1		1.1	V
Voltage range			0.3	0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 KΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0087

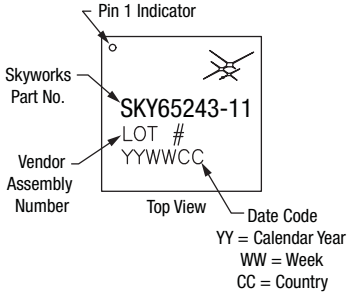
Pin Out (Top View)



Application Circuit



Branding Specifications

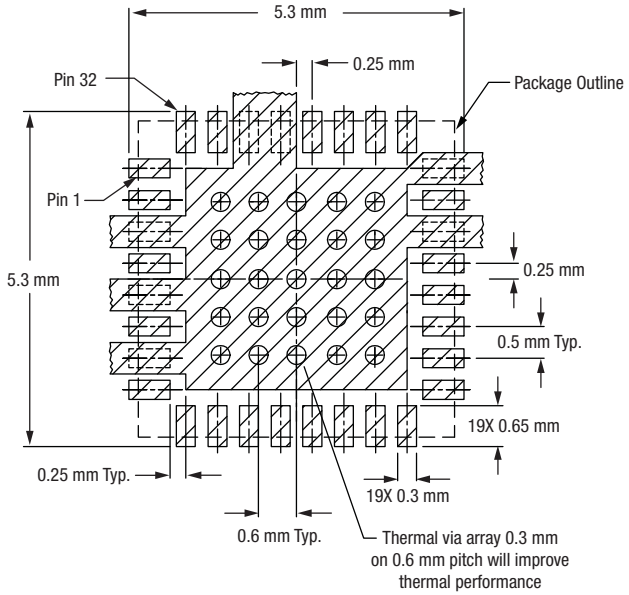


Pin Descriptions

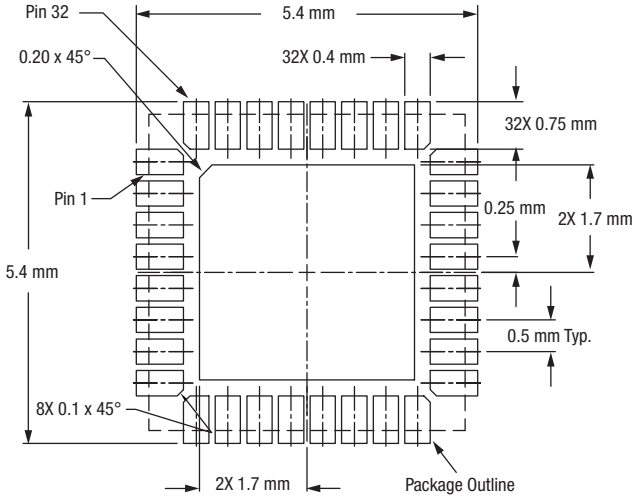
Pin Number	Symbol	Description
1	RxG	Low-band receive output port. Internally matched to 50 Ω and DC blocked.
2	RxA	High-band receive output port. Internally matched to 50 Ω and DC blocked.
3	GND	Ground
4	TxG	Low-band transmit input port. Internally matched to 50 Ω and DC blocked.
5	GND	Ground
6	TxA	High-band transmit input port. Internally matched to 50 Ω and DC blocked.
7	GND	Ground
8	NC	No connection inside the module.
9	$V_{REF}A$	External reference voltage for the high-band PA.
10	$V_{REF}G$	External reference voltage for the low-band PA.
11	V_{CC}	Power supply 3.3 V, A band
12	V_{CC}	Power supply 3.3 V, A band
13	V_{CC}	Power supply 3.3 V, A band
14	NC	No connection inside the module.
15	NC	No connection inside the module.
16	P_{DET}	Directional power detector output.
17	NC	No connection inside the module.
18	NC	No connection inside the module.
19	V_{CC}	Power supply 3.3 V, G band
20	NC	No connection inside the module.
21	Ant 1	Auxiliary antenna RF port. Internally matched to 50 Ω. External DC block cap required.
22	GND	Ground
23	Ant 0	Main antenna RF port. Internally matched to 50 Ω. External DC block cap required.
24	GND	Ground
25	RxA1	Digital control input for DPDT switch
26	TxA1	Digital control input for DPDT switch
27	TxA0	Digital control input for DPDT switch
28	RxA0	Digital control input for DPDT switch
29	GND	Ground
30	GND	Ground
31	NC	No connection inside the module.
32	NC	No connection inside the module.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0088

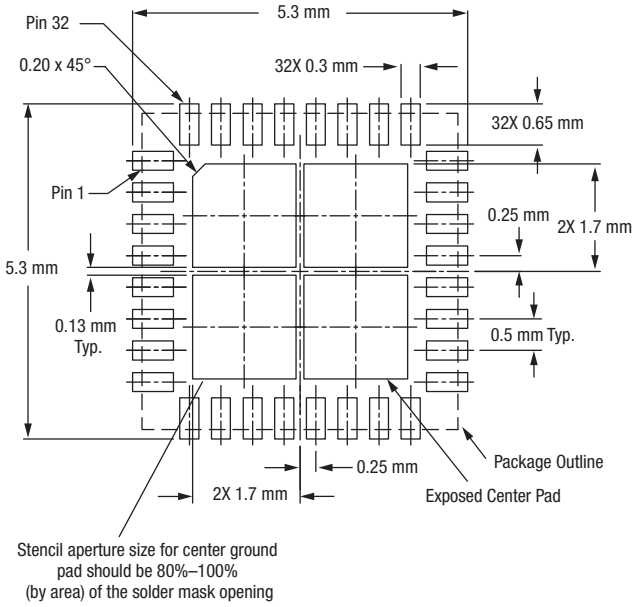
Recommended Footprint



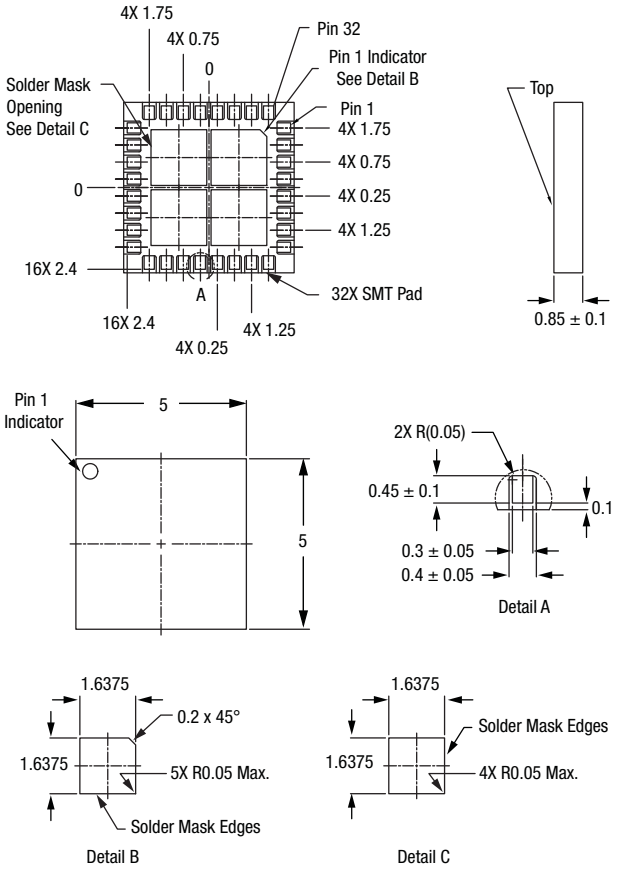
Solder Mask



Stencil Pattern



Package Dimensions



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0089

DATA SHEET

SKY65249-11: WLAN 802.11b, g, n Intera™ Front-End Module

Features

- 2.4 to 2.5 GHz operation
- Cardbus, mini PC1, PCIe and AP applications
- P_{OUT} @ 2.5% EVM (OFDM54): 18 dBm
- Gain: 25 dB
- Integrated PA, filters, directional detector and diversity switch
- Single supply voltage : 3.0 to 3.6 V
- Dual antennas
- Small, ultra thin package 4 x 4 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant

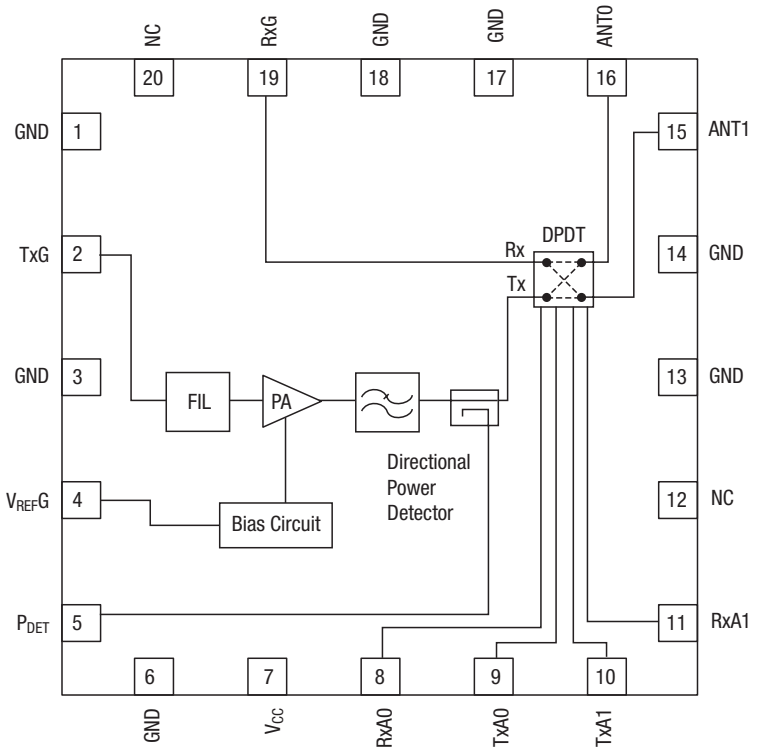
Description

The SKY65249-11 Intera FEM contains one complete 2.4 GHz transmit/receive chain in a compact RF front-end module optimized for single band 2.4–2.5 GHz operation. The SKY65249-11 includes a PA with integrated input filtering for 3.2–3.3 GHz rejection, and temperature-compensated directional power detector with 20 dB dynamic range. Also included are low loss, high rejection harmonic filters and a diversity switch which provide high linearity in transmit and low loss in receive paths.

The SKY65249-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 16 mm^2.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0090

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC}		-0.3		5.5	V
$V_{REF}G$	$V_{REF}G$		-0.3		5.5	V
Tx In	Tx IN				10	dBm
Junction temperature	T_J				150	°C
Dissipated power	P_D			0.6	1.0	W
Thermal resistence	Θ_{JC}				55	°C/W
Moisture sensitivity level	MSL-3				250	°C
Operating temperature range	T_{OP}		-20		85	ºC
Storage temperature range	T_{STO}		-65		150	ºC

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		3	3.3	3.6	V
Reference voltage	$V_{REF}G$		2.8	2.9	3.0	V
Operating temperature	T_{OP}		0	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, $V_{REF}G$ = 2.9 V		180		mA
Total 802.11g Tx quiescent current	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current	I_{CC}-b	P_{OUT} = 20 dBm, 11 Mbps CCK $V_{REF}G$ = 2.9 V		210		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reference voltage high	$V_{REF}G$–H		2.8	2.9	3.0	V
Reference voltage low	$V_{REF}G$–L		0		0.3	V
Reference current high	$I_{REF}G$–H			5		mA
Reference current low	$I_{REF}G$–L			20		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0091

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	V_{CTL}_on		3	3.3	3.6	V
Control voltage - OFF state	V_{CTL}_off		0		0.2	V
Control current - ON state	I_{CTL}_on	RF ON		10	75	uA
Control current - ON state	I_{CTL}_on	RF OFF		2	20	uA

Truth Table

MODE	RxA0 (V)	RxA1 (V)	TxA0 (V)	TxA1 (V)	V_{CC} (V)	V_{REF}G (V)
Rx-ANT0	3.3	0	0	0	3.3	0
Rx-ANT1	0	3.3	0	0	3.3	0
Tx-ANT0	0	0	3.3	0	3.3	2.9
Tx-ANT1	0	0	0	3.3	3.3	2.9
TxRx-ANT0	3.3	0	3.3	0	3.3	2.9

All other conditions not recommended.

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0092

802.11b,g Transmit Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 2.5 %		18		dBm
Compliant output power - b	P_{OUT}_b	11 Mbps CCK		21		dBm
Backed off EVM	BEVM	54 Mbps OFDM, 64 QAM, P_{OUT} = 8 dBm		1.5		%
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\|S_{21}\|$			25		dB
Small signal gain variation over frequency band	$\Delta\|S_{21}\|$			2		dB
Gain, 3.2–3.3 GHz	$\|S_{21}\|$ - 3.2			0		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output			500	ns
Input return loss	$\|S_{11}\|$	Tx In		-10		dB
Output return loss	$\|S_{22}\|$	Ant A or Ant B		-8		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications

Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\|S_{21}\|$			1.1	1.6	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$	RxG, Ant 0, 1		-15		dB
Antenna to Rx isolation		PA off, switch in Tx–Ant0 (Ant1) mode		23		dB
Antenna to antenna isolation		Isolation between Ant0 and Ant1 parts Switch in any mode		19		dB

802.11b,g Power Detector Specification

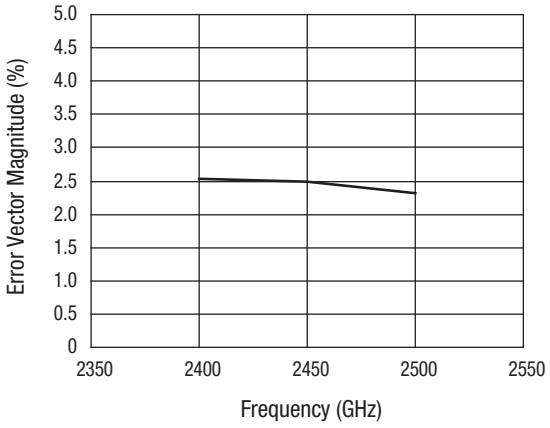
Conditions: V_{CC} = 3.3 V, $V_{REF}G$ = 2.9 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant 0 or Ant 1	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
P_{DET} load impedance				27		kΩ
P_{DET} output impedance					6	kΩ
Voltage limits		Over power range	0.1		1.1	V
Voltage range			0.3	0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

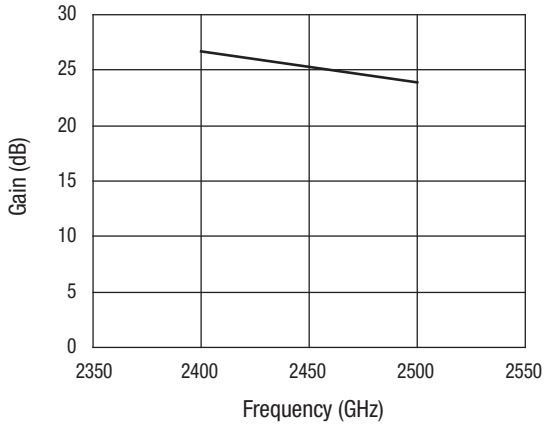
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0093

Typical Performance Data (2.4–2.5 GHz)

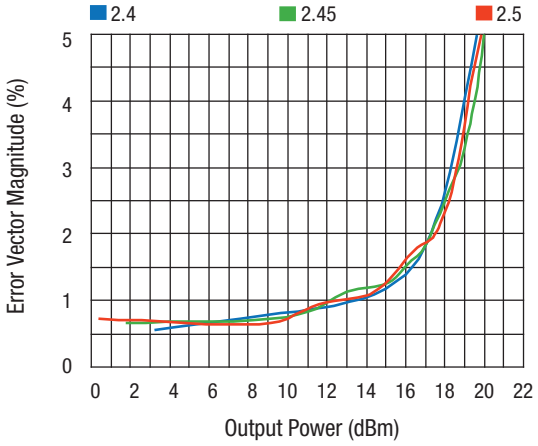
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_O = 50 Ω, unless otherwise noted



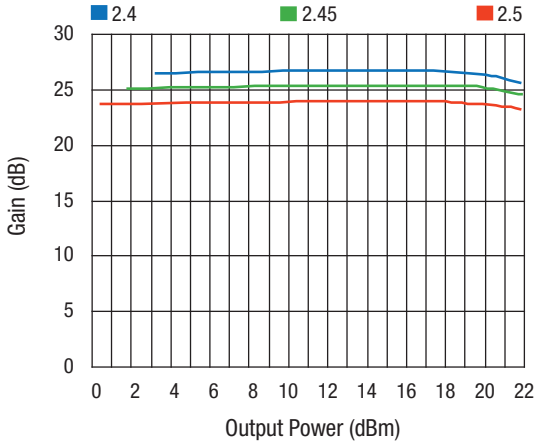
EVM vs. Frequency



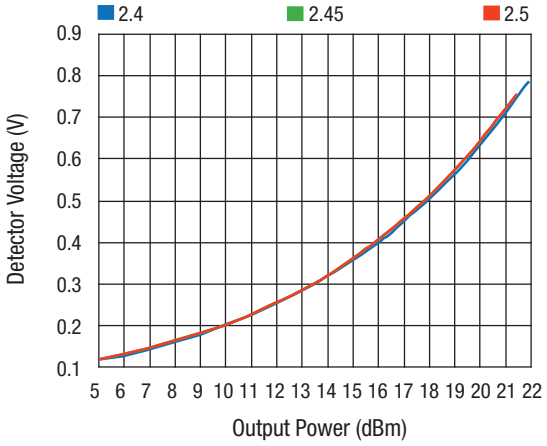
Gain vs. Frequency



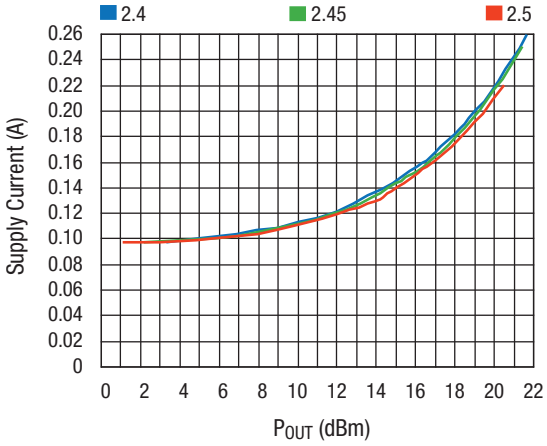
EVM vs. Output Power



Gain vs. Output Power



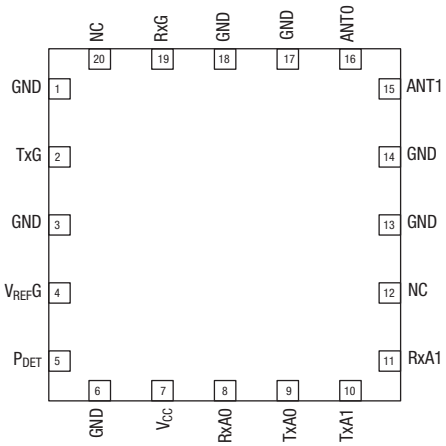
Detector Voltage vs. Output Power



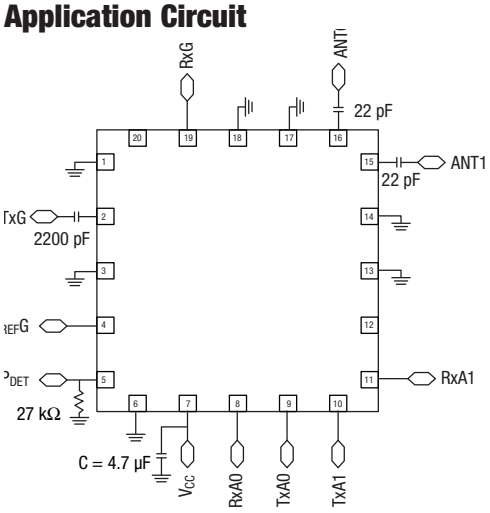
Supply Current vs. Output Power

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0094

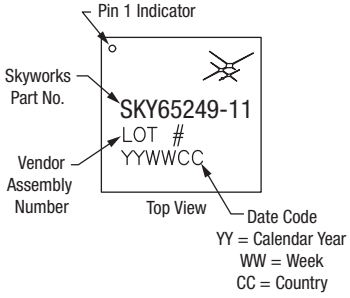
Pin Out



Application Circuit



Branding Specifications



Pin Descriptions

Pin Number	Symbol	Description
1	GND	Ground
2	TxG	Transmit input port. Internally matched to 50 Ω. External DC block required (2200 pF recommended)
3	GND	Ground
4	$V_{REF}G$	External reference voltage for the PA
5	P_{DET}	Directional power detector output
6	GND	Ground
7	V_{CC}	Power supply 3.3 V
8	RxA0	Digital control input DPDT
9	TxA0	Digital control input DPDT
10	TxA1	Digital control input DPDT
11	RxA1	Digital control input DPDT
12	NC	Not connected to anything externally
13	GND	Ground
14	GND	Ground
15	Ant1	Auxiliary antenna port. Internally matched to 50 Ω. External DC block required (22 pF recommended)
16	Ant0	Main antenna port. Internally matched to 50 Ω. External DC block required (22 pF recommended)
17	GND	Ground
18	GND	Ground
19	RxG	Receive output port. Internally matched to 50 Ω and DC blocked. No external DC block required
20	NC	Not connected to anything externally

Recommended Solder Reflow Profiles

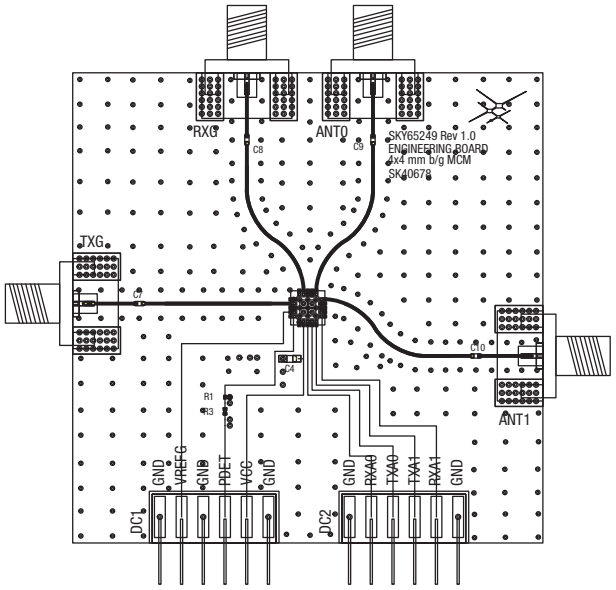
Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

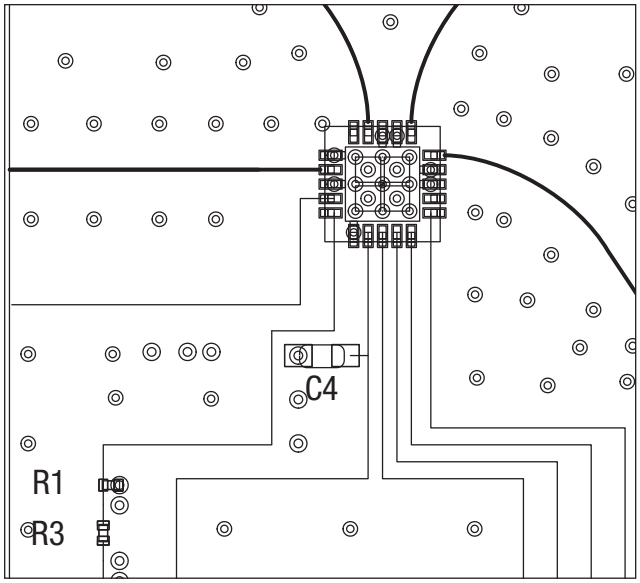
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0095

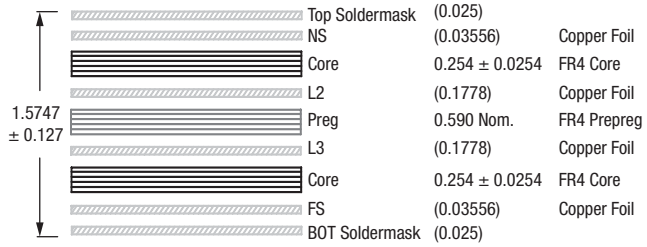
Test Evaluation Board



Test Evaluation Board (Center Enlarged)



Layer Stackup



Dimensions in mm.

Design Information

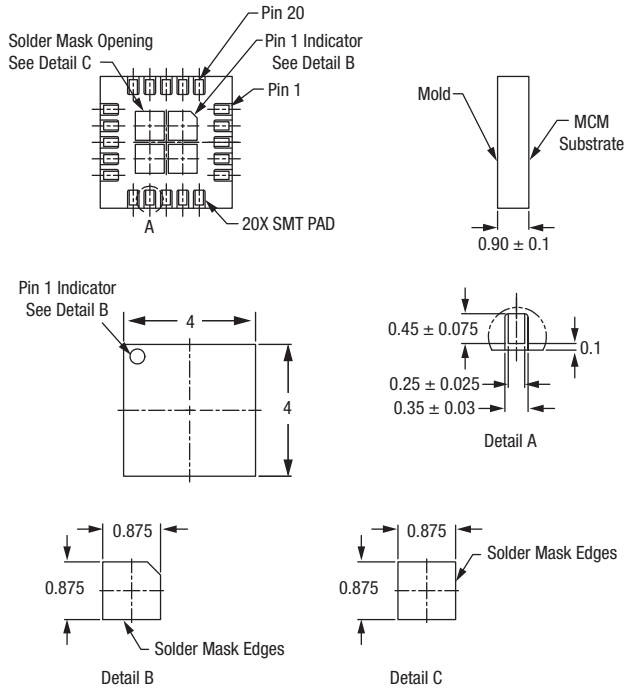
RF line width	19.3 (0.49)	mils (mm)
DC line width	11.3 (0.29)	mils (mm)
Dielectric constant	4.2	

SMT BOM

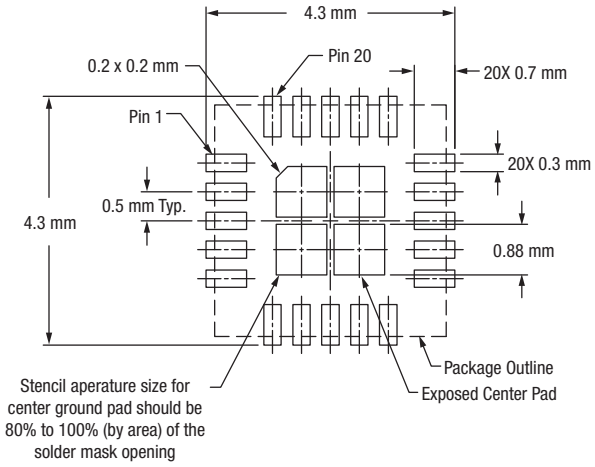
Ref Des	Qty.	Description	Value	Tolerance	Size
C4	1	Capacitor	4.7 µF	± 5%	SMT 0603
C7	1	Capacitor	2200 pF	± 5%	SMT 0402
C8	1	Resistor	0 Ω	± 5%	SMT 0402
C9	1	Capacitor	22 pF	± 5%	SMT 0402
C10	1	Capacitor	22 pF	± 5%	SMT 0402
R1	1	Resistor	27 kΩ	± 5%	SMT 0201
R3	1	Resistor	0 Ω	± 5%	SMT 0201

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0096

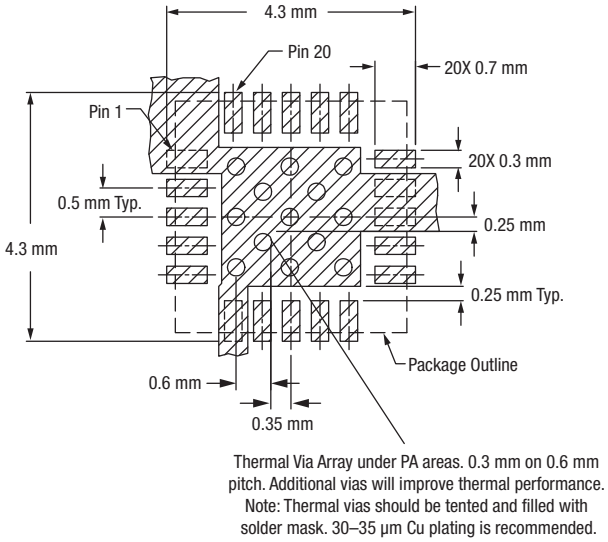
Package Dimensions



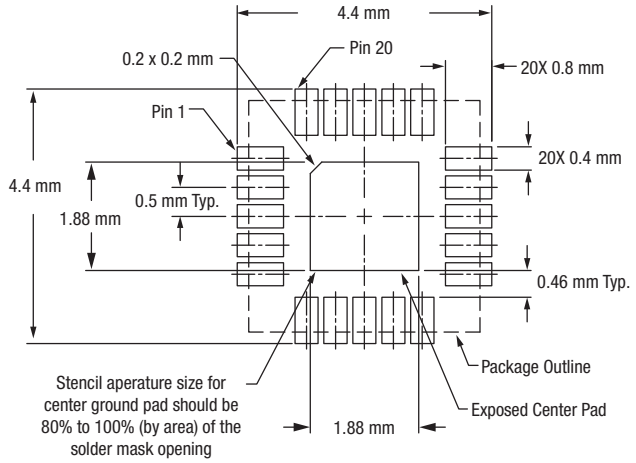
Stencil Aperture (Top View)



Footprint (Top View)



Solder Mask Opening (Top View)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0097

ADVANCED DATA SHEET

SKY65256-11: WLAN 802.11a, b, g, n Dual-Band, Front-End Module Single Antenna

Features

- 2.4 to 2.5 GHz and 4.9 to 5.9 GHz Operation
- Cardbus, mini PCI, PCIe and AP applications
- P_{OUT} @ 3.0% EVM (OFDM54): 16 dBm (a), 21 dBm (b), 18 dBm (g)
- Gain: 24 dB (a), 27 dB (b,g)
- Integrated PA, filters, directional detector and SPDT switch
- Single supply voltage : 3.0 to 3.6 V
- Single antenna
- Small, ultra thin package 5 x 6 x 0.9 mm
- Lead (Pb)-free and RoHS-compliant

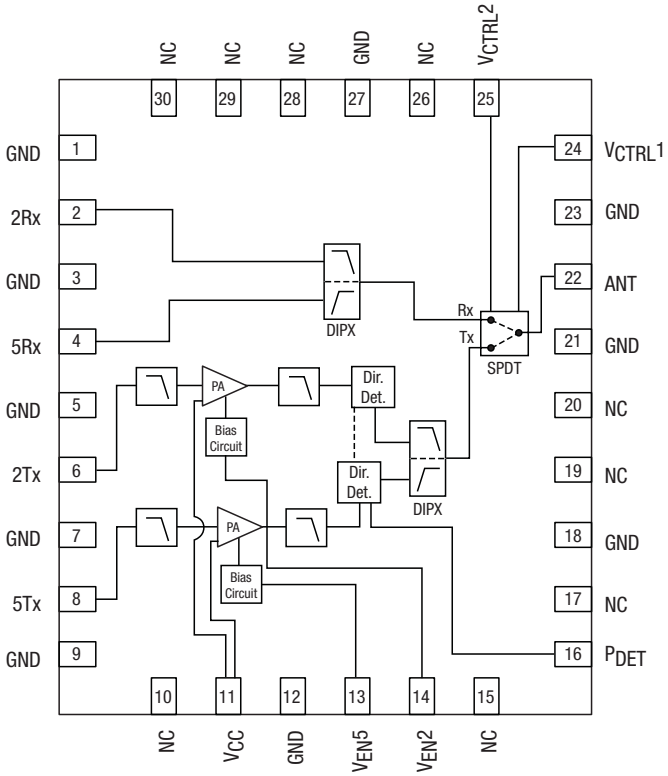
NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Description

The SKY65256-11 FEM contains one complete dual-band transmit/receive chain in a compact RF front-end module. It includes one 5 GHz PA and one 2 GHz PA each with integrated input filtering for 3–4 GHz rejection, and temperature-compensated directional power detector with 20 dB dynamic range. Also included are low loss, high rejection diplexers and a diversity switch which provide high linearity in transmit and low loss in receive paths. All RF ports are matched to 50 Ω.

The SKY65256-11 is packaged in a lead (Pb)-free, RoHS-compliant laminate package, which measures 30 mm^2.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0098

Absolute Maximum Ratings

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC}		-0.3		5.5	V
$V_{EN}2$, $V_{EN}5$			-0.3		3.6	V
2Tx, 5Tx					10	dBm
Operating temperature range	T_{OP}		-20		85	ºC
Storage temperature range	T_{STO}		-65		150	ºC

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

Recommended Operating Conditions

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}		3	3.3	3.6	V
Reference voltage	$V_{EN}2$, $V_{EN}5$		2.8	2.9	3.0	V
Operating temperature	T_{OP}		-10	25	85	ºC

DC Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Total 802.11g Tx supply current	I_{CC}-g	P_{OUT} = 18 dBm, 54 Mbps OFDM, $V_{EN}2$ = 2.9 V, V_{CC} = 3.3 V $V_{EN}5$ = 0 V		180		mA
Total 802.11g Tx quiescent current	I_{CQ}-g	No RF		95		mA
Total 802.11b Tx supply current	I_{CC}-b	P_{OUT} = 20 dBm, 11 Mbps CCK $V_{EN}2$ = 2.9 V, V_{CC} = 3.3 V $V_{EN}5$ = 0 V		220		mA
Total 802.11a Tx supply current, T0a or T1a	I_{CC}-a	P_{OUT} = 15 dBm, 54 Mbps OFDM, $V_{EN}5$ = 2.9 V, V_{CC} = 3.3 V $V_{EN}2$ = 0 V		170		mA
Total 802.11a Tx quiescent current, T0g or T1g	I_{CQ}-a	No RF		130		mA

PA Logic Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reference voltage high		$V_{EN}2$, $V_{EN}5$	2.8	2.9	3.0	V
Reference voltage low		$V_{EN}2$, $V_{EN}5$	0		0.3	V
Reference current high		$I_{EN}2$, $I_{EN}5$		5		mA
Reference current low		$I_{EN}2$, $I_{EN}5$		20		µA

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0099

Switch Characteristics

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Control voltage - ON state	$V_{CTL_}$on		3	3.3	3.6	V
Control voltage - OFF state	$V_{CTL_}$off		0		0.2	V
Control current - ON state	$I_{CTL_}$on	RF ON		10	75	uA
Control current - ON state	$I_{CTL_}$on	RF OFF		2	20	uA

Truth Table

Mode	V_{CTRL}1 (V)	V_{CTRL}2 (V)	V_{EN}5 (V)	V_{EN}2 (V)	V_{CC} (V)
5Tx to ANT	0	3	2.9	0	3.3
2Tx to ANT	0	3	0	2.9	3.3
ANT to 5Rx	3	0	0	0	3.3
ANT to 2Rx	3	0	0	0	3.3

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 employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0100

802.11b,g Transmit Specifications

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Linear output power - g	Plin_g	54 Mbps OFDM, 64 QAM, EVM = 3.0 %		18		dBm
Compliant output power - b	$P_{OUT\_}b$	11 Mbps CCK		21		dBm
1 dB compression point	$P_{1\ dB}$		22.5	25		dBm
Small signal gain	$\|S_{21}\|$			27		dB
Small signal gain variation over frequency band	$\Delta\|S_{21}\|$			2		dB
Gain, 3.2–3.3 GHz	$\|S_{21}\|$ - 3.2			0		dB
Gain, 1.6 GHz	$\|S_{21}\|$ - 1.6			15		dB
Harmonics	2f, 3f	P_{OUT} = 18 dBm, 1 Mbps, CCK, 802.11b		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output			500	ns
Input return loss	$\|S_{11}\|$			-10		dB
Output return loss	$\|S_{22}\|$			-8		dB
Stability	STAB	$P_{OUT} \leq$ 18 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11b,g Receive Specifications

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		2.4		2.5	GHz
Insertion loss	$\|S_{21}\|$			1.6	2.2	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$			-15		dB
Antenna to Rx isolation		PA off		23		dB

802.11b,g Power Detector Specification

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Truth Table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant 0 or Ant 1	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
Voltage limits		Over power range	0.1		1.1	V
Voltage range				0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0101

802.11a Transmit Specifications

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Linear output power - a	Plin_a	54 Mbps OFDM, 64 QAM, EVM = 3.0 %		16		dBm
1 dB compression point	$P_{1\ dB}$		21.5	24		dBm
Small signal gain	$\|S_{21}\|$			25		dB
Small signal gain variation over any 20 MHz band	$\Delta\|S_{21}\|$			2		dB
Gain, 7.25 GHz	$\|S_{21}\|$ - 7.25			7		dB
Gain, 3.2–3.9 GHz	$\|S_{21}\|$ - 3.9			0		dB
Gain, 1.6 GHz	$\|S_{21}\|$ - 1.6			5		dB
Harmonics	2f, 3f	P_{OUT} = 15 dBm, 54 Mbps OFDM		-50	-42	dBm/MHz
Tx switching time	t_sw	50 % of V_{CTL} to 90/10 % RF output power level			500	nS
Input return loss	$\|S_{11}\|$			-6		dB
Output return loss	$\|S_{22}\|$			-10		dB
Stability	STAB	$P_{OUT} \leq$ 15 dBm, load VSWR = 3:1	All non-harmonically related outputs less than -50 dBc/1 MHz			

802.11a Receive Specifications (Rx Chain 0, Rx Chain 1)

Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	F		4.9		5.85	GHz
Insertion loss	$\|S_{21}\|$			2.5	3	dB
Input/output return loss	$\|S_{11}\|$, $\|S_{22}\|$			-15		dB
Antenna to Rx isolation	$\|S_{22}\|$	PA off	55		dB	

802.11a Power Detector Specification

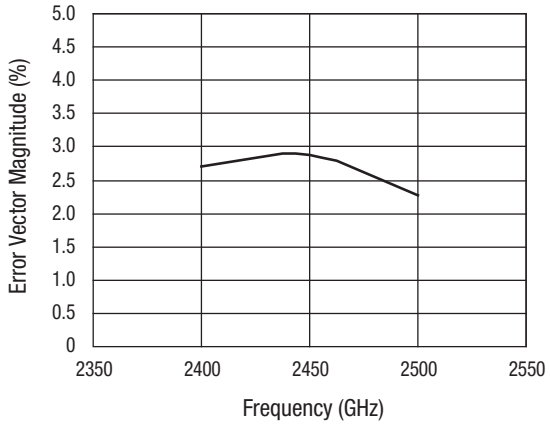
Conditions: V_{CC} = 3.3 V, T_{OP} = 25 ºC. PA enables and control voltages set according to Mode Control Voltage table. Measurements made on Skyworks EVB with all losses de-embedded. All unused ports terminated into 50 Ω unless otherwise specified.

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power detect range	PDR	Ant 0 or Ant 1	5		22	dBm
Power detector accuracy	PDacc2	Over 3:1 VSWR		±1		dB
Voltage limits		Over power range	0.1		1.1	V
Voltage range				0.6		V
Power detector -3 dB corner frequency	LPF-3 dB	10 kΩ load	270	300	400	kHz

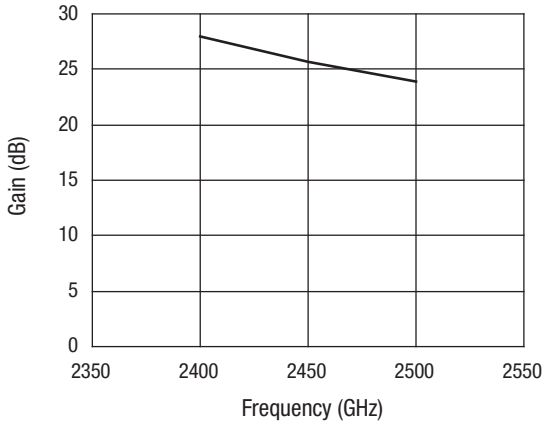
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0102

Typical Performance Data (2.4–2.5 GHz)

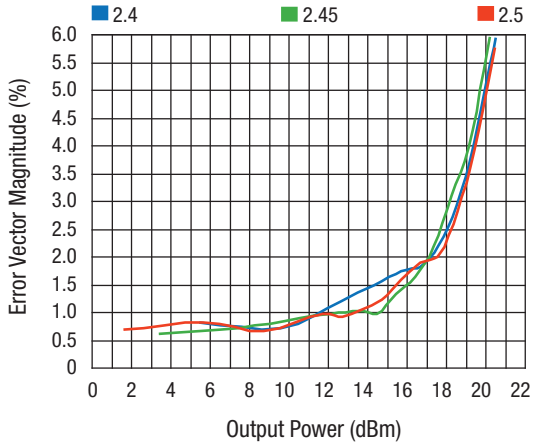
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_O = 50 Ω, unless otherwise noted



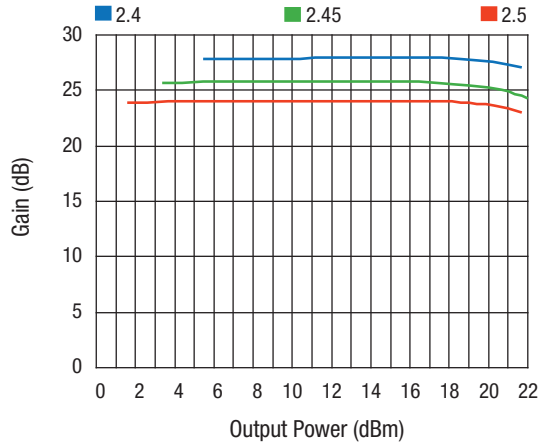
EVM vs. Frequency



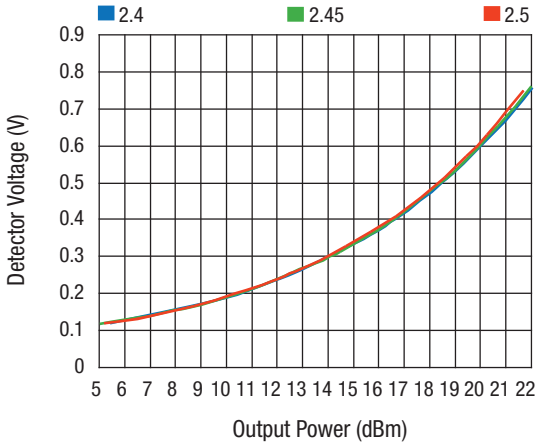
Gain vs. Frequency



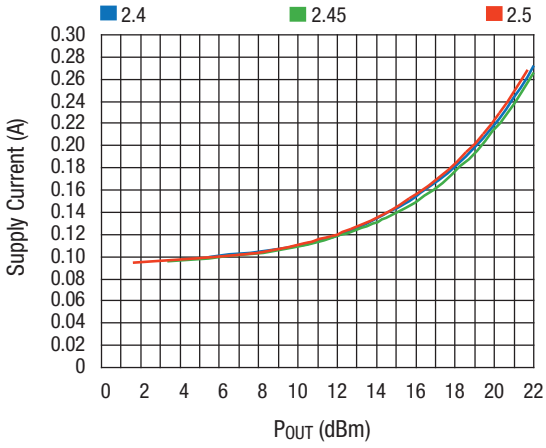
EVM vs. Output Power



Gain vs. Output Power



Detector Voltage vs. Output Power

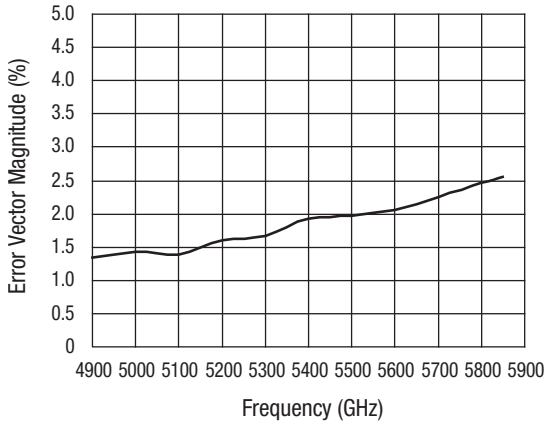


Supply Current vs. Output Power

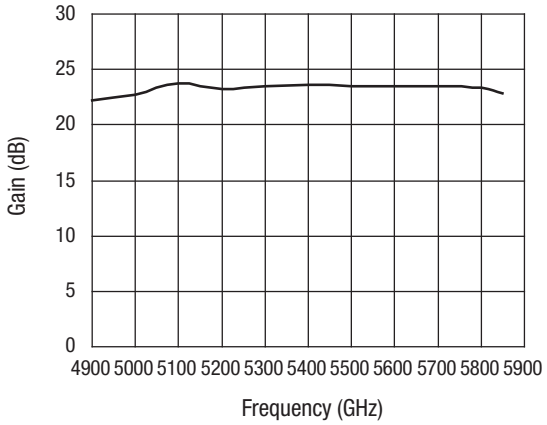
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0103

Typical Performance Data (4.9–5.85 GHz)

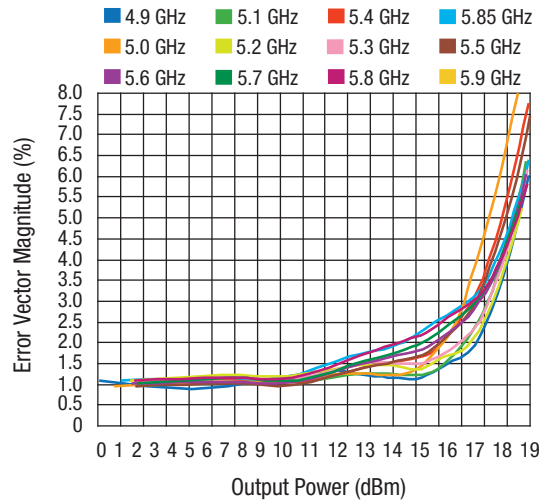
V_{CC} = 3.3 V, T_A = 25 °C, OFDM 54 Mbps, Z_0 = 50 Ω, unless otherwise noted



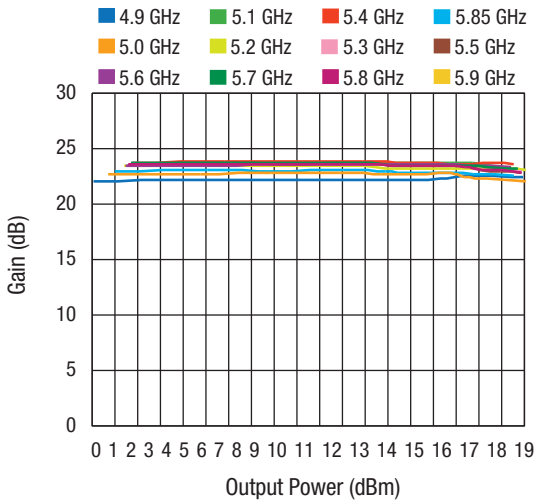
EVM vs. Frequency



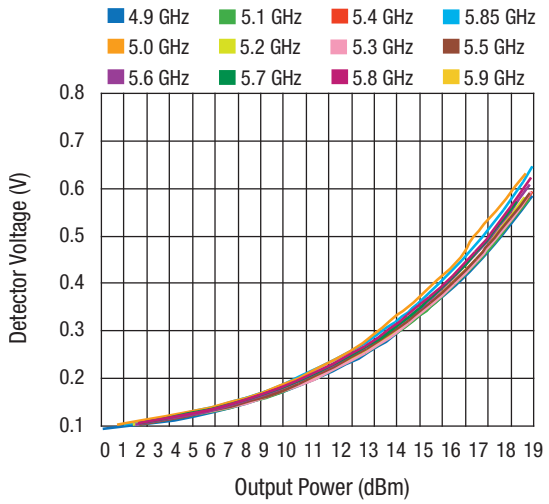
Gain vs. Frequency



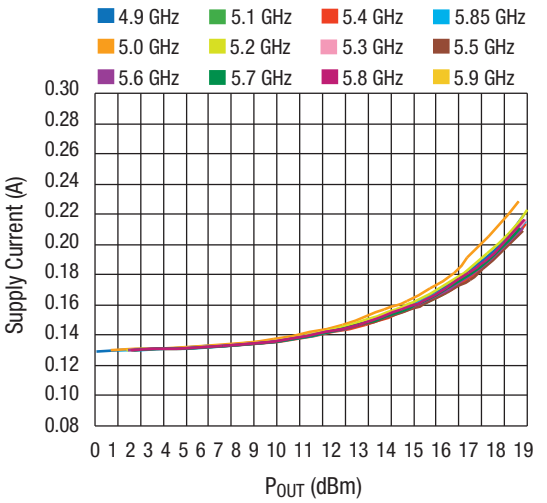
EVM vs. Output Power



Gain vs. Output Power



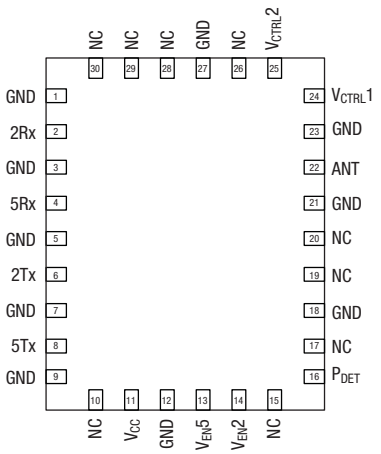
Detector Voltage vs. Output Power



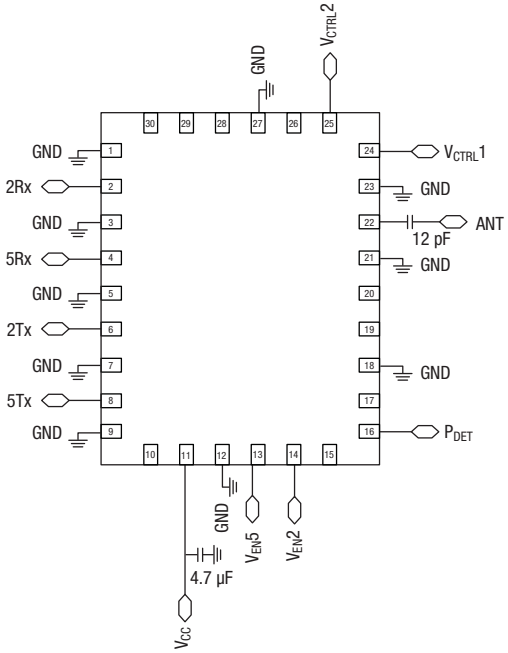
Supply Current vs. Output Power

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0104

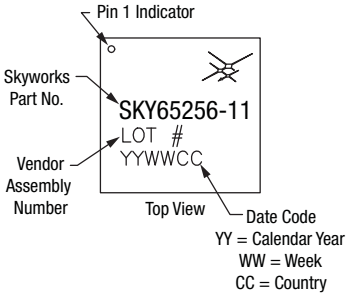
Pin Out (Top View)



Application Circuit



Branding Specifications

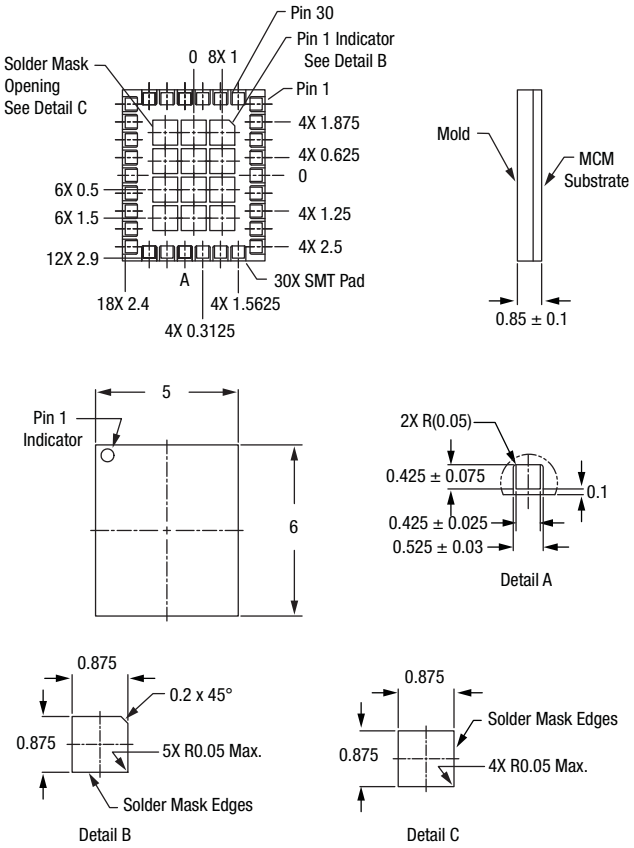


Pin Descriptions

Pin Number	Symbol	Description
1	GND	Ground
2	2Rx	Low-band receive output port. Internally matched to 50 Ω and DC blocked. No external DC block required.
3	GND	Ground
4	5Rx	High-band receive output port. Internally matched to 50 Ω and DC blocked. No external DC block required.
5	GND	Ground
6	2Tx	Low-band transmit input port. Internally matched to 50 Ω and DC blocked. No external DC block required.
7	GND	Ground
8	5Tx	High-band transmit input port. Internally matched to 50 Ω f and DC blocked. No external DC block required.
9	GND	Ground
10	NC	No connection inside the module.
11	V_{CC}	Power supply 3.3 V
12	GND	Ground
13	$V_{EN}5$	External reference voltage for the high-band PA.
14	$V_{EN}2$	External reference voltage for the low-band PA.
15	NC	No connection inside the module.
16	P_{DET}	Directional power detector output.
17	NC	No connection inside the module.
18	GND	Ground
19	NC	No connection inside the module.
20	NC	No connection inside the module.
21	GND	Ground
22	Ant	Antenna RF port. Internally matched to 50 Ω. External DC block required.
23	GND	Ground
24	$V_{CTL}1$	Digital control input for SPDT switch
25	$V_{CTL}2$	Digital control input for SPDT switch
26	GND	Ground
27	GND	Ground
28	NC	No connection inside the module.
29	NC	No connection inside the module.
30	NC	No connection inside the module.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0105

Package Dimensions



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

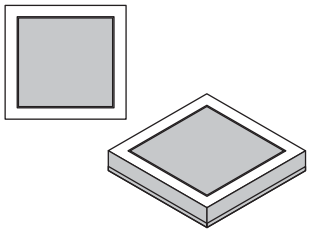
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0106

DATA SHEET

SC Series: MIS Chip Capacitors

Features

- Readily available from stock
- High reliability silicon oxide–nitride dielectric
- Low loss—typically 0.04 dB in a 50 Ω system
- Operation through 26 GHz
- Wide temperature operation
- Available lead (Pb)-free, RoHS-compliant, and Green



Description

Skyworks MIS Chip Capacitors are available in a wide range of sizes and capacitance values. They are frequently used in applications requiring DC blocking, RF bypassing, or as a fixed capacitance tuning element in filters, oscillators, and matching networks. The devices have a dielectric composed of thermally grown silicon dioxide over which a layer of silicon nitride is deposited. This dielectric possesses a low temperature coefficient of capacitance and very high insulation resistance. The devices also exhibit excellent long-term stability making them suitable for high-reliability applications. The capacitors have a high dielectric breakdown which permits the use of thin dielectrics resulting in large capacitance per unit area. The temperature coefficient is less that 50 ppm/°C, and operation is suitable from -65 °C to 200 °C. Compared to ceramic capacitors, Skyworks MIS chip capacitors offer higher Q, and a lower insertion loss of 0.04 dB, in a 50 Ω system. Insulation resistance is greater than 10^5 M Ω. To accommodate high-volume automated assembly methods, wafers can be supplied on expanded film frame. To reduce cost, chips can be supplied packaged in vials with sample testing only. Packaging in waffle packs with 100% electrical test and visual inspection is available.

NEW

Skyworks Green™ products are lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, and are free from antimony trioxide and brominated flame retardants.

Electrical Specifications

Capacitance range: 0.8 to 1000 pF

Temperature coefficient: 50 ppm/°C typical

Capacitance tolerance: ±20%

Operating temperature: -65 °C to +200 °C

Dielectric withstanding voltage: 100 V

Insulation resistance: 10^5 megohms typical

Leakage current: typ. < 1 nA

Absolute Maximum Ratings

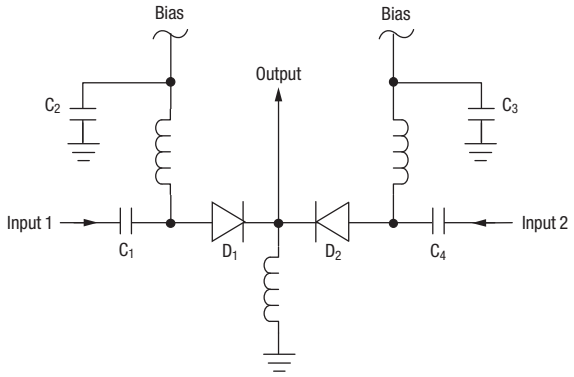
Characteristic	Value
Operating temperature range (T_{OP})	-65 °C to +200 °C
Storage temperature range (T_{STG})	-65 °C to +200 °C
Dielectric withstanding voltage	100 V

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0107

Typical SPDT Switch



C_2, C_3 — Chip MIS capacitor
C_1, C_4 — Chip or beam-lead MIS capacitor
D_1, D_2 DSG9500 beam-lead PIN diode

Example

Part Number Structure — SCXXXXYYZZ

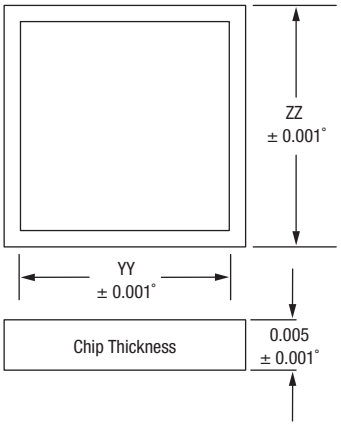
where:

SC = Silicon Capacitor

XXXX = Capacitance (pF)

YY = Square Contact Size (mils)

ZZ = Square Chip Size (mils)



Performance Data

Tests on typical MIS capacitors at L and S band show insertion loss to be 1/2 to 1/3 that of equivalent ceramic-type capacitors, without any of the associated resonance problems. Power tests indicate that the only limitation is the actual breakdown voltage of the device (see data section). A typical insertion loss versus frequency graph is shown in Figure 1. This data is taken from an actual test circuit with series mounted beam-lead or chip capacitors on a 50 Ω microstrip transmission line. The apparent higher loss at lower frequencies on the lower capacitance units is strictly due to the capacitive reactance of the capacitor.

Electrical Specifications

Part Number	Capacitance (±20%) pF	Chip Dimensions (±1 mil)
SC00080912	0.8	9 mil pad/12 mil chip
SC00120912	1.2	9 mil pad/12 mil chip
SC00180912	1.8	9 mil pad/12 mil chip
SC00260912	2.6	9 mil pad/12 mil chip
SC00380912	3.8	9 mil pad/12 mil chip
SC00560912	5.6	9 mil pad/12 mil chip
SC00680912	6.8	9 mil pad/12 mil chip
SC00820710	8.2	7 mil pad/10 mil chip
SC00821518	8.2	15 mil pad/18 mil chip
SC01000710	10	7 mil pad/10 mil chip
SC01000912	10	9 mil pad/12 mil chip
SC01001518	10	15 mil pad/18 mil chip
SC01501518	15	15 mil pad/18 mil chip
SC02201518	22	15 mil pad/18 mil chip
SC03301518	33	15 mil pad/18 mil chip
SC04701518	47	15 mil pad/18 mil chip
SC06801518	68	15 mil pad/18 mil chip
SC10002430	100	24 mil pad/30 mil chip
SC33303440	333	34 mil pad/40 mil chip
SC50004450	500	44 mil pad/50 mil chip
SC99906068	1000	60 mil pad/68 mil chip

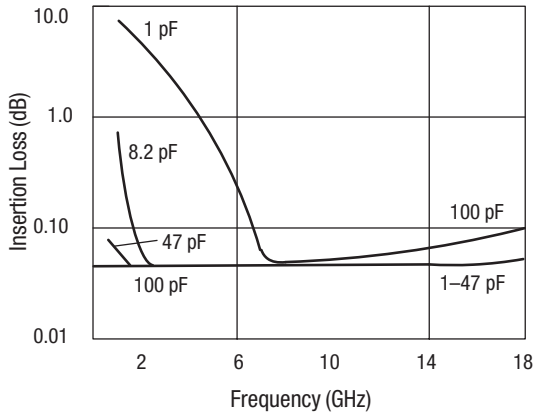


Figure 1. Typical Insertion Loss vs. Frequency (50 Ω System)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0108

Figures 4, 8,

PRELIMINARY DATA SHEET

SKY73025: 2300 – 2700 MHz High Gain and Linearity Diversity Downconversion Mixer

Applications

- 2G/3G base station transceivers:
  - GSM/EDGE, CDMA, UMTS/WCDMA
- WiFi (802.11)
- WiMAX (802.16)
- 3GPP long-term evolution
- Land mobile radio
- Wireless Local Loop
- High performance radio links
- Private mobile radio

Features

- Operating frequency range: 2300 to 2700 MHz
- IF frequency range: 50 to 500 MHz
- Conversion gain: 8.6 dB
- Input IP3: +23.5 dBm
- Output IP3: +32.1 dBm
- Noise Figure: 9.8 dB
- Integrated LO drivers
- Integrated low loss RF baluns
- High linearity IF amplifiers
- On-chip SPDT LO switch (greater than 45 dB LO-to-LO isolation)
- Small, MCM (36-pin, 6 x 6 mm) Pb-free package (MSL3, 260 °C per JEDEC J-STD-020)

NEW

Skyworks offers lead (Pb)-free RoHS (Restriction of Hazardous Substances) compliant packaging.

Description

The SKY73025 is a fully integrated diversity mixer that includes Local Oscillator (LO) drivers, an LO switch, high linearity mixers, and large dynamic range Intermediate Frequency (IF) amplifiers. Low loss RF baluns have also been included to reduce design complications and lower system cost.

The SKY73025 features an input IP3 of +23.5 dBm and a Noise Figure (NF) of 9.8 dB, making the device an ideal solution for high dynamic range systems such as 2G/3G base station receivers. The LO switch provides more than 45 dB of isolation between LO inputs and supports the switching time required for GSM/EDGE base stations.

The SKY73025 is manufactured using a robust silicon BiCMOS process and has been designed for optimum long-term reliability. The SKY73025 diversity downconversion mixer is provided in a compact, 36-pin 6 x 6 mm Multi-Chip Module (MCM). 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.

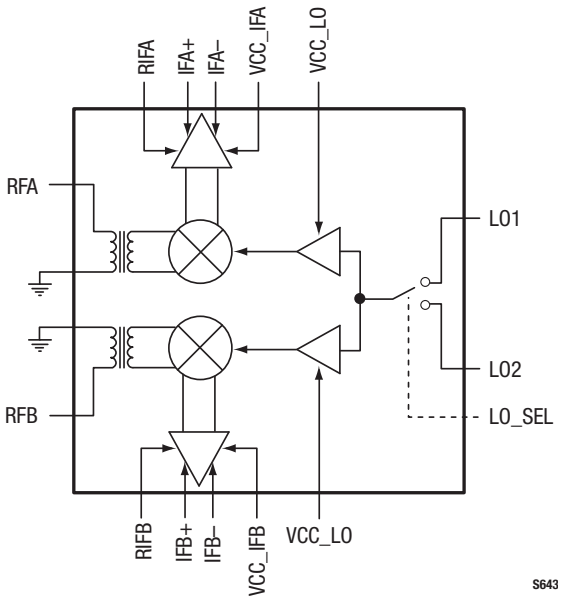


Figure 1. SKY73025 Block Diagram

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0110

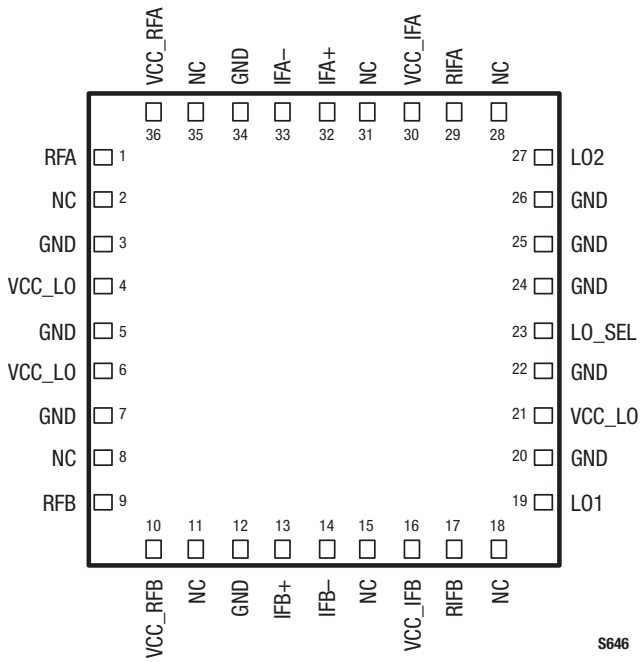


Figure 2. SKY73025 Pinout – 36-Pin MCM

Table 1. SKY73025 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RFA	Channel A RF input	19	LO1	Local oscillator 1 input
2	NC	No connect	20	GND	Ground
3	GND	Ground	21	VCC_LO	DC supply, +5 V
4	VCC_LO	DC supply, +5 V	22	GND	Ground
5	GND	Ground	23	LO_SEL	Local oscillator select switch control
6	VCC_LO	DC supply, +5 V	24	GND	Ground
7	GND	Ground	25	GND	Ground
8	NC	No connect	26	GND	Ground
9	RFB	Channel B RF input	27	LO2	Local oscillator 2 input
10	VCC_RFB	Channel B RF DC supply, +5 V	28	NC	No connect
11	NC	No connect	29	RIFA	Channel A IF bias adjust
12	GND	Ground	30	VCC_IFA	Channel A IF DC supply, +5 V
13	IFB+	Positive channel B IF output	31	NC	No connect
14	IFB–	Negative channel B IF output	32	IFA+	Positive channel A IF output
15	NC	No connect	33	IFA–	Negative channel A IF output
16	VCC_IFB	Channel B IF DC supply, +5 V	34	GND	Ground
17	RIFB	Channel B IF bias adjust	35	NC	No connect
18	NC	No connect	36	VCC_RFA	Channel A RF DC supply, +5 V

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0111

Functional Description

The SKY73025 is a high gain diversity mixer, optimized for base station receiver applications. The device consists of two diversity channels (A and B), each consisting of a low loss RF balun, high linearity passive mixer, and a low noise IF amplifier.

Two LO amplifiers (independent of channels A and B) are also included that allow the SKY73025 to connect directly to the output of a Voltage Controlled Oscillator (VCO). This eliminates the extra gain stages needed by most discrete passive mixers. A Single Pole, Double Throw (SPDT) switch has been included to select between two different LO inputs for frequency hopping applications (i.e., GSM).

RF Baluns and Passive Mixer

The RF baluns provide a single ended input, which can easily be matched to 50 Ω using a simple external matching circuit. The RF baluns offer very low loss, and excellent amplitude and phase balance.

The high linearity SKY73025 is a passive, double balanced mixer that provides a very low conversion loss and an excellent 3rd Order Input Intercept Point (IIP3).

Additionally, the balanced nature of the mixer provides for high port-to-port isolation.

LO Buffers and SPDT LO Switch

The LO buffers allow the input power of the SKY73025 to be in the range of ±6 dBm. The LO section is optimized for low-side LO injection. However, each of the two LOs can be driven over a wide frequency range with only slight degradation in performance.

A high isolation SPDT switch allows the SKY73025 to be used for frequency hopping applications. This switch provides greater than 45 dB of LO1 to LO2 isolation:

LO_SEL Input	LO Path Selected
High	LO1 (pin 19) enabled
Low	LO2 (pin 27) enabled

For applications that do not require frequency hopping, LO_SEL is fixed to one state and the appropriate LO input is used. An internal pull-down resistor enables the LO2 input.

IF Amplifier

The SKY73025 includes high dynamic range IF amplifiers that follow the passive mixers in the signal path. The outputs require a supply voltage connection using inductive chokes. These choke inductors should be high-Q and have the ability to handle 200 mA or greater.

A simple matching network allows the output ports to be matched to a balanced 200 Ω impedance. The IF amplifiers are optimized for IF frequencies between 50 and 500 MHz. The IF amplifiers can be operated outside of this range, but with a slight degradation in performance.

The RIFA and RIFB pins (29 and 17, respectively) can be connected to external resistors (R1 and R2 – see Figure 3) to reduce the IF amplifier bias current. When a resistor is connected to pin 29 (R2), the Channel A IF amplifier current is reduced. When a resistor is connected to pin 17 (R1), the Channel B IF amplifier current is reduced. The total amount of current reduced for Channel A and B IF amplifiers is the amount of mixer current that is reduced.

Table 2 shows the change in Channel A and/or B amplifier current from using either of three different external resistors.

For example, if a 10 kΩ resistor is used on pin 29 and a 5.1 kΩ resistor is used on pin 17, the Channel A IF amplifier current is reduced by 7 mA and the Channel B IF amplifier current is reduced by 14 mA. The total mixer current is reduced by 21 mA (7 mA + 14 mA).

Note that the use of any external resistors on either of these two pins also degrades IIP3 performance. Skyworks recommends using external resistors no smaller than 1 kΩ.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY73025 are provided in Table 3 and the recommended operating conditions in Table 4. Electrical characteristics for the SKY73025 are provided in Table 5.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0112

Table 2. IF Amplifier Bias Current Adjustment

External Resistor Connected to Pin 17 and/or Pin 29 (kΩ)	Channel A and/or Channel B IF Amplifier Bias Current Change (mA)
No external resistor	0
10	–7
5.1	–14
2.2	–33

Note: The resistor values listed here were those tested. Other resistor values can be used with similar reductions in bias current.

Table 3. SKY73025 Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage, +5 V	VCC	4.5	5.5	V
Supply current	I_{CC}		440	mA
RF input power	P_{RF}		+20	dBm
LO input power	P_{LO}		+20	dBm
Operating case temperature	T_C	–40	+85	C
Junction temperature	T_J		+150	C
Storage case temperature	T_{STG}	–40	+125	C

Notes: 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.

Nominal thermal resistance (junction to center ground pad) is 5.1 C/W.

Table 4. SKY73025 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage, +5 V (VCC1 – VCC7)	VCC	4.75	5.00	5.25	V
Supply current	I_{CC}		375		mA
LO input power	P_{LO}	–6	0	+6	dBm
LO select input: high low	 LO_SEL_H LO_SEL_L	 2.2		 0.8	 V V
Operating case temperature	T_C	–40		+85	C
RF frequency range	F_{RF}	2300		2700	MHz
LO frequency range (Note 1)	F_{LO}	1800		2600	MHz
IF frequency range	F_{IF}	50		500	MHz

Note 1: The SKY73025 has been optimized for low-side LO injection. However, the LO can be used outside of the specified frequency range with degraded performance.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0113

Table 5. SKY73025 Electrical Specifications

(Voltage Supply = +5 V, T_C = +25 °C, LO = 0 dBm, RF Frequency = 2570 MHz, IF Frequency = 450 MHz, LO Frequency = 2120 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Conversion gain	G			8.6		dB
Noise Figure	NF			9.8		dB
Noise Figure with a blocker signal	NF_{BLK}	Blocking signal input power = +8 dBm			25	dB
Third order input intercept point	IIP3	F_{RF} = 2570 MHz and 2570.8 MHz, P_{RF} = –10 dBm/tone		+23.5		dBm
Third order output intercept point	OIP3	F_{RF} = 2570 MHz and 2570.8 MHz, P_{RF} = –10 dBm/tone		+32.1		dBm
2RF – 2LO	2x2	P_{RF} = –10 dBm		–62		dBc
3RF – 3LO	3x3	P_{RF} = –10 dBm		–73		dBc
Input 1 dB compression point	IP1dB			+12.3		dBm
Output 1 dB compression point	OP1dB			+19.9		dBm
LO1-to-LO2 isolation				45		dB
Channel-to-channel isolation				25		dB
RF-to IF-isolation				30		dB
LO leakage: @ RF port @ IF port				 –30 –20		 dBm dBm
LO_SEL input			–20	150	250	µA
LO switching time					0.5	µs
RF port input return loss	Z_{IN_RF}	With external matching components	14			dB
LO port input return loss	Z_{IN_LO}	With external matching components	14			dB
IF port input return loss	Z_{OUT_IF}	With external matching components	14			dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0114

Application Circuit Design Considerations

RF Input and IF Output Matching

For best performance, RF and IF matching circuits are needed either for a differential output application or for a single-ended output application. A typical single-ended output application circuit is shown in Figure 3.

The 200 Ω differential IF output impedance could be used to connect to a differential input Surface Acoustic Wave (SAW) filter or Variable Gain Amplifier (VGA). A 4:1 balun transformer could also be used to match the impedance to 50 Ω for a single-ended output application.

As noted in Figure 3, components C1, C2, L1, L2, L3, and L4 are RF matching components; C8, C10, L9, and L10 are IF matching components; T1 and T2 are 4:1 IF baluns.

IF Bias Resistor

Components R1 and R2 (see Figure 3) are for the IF amplifier bias current adjustment. To operate the SKY73025 as specified in Tables 4 and 5, these resistors are not required.

PCB Layout

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 and as low impedance as possible.
2. The ground pad of the SKY73025 provides critical electrical and thermal functionality. 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 heat produced by the circuit board. For more information on soldering the SKY73025, refer to the Package and Handling Information section of this Data Sheet.

DC Power Supply

1. Skyworks recommends including external bypass capacitors on the VCC voltage inputs of the device. Place the bypass capacitors close to the VCC supply pins.
2. Components L5, L6, L7, and L8 (see Figure 3) are high-Q, low loss inductors. These inductors must be able to pass currents in excess of 200 mA DC.

Evaluation Board Description

The SKY73025 Evaluation Board is used to test the performance of the SKY73025 downconversion mixer. An assembly drawing for the Evaluation Board is shown in Figure 4 and the layer detail is provided in Figure 5. A schematic diagram for the SKY73025 Evaluation Board is shown in Figure 6.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0115

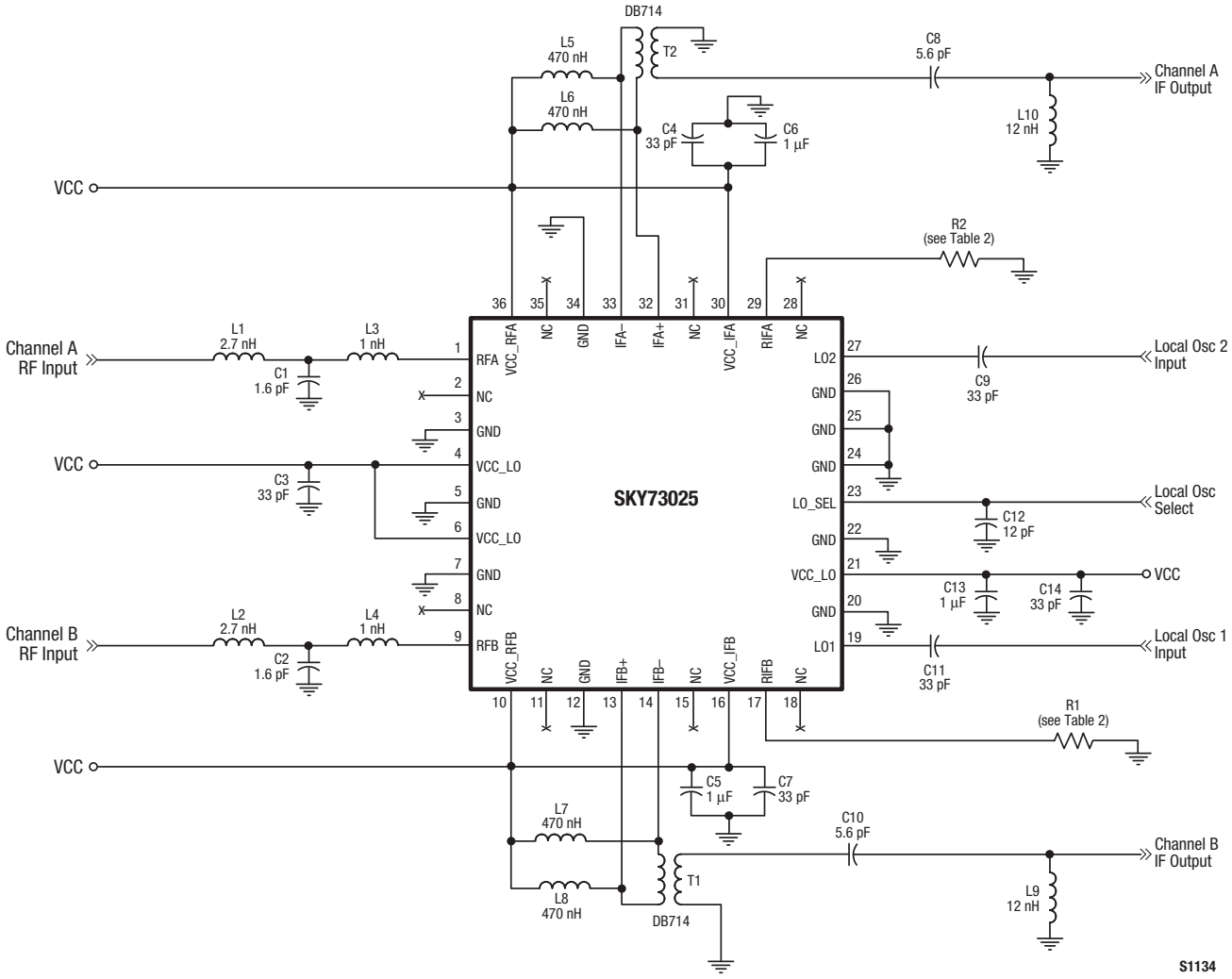


Figure 3. Typical Single-Ended Application Circuit

EX-1042
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0116

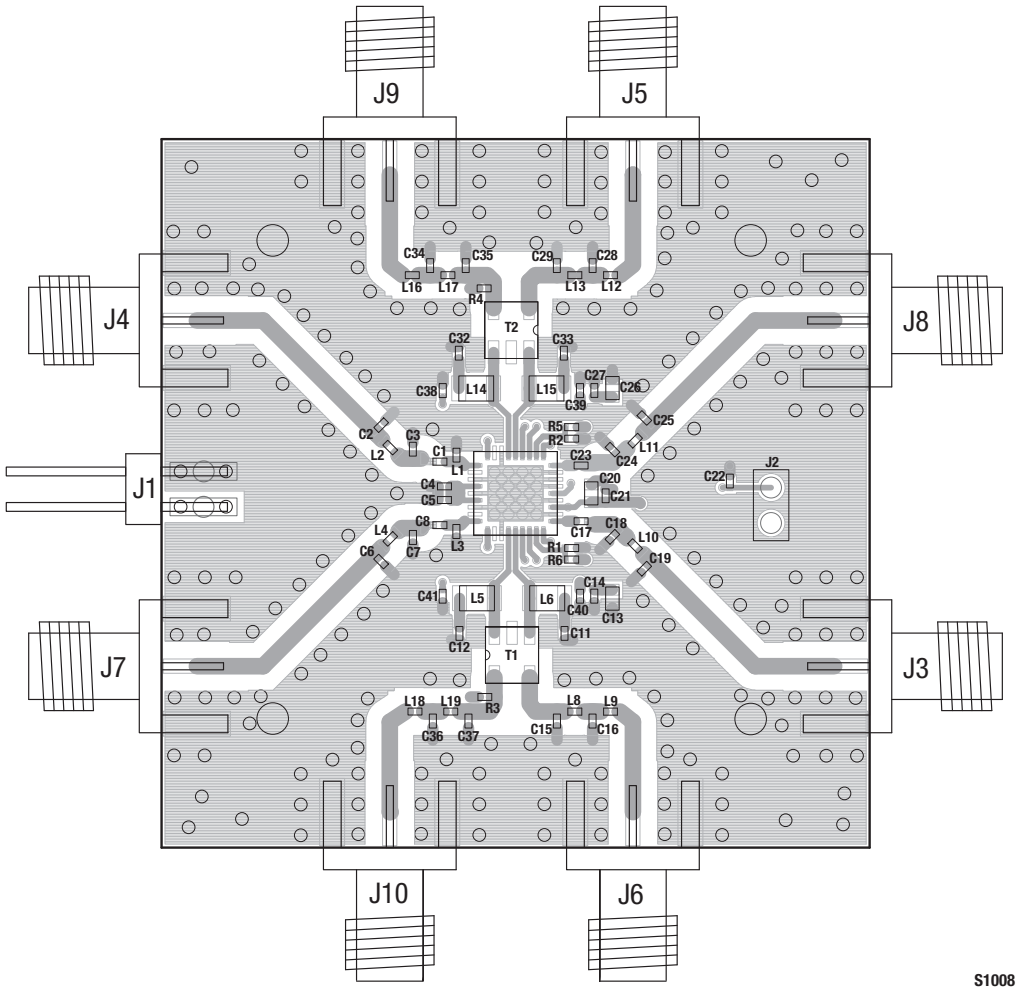
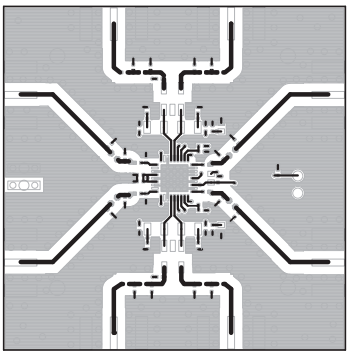
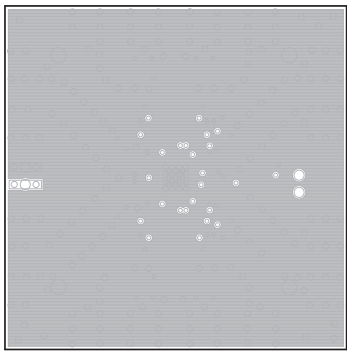


Figure 4. SKY73025 Evaluation Board Assembly Diagram

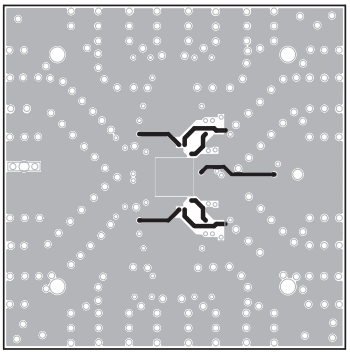
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0117



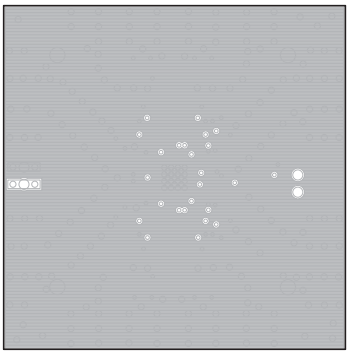
Layer 1: Top – Metal



Layer 2: Ground



Layer 3: Power Plane

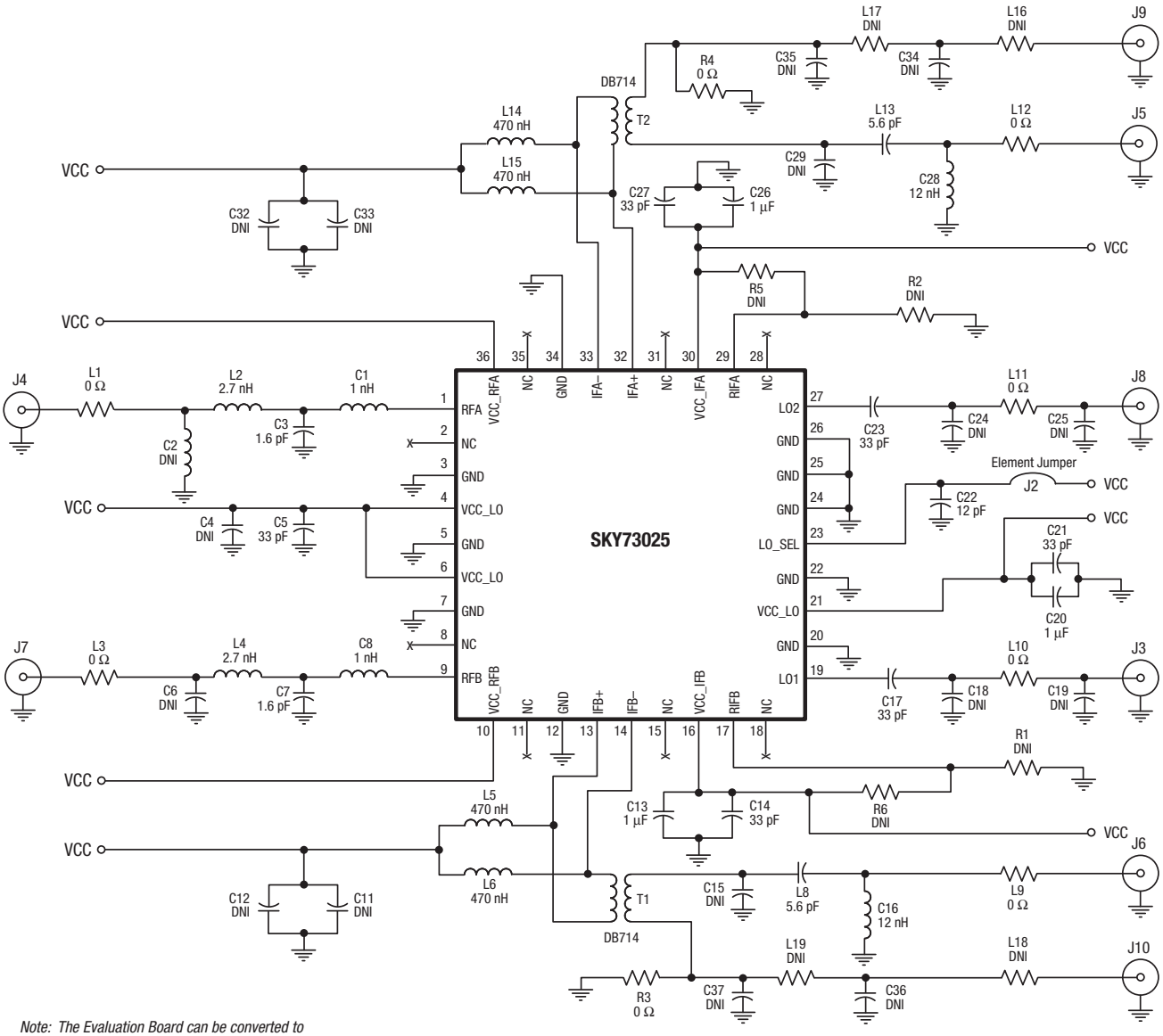


Layer 4: Solid Ground Plane

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Figure 5. SKY73025 Evaluation Board Layer Detail

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0118



Note: The Evaluation Board can be converted to provide a differential output by removing components T1, T2, R3, and R4.

Some component labels may be different than the corresponding component symbol shown here. Component values, however, are accurate as of the date of this Data Sheet.

Figure 6. SKY73025 Evaluation Board Schematic

EX-1042
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0119

Package Dimensions

The PCB footprint for the SKY73025 is provided in Figure 7. Figure 8 shows the package dimensions for the 36-pin MCM, and Figure 9 provides the tape and reel dimensions.

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.

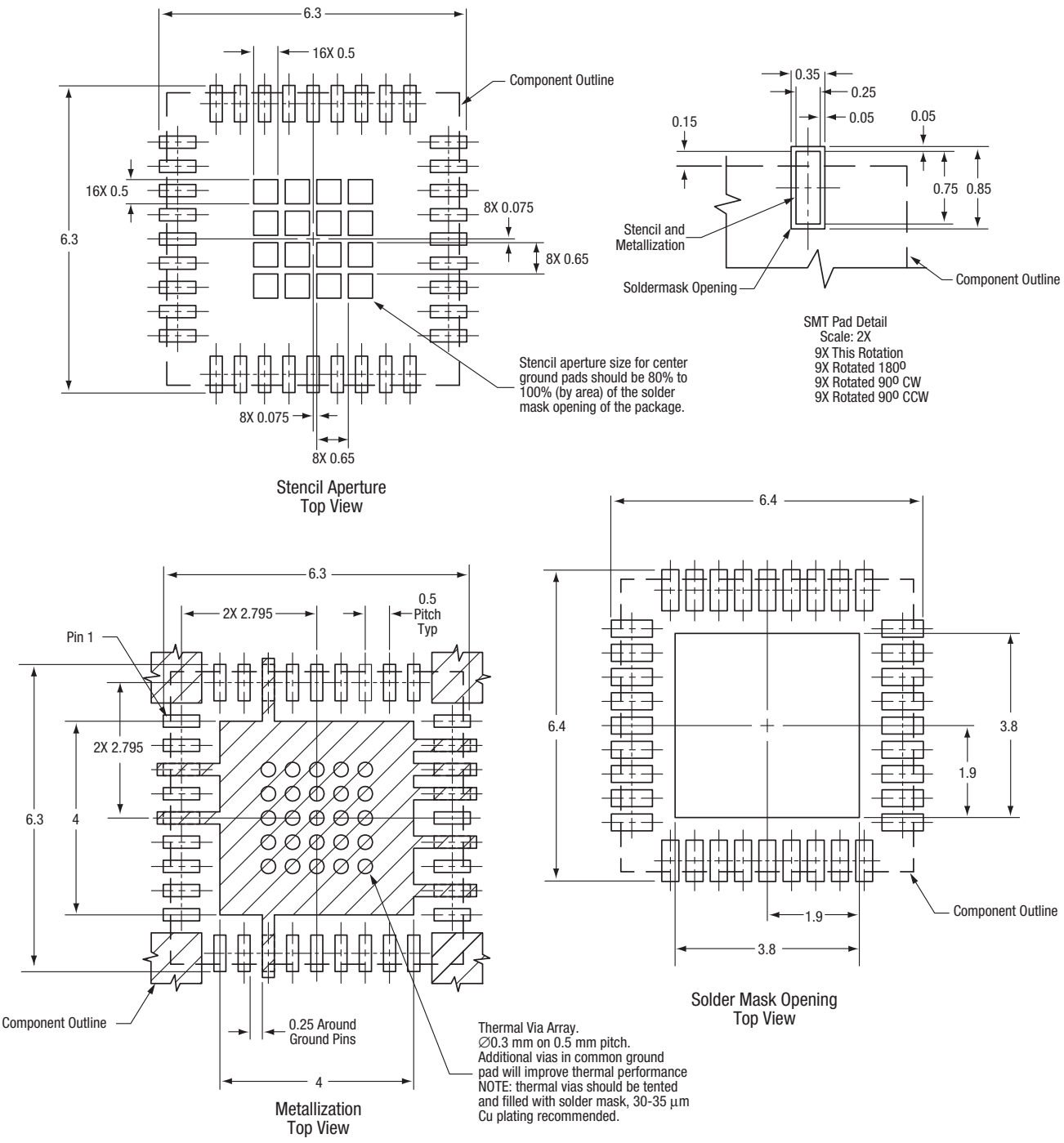
THE SKY73025 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.

Electrostatic Discharge (ESD) Sensitivity

The SKY73025 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

EX-1042
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0120



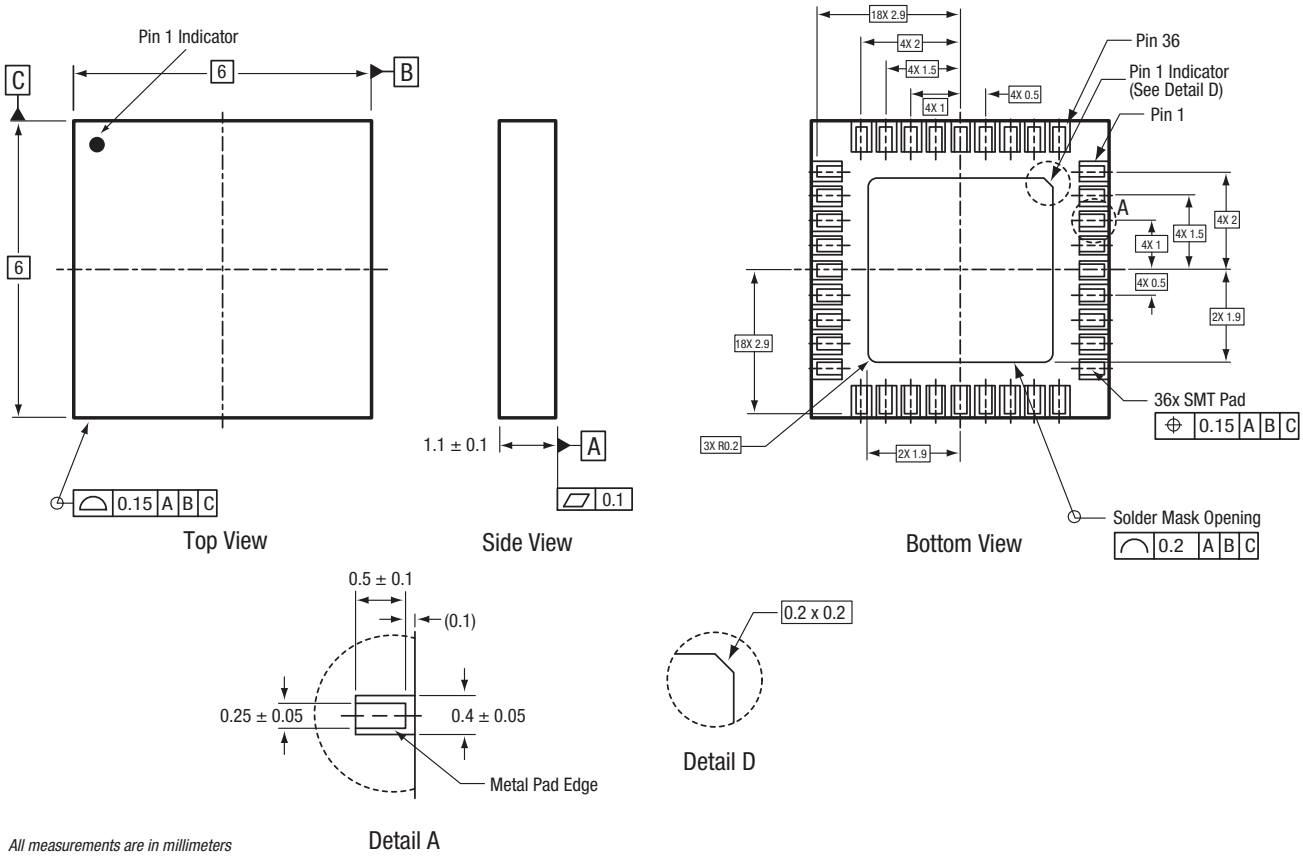
Note: The cross-hatched area represents the merger of the center ground pad +9 individual I/O ground pads. All I/O ground pads should have at least one via connected to internal ground planes for optimum electrical performance.

All measurements are in millimeters

S1125

Figure 7. PCB Layout Footprint for the SKY73025 6 x 6 mm MCM

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0121



All measurements are in millimeters

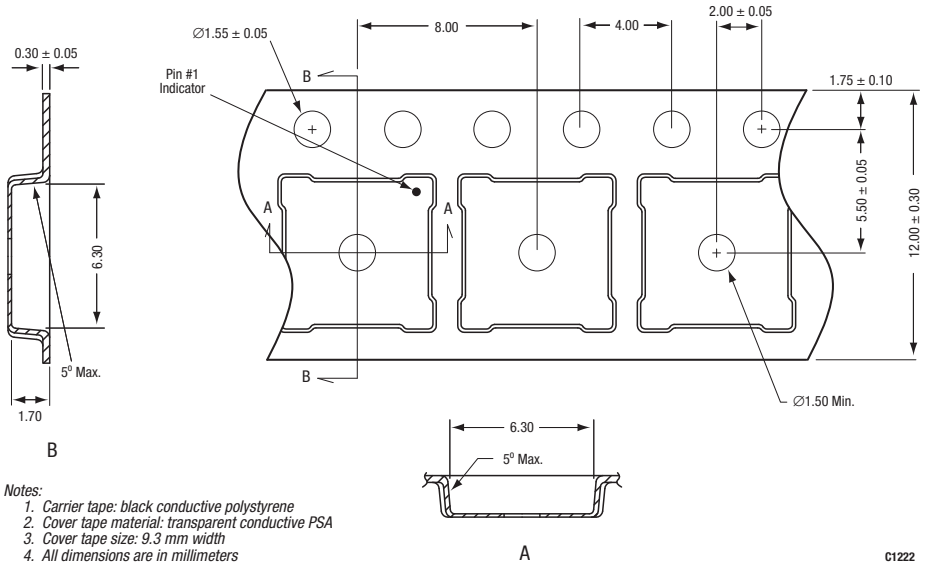
Pads are solder mask defined on one edge and metal defined on three edges.

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

S689_A

Figure 8. SKY73025 36-Pin MCM Package Dimensions

EX-1042
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0122



Notes:
1. *Carrier tape: black conductive polystyrene*
2. *Cover tape material: transparent conductive PSA*
3. *Cover tape size: 9.3 mm width*
4. *All dimensions are in millimeters*

Figure 9. SKY73025 Tape and Reel Dimensions

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0123

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number
SKY73025 Downconversion Mixer	SKY73025-11 (Pb-free package)	

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EX-1042
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0124

DATA SHEET

SKY73021: 1700 – 2200 MHz High Gain and Linearity Diversity Downconversion Mixer for 2G/3G Base Station Transceiver Applications

Applications

- 2G/3G base station transceivers:
  - GSM/EDGE, CDMA, UMTS/WCDMA, PHS
- Land mobile radio
- Wireless Local Loop
- High performance radio links
- Private mobile radio

Features

- Operating frequency range: 1700 to 2200 MHz
- IF frequency range: 40 to 300 MHz
- Conversion gain: 6.0 dB
- Input IP3: 26.0 dBm
- Output IP3: 32.0 dBm
- Noise figure: 9.6 dB
- Integrated LO drivers
- Integrated low loss RF baluns
- High linearity IF amplifiers
- On-chip SPDT LO switch (greater than 50 dB LO-to-LO isolation)
- Small, MCM (36-pin, 6 x 6 mm) Pb-free package (MSL3, 260 °C per JEDEC J-STD-020)

NEW

Skyworks offers lead (Pb)-free RoHS (Restriction of Hazardous Substances) compliant packaging.

Description

The SKY73021 is a fully integrated diversity mixer that includes Local Oscillator (LO) drivers, an LO switch, high linearity mixers, and large dynamic range Intermediate Frequency (IF) amplifiers. Low loss RF baluns have also been included to reduce design complications and lower system cost.

The SKY73021 features an input IP3 of 26.0 dBm and a Noise Figure (NF) of 9.6 dB, making the device an ideal solution for high dynamic range systems such as 2G/3G base station receivers. The LO switch provides more than 50 dB of isolation between LO inputs and supports the switching time required for GSM/EDGE base stations.

The SKY73021 is manufactured using a robust silicon BiCMOS process and has been designed for optimum long-term reliability. The SKY73021 diversity downconversion mixer is provided in a compact, 36-pin 6 x 6 mm Multi-Chip Module (MCM). 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.

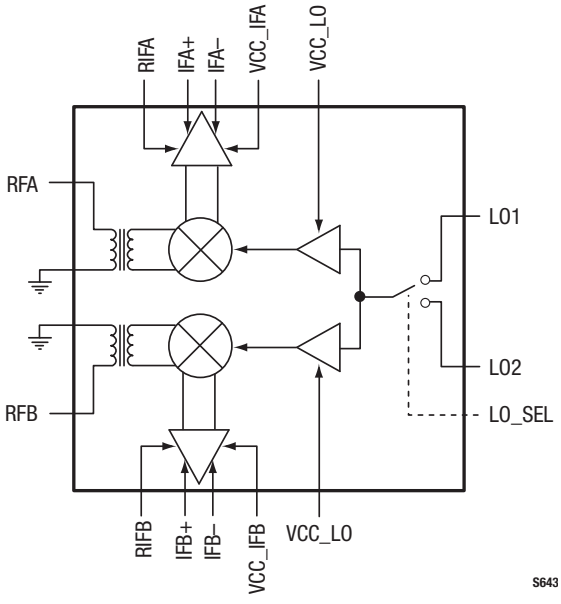


Figure 1. SKY73021 Block Diagram

EX-1042
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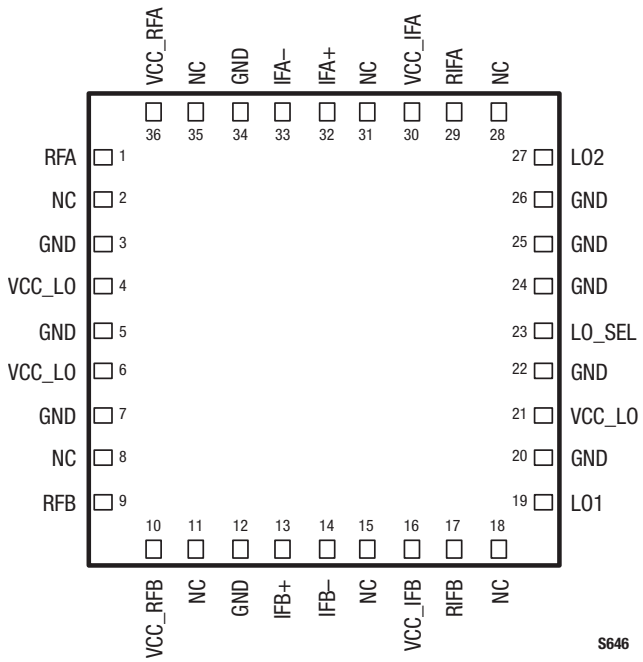


Figure 2. SKY73021 Pinout – 36-Pin MCM

Table 1. SKY73021 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	RFA	Channel A RF input	19	LO1	Local oscillator 1 input
2	NC	No connect	20	GND	Ground
3	GND	Ground	21	VCC_LO	DC supply, +5 V
4	VCC_LO	DC supply, +5 V	22	GND	Ground
5	GND	Ground	23	LO_SEL	Local oscillator select switch control
6	VCC_LO	DC supply, +5 V	24	GND	Ground
7	GND	Ground	25	GND	Ground
8	NC	No connect	26	GND	Ground
9	RFB	Channel B RF input	27	LO2	Local oscillator 2 input
10	VCC_RFB	Channel B RF DC supply, +5 V	28	NC	No connect
11	NC	No connect	29	RIFA	Channel A IF bias adjust
12	GND	Ground	30	VCC_IFA	Channel A IF DC supply, +5 V
13	IFB+	Positive channel B IF output	31	NC	No connect
14	IFB–	Negative channel B IF output	32	IFA+	Positive channel A IF output
15	NC	No connect	33	IFA–	Negative channel A IF output
16	VCC_IFB	Channel B IF DC supply, +5 V	34	GND	Ground
17	RIFB	Channel B IF bias adjust	35	NC	No connect
18	NC	No connect	36	VCC_RFA	Channel A RF DC supply, +5 V

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0126

Functional Description

The SKY73021 is a high gain diversity mixer, optimized for base station receiver applications. The device consists of two diversity channels (A and B), each consisting of a low loss RF balun, high linearity passive mixer, and a low noise IF amplifier.

Two LO amplifiers (independent of channels A and B) are also included that allow the SKY73021 to connect directly to the output of a Voltage Controlled Oscillator (VCO). This eliminates the extra gain stages needed by most discrete passive mixers. A Single Pole, Double Throw (SPDT) switch has been included to select between two different LO inputs for frequency hopping applications (i.e., GSM).

RF Baluns and Passive Mixer

The RF baluns provide a single ended input, which can easily be matched to 50 Ω using a simple external matching circuit. The RF baluns offer very low loss, and excellent amplitude and phase balance.

The high linearity SKY73021 is a passive, double balanced mixer that provides a very low conversion loss and an excellent 3rd Order Input Intercept Point (IIP3).

Additionally, the balanced nature of the mixer provides for high port-to-port isolation.

LO Buffers and SPDT LO Switch

The LO buffers allow the input power of the SKY73021 to be in the range of ±3 dBm. The LO section is optimized for low-side LO injection. However, each of the two LOs can be driven over a wide frequency range with only slight degradation in performance.

A high isolation SPDT switch allows the SKY73021 to be used for frequency hopping applications. This switch provides greater than 50 dB of LO1 to LO2 isolation:

LO_SEL Input	LO Path Selected
High	LO1 (pin 19) enabled
Low	LO2 (pin 27) enabled

For applications that do not require frequency hopping, LO_SEL is fixed to one state and the appropriate LO input is used. An internal pull-down resistor enables the LO2 input.

IF Amplifier

The SKY73021 includes high dynamic range IF amplifiers that follow the passive mixers in the signal path. The outputs require a supply voltage connection using inductive chokes. These choke inductors should be high-Q and have the ability to handle 200 mA or greater.

A simple matching network allows the output ports to be matched to a balanced 200 Ω impedance. The IF amplifiers are optimized for IF frequencies between 40 and 300 MHz. The IF amplifiers can be operated outside of this range, but with a slight degradation in performance.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY73021 are provided in Table 2 and the recommended operating conditions in Table 3. Electrical characteristics for the SKY73021 are provided in Table 4.

Typical performance characteristics of the SKY73021 are illustrated in Figures 3 through 35.

Table 2. SKY73021 Absolute Maximum Ratings

Parameter	Symbol	Minimum	Maximum	Units
Supply voltage, +5 V (VCC_LO, VCC_RFA, VCC_RFB, VCC_IFA, VCC_IFB)	VCC	4.5	5.5	V
Supply current	I_{CC}		440	mA
RF input power	P_{RF}		20	dBm
LO input power	P_{LO}		20	dBm
Operating case temperature	T_C	–40	+85	C
Junction temperature	T_J		150	C
Storage case temperature	T_{STG}	–40	+125	C

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.

Nominal thermal resistance (junction to center ground pad) is 5.1 C/W.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0127

Table 3. SKY73021 Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply voltage, +5 V (VCC_LO, VCC_RFA, VCC_RFB, VCC_IFA, VCC_IFB)	VCC	4.75	5.00	5.25	V
Supply current	I_{CC}		380		mA
LO input power	P_{LO}	–6	0	+6	dBm
LO select input: high low	 LO_SEL_H LO_SEL_L	 2.2		 0.8	 V V
Operating case temperature	T_C	–40		+85	C
RF frequency range	F_{RF}	1700		2200	MHz
LO frequency range (Note 1)	F_{LO}	1460		2000	MHz
IF frequency range	F_{IF}	40		300	MHz

Note 1: The SKY73021 has been optimized for low side LO injection. However, the LO can be used outside of the specified frequency range with degraded performance.

Table 4. SKY73021 Electrical Specifications (1 of 2)
(Voltage Supply = +5 V, T_C = +25 °C, LO = 0 dBm, RF Frequency = 1750 MHz, IF Frequency = 201 MHz, LO Frequency = 1549 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
Conversion gain	G		5.6	6.0	6.6	dB
Gain versus temperature		–40 to +85 °C		±0.7		dB
Noise Figure	NF			9.6	10.9	dB
Noise Figure versus temperature		–40 to +85 °C		±0.8		dB
Noise Figure with a blocker signal	NF_{BLK}	Blocking signal input power = +8 dBm		21	23	dB
Third order input intercept point	IIP3	F_{RF} = 1750.0 MHz and 1750.8 MHz, P_{RF} = –10 dBm/tone	25.0	26.0		dBm
Third order input intercept point versus temperature		–40 to +85 °C		±0.6		dB
Third order output intercept point	OIP3	F_{RF} = 1750.0 MHz and 1750.8 MHz, P_{RF} = –10 dBm/tone		32.0		dBm
2RF – 2LO	2x2	P_{RF} = –10 dBm		–66	–57	dBc
3RF – 3LO	3x3	P_{RF} = –10 dBm		–80		dBc
Input 1 dB compression point	IP1dB		15.5	17.0		dBm
Output 1 dB compression point	OP1dB			22.0		dBm
LO1-to-LO2 isolation			40	50		dB
Channel-to-channel isolation			30	47		dB
RF-to IF-isolation			30	66		dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0128

Table 4. SKY73021 Electrical Specifications (2 of 2)
(Voltage Supply = +5 V, T_C = +25 °C, LO = 0 dBm, RF Frequency = 1750 MHz, IF Frequency = 201 MHz, LO Frequency = 1549 MHz, Unless Otherwise Noted)

Parameter	Symbol	Test Condition	Min	Typical	Max	Units
LO leakage: @ RF port @ IF port				 –41 –50	 –24 –27	 dBm dBm
LO_SEL input			–20	+150	+250	µA
LO switching time					0.5	µs
RF port input return loss	Zin_rf	With external matching components	14			dB
LO port input return loss	Zin_lo	With external matching components	14			dB
IF port input return loss	Zout_if	With external matching components	14			dB

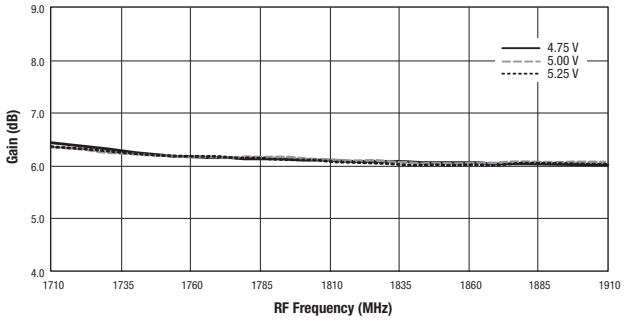


Figure 3. Mixer A Gain vs Frequency and Supply Voltage

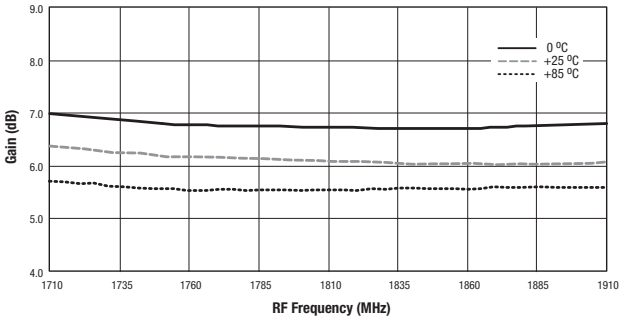


Figure 4. Mixer A Gain vs Frequency and Temperature

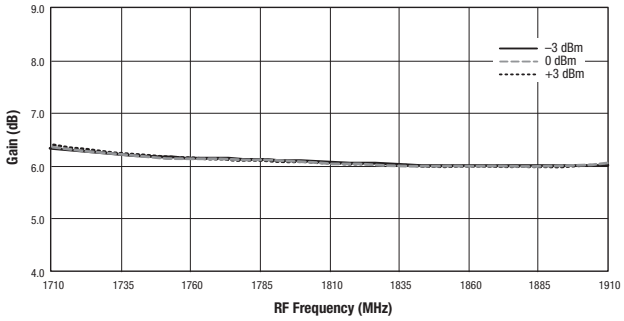


Figure 5. Mixer A Gain vs Frequency and LO Power

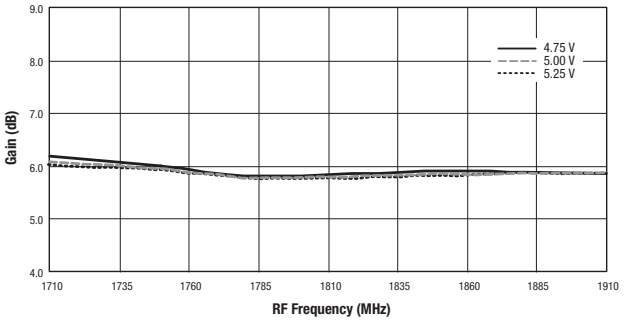


Figure 6. Mixer B Gain vs Frequency and Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0129

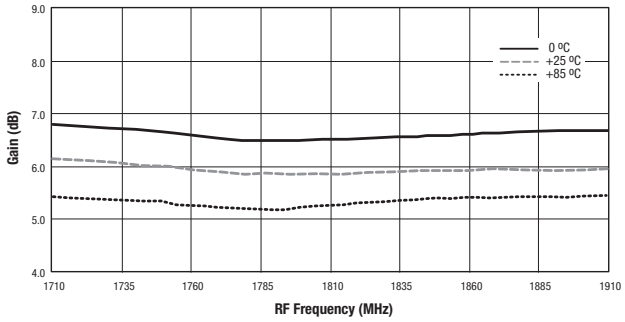


Figure 7. Mixer B Gain vs Frequency and Temperature

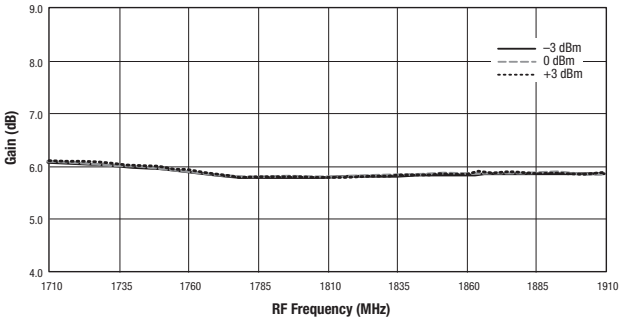


Figure 8. Mixer B Gain vs Frequency and LO Power

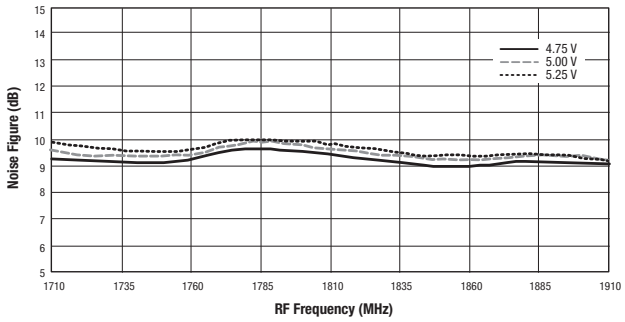


Figure 9. Mixer A Noise Figure vs Frequency and Supply Voltage

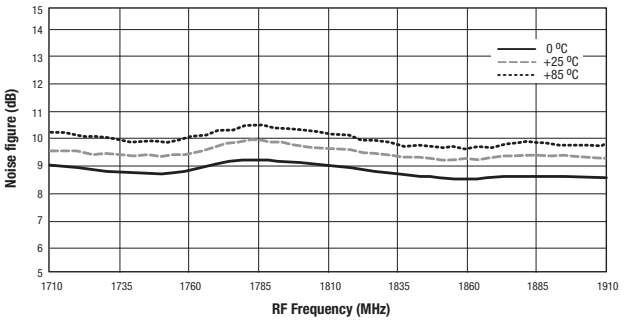


Figure 10. Mixer A Noise Figure vs Frequency and Temperature

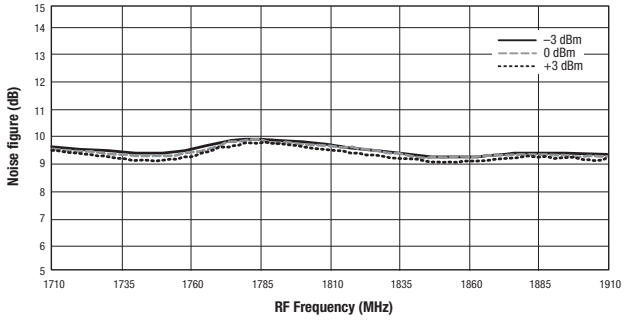


Figure 11. Mixer A Noise Figure vs Frequency and LO Power

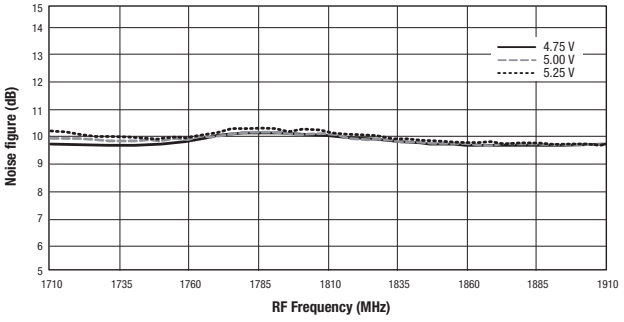


Figure 12. Mixer B Noise Figure vs Frequency and Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0130

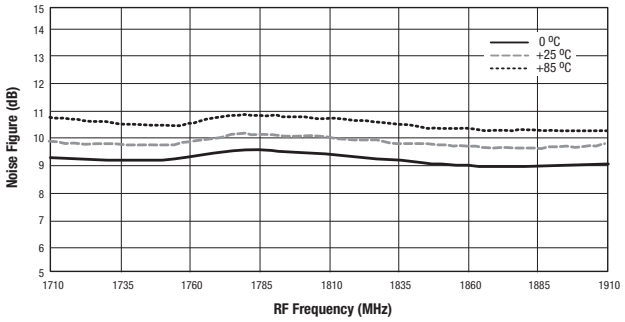


Figure 13. Mixer B Noise Figure vs Frequency and Temperature

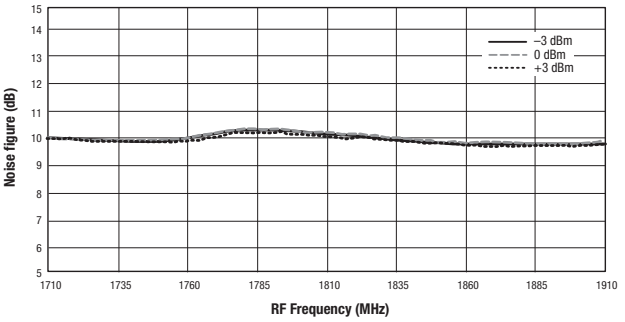


Figure 14. Mixer B Noise Figure vs Frequency and LO Power

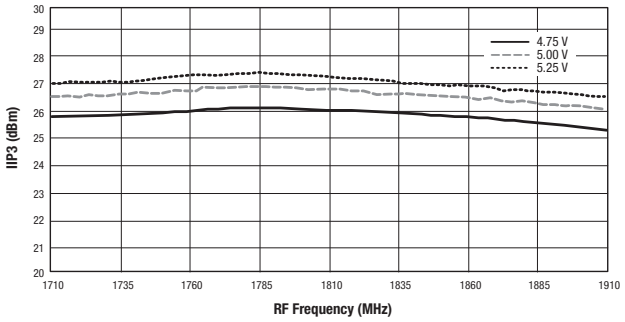


Figure 15. Mixer A IIP3 vs Frequency and Supply Voltage

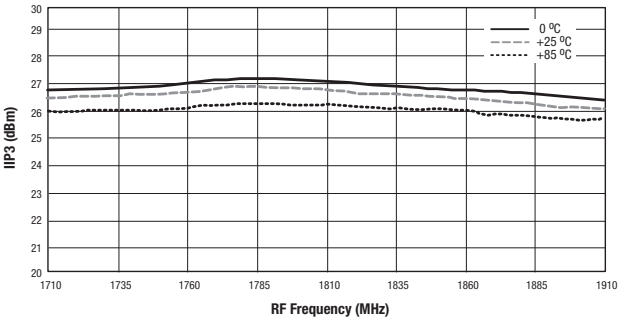


Figure 16. Mixer A IIP3 vs Frequency and Temperature

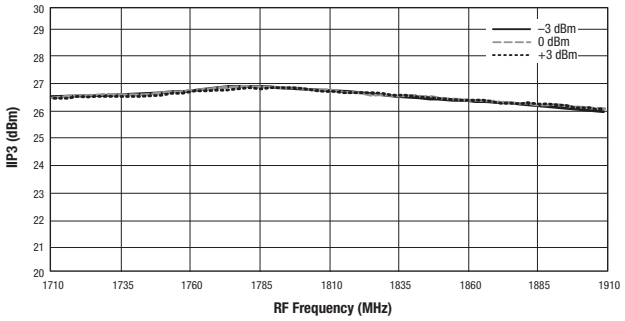


Figure 17. Mixer A IIP3 vs Frequency and LO Power

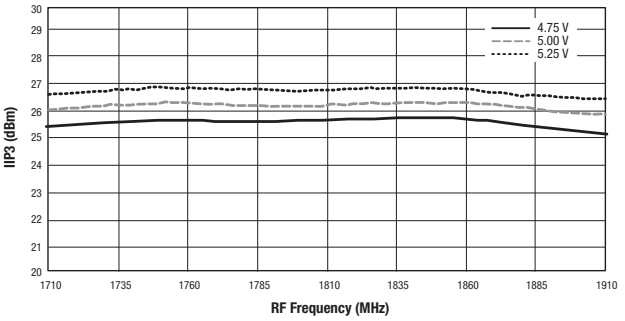


Figure 18. Mixer B IIP3 vs Frequency and Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0131

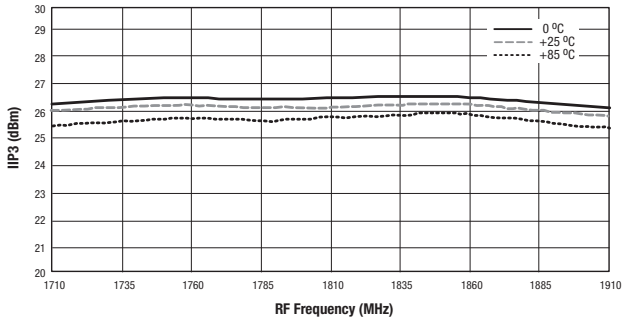


Figure 19. Mixer B IIP3 vs Frequency and Temperature

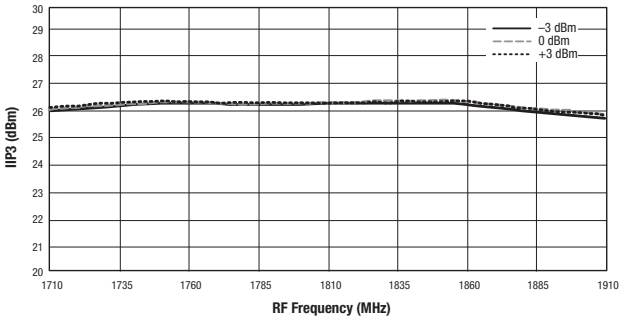


Figure 20. Mixer B IIP3 vs Frequency and LO Power

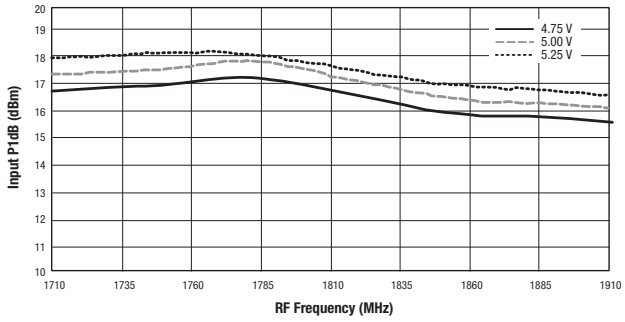


Figure 21. Mixer A Input P1dB vs Frequency and Supply Voltage

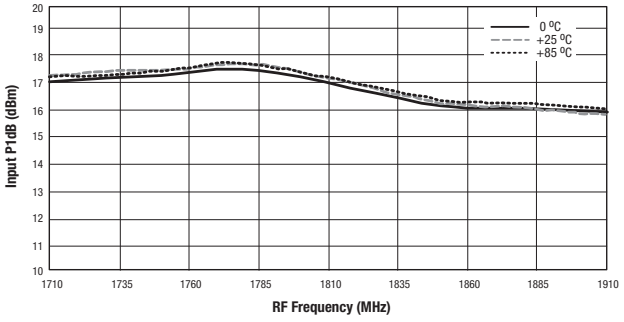


Figure 22. Mixer A Input P1dB vs Frequency and Temperature

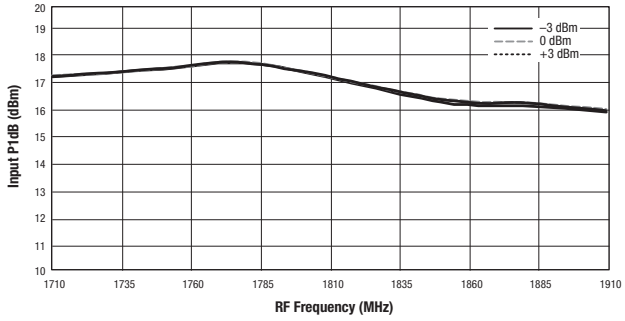


Figure 23. Mixer A Input P1dB vs Frequency and LO Power

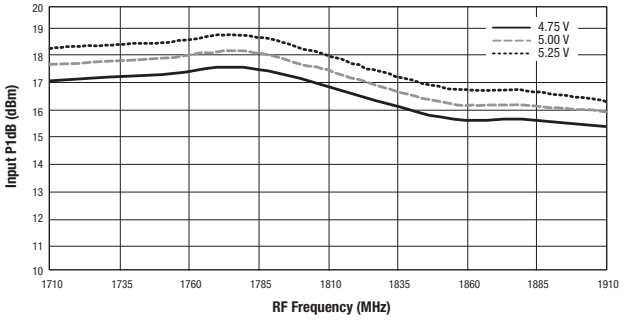


Figure 24. Mixer B Input P1dB vs Frequency and Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0132

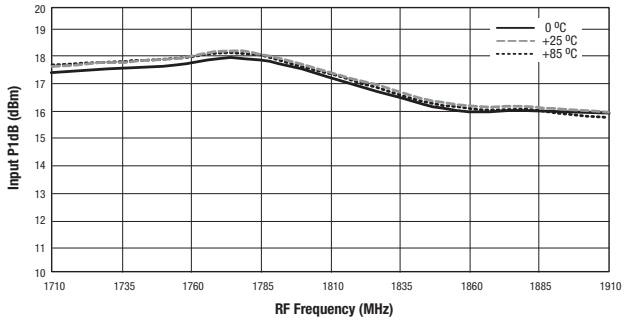


Figure 25. Mixer B Input P1dB vs Frequency and Temperature

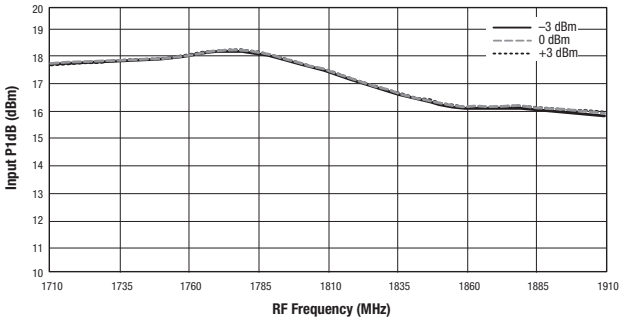


Figure 26. Mixer B Input P1dB vs Frequency and LO Power

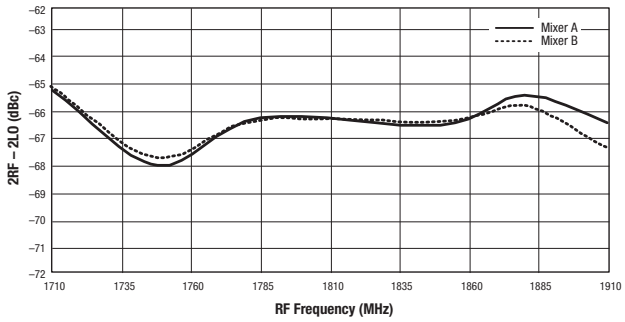


Figure 27. Mixer A and B 2RF – 2LO vs Frequency

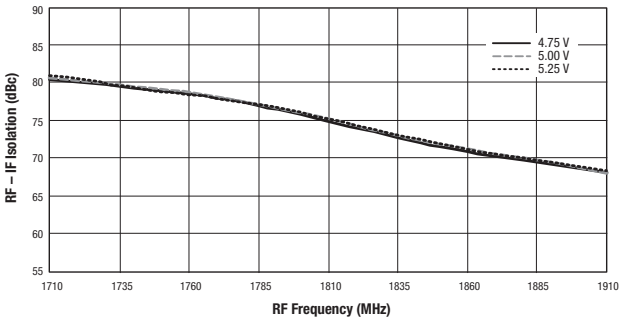


Figure 28. Mixer A RF to IF Isolation vs Frequency and Supply Voltage

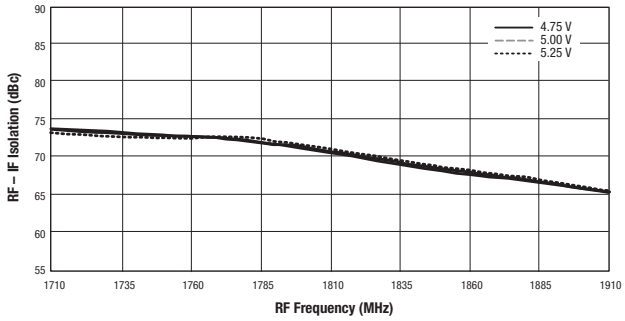


Figure 29. Mixer B RF to IF Isolation vs Frequency and Supply Voltage

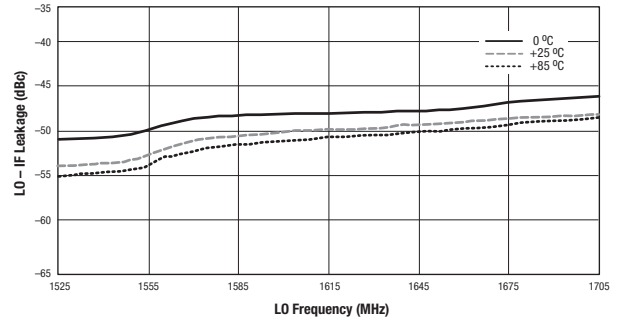


Figure 30. Mixer A LO to IF Leakage vs Frequency and Temperature

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0133

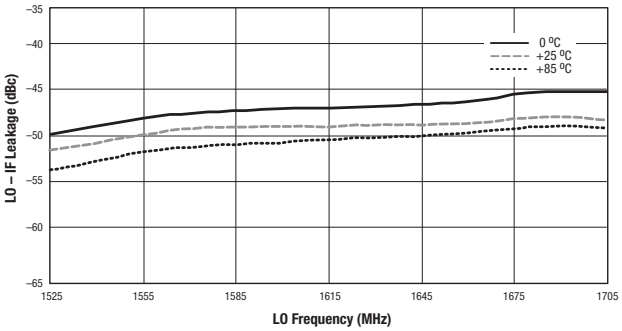


Figure 31. Mixer B LO to IF Leakage vs Frequency and Temperature

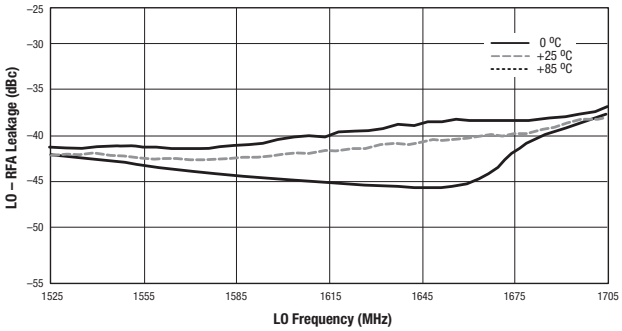


Figure 32. Mixer A LO to RF Leakage vs Frequency and Temperature

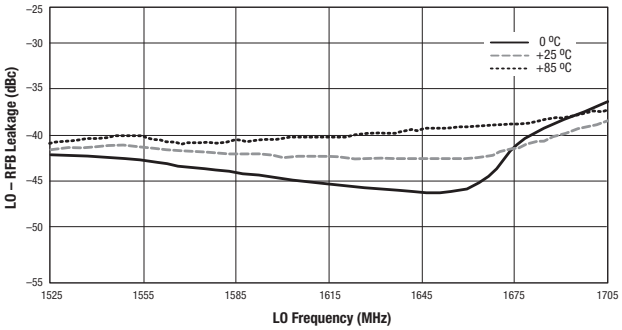


Figure 33. Mixer B LO to RF Leakage vs Frequency and Temperature

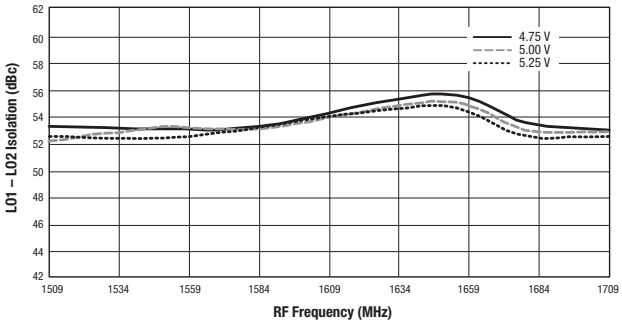


Figure 34. LO1 to LO2 Isolation vs Frequency and Supply Voltage

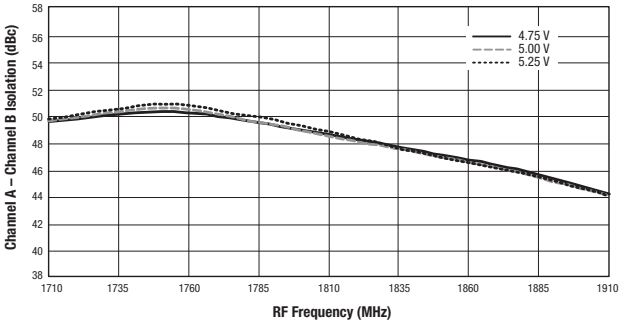


Figure 35. Channel A to Channel B IF Isolation vs Frequency and Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0134

Evaluation Board Description

The SKY73021 Evaluation Board is used to test the performance of the SKY73021 downconversion mixer. An assembly drawing for the Evaluation Board is shown in Figure 36 and the layer detail is provided in Figure 37.

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 and as low impedance as possible.
2. The ground pad of the SKY73021 provides critical electrical and thermal functionality. 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 heat produced by the circuit board. For more information on soldering the SKY73021, refer to the Package and Handling Information section of this Data Sheet.
3. Skyworks recommends including external bypass capacitors on the VCC voltage inputs of the device.
4. Components L5, L6, L14, and L15 (see Figure 38) are high-Q, low loss inductors. These inductors must be able to pass currents in excess of 200 mA DC.
5. Components R1 and R2 (see Figure 38) allow for external adjustment of the IF amplifier bias points. For operation as specified in Tables 3 and 4, these resistors are not required.

A schematic diagram for the SKY73021 Evaluation Board is shown in Figure 38.

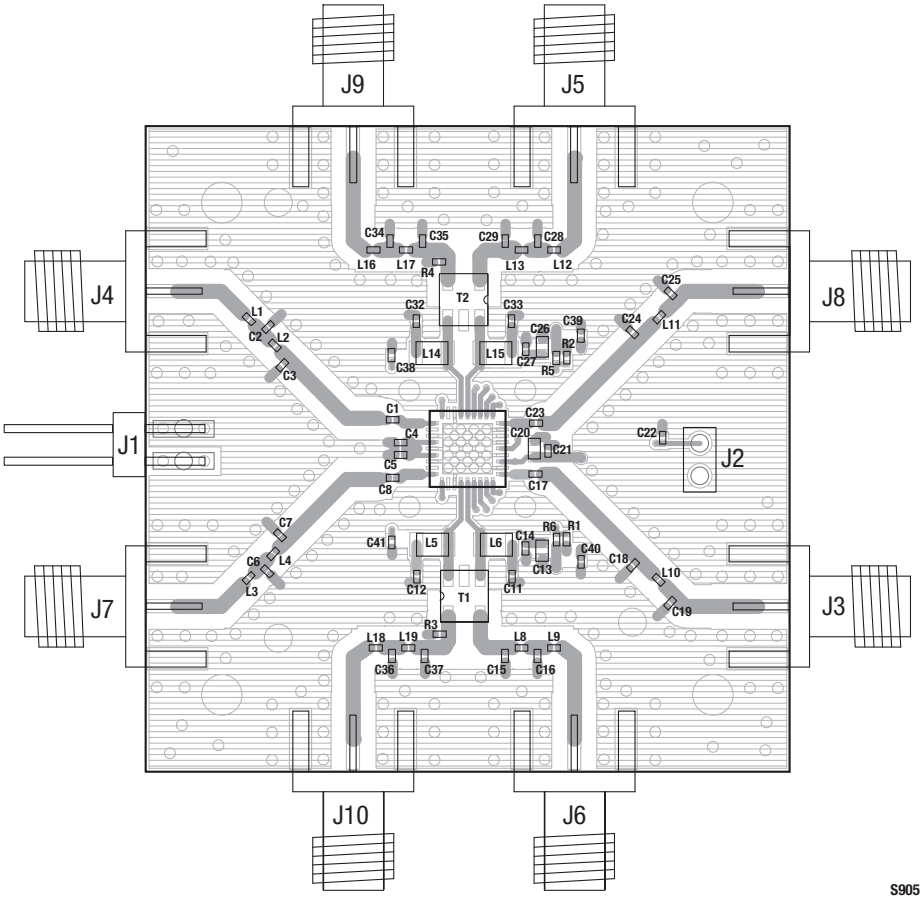
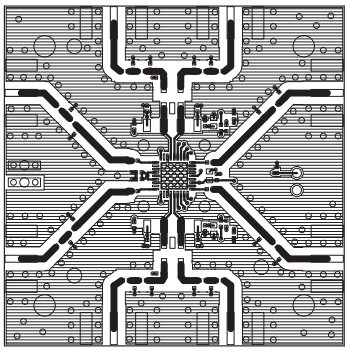
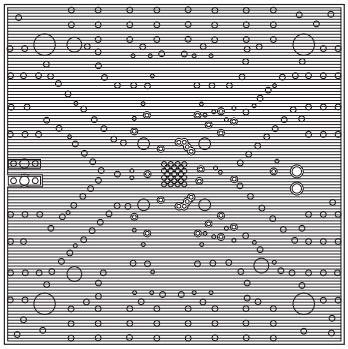


Figure 36. SKY73021 Evaluation Board Assembly Diagram

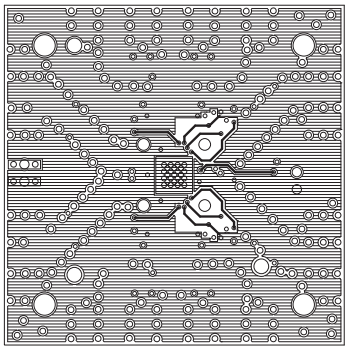
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0135



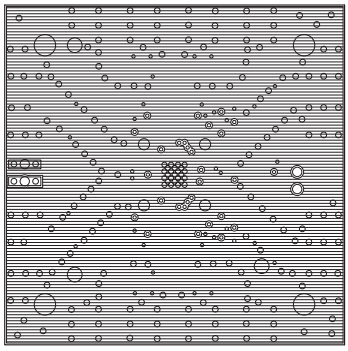
Layer 1: Top -- Metal



Layer 2: Ground



Layer 3: Power Plane

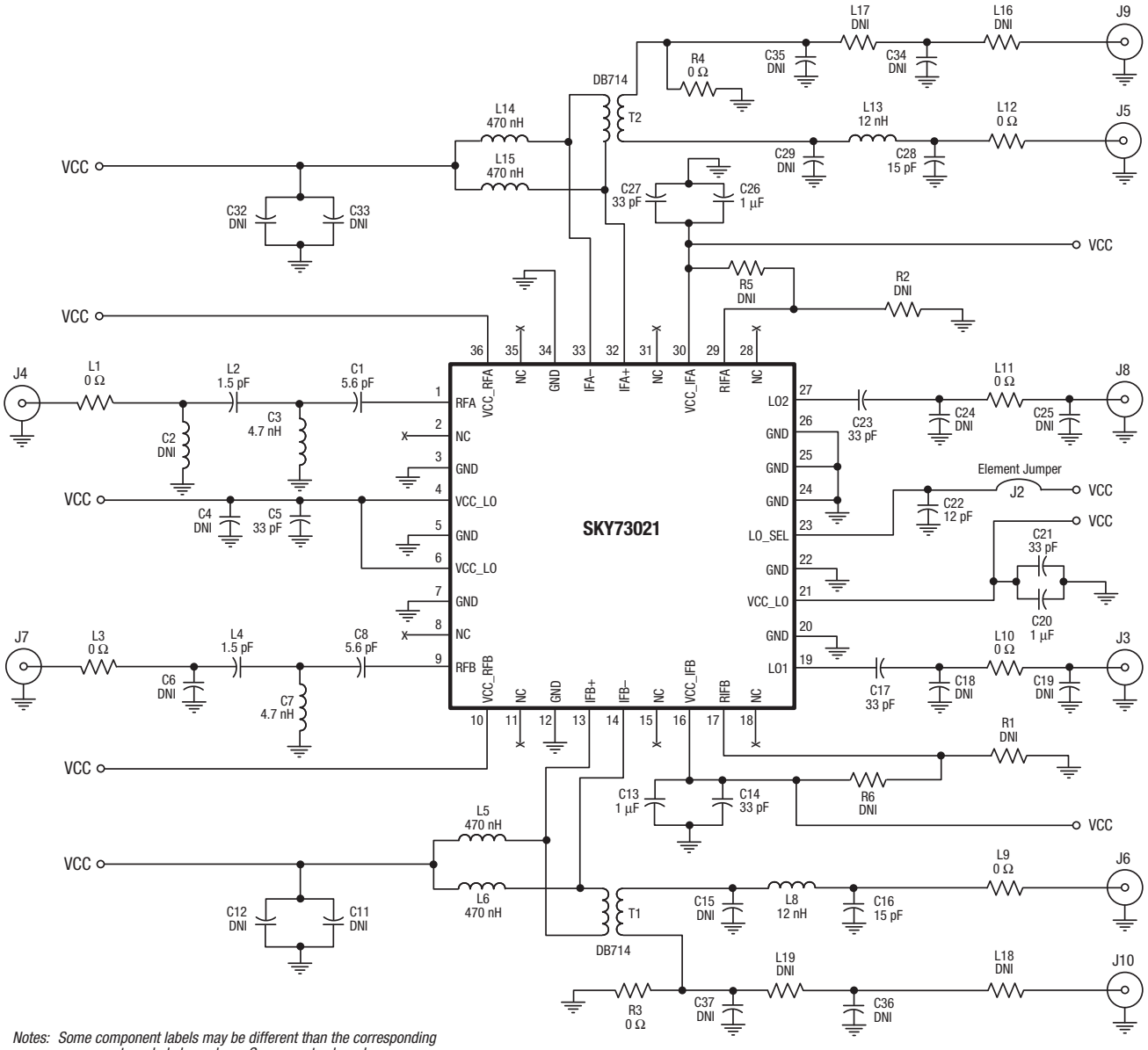


Layer 4: Solid Ground Plane

S904

Figure 37. SKY77021 Evaluation Board Layer Detail

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0136



Notes: Some component labels may be different than the corresponding component symbol shown here. Component values, however, are accurate as of the date of this Data Sheet.

The Evaluation Board can be converted to provide a differential output by removing components T1, T2, R3, and R4.

Figure 38. SKY73021 Evaluation Board Schematic

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0137

Package Dimensions

The PCB layout footprint for the SKY73021 is provided in Figure 39. Figure 40 shows the package dimensions for the 36-pin MCM, and Figure 41 provides the tape and reel dimensions.

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.

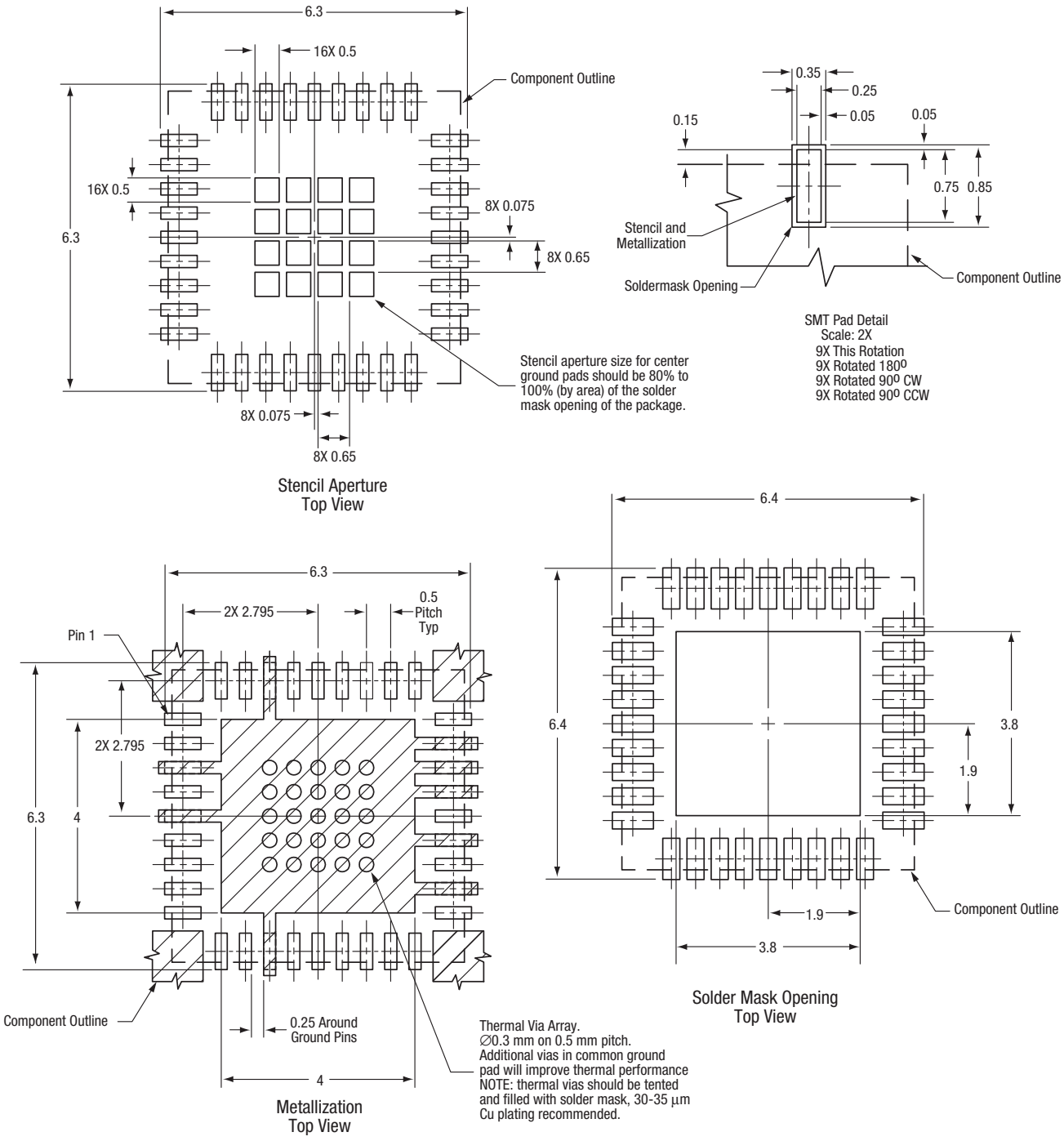
THE SKY73021 is rated to Moisture Sensitivity Level 3 (MSL3) at 260 °C. It can be used for lead or lead-free soldering. For additional information, refer to the Skyworks Application Note, *PCB Design & SMT Assembly/Rework Guidelines for MCM-L Packages*, document number 101752.

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. For packaging details, refer to the Skyworks Application Note, *Tape and Reel*, document number 101568.

Electrostatic Discharge (ESD) Sensitivity

The SKY73021 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0138



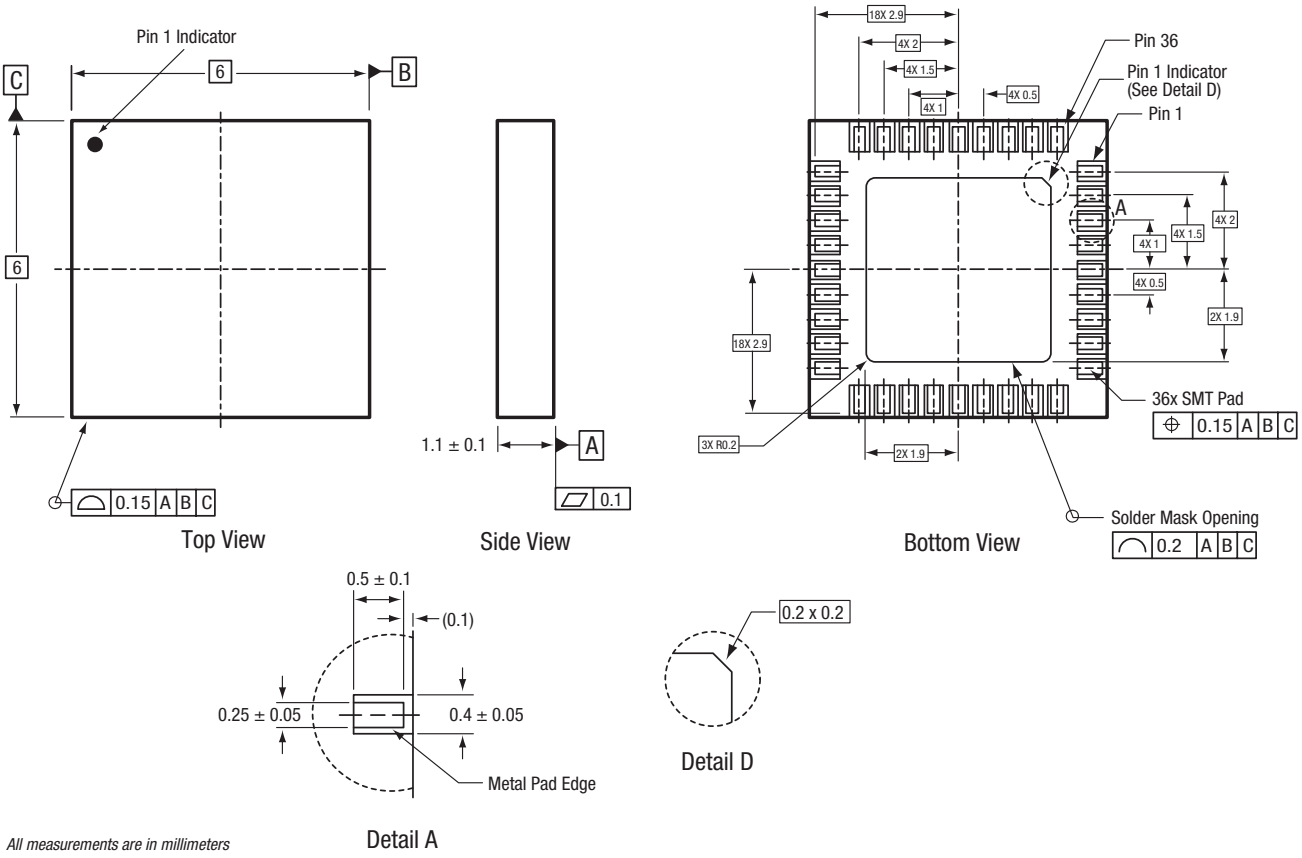
Note: The cross-hatched area represents the merger of the center ground pad +9 individual I/O ground pads. All I/O ground pads should have at least one via connected to internal ground planes for optimum electrical performance.

All measurements are in millimeters

S1125

Figure 39. PCB Layout Footprint for the SKY73021 6 x 6 mm MCM

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0139



All measurements are in millimeters

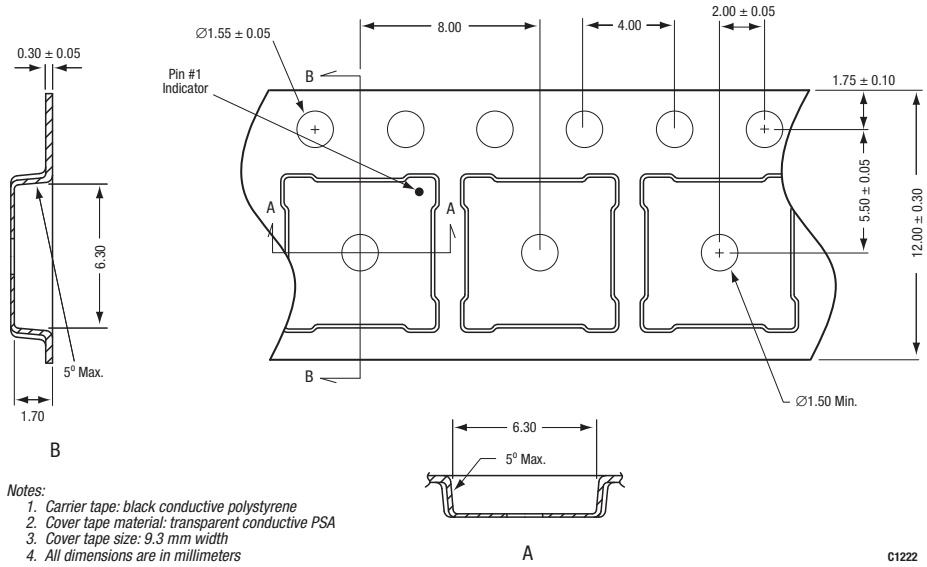
Pads are solder mask defined on one edge and metal defined on three edges.

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

S689_A

Figure 40. SKY73021 36-Pin MCM Package Dimensions

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0140



Notes:
1. *Carrier tape: black conductive polystyrene*
2. *Cover tape material: transparent conductive PSA*
3. *Cover tape size: 9.3 mm width*
4. *All dimensions are in millimeters*

Figure 41. SKY73021 Tape and Reel Dimensions

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0141

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Board Part Number
SKY73021 Downconversion Mixer	SKY73021-11 (Pb-free package)	TW16-D670

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EX-1042
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0142

SKYWORKS®

DATA SHEET

AS188-92, AS188-92LF: PHEMT GaAs IC High-Linearity Positive Control SPDT Switch 300 kHz–2 GHz

Features

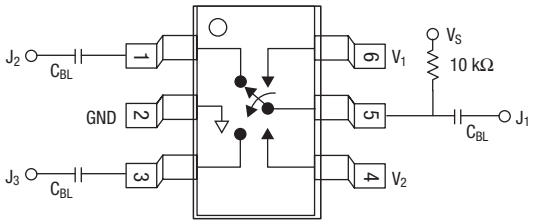
- High linearity (50 dBm IP3 @ 0.9 GHz) @ 3 V
- Low insertion loss (0.35 dB @ 0.9 GHz)
- 3 V operation
- Ultraminiature SC-70 6-lead package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS188-92 is a PHEMT GaAs FET IC high-linearity SPDT switch in a SC-70 6-lead plastic package. This switch has been designed for use where extremely high linearity, low insertion loss and ultraminiature package size are required. It can be controlled with positive, negative or a combination of both voltages. Some standard implementations include antenna changeover, T/R and diversity switching over 2 W. The AS188-92 switch can be used in many analog and digital wireless communication systems including cellular, GSM and DECT applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 100 pF for operating frequency >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–0.5 GHz		0.35	0.4	dB
	300 kHz–1.0 GHz		0.35	0.5	dB
	300 kHz–2.0 GHz		0.55	0.7	dB
Isolation	300 kHz–0.5 GHz	23	26		dB
	300 kHz–1.0 GHz	18	22		dB
	300 kHz–2.0 GHz	13	17		dB
VSWR[3]	300 kHz–1.0 GHz		1.3:1	1.5:1	dB
	300 kHz–2.0 GHz		1.3:1	1.5:1	dB

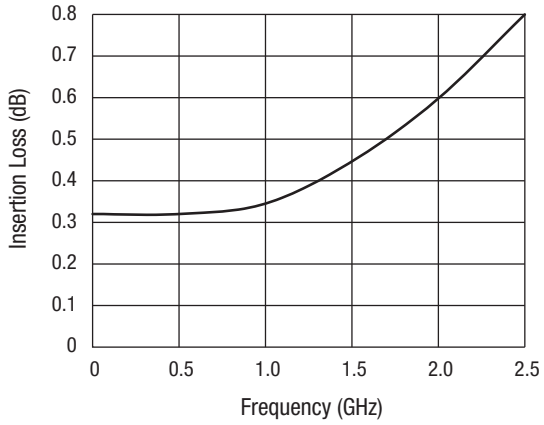
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0143

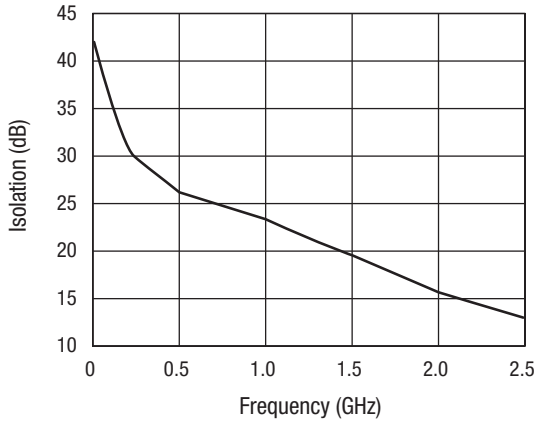
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input Power for 1 dB compression		0.9 GHz		33		dBm
Intermodulation intercept point (IP3)	For two-tone input power 17 dBm	0.9 GHz		50		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max. $V_S = V_{HIGH} \pm 0.2$ V					

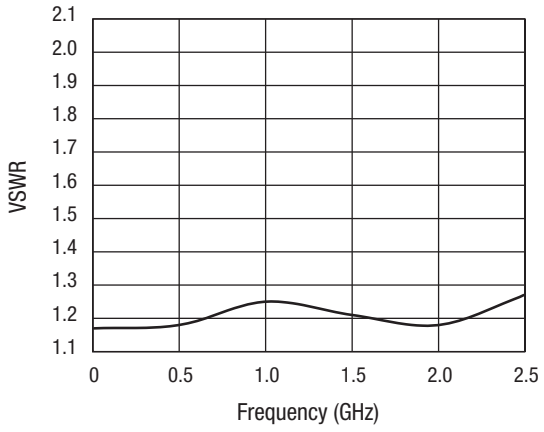
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0144

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W max. > 900 MHz 0/7 V control
Control voltage	-0.2 V, +7 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

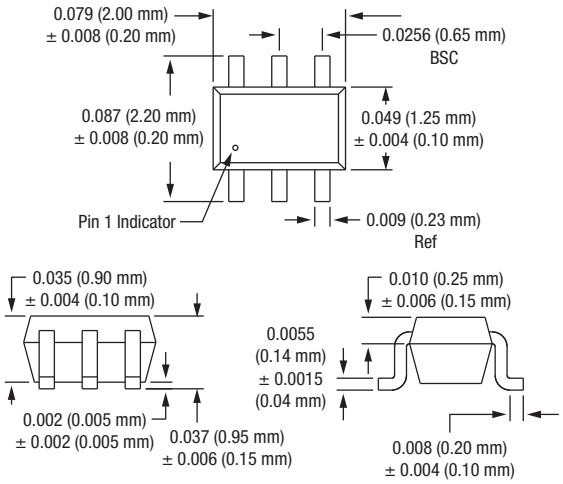
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 to 5 V ($V_S = V_{HIGH} \pm 0.2$ V).

SC-70 6-Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0145

SKYWORKS®

DATA SHEET

AS002R2-12, AS002R2-12LF: GaAs IC SPDT Low-Loss Reflective Switch 300 kHz–2.5 GHz

Features

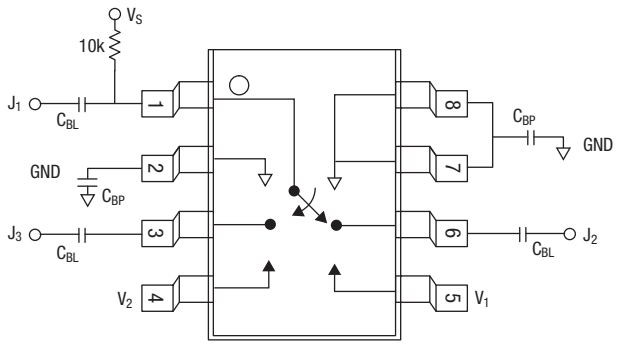
- Low insertion loss (0.5 dB @ 0.9 GHz)
- High isolation (35 dB @ 0.9 GHz)
- Low-power T/R switch
- Low-cost SOIC-8 plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS002R2-12 is a low-loss IC FET SPDT reflective general-purpose switch in a plastic SOIC-8 package for commercial low- cost, low-power applications. The switch operates with -5, 0 V or 0, +5 V when "floated" as shown in the Pin Out diagram.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



External components shown are for positive voltage operation only.
C_{BL} = 100 pF, C_{BP} = 1000 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, -5 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–0.5 GHz		0.4	0.5	dB
	300 kHz–1.0 GHz		0.5	0.6	dB
	300 kHz–2.0 GHz		0.7	0.8	dB
	300 kHz–2.5 GHz		0.8	0.9	dB
Isolation	300 kHz–0.5 GHz	40	42		dB
	300 kHz–1.0 GHz	30	32		dB
	300 kHz–2.0 GHz	22	24		dB
	300 kHz–2.5 GHz	18	20		dB
VSWR[3]	300 kHz–0.5 GHz		1.2:1	1.3:1	
	300 kHz–1.0 GHz		1.3:1	1.5:1	
	300 kHz–2.5 GHz		1.5:1	1.7:1	

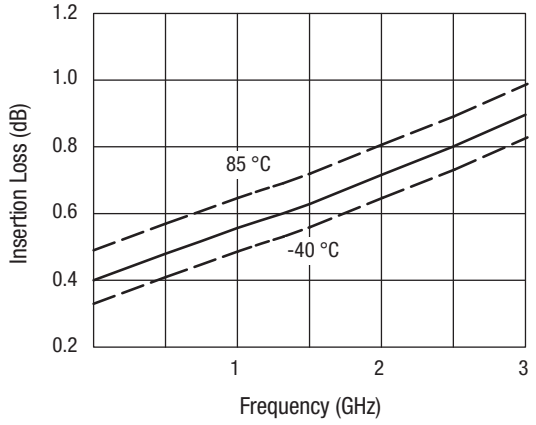
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0146

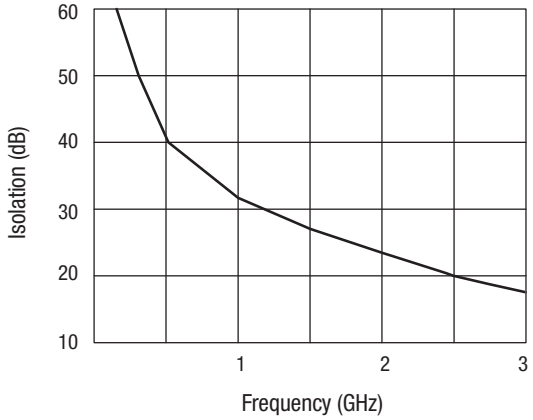
Operating Characteristics at 25 °C (0, -5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			3		ns
On, off	50% CTL to 90/10% RF			6		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			15		mV
Input power for 1 dB compression		0.5–2 GHz		24		dBm
		0.05 GHz		16		dBm
Intermodulation intercept point (IP3)	For two-tone input power 13 dBm	0.5–2 GHz		46		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to -0.2 V @ 20 µA max. V_{HIGH} = -5 V @ 50 µA to -8 V @ 200 µA max.					

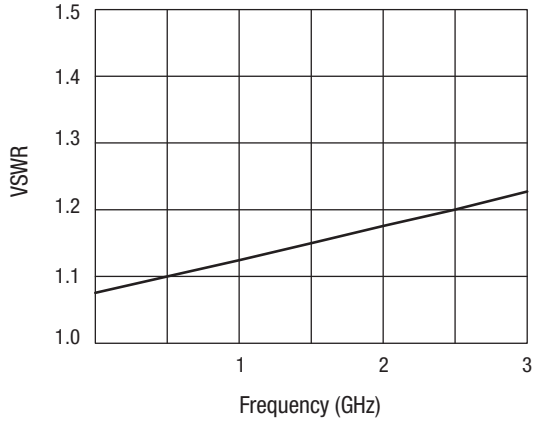
Typical Performance Data (0, -5 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0147

Truth Table

Negative Operation

V_1	V_2	J_1–J_2	J_1–J_3
0	-5	Isolation	Insertion loss
-5	0	Insertion loss	Isolation

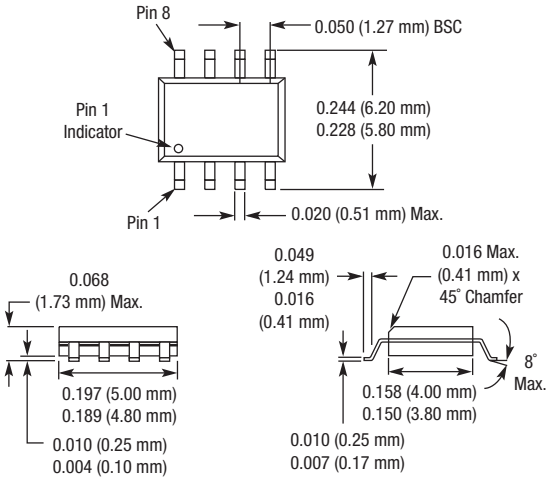
All other conditions not recommended.

Positive Operation

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 5 to 8 V ($V_S = V_{HIGH} \pm 0.2$ V).

SOIC-8



Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W > 500 MHz 0/-8 V 0.5 W @ 50 MHz 0/-8 V
Control voltage	+0.2 V, -8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0148

DATA SHEET

AS169-73, AS169-73LF: PHEMT GaAs IC SPDT Switch 300 kHz–2.5 GHz

Applications

- General-purpose medium-power switches in telecommunication applications
- T/R switches in 802.11b, g WLAN Bluetooth™ systems

Features

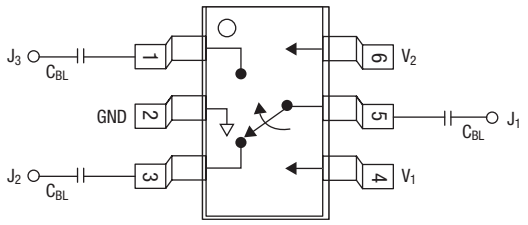
- $P_{1\ dB}$ 30 dBm typical @ 3 V
- IP3 52 dBm typical
- Low insertion loss (0.3 dB @ 0.9 GHz)
- Low DC power consumption
- Ultraminiature low-cost SOT-6 plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS169-73 is an IC FET SPDT switch in a low-cost SOT-6 plastic package. The AS169-73 features low insertion loss and positive voltage operation with very low DC power consumption. This general-purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C

Z_0 = 50 Ω, V_{CTL} = 0/3 V unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[1]	300 kHz–1.0 GHz 300 kHz–2.5 GHz		0.3 0.4	0.4 0.5	dB dB
Isolation	300 kHz–1.0 GHz 300 kHz–2.5 GHz	22 21	25 24		dB dB
VSWR[2]	300 kHz–1.0 GHz 300 kHz–2.5 GHz		1.15:1 1.3:1	1.25:1 1.4:1	

1. Insertion loss changes by 0.003 dB/°C.
2. Insertion loss state.

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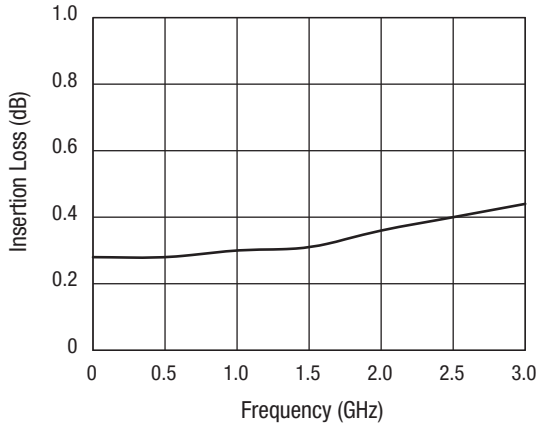
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0149

Operating Characteristics at 25 °C (0, 3 V)

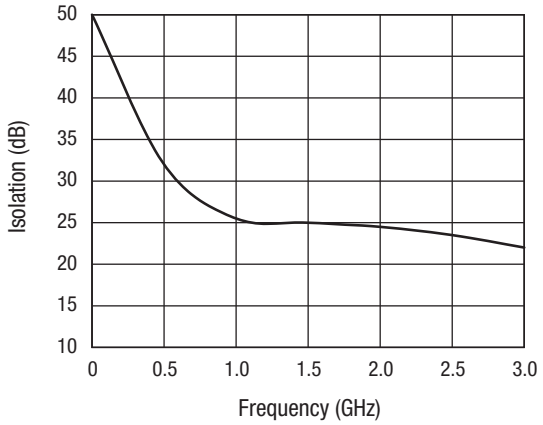
Z_0 = 50 Ω, V_{CTL} = 0/3 V unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall time	10/90% or 90/10% RF			25		ns
On, off time	50% CTL to 90/10% RF			35		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			10		mV
Input power for 1 dB compression	V_{CTL} = 0/3 V	0.5–2.5 GHz		30		dBm
	V_{CTL} = 0/5 V	0.5–2.5 GHz		34		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	V_{CTL} = 0/3 V	0.5–2.5 GHz		43		dBm
	V_{CTL} = 0/5 V	0.5–2.5 GHz		50		dBm
Thermal resistance				25		°C/W
ESD rating	Human body model (Class 1A)					
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

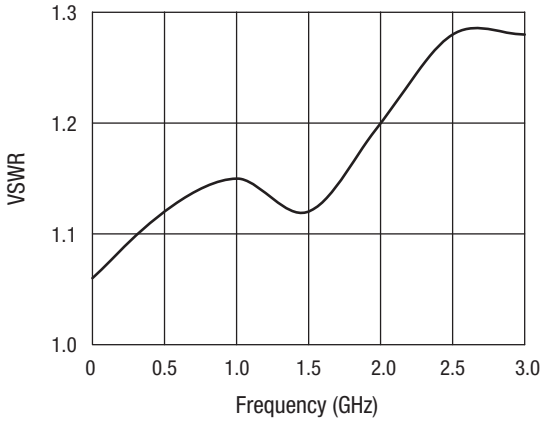
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0150

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	V_{LOW}	Isolation	Insertion loss
V_{LOW}	V_{HIGH}	Insertion loss	Isolation

All other conditions not recommended.
$3\ V \le V_{HIGH} \le 5\ V$, $0\ V \le V_{LOW} \le 0.2\ V$.

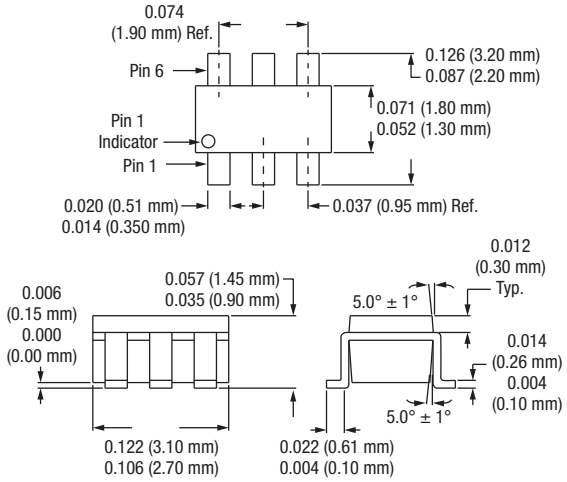
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

SOT-6



Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0151

PRELIMINARY DATA SHEET

AS183-92, AS183-92LF: PHEMT GaAs IC SPDT Switch 300 kHz–2.5 GHz

Features

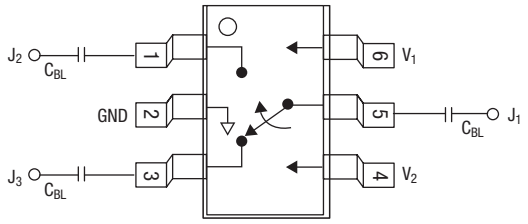
- $P_{1\ dB}$ 30 dBm typical @ 3 V
- IP3 43 dBm typical @ 3 V
- Low insertion loss (0.3 dB @ 0.9 GHz)
- Low DC power consumption
- Miniature SC-70 6-lead plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS183-92 is an IC FET SPDT switch in a very small SC-70 6-lead plastic package. The AS183-92 features low insertion loss and positive voltage operation with very low DC power consumption. This switch is suitable for handset applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–1.0 GHz		0.30	0.4	dB
	300 kHz–2.0 GHz		0.30	0.4	dB
	300 kHz–2.5 GHz		0.55	0.6	dB
Isolation	300 kHz–1.0 GHz	18	20		dB
	300 kHz–2.0 GHz	12	14		dB
	300 kHz–2.5 GHz	11	13		dB
VSWR[3]	300 kHz–2.5 GHz		1.2:1	1.6:1	

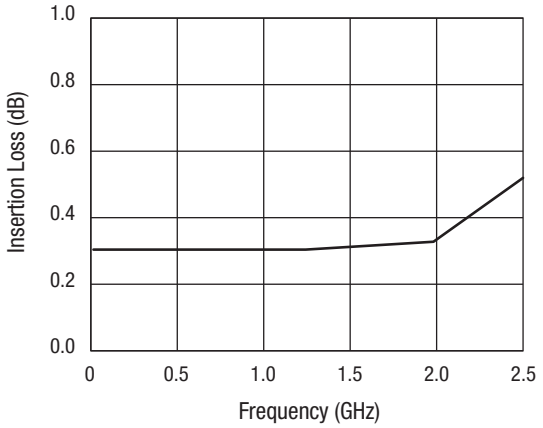
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0152

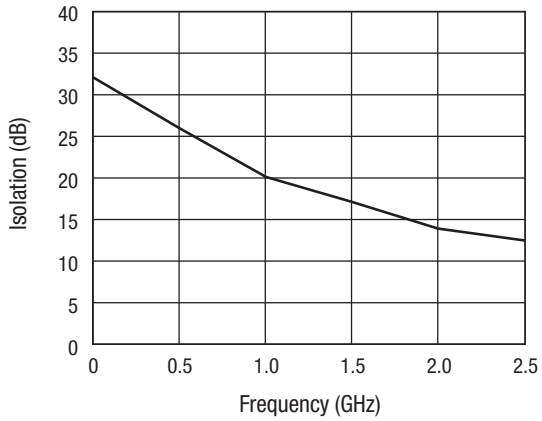
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/3 V	0.5–2.5 GHz		30		dBm
	V_{CTL} = 0/5 V	0.5–2.5 GHz		34		dBm
Intermodulation intercept point (IP3)	For two-tone input power 15 dBm					
	V_{CTL} = 0/3 V	0.5–2.5 GHz		43		dBm
	V_{CTL} = 0/5 V	0.5–2.5 GHz		50		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

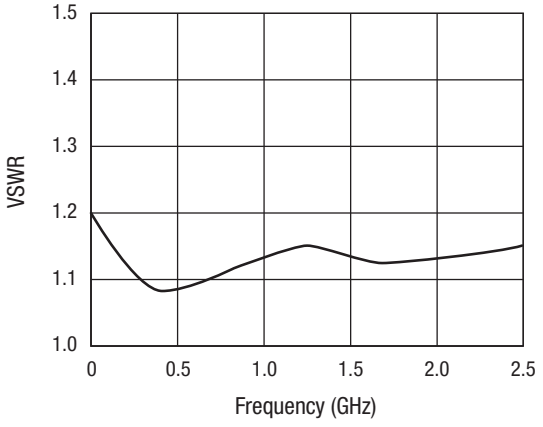
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0153

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

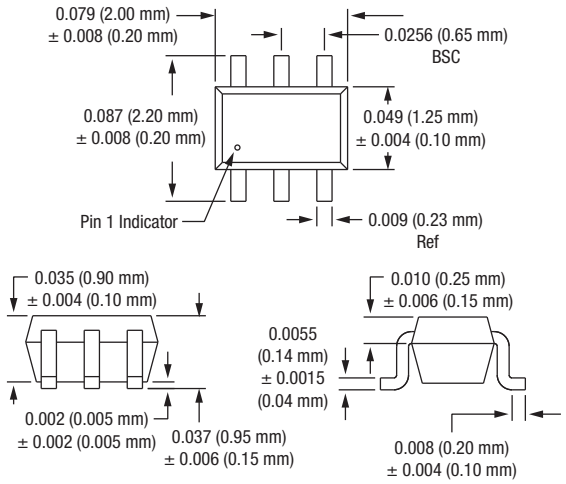
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{High}	Isolation	Insertion loss
V_{High}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 to 5 V.

SC-70 6-Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0154

SKYWORKS®

DATA SHEET

AS216-339, AS216-339LF: GaAs SPDT IC 7 W T/R Switch 300 kHz–2.5 GHz

Features

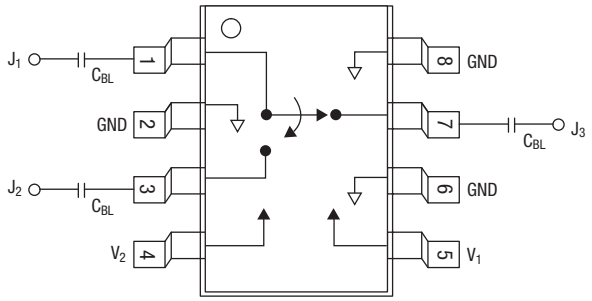
- High isolation (30 dB @ 0.9 GHz)
- Designed for mobile radio applications
- $P_{-1\ dB}$ = 10 W @ 0.9 GHz, 25 °C
- High intercept point (IP3 63 dBm,@ 0.9 GHz)
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS216-339 is a high-power IC FET SPDT switch in a plastic SOIC-8 exposed paddle package. This switch has been designed for use where extremely high linearity is required. It can be controlled with positive, negative or a combination of both voltages. Some standard implementations include antenna changeover, T/R and diversity switching over 2 W. This switch can be used in many analog and digital wireless communication systems including cellular, GSM and PCS applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



External DC blocking capacitors (C_{BL}) are required only if V_{HIGH} > 0.0 V.
C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, -5 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–0.5 GHz		0.7	0.8	dB
	300 kHz–1.0 GHz		0.8	0.9	dB
	300 kHz–2.5 GHz		1.0	1.1	dB
Isolation	300 kHz–0.5 GHz	32	34		dB
	300 kHz–1.0 GHz	27	28		dB
	300 kHz–2.5 GHz	19	20		dB
VSWR[3]	300 kHz–1.0 GHz		1.2:1	1.4:1	dB
	300 kHz–2.5 GHz		1.5:1	1.7:1	dB

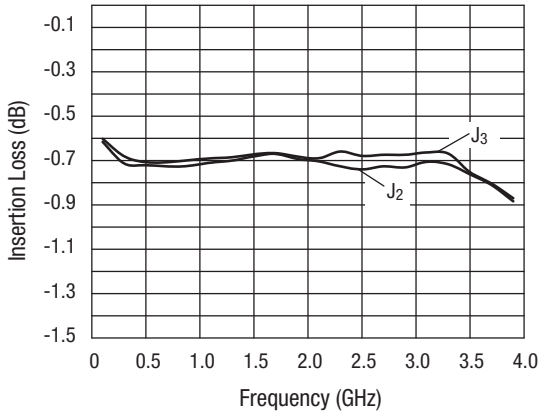
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0155

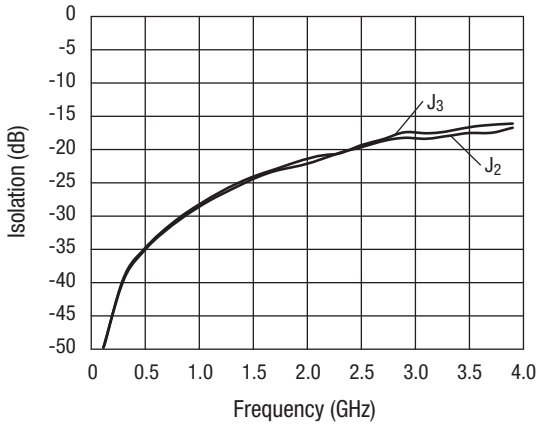
Operating Characteristics at 25 °C (0, -5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			6		ns
On, off	50% CTL to 90/10% RF			12		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			30		mV
Input power for 1 dB compression	V_{CTL} = 5 V	0.9 GHz		35		dBm
	V_{CTL} = 10 V	0.9 GHz		40		dBm
Intermodulation intercept point	For two-tone input power 13 dBm					
	IP3	0.9 GHz		63		dBm
Thermal resistance				45		°C/W
Control voltages	V_{LOW}= -12 V ≤ V_{LOW} ≤ 0 V, 500 µA max. V_{HIGH}= 0 V ≤ V_{HIGH} ≤ 12 V, 500 µA max. Differential = 5 V ≤ (V_{HIGH} – V_{LOW}) < 12 V					

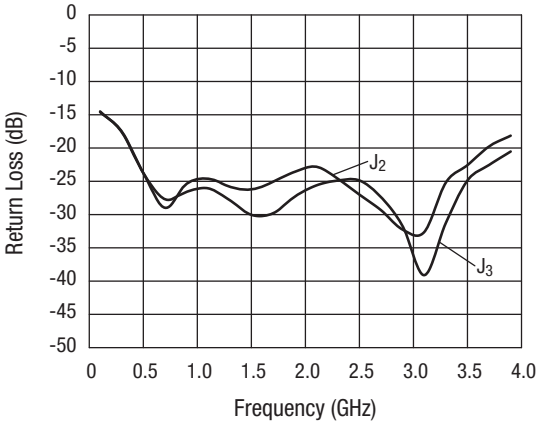
Typical Performance Data (0, -5 V)



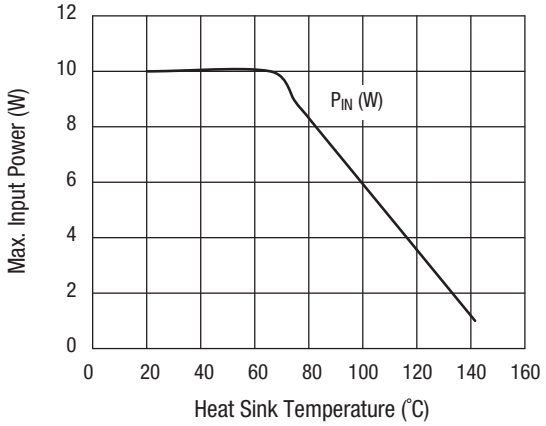
Insertion Loss vs. Frequency



Typical Isolation vs. Frequency

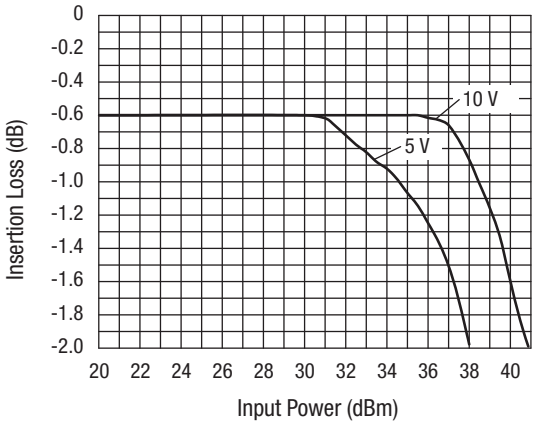


Typical Return Loss vs. Frequency



Temperature Derating Curve (0, +10)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0156



Compression at 900 MHz 25 °C

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{LOW}	V_{HIGH}	Insertion loss	Isolation
V_{HIGH}	V_{LOW}	Isolation	Insertion loss

All other conditions not recommended.
V_{LOW} = 0 to -12 V.
V_{HIGH} = 0 to 12 V.
Differential = 5 V ≤ (V_{HIGH}– V_{LOW}) < 12 V.
Refer to Application Notes for further information on differential voltage operation.

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

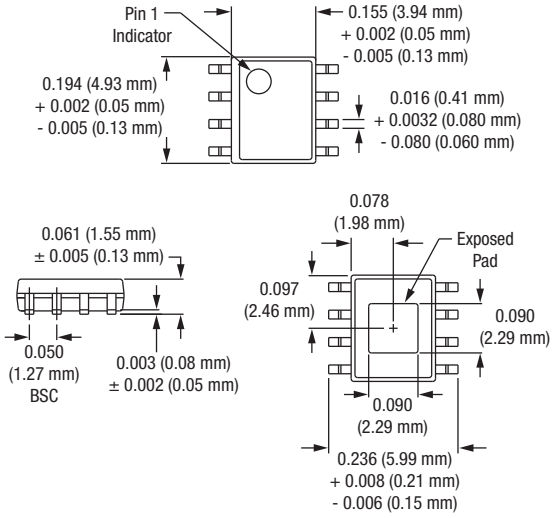
Absolute Maximum Ratings

Characteristic	Value
RF input power	8 W > 0.9 GHz, 0, -12 V
Control voltage	(V_{HIGH} – V_{LOW}) < 12 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

SOIC-8 Exposed Paddle



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0157

DATA SHEET

AS338-12, AS338-12LF: GaAs IC SPDT Nonreflective Switch 300 kHz–2.5 GHz

Features

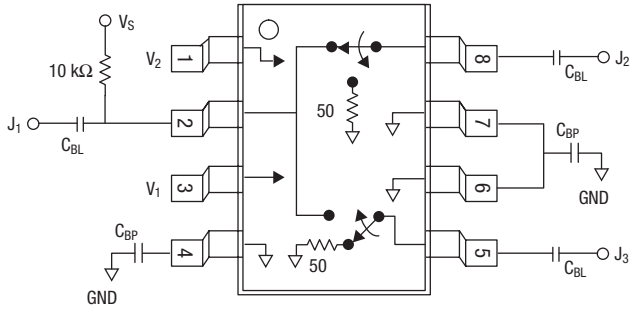
- Low DC power consumption
- High isolation (40 dB @ 0.9 GHz)
- Nonreflective
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS338-12 is a low-cost IC FET SPDT nonreflective switch in a plastic SOIC-8 package for commercial applications. The switch operates with -5, 0 V or 0, +5 V when "floated" as shown on the following page. This general-purpose SPDT switch is used in various telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



External components shown are for positive voltage operation only.
C_{BL} = 100 pF, C_{BP} = 1000 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, -5 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion Loss[2]	300 kHz–0.5 GHz		0.5	0.7	dB
	300 kHz–1.0 GHz		0.6	0.8	dB
	300 kHz–2.0 GHz		0.7	0.9	dB
	300 kHz–2.5 GHz		1.2	1.4	dB
Isolation	300 kHz–0.5 GHz	43	46		dB
	300 kHz–1.0 GHz	36	39		dB
	300 kHz–2.0 GHz	27	30		dB
	300 kHz–2.5 GHz	23	26		dB
VSWR[3]	300 kHz–0.5 GHz		1.2:1	1.3:1	
	300 kHz–1.0 GHz		1.2:1	1.4:1	
	300 kHz–2.5 GHz		1.3:1	1.5:1	

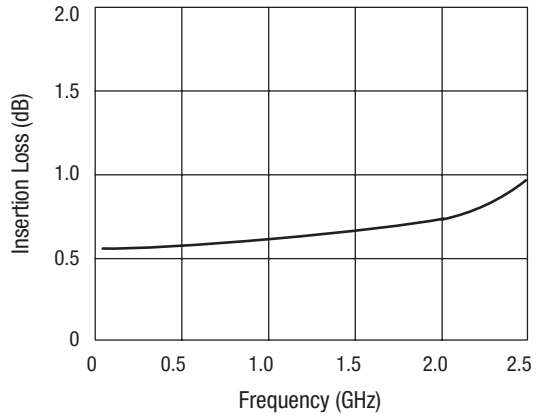
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Input/output.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0158

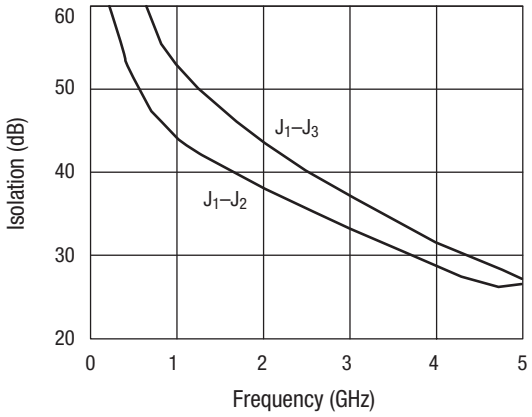
Operating Characteristics at 25 °C (0, -5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			8		ns
On, off	50% CTL to 90/10% RF			30		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression		0.5–2.5 GHz 0.05 GHz		28 23		dBm dBm
Intermodulation intercept point	For two-tone input power 5 dBm	0.5–2.5 GHz 0.05 GHz		46 40		dBm dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = -5 V @ 50 µA to -8 V @ 200 µA max.					

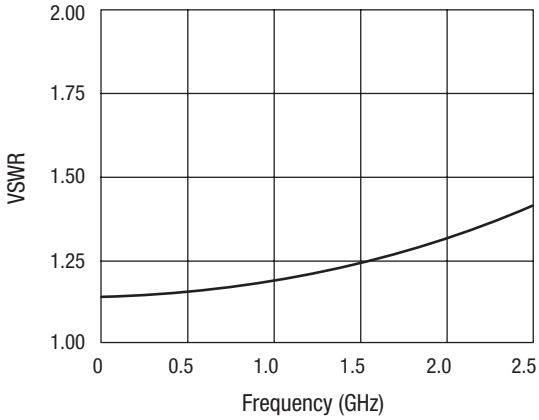
Typical Performance Data (0, -5 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0159

Truth Table

Negative Operation

V_1	V_2	J_1–J_2	J_1–J_3
0	-5	Insertion loss	Isolation
-5	0	Isolation	Insertion loss

All other conditions not recommended.

Positive Operation(1)

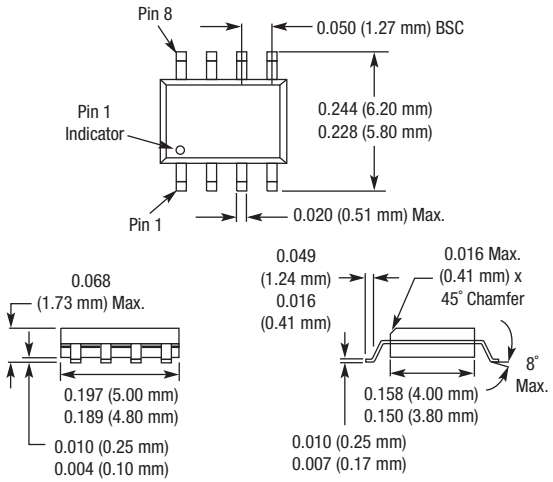
V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Insertion loss	Isolation
0	V_{HIGH}	Isolation	Insertion loss

All other conditions not recommended.

V_{HIGH} = 5 to 8 V ($V_S = V_{HIGH} \pm 0.2$ V).

1. Refer to Application Notes for further information.

SOIC-8



Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W > 500 MHz 0/-8 V 0.5 W @ 50 MHz 0/-8 V
Control voltage	+0.2 V, -8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0160

SKYWORKS®

DATA SHEET

AW002R2-12, AW002R2-12LF: GaAs SPDT IC 5 W T/R Switch 300 kHz–2.5 GHz

Features

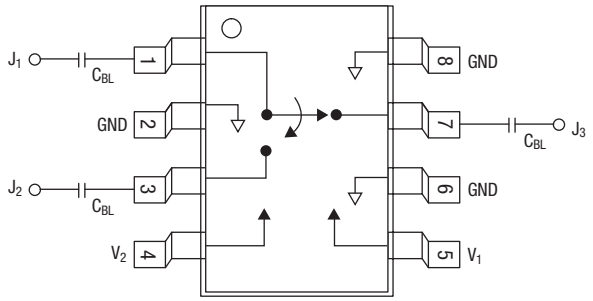
- High isolation (30 dB @ 0.9 GHz)
- Designed for mobile radio applications
- $P_{-1\ dB}$ = 10 W @ 0.9 GHz @ 25 °C
- High intercept point (IP3 63 dBm,@ 0.9 GHz)
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AW002R2-12 is a high-power IC FET SPDT switch in a plastic SOIC-8 package. This switch has been designed for use where extremely high linearity is required. It can be controlled with positive, negative or a combination of both voltages. Some standard implementations include antenna changeover, T/R and diversity switching over 2 W. This switch can be used in many analog and digital wireless communication systems including cellular, GSM and PCS applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



External DC blocking capacitors (C_{BL}) are required only if V_{HIGH} > 0.0 V.
C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, -5 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion Loss[2]	300 kHz–0.5 GHz		0.7	0.8	dB
	300 kHz–1.0 GHz		0.8	0.9	dB
	300 kHz–2.5 GHz		1.0	1.1	dB
Isolation	300 kHz–0.5 GHz	33	37		dB
	300 kHz–1.0 GHz	28	30		dB
	300 kHz–2.5 GHz	20	22		dB
VSWR[3]	300 kHz–1.0 GHz		1.2:1	1.4:1	dB
	300 kHz–2.5 GHz		1.5:1	1.7:1	dB

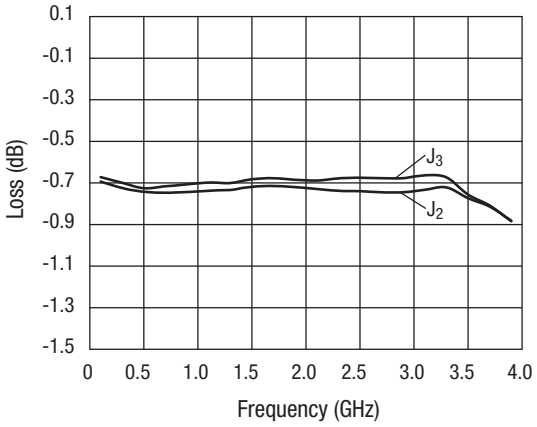
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0161

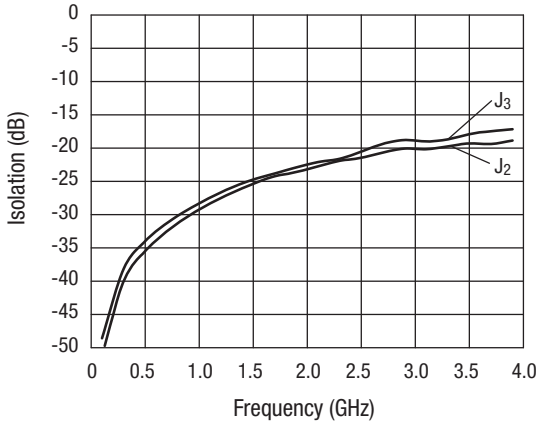
Operating Characteristics at 25 °C (0, -5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			6		ns
On, off	50% CTL to 90/10% RF			12		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			30		mV
Input Power for 1 dB compression	V_{CTL} = 5 V V_{CTL} = 10 V	0.9 GHz 0.9 GHz		35 40		dBm dBm
Intermodulation intercept point	For two-tone input power 13 dBm	0.9 GHz		63		dBm
Thermal resistance				60		°C/W
Control voltages	V_{LOW} = -12 V ≤ V_{LOW} ≤ 0 V, 500 µA max. V_{HIGH} = 0 V ≤ V_{HIGH} ≤ 12 V, 500 µA max. Differential = 5 V ≤ (V_{HIGH}– V_{LOW}) < 12 V					

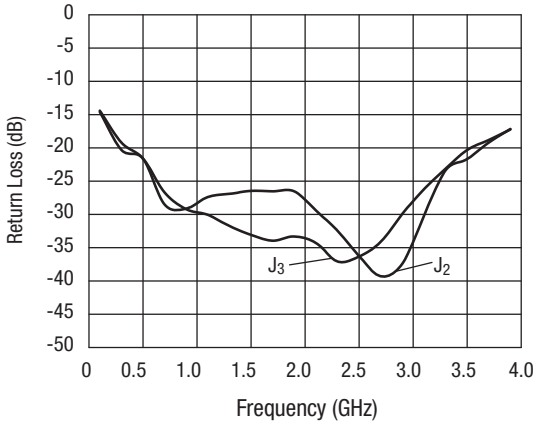
Typical Performance Data (0, -5 V)



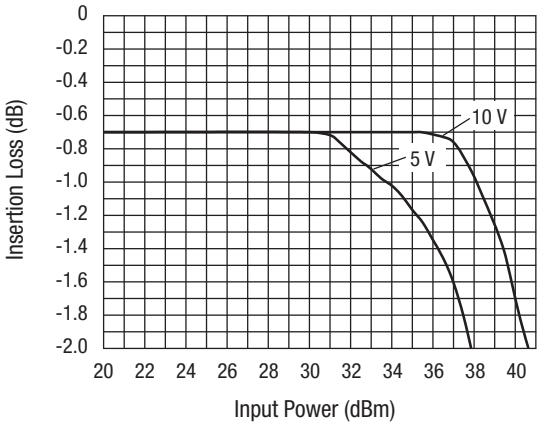
Typical Insertion Loss vs. Frequency



Typical Isolation vs. Frequency

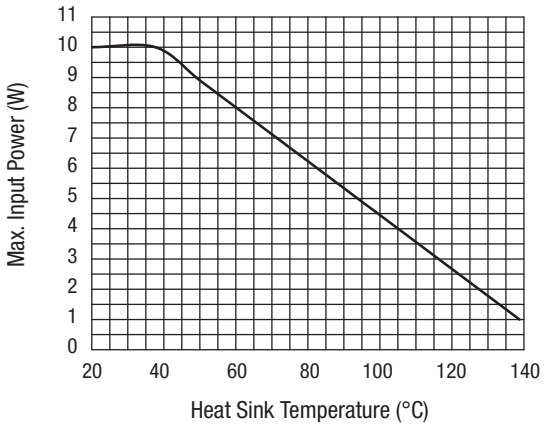


Typical Return Loss vs. Frequency



Compression at 900 MHz 25 ˚C

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0162



Temperature Derating Curve (0, 10 V)

Absolute Maximum Ratings

Characteristic	Value
RF input power	5 W > 0.9 GHz, 0, -12 V
Control voltage	$(V_{HIGH} - V_{LOW}) < 12$ V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

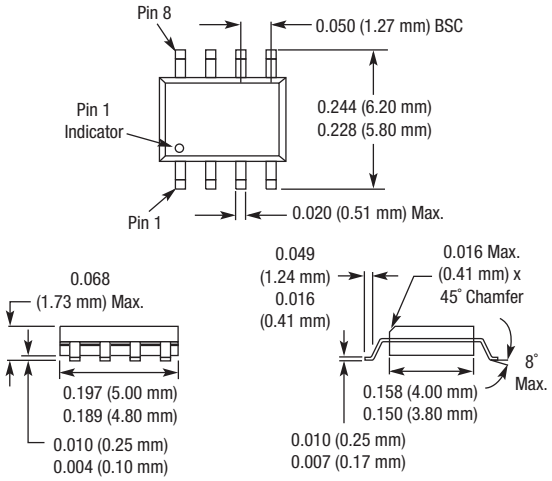
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{LOW}	V_{HIGH}	Insertion loss	Isolation
V_{HIGH}	V_{LOW}	Isolation	Insertion loss

All other conditions not recommended.
V_{LOW} = 0 to -12 V.
V_{HIGH} = 0 to 12 V.
Differential = 5 V ≤ (V_{HIGH}– V_{LOW}) < 12 V.
Refer to Application Notes for further information on differential voltage operation.

SOIC-8



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0163

PRELIMINARY DATA SHEET

SKY13270-92LF: GaAs SPDT Switch 100 MHz–2.5 GHz

Features

- Broadband: 100 MHz–2.5 GHz
- Very low insertion loss: 0.35 dB typical @ 900 MHz
- High isolation: 24 dB typical @ 900 MHz
- $P_{0.1\ dB}$: 37 dBm typical @ 3 V
- Low current consumption: <100 µA @ 3 V
- Miniature SC-70 6-lead package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13270-92LF is a PHEMT GaAs FET IC high-linearity SPDT switch. This wideband switch has been designed for use from 100 MHz to 2.5 GHz, where extremely high linearity, low control voltage, high isolation, low insertion loss, and ultraminiature package size are required. It can be controlled with positive, negative, or a combination of both voltages. The RF signal paths within the SKY13270-92 are fully bilateral.

Some standard implementations include T/R switching and diversity switching over 3 W. The SKY13270-92LF switch can be used in many analog and digital wireless communication systems including cellular, GSM and UMTS applications.

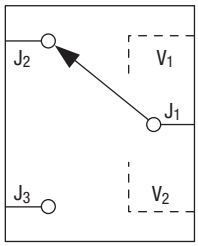
Switching is controlled via two control voltage inputs. Depending upon the voltage level applied to the control voltage pins, the common RF port (J_1) is connected to one of two RF ports (J_2 or J_3) via a low insertion loss path, while the path between J_1 and the other RF port is in its isolation state. When the control voltages are toggled, the states between J_1 and J_2, as well as J_1 and J_3, are also toggled.

This part is available in a lead (Pb)-free, 6-lead SC-70 package which is RoHS-compliant.

An evaluation board is available upon request.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0164

Electrical Specifications

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.1–0.5 GHz		0.30	0.4	dB
	0.5–1.0 GHz		0.35	0.5	dB
	1.0–2.0 GHz		0.45	0.6	dB
	2.0–2.5 GHz		0.55	0.7	dB
Isolation	0.1–0.5 GHz	28	30		dB
	0.5–1.0 GHz	22	24		dB
	1.0–2.0 GHz	17	19		dB
	2.0–2.5 GHz	15	17		dB
VSWR	0.1–1.0 GHz		1.2:1		
	1.0–2.5 GHz		1.3:1		

Operating Characteristics

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	0/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for -0.1 dB compression		900 MHz		37		dBm
Second, third harmonics	P_{IN} = 34.5 dBm, f_{IN} = 900 MHz			-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 @ 20 µA max. V_{HIGH} = 2.5 V @ 100 µA max. to 5 V @ 200 µA max.					

Absolute Maximum Ratings

Characteristic	Value
Control voltage range	$-0.2 \le V_C \le 8$ V
RF input power @ 0/5 V	6 W, f > 900 MHz
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Truth Table

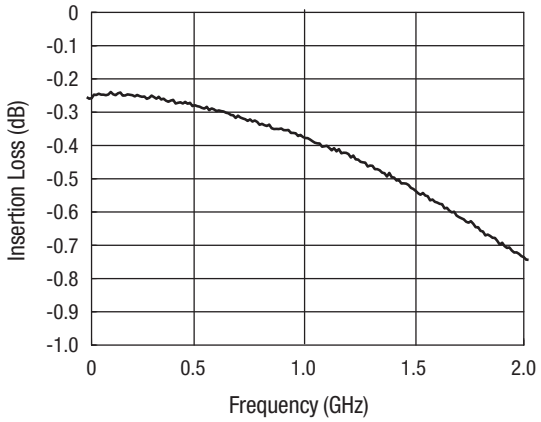
V_1	V_2	J_1–J_2	J_1–J_3
V_{LOW}	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	V_{LOW}	Insertion loss	Isolation

$2.5 \text{ V} \le V_{HIGH} \le 5 \text{ V}$, $0 \le V_{LOW} \le 0.2$ V.
All other conditions not recommended.

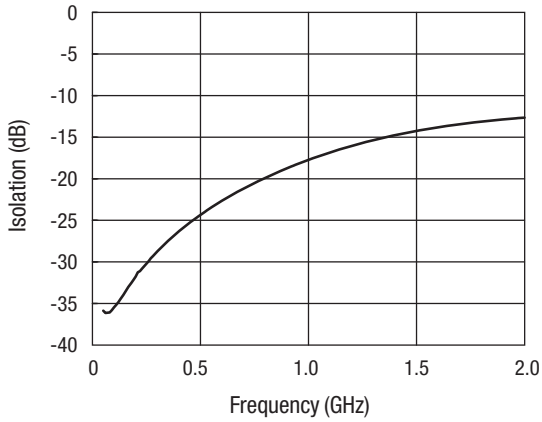
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0165

Typical Performance Data

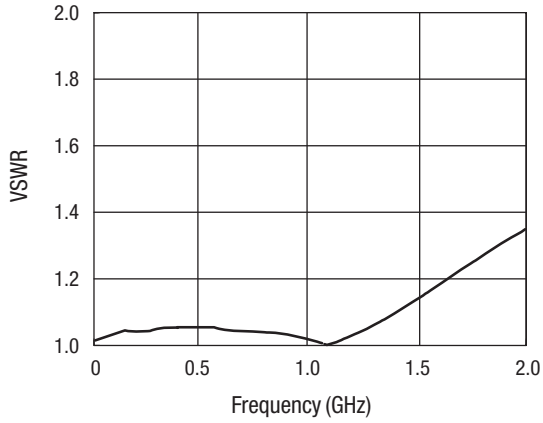
T = 25 °C, Z_0 = 50 Ω, unless otherwise noted



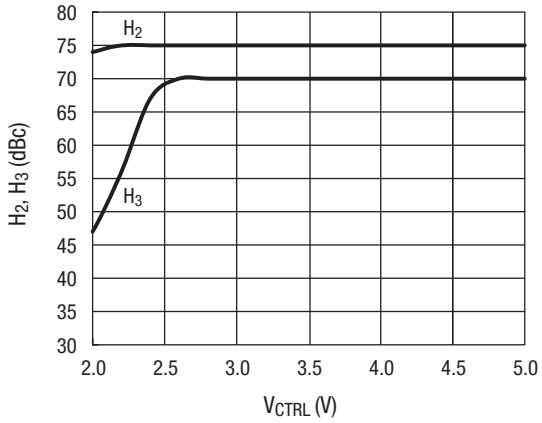
Insertion Loss vs. Frequency



Isolation vs. Frequency



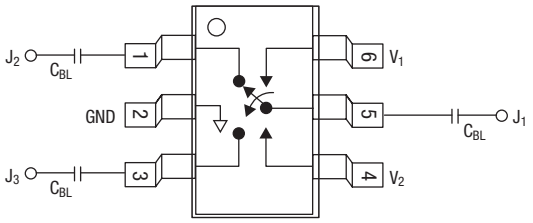
VSWR vs. Frequency



Second and Third Harmonics vs. Control Voltage
f_{IN} = 900 MHz, P_{IN} = 34.5 dBm, GSM Signal

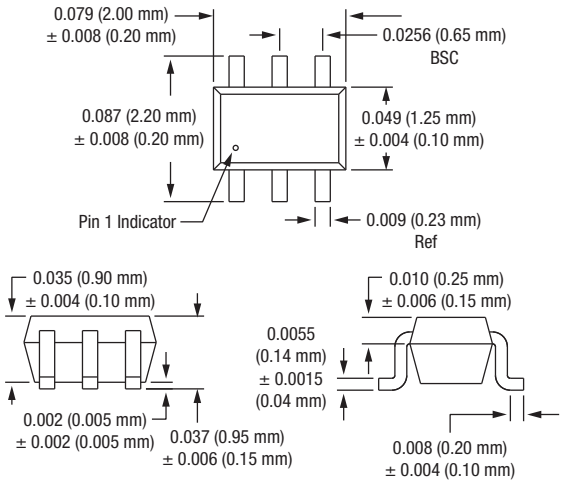
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0166

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 100 pF for operating frequency >500 MHz.

SC-70 Package Outline



Pin Descriptions

Pin Number	Pin Name	Description
1	J_2	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2
2	GND	Equipotential Point – Internal circuit common, which must be connected to the pcb ground or common via the lowest possible impedance
3	J_3	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2
4	V_2	Control Voltage 2 – Control voltage input #2. The logic voltage level applied to this pin, along with the voltage level applied to V_1 (pin 6), determines the states of the RF paths between J_1–J_2 and J_1–J_3
5	J_1	RF Common Input/Output – RF common input/output port which is either connected to J_2 or to J_3 via a low insertion loss and isolated from the other RF port, according to the logic voltage levels applied to V_1 and V_2
6	V_1	Control Voltage 1 – Control voltage input #1. The logic voltage level applied to this pin, along with the voltage level applied to V_2 (pin 4), determines the states of the RF paths between J_1–J_2 and J_1–J_3

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0167

DATA SHEET

SKY13278-313LF: GaAs SPDT Switch 100 MHz–2.5 GHz

Features

- Broadband: 100 MHz–2.5 GHz
- Very low insertion loss: 0.4 dB typ. @ 900 MHz
- High isolation: 26 dB typ. @ 900 MHz
- Low current consumption: <100 µA @ 3 V
- Miniature QFN-6 2 x 3 mm package
- Lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

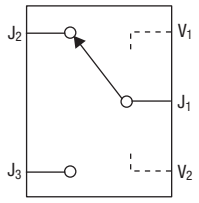
Description

The SKY13278-313LF is a pHEMT GaAs FET IC high linearity SPDT switch. This wideband switch has been designed for use from 100 MHz to 2.5 GHz, where extremely high linearity, low control voltage, high isolation, low insertion loss and ultra-miniature package size are required. It can be controlled with positive, negative or a combination of both voltages. The RF signal paths within the SKY13278-313LF are fully bilateral.

Some standard implementations include T/R switching and diversity switching over 3 W. The SKY13278-313LF switch can be used in many analog and digital wireless communication systems including cellular, GSM and UMTS applications.

Switching is controlled via two control voltage inputs. Depending upon the voltage level applied to the control voltage pins, the common RF port (J_1) is connected to one of two RF ports (J_2 or J_3) via a low insertion loss path, while the path between J_1 and the other RF port is in its isolation state. When the control voltages are toggled, the states between J_1 and J_2, as wells as J_1 and J_3, are also toggled.

Function Block Diagram



The SKY13278-313LF is available in a lead(Pb)-free, RoHS-compliant, QFN-6 2 x 3 mm plastic package.

An evaluation board is available upon request.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications

V_{CTL} = 0/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.1–0.5 GHz		0.40	0.5	dB
	0.5–1.0 GHz		0.40	0.5	dB
	1.0–2.0 GHz		0.45	0.6	dB
	2.0–2.5 GHz		0.55	0.7	dB
Isolation	0.1–0.5 GHz	29	32		dB
	0.5–1.0 GHz	23	26		dB
	1.0–2.0 GHz	17	20		dB
	2.0–2.5 GHz	15	18		dB
Return loss (insertion loss state)	0.1–0.5 GHz		20		dB
Lower frequency return loss is dependent on DC blocks	1.0–2.0 GHz		20		dB

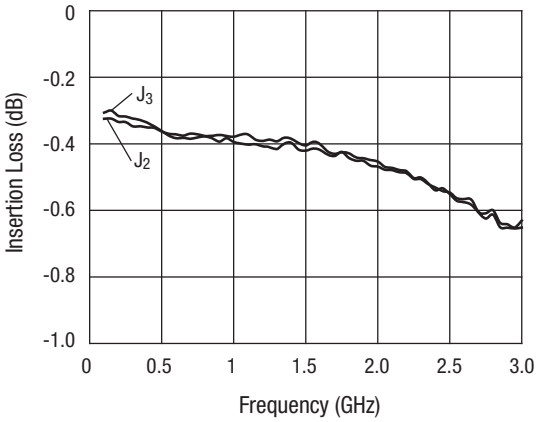
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0168

Operating Characteristics

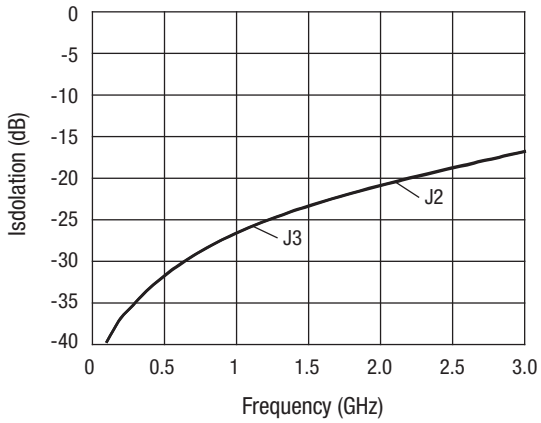
V_{CTL} = 0/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise, fall On, off	 10/90% or 90/10% RF 50% CTL to 90/10% RF			 650 800		 ns ns
Input power for 0.1 dB compression		900 MHz		40		dBm
Second, third harmonics	P_{IN} = 34.5 dBm, f_{IN} = 900 MHz			-75		dBc
Second, third harmonics	P_{IN} =32 dBm, f_{IN}= 1800 MHz			-70		dBc
Blocker performance	T_1 = 1950 MHz @ 20 dBm T_2 = 1760 MHz @ -15 dBm IMD3 measured at 2140 MHz			-105		dBm
Thermal resistance				45		°C/W
Control voltages	V_{LOW} = 0 V @ 20 µA maximum V_{HIGH} = 2.8 V @ 100 µA maximum to 5 V @ 200 µA maximum					

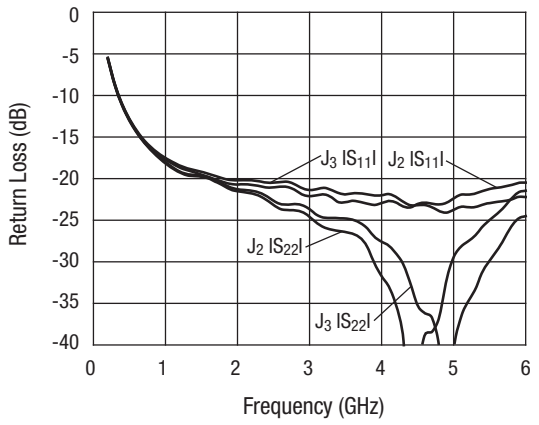
Typical Performance Data



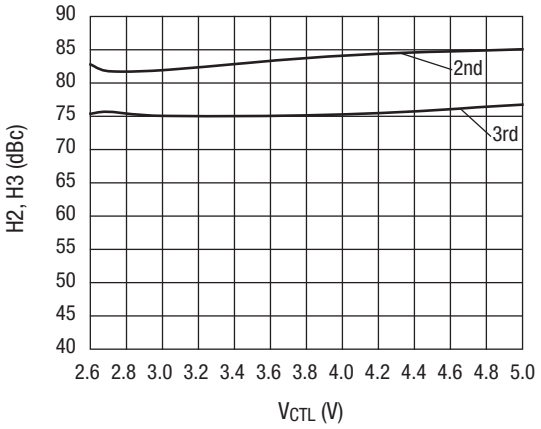
Insertion Loss vs. Frequency



Isolation vs. Frequency

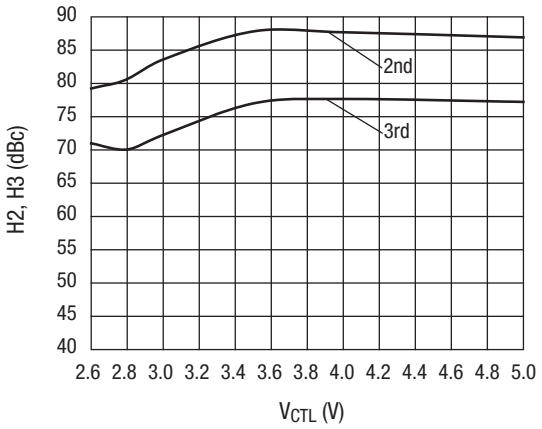


Return Loss vs. Frequency

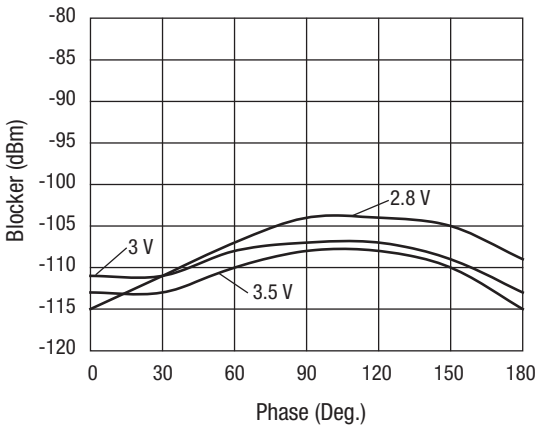


Second and Third Harmonics vs. Control Voltage
F_{IN} = 900 MHz P_{IN} = 34.5 dBm

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0169



Second and Third Harmonics vs. Control Voltage
F_{IN} = 1800 MHz P_{IN} = 32 dBm



Blocker Performance vs. Phase
f1 = 1950 MHz, P_{IN} = +20 dBm
f2 = 1760 MHz, P_{IN} = -15 dBm
Blocker Measured at 2140 MHz

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{LOW}	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	V_{LOW}	Insertion loss	Isolation
V_{LOW}	V_{LOW}	Not recommended(1)	
V_{HIGH}	V_{HIGH}	Not recommended(1)	

$2.8\ V \leq V_{HIGH} \leq 5\ V$, $0 \leq V_{LOW} \leq 0.2\ V$.
1. Switch is in an undefined state.

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Absolute Maximum Ratings

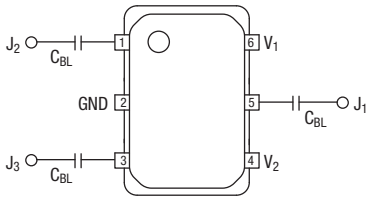
Characteristic	Value
RF input power @ 5 V	10 W, f > 900 MHz @ 25 °C
Control voltage	$-0.2 \leq V_1, V_2 \leq 8$ V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

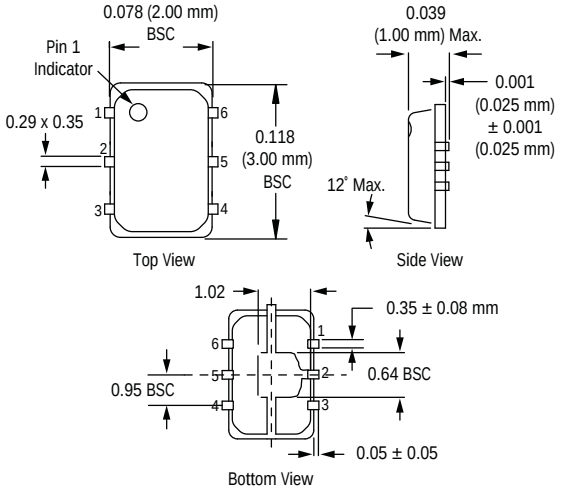
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0170

Pin Out



QFN-6



Pin Descriptions

Pin Number	Pin Name	Description
1	J_2	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2.
2	GND	Equipotential Point – Internal circuit common, which must be connected to the pcb ground or common via the lowest possible impedance.
3	J_3	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2.
4	V_2	Control Voltage 2 – Control voltage input #2. The logic voltage level applied to this pin, along with the voltage level applied to V_1 (pin 6), determines the states of the RF paths between J_1–J_2 and J_1–J_3.
5	J_1	RF Common Input/Output – RF common input/output port which is either connected to J_2 or to J_3 via a low insertion loss and isolated from the other RF port, according to the logic voltage levels applied to V_1 and V_2.
6	V_1	Control Voltage 1 – Control voltage input #1. The logic voltage level applied to this pin, along with the voltage level applied to V_2 (pin 4), determines the states of the RF paths between J_1–J_2 and J_1–J_3.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0171

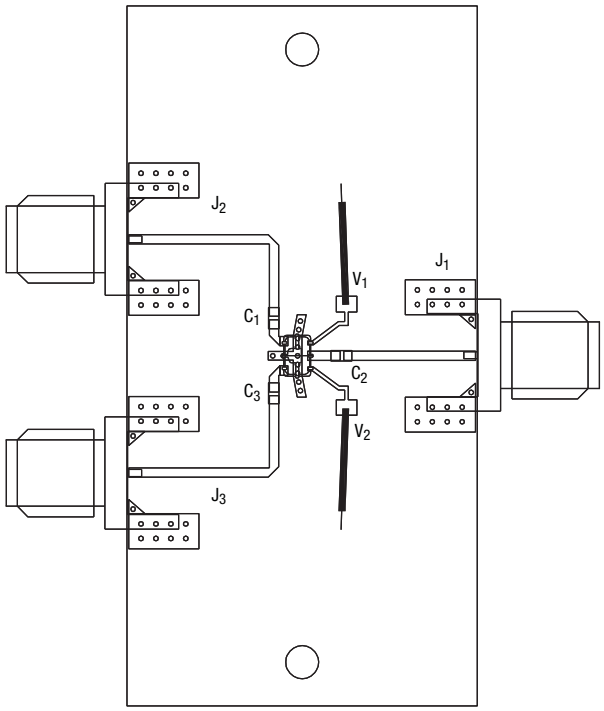
Evaluation Board

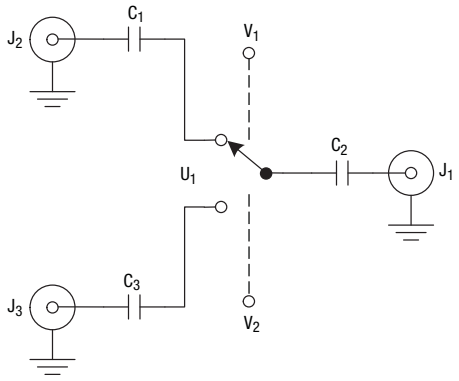
The evaluation board for the SKY13278-313 allows the switch to be fully exercised. The RF common port is marked "J_1", and the two switched RF ports are marked "J_2" and "J_3". All of the RF ports have SMA connectors mounted. The control voltage inputs are marked "V_1" and "V_2".

The printed circuit board material is FR4. The RF dielectric layer is 0.012 inches thick, ½ oz. copper. The RF transmission lines are each 50 Ω (nominal) microstrip.

There are three DC blocking capacitors on the board, C_1, C_2 and C_3, each of which is in series with one of the RF ports. These capacitors are 47 pF. For improved insertion loss at signal frequencies below approximately 500 MHz these capacitors should be replaced with larger capacitance capacitors, such as 1000 pF.

Item	Description	Comments
C_1, C_2, C_3	DC Blocking Capacitor, 47 pF	0402
J_1, J_2, J_3	SMA Connector, Edge Mount	
U1	SKY13278-313	
Printed Circuit Board	Skyworks SK39990	





EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0172

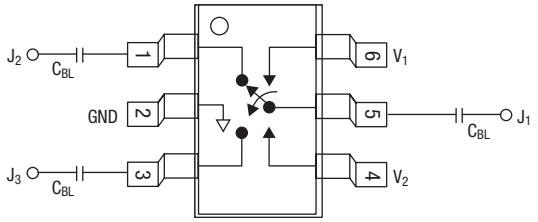
DATA SHEET

AS193-73, AS193-73LF: PHEMT GaAs IC High-Linearity 3 V Control SPDT Switch 0.1–2.5 GHz

Features

- 2.5 to 5 V linear operation
- Harmonics H_2, H_3 > 65 dBc @ P_{IN} = 34.5 dBm
- Low insertion loss (0.35 dB @ 0.9 GHz)
- High isolation (24 dB @ 0.9 GHz)
- Ultraminiature SOT-6 package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 100 pF for operating frequency >500 MHz.

Description

The AS193-73 is a PHEMT GaAs FET IC high-linearity SPDT switch in a SOT-6 plastic package. This switch has been designed for use where extremely high linearity, low control voltage, high isolation, low insertion loss and ultraminiature package size are required. It can be controlled with positive, negative or a combination of both voltages. Some standard implementations include antenna changeover, T/R and diversity switching over 3 W. The AS193-73 switch can be used in many analog and digital wireless communication systems including cellular, GSM and UMTS applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	0.1–0.5 GHz		0.30	0.4	dB
	0.5–1.0 GHz		0.35	0.5	dB
	1.0–2.0 GHz		0.45	0.6	dB
	2.0–2.5 GHz		0.55	0.7	dB
Isolation	0.1–0.5 GHz	28	30		dB
	0.5–1.0 GHz	22	24		dB
	1.0–2.0 GHz	17	19		dB
	2.0–2.5 GHz	15	17		dB
VSWR[3]	0.1–1.0 GHz		1.2:1		dB
	1.0–2.5 GHz		1.3:1		dB

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

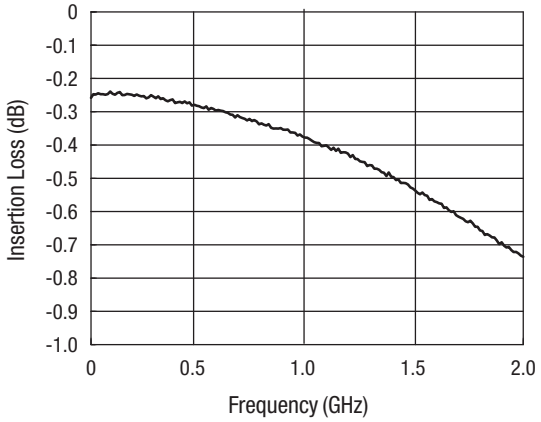
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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0173

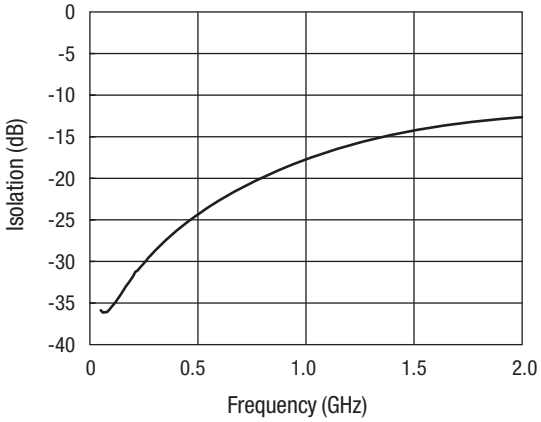
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for -0.1 dB compression	V_{CTL} = 0/3 V	0.9 GHz		37		dBm
Harmonics H_2, H_3	P_{IN} = 34.5 dBm	0.9 GHz		-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 2.5 V @ 100 µA max. to 5 V @ 200 µA max.					

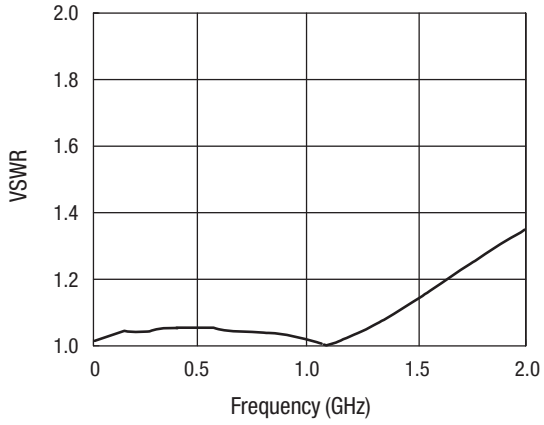
Typical Performance Data



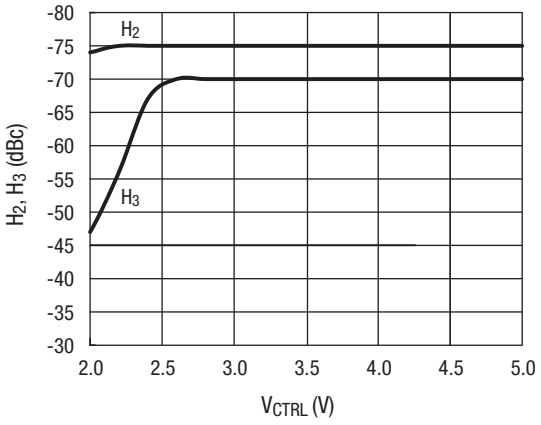
Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency



Harmonics vs. Control Voltage
34.5 dBm 900 MHz GSM Pulse

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0174

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W max. > 900 MHz, 0/5 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

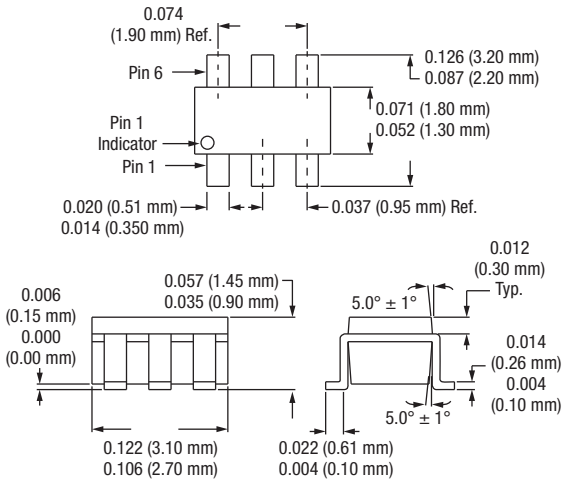
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.5 to 5 V.

SOT-6



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0175

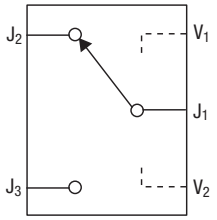
DATA SHEET

SKY13290-313LF: PHEMT 10 W SPDT Switch 500 MHz–2.5 GHz

Features

- Broadband: 500 MHz–2.5 GHz
- Very low insertion loss: 0.4 dB typ. @ 900 MHz
- High isolation: 26 dB typ. @ 900 MHz
- High input power compression: 0.1 dB at > 40 dBm
- Low current consumption: <100 µA @ 3 V
- Miniature QFN-6 2 x 3 mm package
- Lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Functional Block Diagram



Description

The SKY13290-313LF is a PHEMT IC high-power SPDT switch. This high-power switch has been designed for use from 500 MHz–2.5 GHz, where low loss, high isolation, low control voltage and ultraminiature package size are required. It can be controlled with positive, negative or a combination of both voltages. The RF signal paths within the SKY13290-313LF are fully bilateral.

Some standard implementations include T/R switching for telematic applications at elevated power levels.

Switching is controlled via two control voltage inputs. Depending upon the voltage level applied to the control voltage pins, the common RF port (J_1) is connected to one of two RF ports (J_2 or J_3) via a low insertion loss path, while the path between J_1 and the other RF port is in its isolation state. When the control voltages are toggled, the states between J_1 and J_2, as well as J_1 and J3, are also toggled.

The SKY13290-313LF is available in a lead (Pb)-free, RoHS-compliant, QFN-6 2 x 3 mm plastic package.

An evaluation board is available upon request.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0176

Electrical Specifications at 25 °C

V_{CTRL} = 0/3 V, T = 25°C, P_{INPUT} = 0 dbm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.5–1.0 GHz		0.40	0.5	dB
	1.0–2.0 GHz		0.45	0.6	dB
	2.0–2.5 GHz		0.55	0.7	dB
Isolation	0.5–1.0 GHz	23	26		dB
	1.0–2.0 GHz	17	20		dB
	2.0–2.5 GHz	15	18		dB
Return loss[1]	0.5–1.0 GHz		20		dB
	1.0–2.5 GHz		20		dB

1. Return loss state. Lower frequency return loss is dependent on value of the DC blocks.

Operating Characteristics at 25 °C

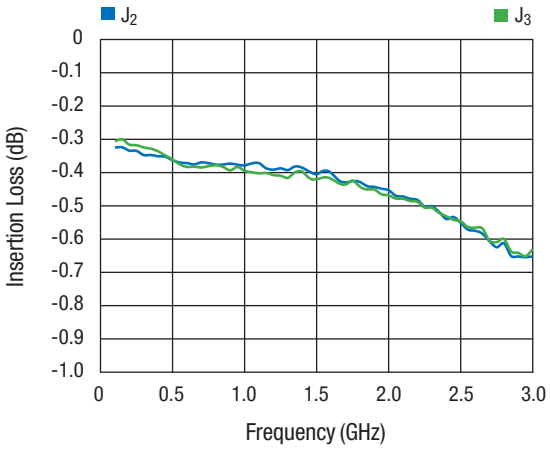
V_{CTRL} = 0/3 V, T = 25°C, P_{INPUT} = 0 dbm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics:						
Rise/fall time	10/90% or 90/10% RF			650		ns
On/off time	50% V_{CTL} to 90/10% RF			800		ns
Input power for 0.1 dB compression		900 MHz		40.5		dBm
Thermal resistance				45		°C/W
Control voltage	V_{LOW} = 0 V @ 20 µA maximum V_{HIGH} = 2.7 V @ 100 µA maximum to 10 V @ 200 µA maximum					

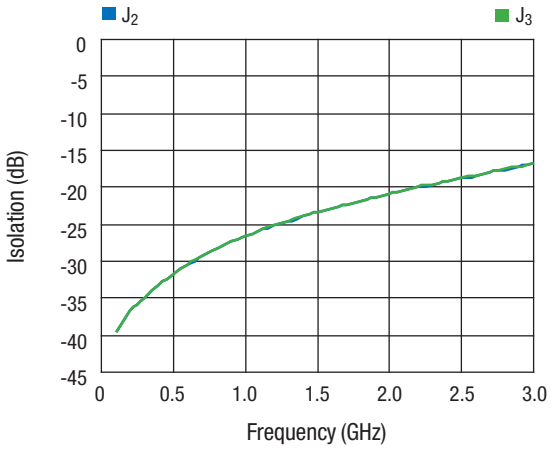
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0177

Typical Performance Data

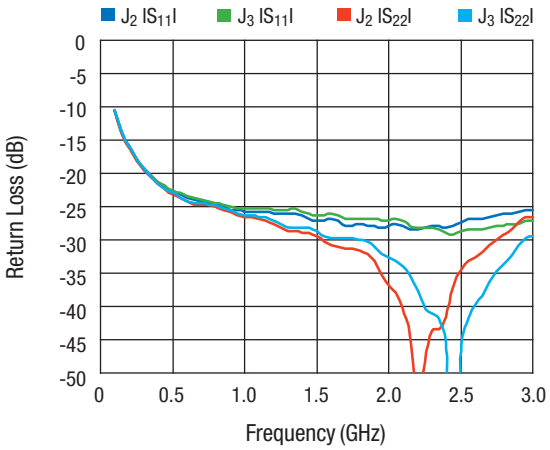
Z_0 = 50 Ω, V_{CTRL} = 0/3 V, unless otherwise noted



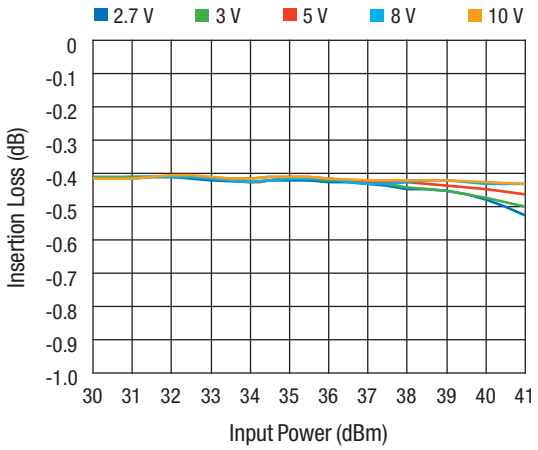
Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency (Insertion Loss State)



Insertion Loss vs. Input Power F = 900 MHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0178

Absolute Maximum Ratings

Characteristic	Value
Control voltage range	$0 \le V_C \le 10$ V
RF input power	43.5 dBm, f > 900 MHz
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

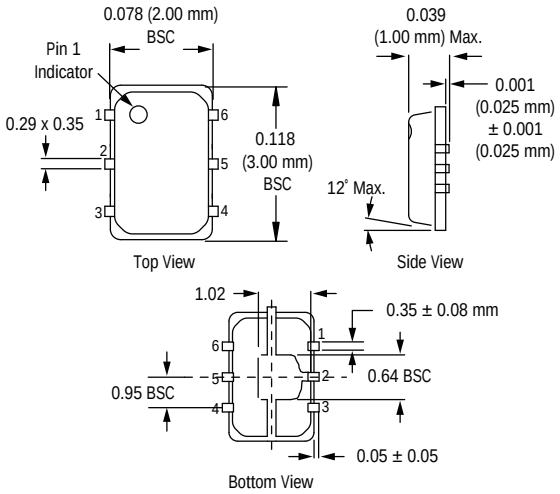
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

QFN-6

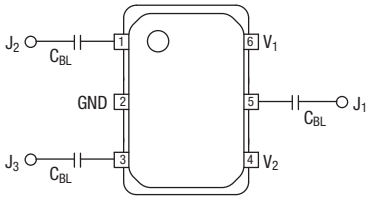


Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{LOW}	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	V_{LOW}	Insertion loss	Isolation
V_{LOW}	V_{LOW}	Not recommended(1)	
V_{HIGH}	V_{HIGH}	Not recommended(1)	

2.7 V < V_{HIGH} < 10 V, 0 < V_{LOW} < 0.2 V.
1. Switch in undefined state.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) must be supplied externally.

Pin Descriptions

Pin Number	Pin Name	Description
1	J_2	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2.
2	GND	Equipotential Point – Internal circuit common, which must be connected to the pcb ground or common via the lowest possible impedance.
3	J_3	RF Input/Output – RF input/output port which is either connected to J_1 via a low insertion loss path or isolated from J_1, according to the logic voltage levels applied to V_1 and V_2.
4	V_2	Control Voltage 2 – Control voltage input #2. The logic voltage level applied to this pin, along with the voltage level applied to V_1 (pin 6), determines the states of the RF paths between J_1–J_2 and J_1–J_3.
5	J_1	RF Common Input/Output – RF common input/output port which is either connected to J_2 or to J_3 via a low insertion loss and isolated from the other RF port, according to the logic voltage levels applied to V_1 and V_2.
6	V_1	Control Voltage 1 – Control voltage input #1. The logic voltage level applied to this pin, along with the voltage level applied to V_2 (pin 4), determines the states of the RF paths between J_1–J_2 and J_1–J_3.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0179

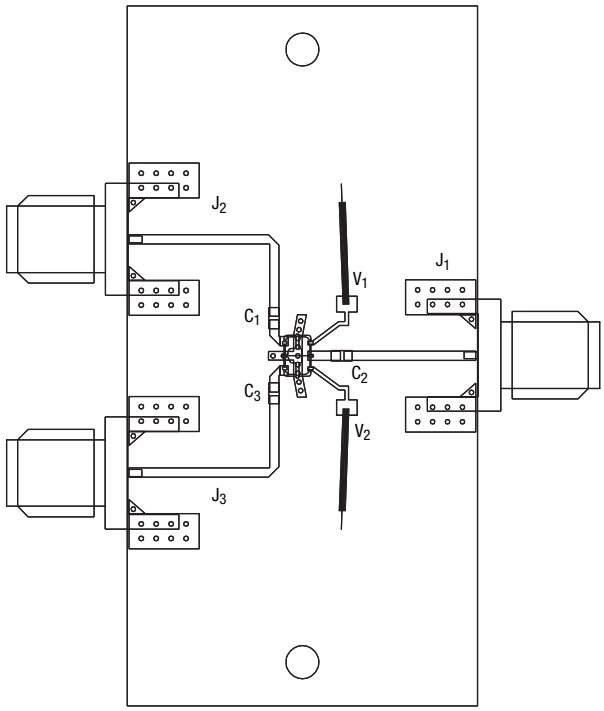
Evaluation Board

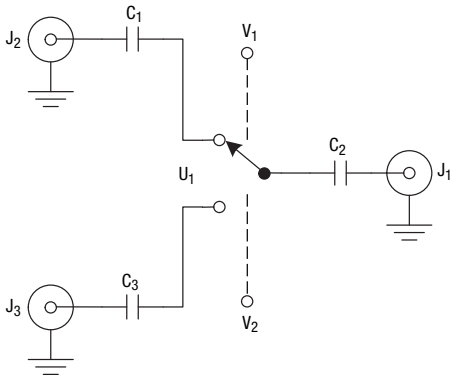
The evaluation board for the SKY13290-313 allows the switch to be fully exercised. The RF common port is marked "J_1", and the two switched RF ports are marked "J_2" and "J_3". All of the RF ports have SMA connectors mounted. The control voltage inputs are marked "V_1" and "V_2".

The printed circuit board material is Rogers 4003. The RF dielectric layer is 0.012 inches thick, ½ oz. copper. The RF transmission lines are each 50 Ω (nominal) microstrip.

There are three DC blocking capacitors on the board, C_1, C_2 and C_3, each of which is in series with one of the RF ports. These capacitors are 47 pF. For improved insertion loss at signal frequencies below approximately 500 MHz these capacitors should be replaced with larger capacitance capacitors, such as 1000 pF.

Item	Description	Comments
C_1, C_2, C_3	DC Blocking Capacitor, 47 pF	0402
J_1, J_2, J_3	SMA Connector, Edge Mount	
U1	SKY13290-313	
Printed Circuit Board	Skyworks SK39990	





EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0180

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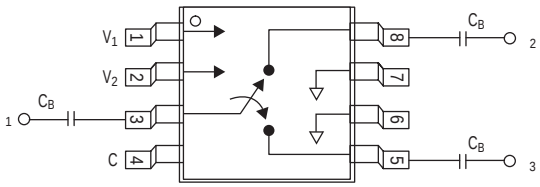
DATA SHEET

AS176-59, AS176-59LF: GaAs IC High-Isolation Positive Control SPDT Switch 300 kHz–3 GHz

Features

- Positive voltage control (0/3 to 5 V)
- High isolation (50 dB @ 0.9, 1.9 GHz)
- Low DC power consumption
- Ideal for cellular, GSM, DCS,PCS, 3G and 2.4 GHz ISM applications
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Pin Out



C_{BL} = 47 pF.

Description

The AS176-59 is a GaAs FET IC SPDT switch packaged in an MSOP-8 plastic package for low-cost, high-isolation commercial applications. It is an ideal building block for base station dual-band applications where synthesizer isolation is critical. Use in conjunction with the AS165-59 SPST switch to meet GSM synthesizer isolation requirements.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C (0, 3 V), (0, 5 V)

Parameter[1]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]		300 kHz–1.0 GHz		0.7	0.9	dB
		300 kHz–2.0 GHz		0.8	1.0	dB
		300 kHz–2.5 GHz		0.8	1.1	dB
		300 kHz–3.0 GHz		0.9	1.2	dB
Isolation[3]	J_1–J_2/J_1–J_3	300 kHz–1.0 GHz	45/50	50/55		dB
	J_1–J_2/J_1–J_3	300 kHz–2.0 GHz	41/38	45/42		dB
		300 kHz–2.5 GHz	29	34		dB
		300 kHz–3.0 GHz	22	27		dB
Isolation[4]	J_1–J_2/J_1–J_3	300 kHz–1.0 GHz	45/50	50/55		dB
		300 kHz–2.0 GHz	47	52		dB
		300 kHz–2.5 GHz	36	40		dB
		300 kHz–3.0 GHz	30	35		dB
VSWR[5]		300 kHz–2.0 GHz		1.3:1	1.5:1	
		300 kHz–3.0 GHz		1.5:1	1.8:1	

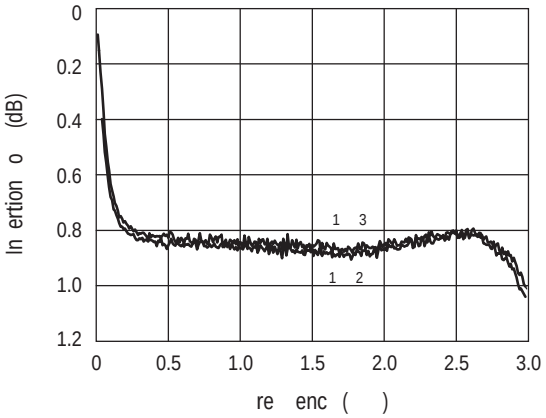
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Pin 4: N/C.
4. Pin 4: GND.
5. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0181

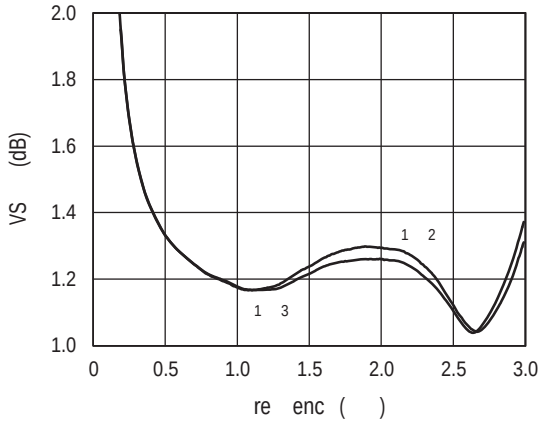
Operating Characteristics at 25 °C (0, 5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Intermodulation intercept point (IP3)	Two-tone input power 5 dBm					
	V_{CTL} = 3 V	0.5–3 GHz		41		dBm
	V_{CTL} = 5 V	0.5–3 GHz		45		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

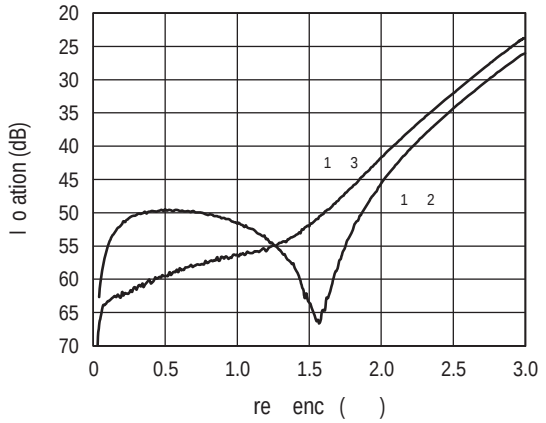
Typical Performance Data (0, 5 V)



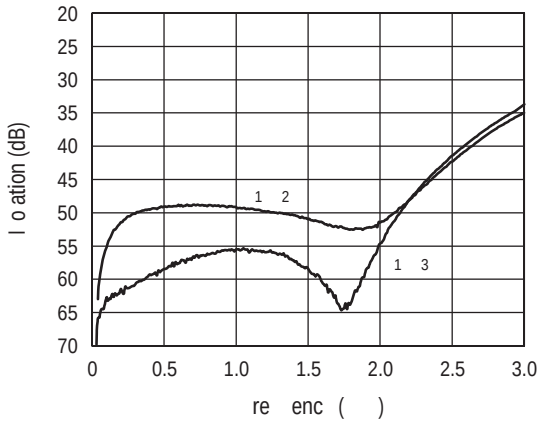
Insertion Loss vs. Frequency



vs. Frequency



Isolation vs. Frequency
Pin 4: N/C



Isolation vs. Frequency
Pin 4: N

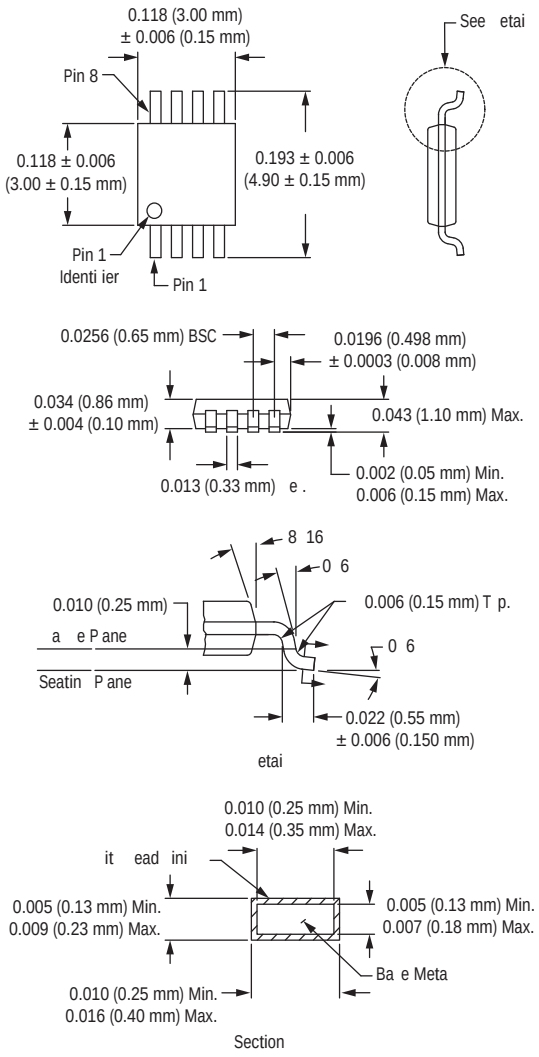
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0182

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 V to 5 V.

MSOP-8



Absolute Maximum Ratings

Characteristic	Value
RF input power	1 W max. for f > 500 MHz 100 mW for f < 500 MHz V_{CTL} = 0/8 V
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0183

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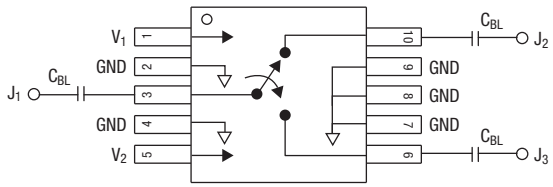
DATA SHEET

AS177-86, AS177-86LF: GaAs IC High-Isolation Positive Control SPDT Switch 300 kHz–3.0 GHz

Features

- Positive voltage control (0/3, 5 V)
- High isolation (50 dB @ 0.9, 1.9 GHz)
- Low DC power consumption
- Ideal for GSM, PCS, 3G and ISM 2.4 GHz applications
- Miniature low-cost MSOP-10 plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Pin Out



C_{BL} = 47 pF for operation >500MHz.

Description

The AS177-86 is a GaAs FET IC SPDT switch packaged in an MSOP-10 plastic package for low-cost, high-isolation commercial applications. It is an ideal building block for base station dual-band applications where synthesizer isolation is critical. Use in conjunction with the AS165-59 SPST switch to meet GSM synthesizer isolation requirements.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C (0, 3 V), (0, 5 V)

Parameter[1]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]		300 kHz–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz		0.7 0.8 0.9	0.85 1 1.2	dB dB dB
Isolation	J_1–J_2/J_1–J_3 J_1–J_2/J_1–J_3	300 kHz–2.0 GHz 2.0–2.5 GHz 2.5–3.0 GHz	44/50 41/44 34	48/55 46/50 40		dB dB
VSWR[3]		300 kHz–3.0 GHz		1.3:1	1.5:1	

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

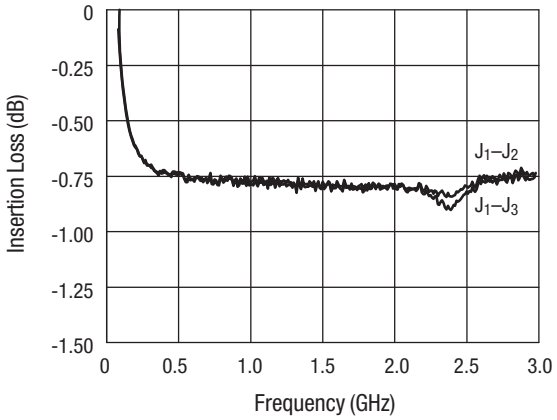
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0184

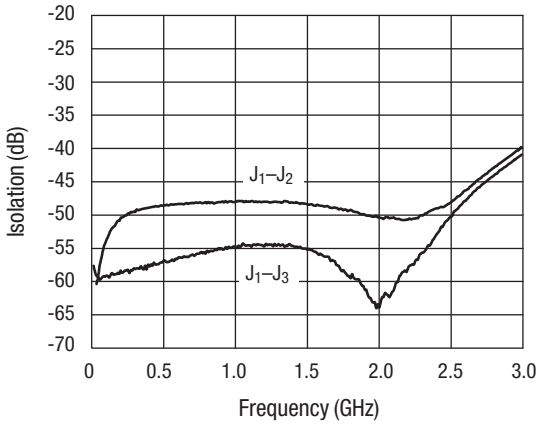
Operating Characteristics at 25 °C (0, 5 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			50		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 3 V	0.5–3.0 GHz		21		dB
	V_{CTL} = 5 V	0.5–3.0 GHz		27		dB
Intermodulation intercept point (IP3)	Two-tone input power 5 dBm					
	V_{CTL} = 3 V	0.5–3.0 GHz		41		dBm
	V_{CTL} = 5 V	0.5–3.0 GHz		45		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

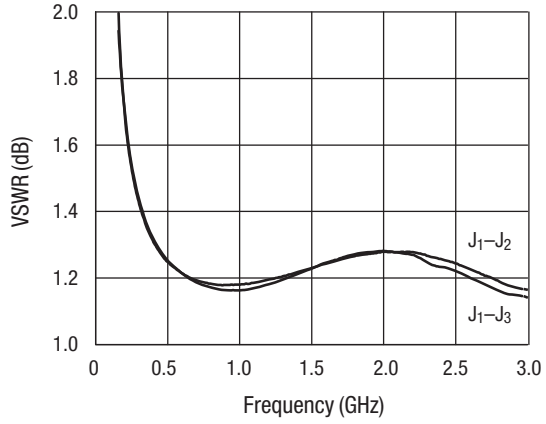
Typical Performance Data (0, 5 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0185

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 V to 5 V.

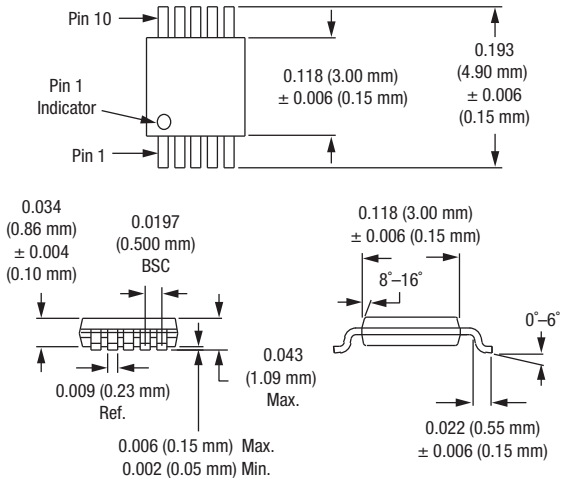
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

MSOP-10



Absolute Maximum Ratings

Characteristic	Value
RF input power	1 W max. for f > 500 MHz 100 mW for f < 500 MHz V_{CTL} = 0/8 V
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0186

DATA SHEET

AS179-92, AS179-92LF: PHEMT GaAs IC SPDT Switch 300 kHz–3 GHz

Applications

- General-purpose medium-power switches in telecommunication applications
- T/R switches in 802.11b, g WLAN Bluetooth™ systems

Features

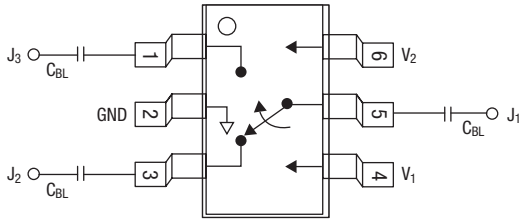
- $P_{1\ dB}$ 30 dBm typical @ 3 V
- IP3 43 dBm typical @ 3 V
- Low insertion loss (0.3 dB @ 0.9 GHz)
- Low DC power consumption
- Ultraminiature SC-70 6-lead package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS179-92 is an IC FET SPDT switch in a low-cost miniature SC-70 6-lead plastic package. The AS179-92 features low insertion loss and positive voltage operation with very low DC power consumption. This general-purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–1 GHz		0.3	0.4	dB
	1–2 GHz		0.4	0.5	dB
	2–3 GHz		0.4	0.6	dB
Isolation	300 kHz–1 GHz	22	25		dB
	1–2 GHz	22	25		dB
	2–3 GHz	20	23		dB
VSWR[3]	300 kHz–1 GHz		1.2:1	1.4:1	
	1–2 GHz		1.2:1	1.4:1	
	2–3 GHz		1.3:1	1.45:1	

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

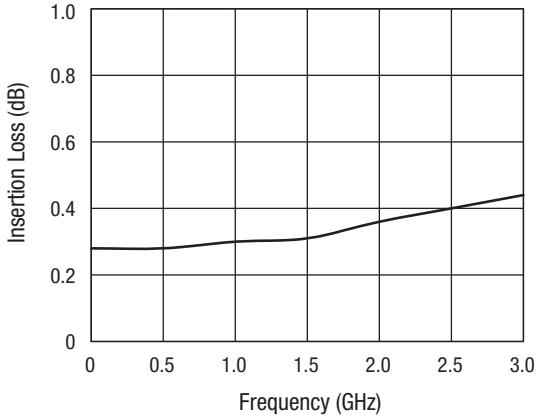
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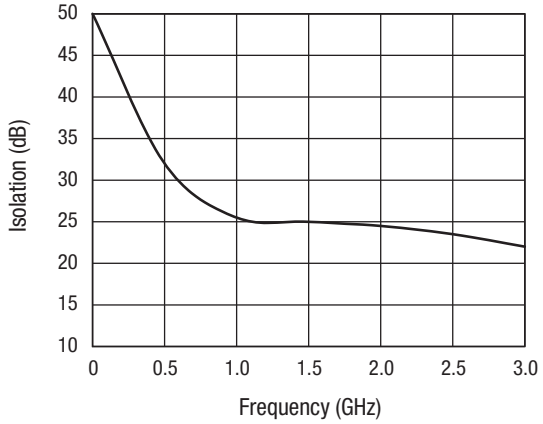
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/3 V	0.5–3 GHz		30		dBm
	V_{CTL} = 0/5 V	0.5–3 GHz		34		dBm
Intermodulation intercept point (IP3)	For two-tone input power +5 dBm					
	V_{CTL} = 0/3 V	0.5–3 GHz		43		dBm
	V_{CTL} = 0/5 V	0.5–3 GHz		50		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

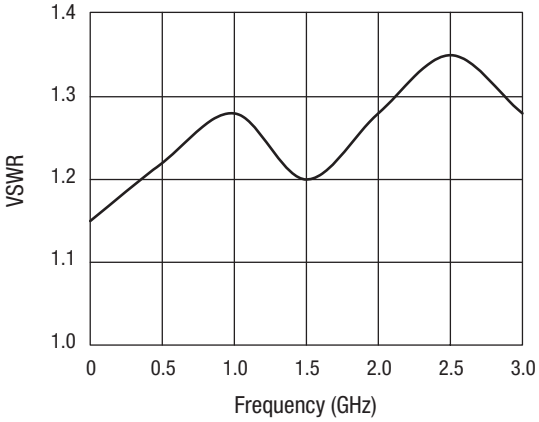
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0188

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W max. for f > 500 MHz 500 mW for f < 500 MHz V_{CTL} = 0/7 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

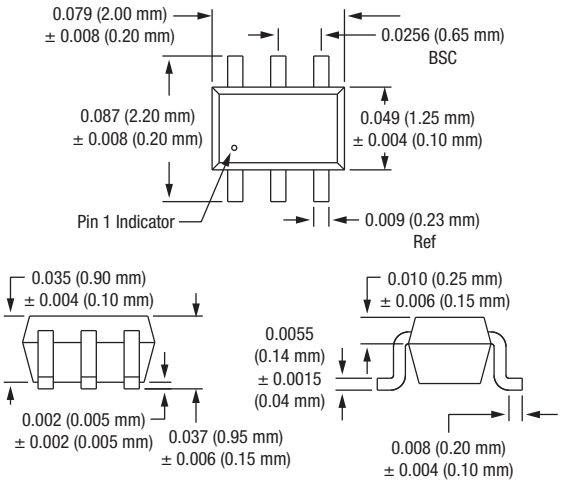
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 to 5 V.

SC-70 6-Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0189

PRELIMINARY DATA SHEET

AS179-000: GaAs SPDT Switch 300 kHz–3 GHz Medium Power

Applications

- General-purpose medium-power switch in telecommunication applications
- Transceiver transmit-receive switch in 802.11b/g WLAN, etc., systems

Features

- Broadband: 300 kHz–3 GHz
- Low insertion loss: 0.3 dB @ 900 MHz
- High isolation: 25 dB @ 900 MHz
- $P_{1\ dB}$: 30 dBm @ 3 V control voltage
- IP3: 43 dBm @ 3 V control voltage
- Low DC power consumption
- 100% RF tested in die form
- Lead (Pb)-free, RoHS-compliant, and Green
- ESD Class 1A

Description

The AS179-000 is a monolithic SPDT switch, fabricated using Skyworks proprietary GaAs PHEMTs as the switching elements. This wideband switch operates with RF signals from 300 kHz–3 GHz. The RF signal paths within the AS179-000 are bilateral. The J_1 and J_2 RF input/output terminals are reflective.

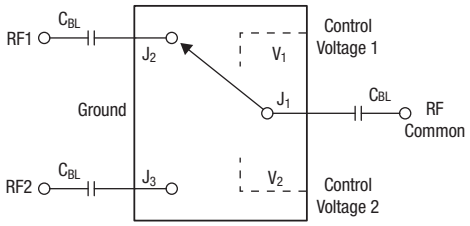
Switching is controlled via a pair of high impedance control voltage inputs. Depending upon the logic voltage level applied to the control voltage pins, the common RF pin (J_1) is connected to one of two switched RF pins (J_2 or J_3) via a low insertion loss path, while the path between the RF common and the other RF pin is in its high-isolation state.

DC power consumption is very low, 100 µA nominal with control voltage of 3 V. The switch can operate over the temperature range of -40° C to +85° C.

NEW

Skyworks Green products are lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, and are free from antimony trioxide and brominated flame retardants.

Functional Block Diagram



DC blocks required on all RF ports for positive control voltage operation.

Absolute Maximum Ratings

Characteristic	Value
RF input power (V_{CTL} 0 V/7 V)	6 W, f > 500 MHz 2 W, 100 > f > 500 MHz 315 mW, f = 300 kHz[1]
Control voltage range	-0.2 V ≤ V_C ≤ +8 V
Operating temperature range	-40 °C to +85 °C
Storage temperature range	-40 °C to +150 °C

1. Derate linearly for 300 kHz < f < 100 MHz.

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0190

Electrical Specifications at 25 °C

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	300 kHz–1 GHz		0.30	0.4	dB
	1–2 GHz		0.30	0.4	dB
	2–3 GHz		0.35	0.5	dB
Isolation	300 kHz–1 GHz	22	25		dB
	1–2 GHz	20	22		dB
	2–3 GHz	20	22		dB
VSWR[1]	300 kHz–3 GHz		1.1:1	1.3:1	

1. Insertion loss state.

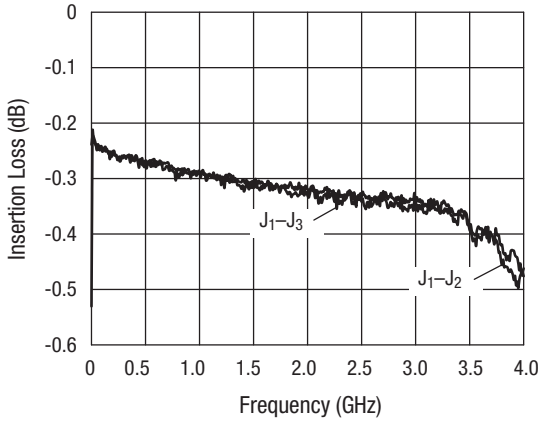
Operating Characteristics at 25 °C

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

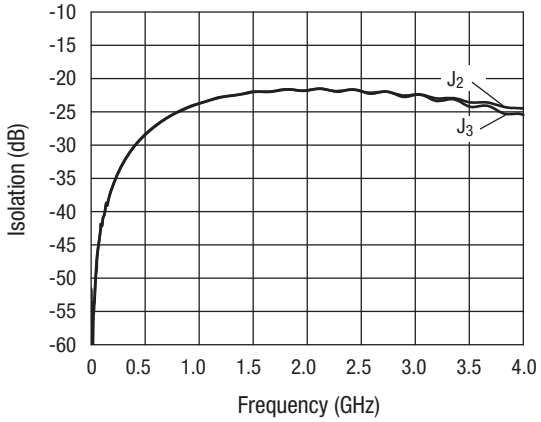
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression ($IP_{1\ dB}$)	V_{CTL} = 0/3 V	0.5–3 GHz		30		dBm
	V_{CTL} = 0/5 V	0.5–3 GHz		34		dBm
Input Intermodulation intercept point (IIP3)	For two-tone input power 5 dBm					
	V_{CTL} = 0/3 V	0.5–3 GHz		43		dBm
	V_{CTL} = 0/5 V	0.5–3 GHz		50		dBm
Thermal resistance				15		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 100 µA max.					

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0191

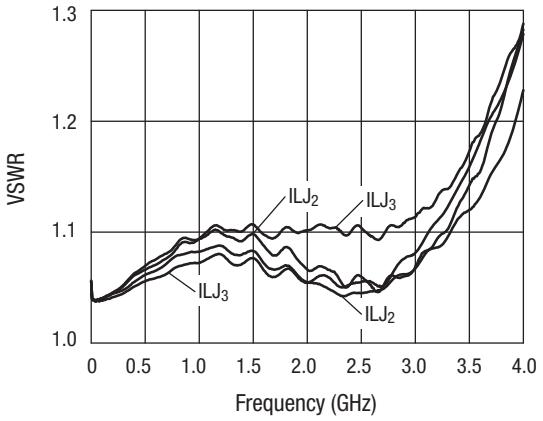
Typical Performance Data



Insertion Loss vs. Frequency

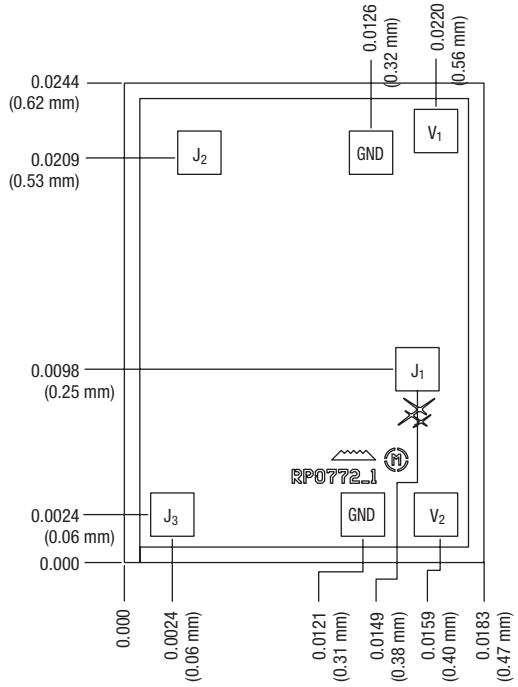


Isolation vs. Frequency



VSWR vs. Frequency

Die Outline



Bond-pad dimensions: 0.0022 (0.06 mm) square.
Bond-pad metallization: Gold.
Backside metallization: None.
Die thickness 0.008 ± 0.001 (0.203 ± 0.025).
Dimensions in inches (mm).

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0192

Port Descriptions

Parameter	Description
J_1	**RF Common** — RF input/output port that is connected via low impedance path to either RF1 or RF2, depending upon the voltage applied to control voltage pin. External DC block required for positive control voltages.
J_2, J_3	**RF Input/Output** — RF input/output port that is connected via low impedance path to either RF common (J_1) or to ground, depending upon the voltage levels applied to control voltage pins. External DC block required for positive control voltages.
V_1, V_2	**Control Voltage Inputs** — Combination of voltage logic levels applied to these pins determines the state of the RF paths between J_1 and J_2/J_3.
GND	**Ground** — Should be down-bonded to circuit ground

Truth Table

V_{CTL1}	V_{CTL2}	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation
0	0	Not allowed	Not allowed
V_{HIGH}	V_{HIGH}	Not allowed	Not allowed

Theory of Operation

The AS179-000 Single Pole Double Throw (SPDT) switch comprises two RF signal paths, one of which connects the RF common pin (J_1) to RF1 (J_2) and the other connects RF common to RF2 (J_3). Depending upon the logic voltage levels applied to the control voltage pins (V_1 and V_2), one of these paths is in its minimum insertion loss state while the other is in its high-isolation state. When these logic levels are toggled, the state of each of the paths toggles accordingly.

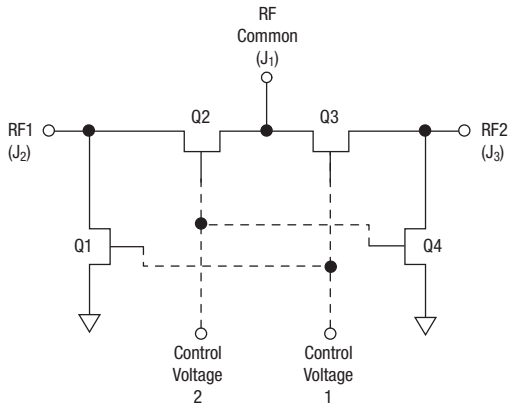
Starting at the RF common pin, each signal path is comprised of a depletion mode PHEMT, Q2 or Q3, in series with the signal path, followed by another depletion mode PHEMT, Q1 or Q4, in shunt with the signal path. A HI logic level applied to the control voltage pin V_1 and a low logic level applied to the control voltage pin V_2 forces the path between RF common and RF1 into its high-isolation state and the other path, from RF common to RF2, into its low insertion loss state.

The shunt PHEMT to common, Q1 or Q4, is biased to produce minimum impedance when the signal path of which it is part is placed into its isolation state. Consequently, the magnitude of the reflection coefficient looking into this pin is close to 1, that is, the VSWR looking into that port approaches infinity.

The AS179-000 can operate with control voltage from 3 V up to 5 V.

The logic threshold voltage for the control voltage pin is one half of the minimum high control voltage. The impedance looking into each of the control voltage pins is several tens of kilohms. For positive control voltage, DC blocks are required on each RF port.

Simplified Block Diagram

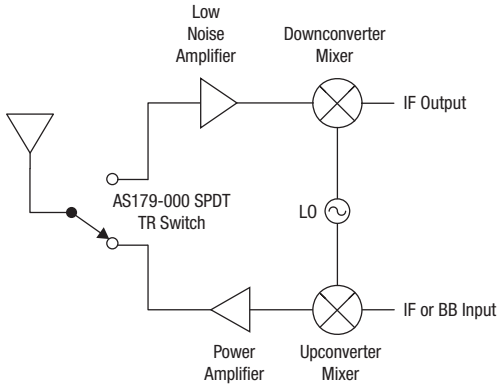


Applications

The AS179-000 SPDT switch can be used in a number of ways: it can be used to select one of two loads; it can also be used to alternately connect an antenna to a radio transmitter and receiver, etc.

Transmit-Receive Switch

A SPDT switch can be used as a transmit-receive (TR) switch, to alternately connect a transmitter and a receiver to a single antenna in a single duplex system.



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0193

Ordering Information

Model Name	Operating Temperature Range	Ordering Part Number	Package Description
AS179-000 GaAs SPDT switch	-40 °C to +85 °C	AS179-000	Wafer on plastic-ring film frame

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0194

SKYWORKS®

DATA SHEET

AS213-92, AS213-92LF: PHEMT GaAs IC SPDT Switch 0.1–3 GHz

Applications

- T/R switch in WLANs, Bluetooth® and medium-power telecommunication applications

Features

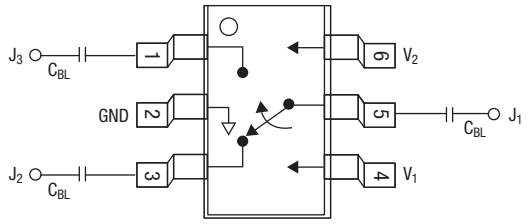
- Low insertion loss (0.4 dB @ 2.4 GHz)
- Isolation 22 dB @ 2.4 GHz
- Low DC power consumption
- PHEMT process
- Operates with 1.8 V control voltage
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS213-92 is a medium-power IC FET SPDT switch in a low-cost miniature SC-70 6-lead plastic package. The AS213-92 features low insertion loss and positive voltage operation with very low DC power consumption. This general-purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	0.1–1.0 GHz		0.3	0.5	dB
	1.0–2.0 GHz		0.4	0.6	dB
	2.0–3.0 GHz		0.5	0.7	dB
Isolation	0.1–1.0 GHz	24	27		dB
	1.0–2.0 GHz	20	23		dB
	2.0–3.0 GHz	16	19		dB
VSWR[3]	0.1–1.0 GHz		1.3:1		
	1.0–3.0 GHz		1.4:1		

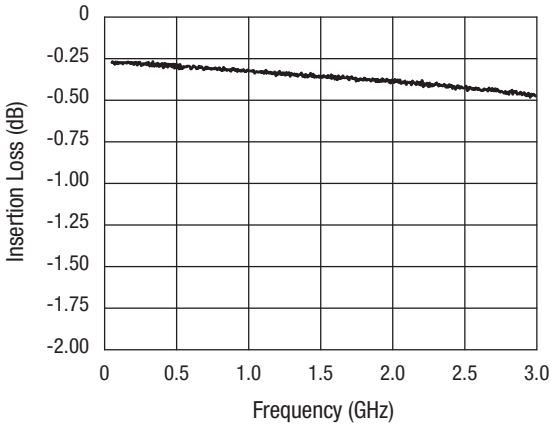
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0195

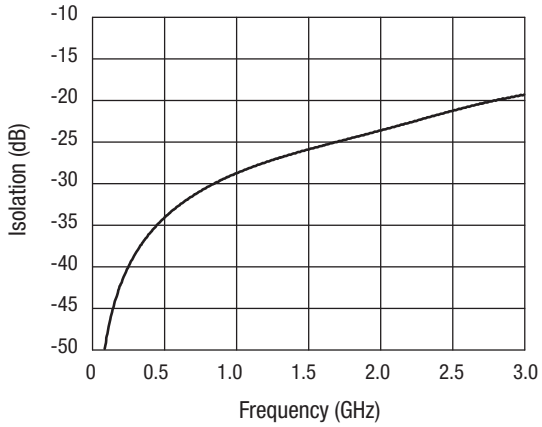
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	0/1.8 V	0.5–3 GHz		20		dBm
	0/3 V	0.5–3 GHz		27		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	0/3 V	0.5–3 GHz		40		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 1.8 V @ 100 µA max. to 5 V @ 200 µA max.					

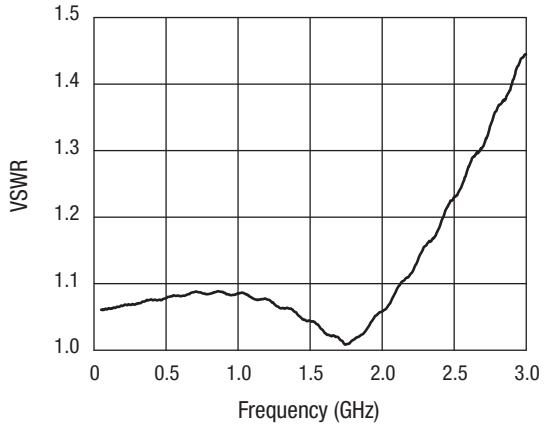
Simulated Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0196

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W max. for f > 500 MHz 500 mW for f < 500 MHz V_{CTL} = 0/8 V
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

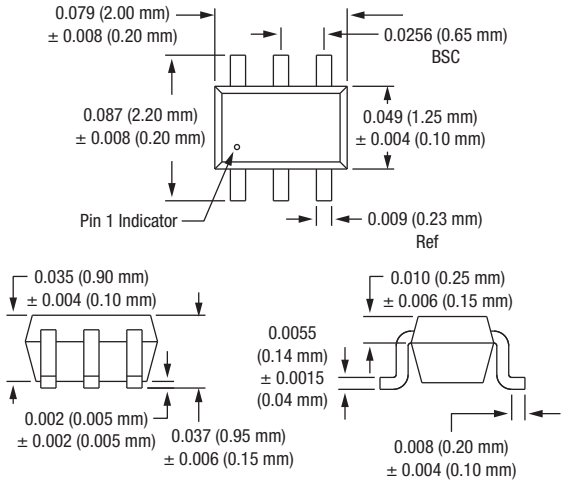
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 1.8 to 5 V.

SC-70 6 Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0197

SKYWORKS®

DATA SHEET

AS214-92, AS214-92LF: PHEMT GaAs IC SPDT Switch 0.1–3 GHz

Applications

- T/R switch in WLANs, Bluetooth™ and medium-power telecommunication applications

Features

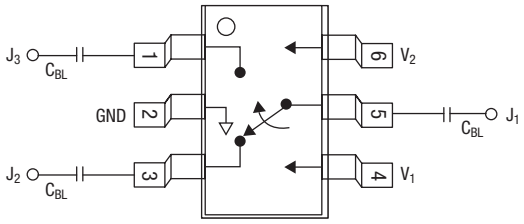
- Low insertion loss (0.4 dB @ 2.4 GHz)
- Isolation 26 dB @ 2.4 GHz
- Low DC power consumption
- PHEMT process
- Operates at 1.8 V control voltage
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS214-92 is a medium-power IC FET SPDT switch in a low-cost miniature SC-70 6-lead plastic package. The AS214-92 features low insertion loss and positive voltage operation with very low DC power consumption. This general purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	0.5–1.0 GHz		0.3	0.5	dB
	1.0–2.0 GHz		0.4	0.6	dB
	2.0–3.0 GHz		0.4	0.6	dB
Isolation	0.5–1.0 GHz	27	30		dB
	1.0–2.0 GHz	24	27		dB
	2.0–3.0 GHz	22	25		dB
VSWR[3]	0.5–1.0 GHz		1.1:1		
	1.0–2.0 GHz		1.1:1		
	2.0–3.0 GHz		1.4:1		

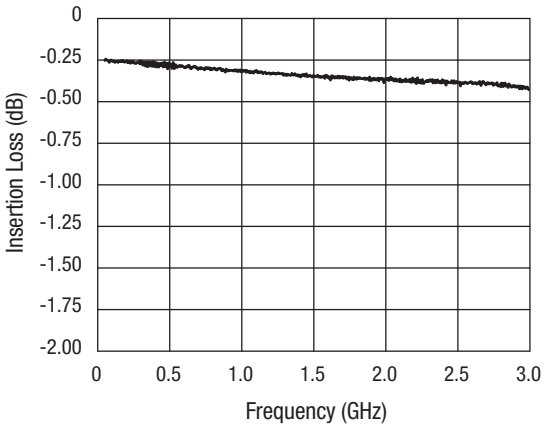
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0198

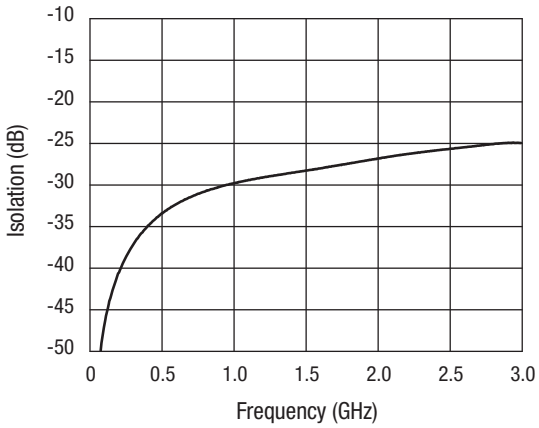
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/1.8 V	0.5–3.0 GHz		20		dBm
	V_{CTL} = 0/3 V	0.5–3.0 GHz		27		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	V_{CTL} = 0/3 V 0.5–3 GHz			40		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max.					
	V_{HIGH} = 2.7 V @ 100 µA max. to 5 V @ 200 µA max.					

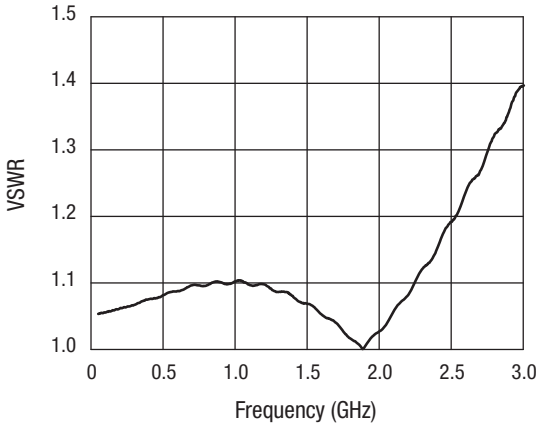
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0199

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W max. for f > 500 MHz 500 mW for f < 500 MHz V_{CTL} = 0/8 V
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

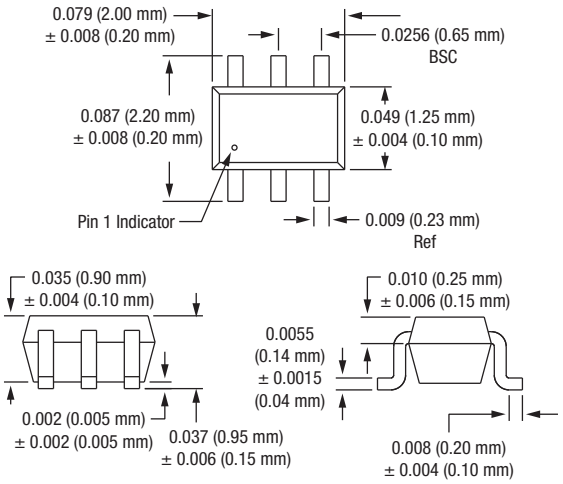
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.7 to 5 V.

SC-70 6-Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0200

SKYWORKS®

DATA SHEET

AS222-92, AS222-92LF: PHEMT GaAs IC SPDT Switch 0.1–3 GHz

Applications

- T/R switch in WLANs, Bluetooth™ and medium-power telecommunication applications

Features

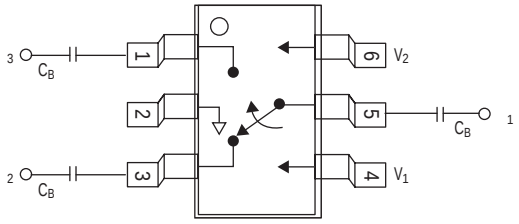
- Low insertion loss
- Isolation 22 dB @ 2.4 GHz
- Low DC power consumption
- Operates with 1.8 V control voltage
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS222-92 is a medium-power IC FET SPDT switch in a low-cost miniature SC-70 6-lead plastic package. The AS222-92 features low insertion loss and positive voltage operation with very low DC power consumption. This general-purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	0.1–1.0 GHz		0.35	0.5	dB
	1.0–2.4 GHz		0.45	0.6	dB
	2.4–3.0 GHz		0.50	0.7	dB
Isolation	0.1–1.0 GHz	24	27		dB
	1.0–2.4 GHz	19	22		dB
	2.4–3.0 GHz	16	18		dB
Return loss[3]	0.1–1.0 GHz		19		dB
	1.0–2.4 GHz		21		dB
	2.4–3.0 GHz		18		dB

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

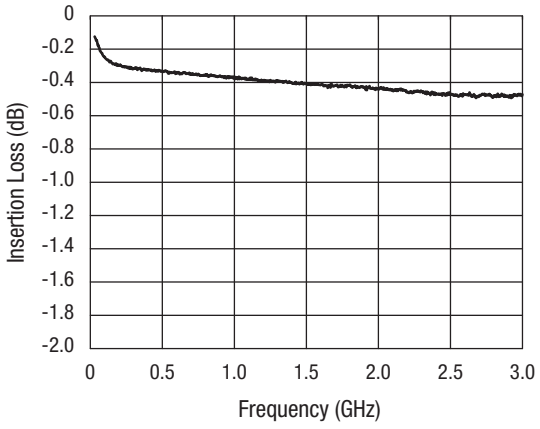
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0201

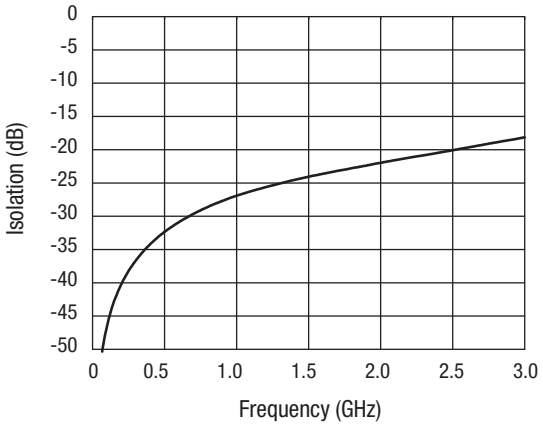
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			20		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/1.8 V	0.5–3 GHz		20		dBm
	V_{CTL} = 0/3 V	0.5–3 GHz		27		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	V_{CTL} = 0/3 V	0.5–3 GHz		44		dBm
Thermal resistance				25		°C/W
Control voltage	V_{CTL} = High		1.8		5.0	V
	V_{CTL} = Low		0		0.2	V
Control port current	V_{CTL} = 5 V				200	µA
	V_{CTL} = 2.5 V				100	µA
	V_{CTL} = 0.2 V				20	µA
	V_{CTL} = 0 V				20	µA

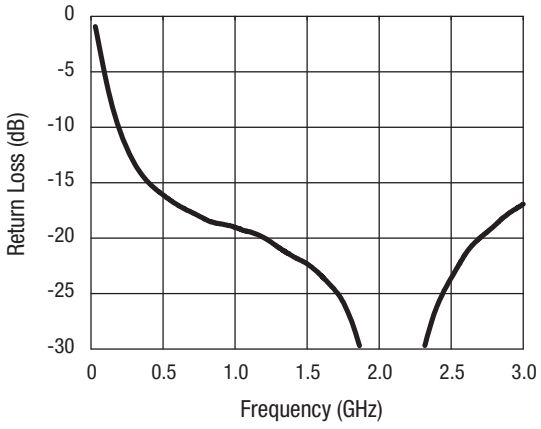
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0202

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W max. > 500 MHz 0/8 V control
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

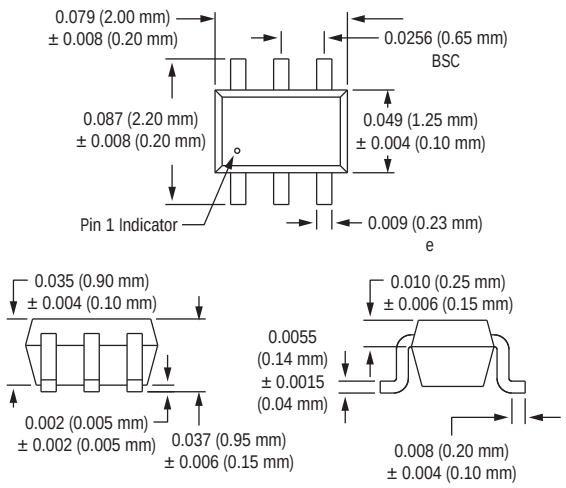
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 1.8 to 5 V.

SC-70 6-Lead



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0203

DATA SHEET

AS215-92, AS215-92LF: Single Positive Control PHEMT GaAs IC SPDT Switch 0.5–3 GHz

Applications

- T/R switch for Bluetooth™ and general-purpose telecommunication applications

Features

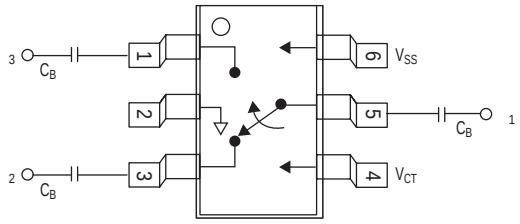
- Single bias control
- Operates with 1.8 V control voltage
- Low DC power consumption
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS215-92 is a medium-power IC FET SPDT switch in a low-cost, miniature SC-70 6-lead plastic package. The AS215-92 features low insertion loss and positive voltage operation with very low DC power consumption. This general-purpose switch can be used in a variety of telecommunications applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications

V_S = 3 V, V_{CTL} = 0/3 V, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[1]	0.5–1 GHz		0.75	1.0	dB
	1.0–2 GHz		0.60	0.8	dB
	2.0–3 GHz		0.50	0.7	dB
Isolation	0.5–1 GHz	25	28		dB
	1.0–2 GHz	21	24		dB
	2.0–3 GHz	17	20		dB
VSWR[2]	0.5–1 GHz		1.1:1		
	1.0–2 GHz		1.4:1		
	2.0–3 GHz		1.2:1		

1. Insertion loss changes by 0.003 dB/°C.
2. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0204

Operating Characteristics at 25 °C

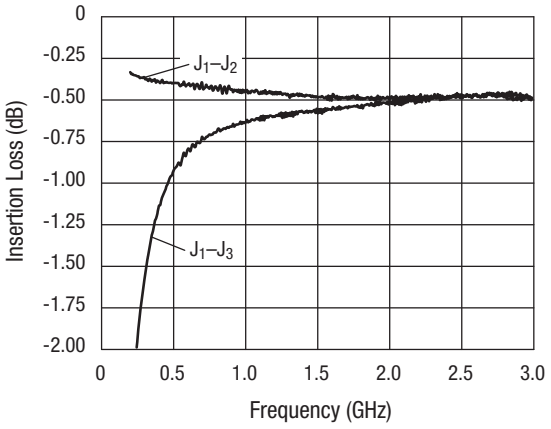
V_S = 3 V, V_{CTL} = 0/3 V, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/1.8 V	0.5–3 GHz		20		dBm
	V_{CTL} = 0/3 V	0.5–3 GHz		27		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	V_{CTL} = 0/3 V	0.5–3 GHz		40		dBm
Thermal resistance				25		°C/W
Control voltages	Low		0		0.2	V
	High		1.8		5.0	V
Control port current	V_{CTL} = low				20	µA
	V_{CTL} = 2.7 V				100	µA
	V_{CTL} = 5 V				200	µA
Supply voltage			V_{HIGH} -0.2		V_{HIGH} +0.2	V

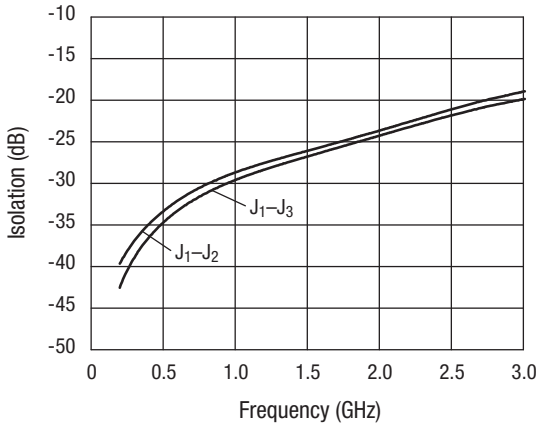
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0205

Typical Performance Data

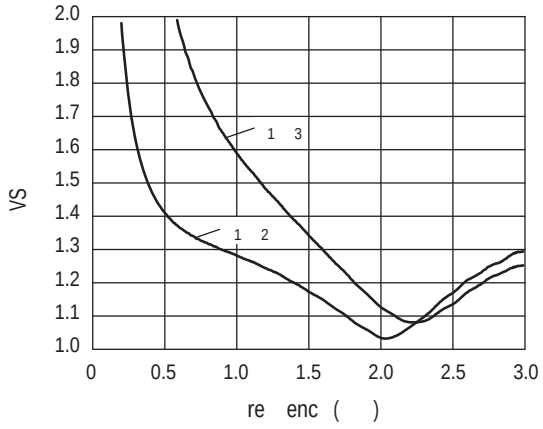
V_S = 3 V, V_{CTL} = 0/3 V, Z_0 = 50 Ω, unless otherwise noted



Insertion Loss vs. Frequency



Isolation vs. Frequency



vs. Frequency

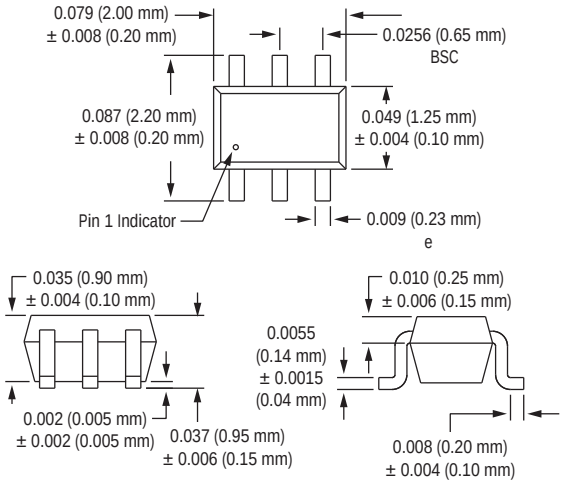
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Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0206

Truth Table

V_1	J_1–J_2	J_1–J_3
0	Isolation	Insertion loss
V_{HIGH}	Insertion loss	Isolation

$1.8 \leq V_{HIGH} \leq 5$ V.
$V_{DD} = V_{HIGH} \pm 0.2$ V.

SC-70 6 Lead (SC-88)



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W max. > 500 MHz 0/8 V control
Supply voltage	8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0207

DATA SHEET

AS211-334: PHEMT GaAs IC SPDT Switch LF–4 GHz

Applications

- General-purpose switch for telecommunication applications

Features

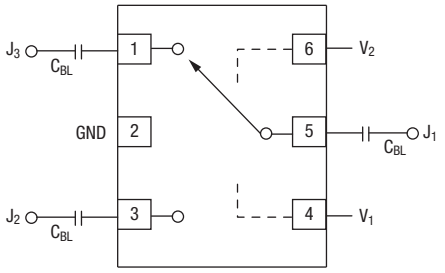
- $P_{1\ dB}$ 30 dBm typical @ 3 V
- IP3 43 dBm typical @ 3 V
- Low insertion loss (0.3 dB @ 0.9 GHz)
- Low DC power consumption
- 1.5 x 1.2 x 0.8 mm Land Grid Array (LGA) package
- PHEMT process
- Lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS211-334 is an IC FET SPDT switch in a low-cost miniature LGA package. The AS211-334 features low insertion loss and positive voltage operation with very low DC power consumption.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 47 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.1–1 GHz		0.3	0.5	dB
	1.0–2 GHz		0.4	0.6	dB
	2.0–3 GHz		0.5	0.7	dB
	3.0–4 GHz		0.6	0.8	dB
Isolation	0.1–1 GHz	22	25		dB
	1.0–2 GHz	20	22		dB
	2.0–3 GHz	20	23		dB
	3.0–4 GHz	23	26		dB
VSWR	LF–4 GHz		1.2:1	1.3:1	

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0208

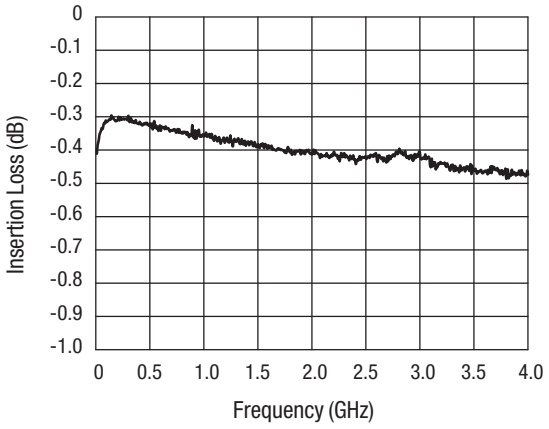
Operating Characteristics at 25 °C (0, 3 V)

Z_0 = 50 Ω, unless otherwise noted

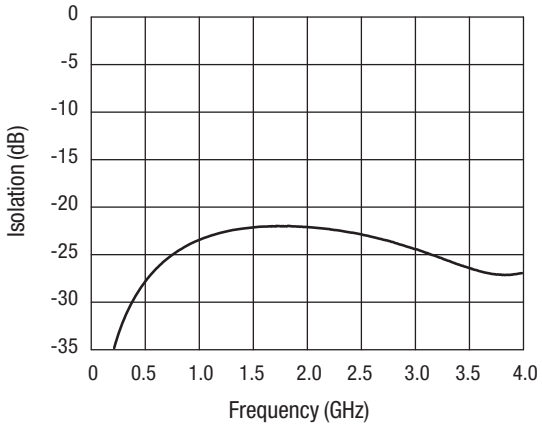
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			10		ns
On, off	50% CTL to 90/10% RF			20		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	0/3 V	0.5–3 GHz		30		dBm
	0/5 V	0.5–3 GHz		34		dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm					
	0/3 V	0.5–3 GHz		43		dBm
	0/5 V	0.5–3 GHz		50		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

Typical Performance Data (3 V, C_{BL} = 47 pF)

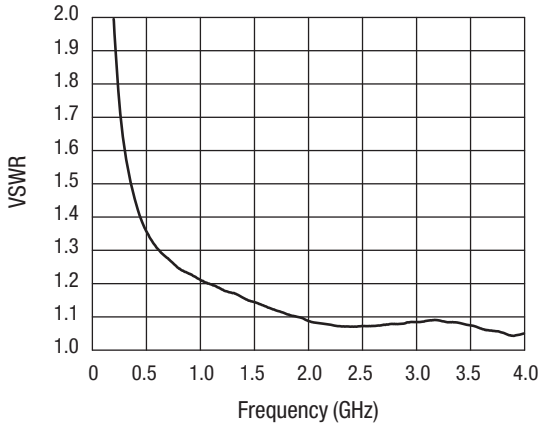
Z_0 = 50 Ω, unless otherwise noted



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0209

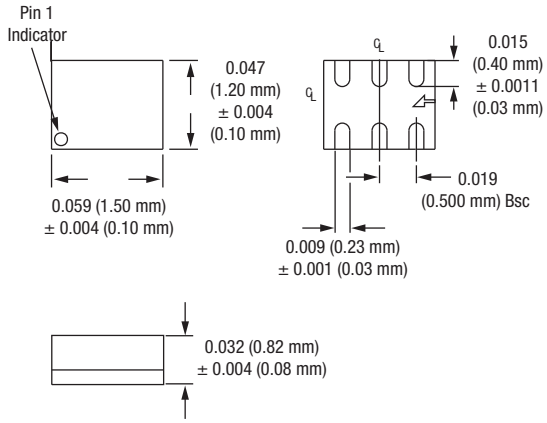
Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

LGA-6 (1.5 x 1.2 mm)



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

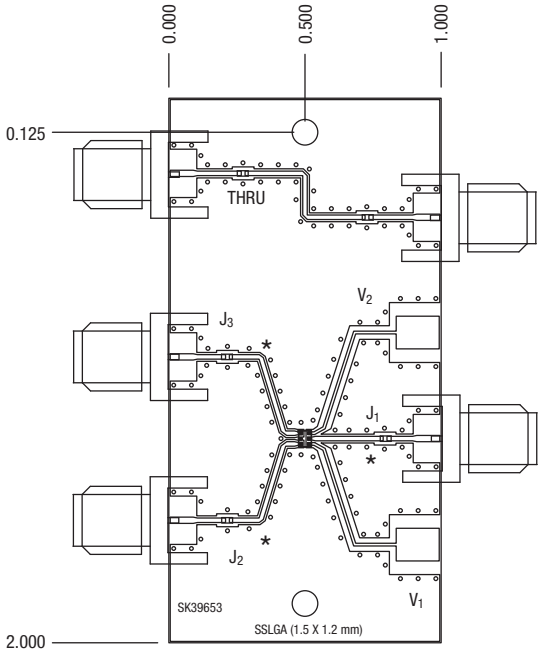
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	V_{LOW}	Isolation	Insertion loss
V_{LOW}	V_{HIGH}	Insertion loss	Isolation

All other states not recommended.
V_{LOW} = 0 to 0.2 V.
V_{HIGH} = 3 to 5 V.

Test Board



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0210

DATA SHEET

AS186-302, AS186-302LF: GaAs IC High-Isolation Positive Control SPDT Nonreflective Switch LF–4 GHz

Applications

- Typical applications include GSM, PCS, WCDMA, 2.4 GHz ISM and 3.5 GHz wireless local loop

Features

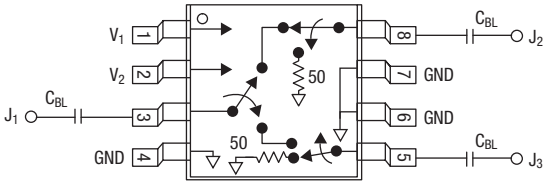
- Positive voltage control (0/3 to 0/5 V)
- High isolation (55 dB @ 0.9 GHz and 1.9 GHz)
- Miniature MSOP-8 exposed pad package
- Three-switch solution for base station synthesizer switch
- Nonreflective
- Operation to 6 GHz
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS186-302 is a GaAs FET IC SPDT nonreflective switch, packaged in an MSOP-8 exposed pad plastic package for low-cost, high-isolation commercial applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



C_{BL} = 47 pF for operation > 500 MHz.

Electrical Specifications

-40 °C ≤ T ≤ +85 °C, V_{CTL} = 0/5 V, Z_0 = 50 Ω unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss		LF–2 GHz LF–3 GHz LF–4 GHz		0.8 0.9 1.0	1.05 1.15 1.25	dB dB dB
Isolation(1)		LF–2 GHz LF–3 GHz LF–4 GHz	50 45 35	55 50 40		dB dB dB
VSWR (on state)		LF–2 GHz LF–4 GHz		1.3:1 1.3:1	1.5:1 1.6:1	
VSWR (off state)		0.5–4 GHz		1.35:1	1.7:1	

1. Backside of exposed pad must be connected to RF ground to obtain specified isolation.

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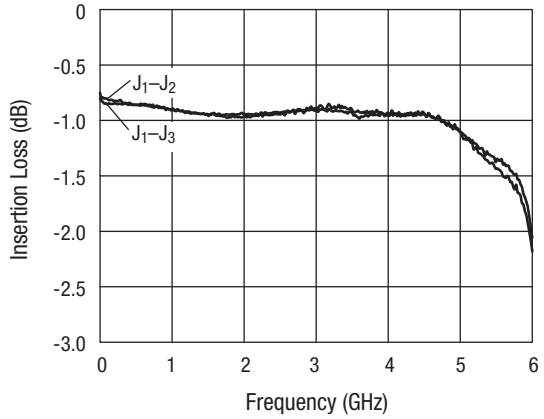
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0211

Operating Characteristics

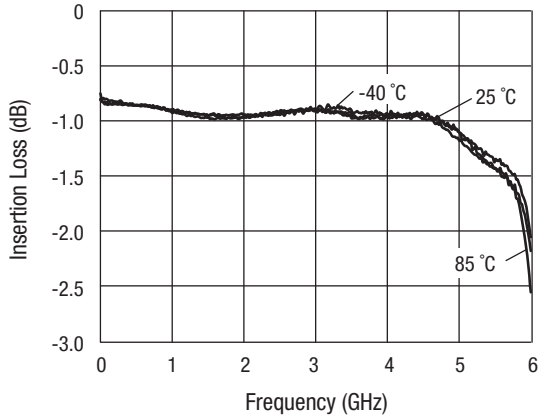
-40 °C ≤ T ≤ +85 C, V_{CTL} = 0/5 V, Z_0 = 50 Ω unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			30		ns
On, off	50% CTL to 90/10% RF			50		ns
Video feedthru	T_{RISE} = 3 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/3 V	0.9–4 GHz	23	25		dBm
	V_{CTL} = 0/5 V	0.9–4 GHz	27	30		dBm
Input 3rd order intermodulation intercept point (IIP3)	For two-tone input power 8 dBm					
	V_{CTL} = 0/3 V	0.9–4 GHz	27	38		dBm
	V_{CTL} = 0/5 V	0.9–4 GHz	42	46		dBm
Thermal resistance				25		°C/W
ESD rating	Human body model		Class 1A			
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

Typical Performance Data (0, 5 V)

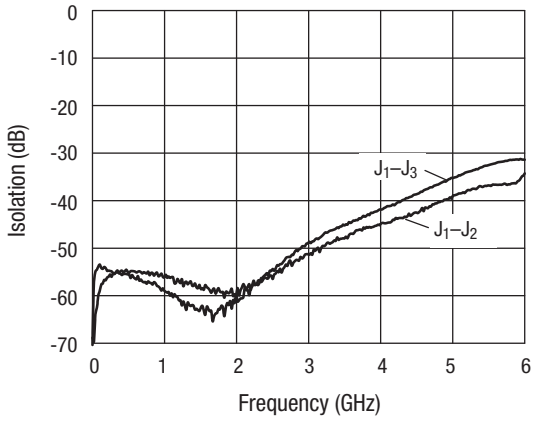


Insertion Loss vs. Frequency

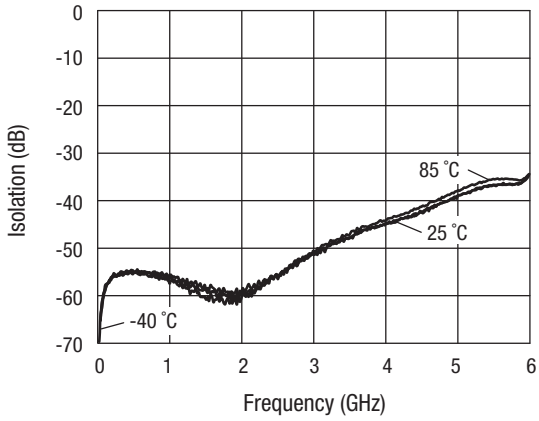


Insertion Loss vs. Frequency -40, 25, 85 ˚C

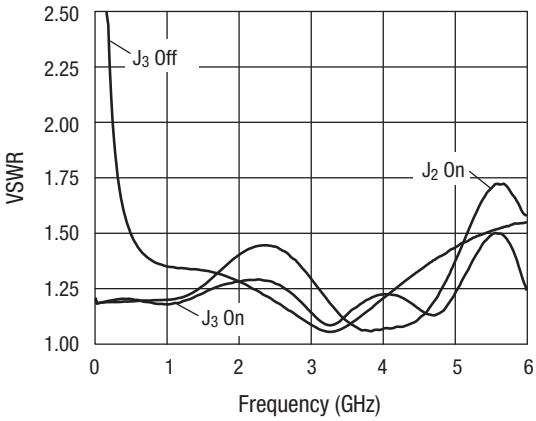
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0212



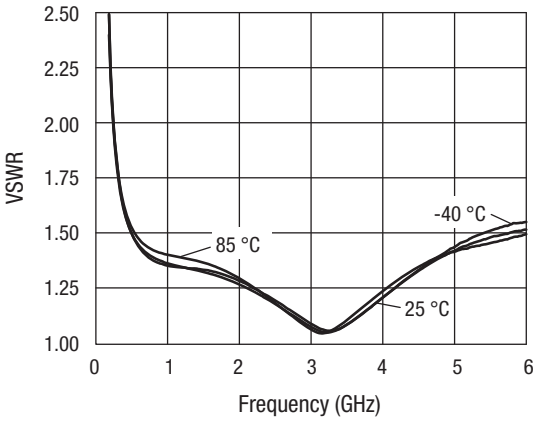
Isolation vs. Frequency



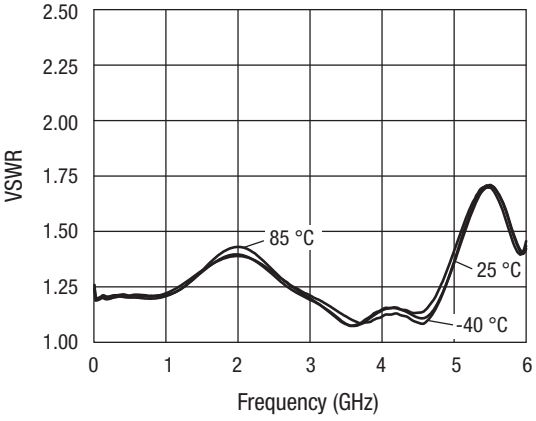
Isolation vs. Frequency
-40, 25, 85 ˚C



VSWR vs. Frequency



VSWR vs Frequency
-40, 25, 85 °C (J_3 Off)



Input VSWR vs Frequency
-40, 25, 85 °C

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0213

IP3 vs. Voltage and Temperature

Control Voltage (V)	Temperature (°C)	IP3 @ 8 dBm Each Tone (dBm)
3	-40	44
3	25	38
3	85	29.5
5	-40	47.5
5	25	46.5
5	85	45.5

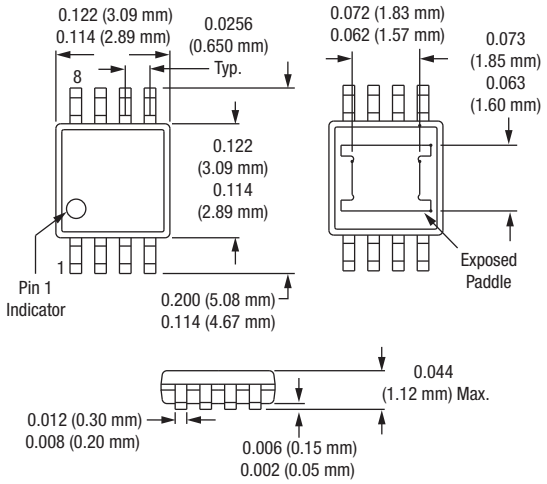
Tone frequencies: 900 and 901 MHz.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 3 V to 5 V.

MSOP-8 Exposed Pad



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Compression Point vs. Voltage and Temperature @ 900 MHz

Control Voltage (V)	Temperature (°C)	Input Power @ 1 dB Compression (dBm)	Input power @ 0.1 dB Compression (dBm)
3	-40	20.5	16.5
3	25	20	15.3
3	85	19	14
5	-40	28.5	23
5	25	28	23
5	85	27.5	23

Frequency: 900 MHz.

Absolute Maximum Ratings

Characteristic	Value
RF input power	1 W max. for f > 500 MHz 100 mW for f < 500 MHz V_{CTL} = 0/8 V
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0214

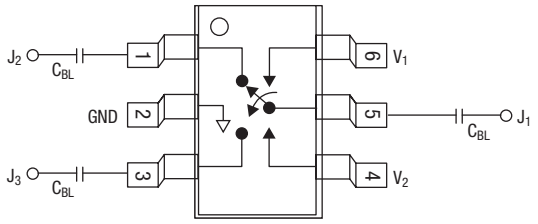
DATA SHEET

AS191-73, AS191-73LF: PHEMT GaAs IC High-Linearity 3 V Control SPDT Switch 0.1–4 GHz

Features

- 2.5 to 5 V linear operation
- Harmonics H_2, H_3 > 65 dBc @ P_{IN} = 34.5 dBm
- Low insertion loss (0.5 dB @ 0.9 GHz)
- High isolation (27 dB @ 0.9 GHz)
- Ultraminiature SOT-6 package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 47 pF for operating frequency >500 MHz.

Description

The AS191-73 is a PHEMT GaAs FET IC high-linearity SPDT switch in a SOT-6 plastic package. This switch has been designed for use where extremely high linearity, low control voltage, high isolation, low insertion loss and ultraminiature package size are required. It can be controlled with positive, negative or a combination of both voltages. Some standard implementations include antenna changeover, T/R and diversity switching over 3 W. The AS191-73 switch can be used in many analog and digital wireless communication systems including cellular, GSM and DECT applications.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion Loss[2]	0.1–1 GHz		0.50	0.6	dB
	1.0–2 GHz		0.55	0.7	dB
	2.0–4 GHz		0.70	1.0	dB
Isolation	0.1–1 GHz	25	27		dB
	1.0–2 GHz	19	21		dB
	2.0–4 GHz	14	18		dB
VSWR[3]	0.1–4 GHz		1.3:1		dB

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

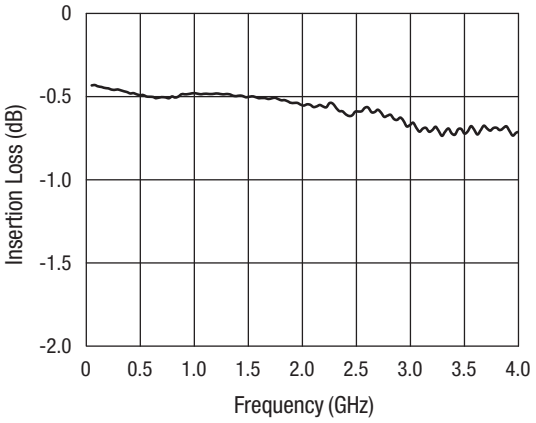
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0215

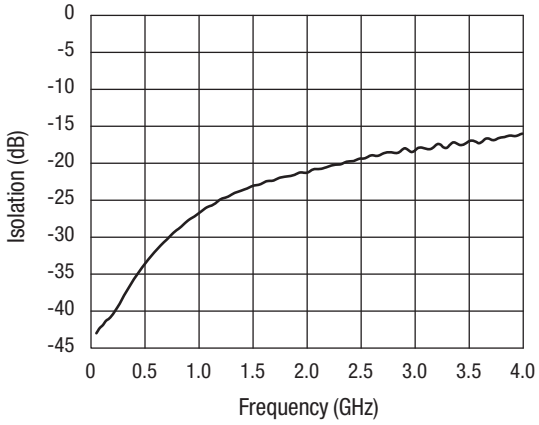
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for -0.1 dB compression	V_{CTL} = 0/3 V	0.9 GHz		35		dBm
Harmonics H_2, H_3	P_{IN} = 34.5 dBm	0.9 GHz		-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 2.5 V @ 100 µA max. to 5 V @ 200 µA max.					

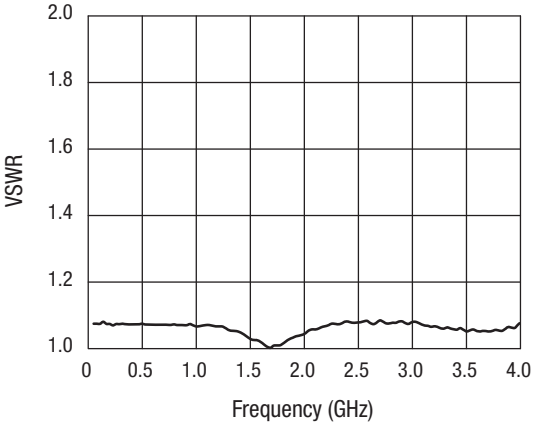
Typical Performance Data



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0216

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W max. > 900 MHz, 0/5 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

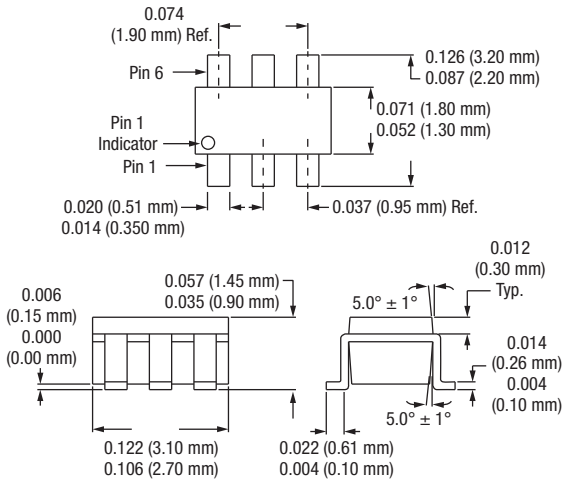
Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.5 to 5 V.

SOT-6



EX-1042
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0217

DATA SHEET

SKY13299-321LF: GaAs SPDT 7 W Switch 100 MHz–4 GHz

Features

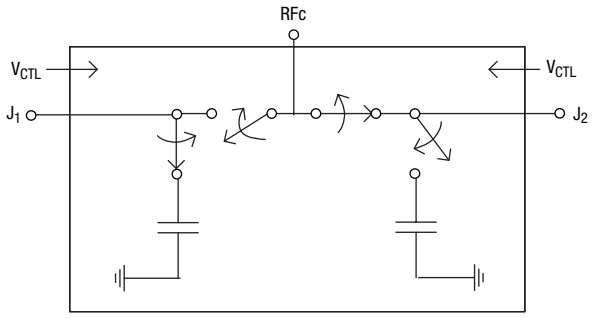
- Positive voltage control (0/3 to 0/5 V)
- Low insertion loss 0.5 dB typical at 3.5 GHz
- High isolation >35 dB at 3.5 GHz
- High $P_{-0.1\ dB}$ of 38.5 dBm at 3.3 V
- Low gate lag process for fast settling time applications
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13299-321LF is a pHEMT GaAs FET IC high power switch packaged in a 12-lead exposed pad plastic package for low-cost commercial applications. This switch is an ideal choice for WiMax and WLAN applications where low loss, high isolation and excellent linearity are key requirements.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Diagram



Electrical Specifications at 25°C

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.1–1.0 GHz		0.30	0.50	dB
	1.0–2.0 GHz		0.40	0.60	dB
	2.0–3.0 GHz		0.45	0.65	dB
	3.0–4.0 GHz		0.65	0.85	dB
Isolation	0.1–1.0 GHz	26	29		dB
	1.0–2.0 GHz	26	29		dB
	2.0–3.0 GHz	26	29		dB
	3.0–4.0 GHz	27	30		dB
Return loss (Insertion loss state)	0.1–1.0 GHz		20		dB
Lower frequency return loss is dependent on DC blocks	1.0–2.0 GHz		17		dB
	2.0–3.0 GHz		20		dB
	3.0–4.0 GHz		17		dB

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0218

Operating Characteristics at 25°C

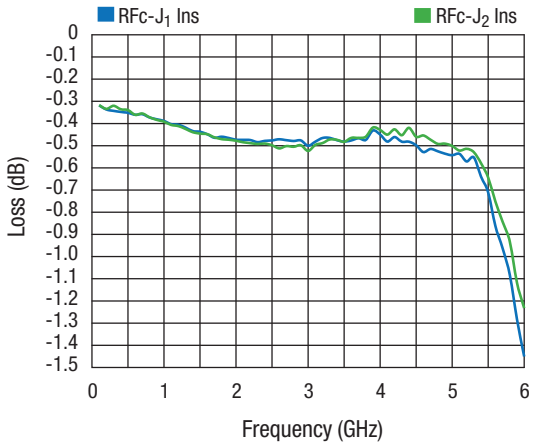
V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise/fall time	10/90% or 90/10% RF			200		ns
On/off time	50% V_{CTL} to 90/10% RF			300		ns
Settling time	50% CTL to 0.1 dB final value			2		µs
Harmonics H2, H3	P_{IN} = 34 dBm CW	F_0 = 900 MHz		-80		dBc
Input power for 0.1 dB compression		0.7–4 GHz		38.5		dBm
Input IP3	Two tone input power 27 dBm per tone V_{CTL}= 3 V	900, 901 MHz		65		dBm
	Two tone input power 27 dBm per tone V_{CTL}= 3 V	2400, 2401 MHz		66		dBm
	Two tone input power 27 dBm per tone V_{CTL}= 3 V	3500, 3501 MHz		61		dBm
Control voltages	$V_{CTL\ LOW}$		0		0.2	V
	$V_{CTL\ HIGH}$		2.75		5	V
Supply currents	$V_{CTL\ LOW}$			5		uA
	$V_{CTL\ HIGH}$ @ 3.3 V and < 30 dBm input			50		uA
	$V_{CTL\ HIGH}$ @ 3.3 V and 30–37 dBm input			100		uA
	$V_{CTL\ HIGH}$ @ 3.3 V and 37–38 dBm input			200		uA

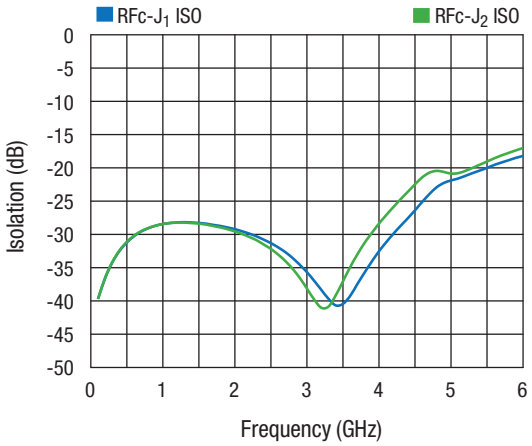
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0219

Typical Performance Data

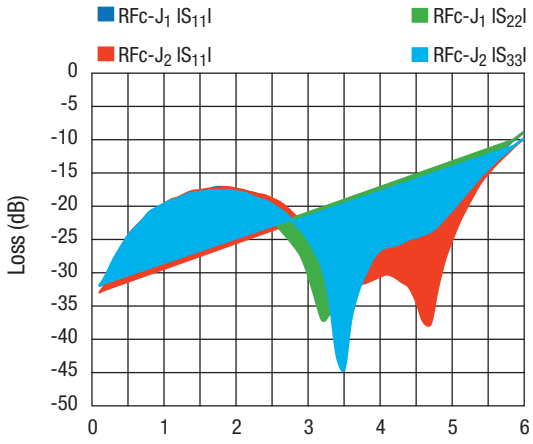
V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted



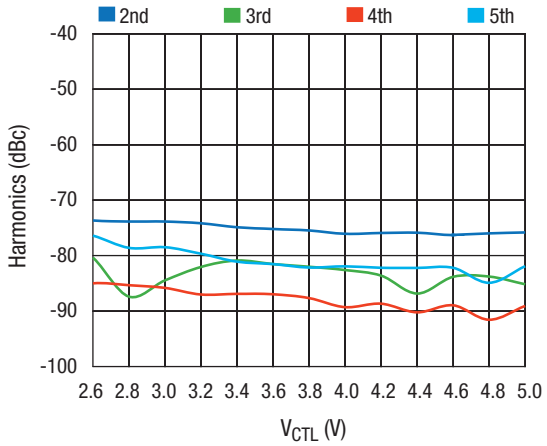
Typical Insertion Loss



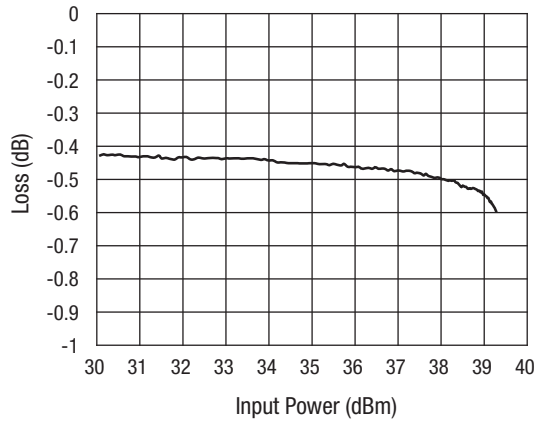
Typical Isolation



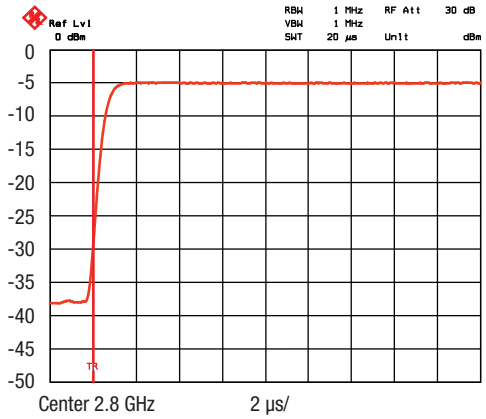
Typical Return Loss



Typical Harmonics
Frequency = 900 MHz, P_{IN} = 34 dBm CW



Typical Loss vs. Input Power
2500 MHz V_{CTL} = 3.3 V



Typical Settling Time

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0220

Pin Descriptions

Pin #	Pin Name	Description
1	$V_{CTL}1$	DC control voltage
2	Gnd	Ground
3	J_1	RF port must be DC blocked
4	Gnd	Ground
5	Gnd	Ground
6	Gnd	Ground
7	J_2	RF port must be DC blocked
8	Gnd	Ground
9	$V_{CTL}2$	DC control voltage
10	Gnd	Ground
11	RFc	RF common port must be DC blocked
12	Gnd	Ground
Paddle	Paddle	Exposed paddle must be grounded

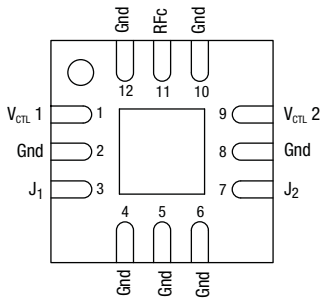
Truth Table

V_{CTL} 1	V_{CTL} 2	RFc to J_1	RFc to J_2
1	0	Insertion loss	Isolation
0	1	Isolation	Insertion loss
1	1	undefined	undefined
0	0	undefined	undefined

0 = 0 to 0.2 V.
1 = 2.75 to 5 V.

Pin Out (Top View)

X-ray of pads on bottom of package



Absolute Maximum Ratings

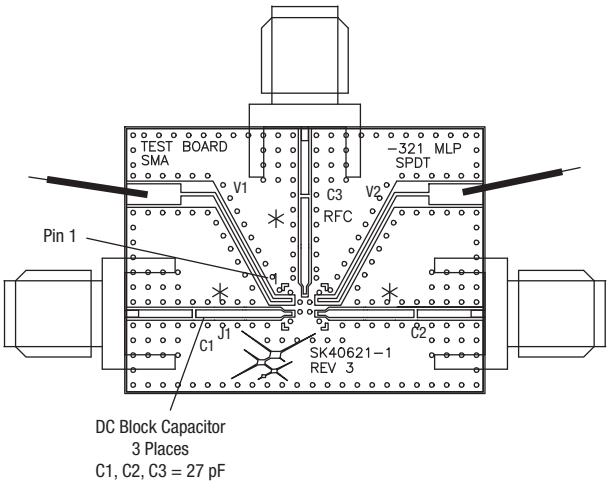
Characteristic	Value
V_{CTL} voltage range	$2.75 \leq V_{CTL} \leq 7$ V
RF input power @ 3.3V	39.5 dBm, f > 700 MHz
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

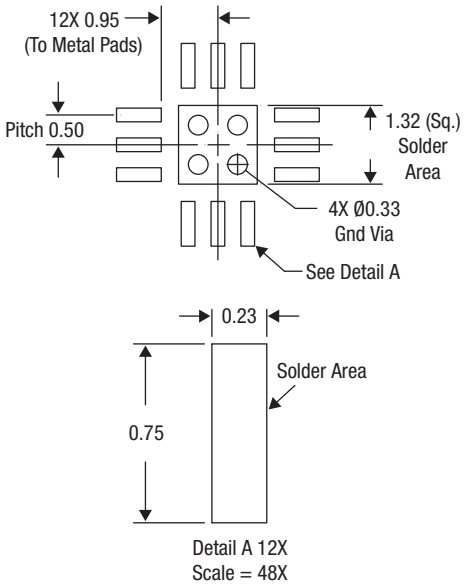
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0221

Test Board Assembly

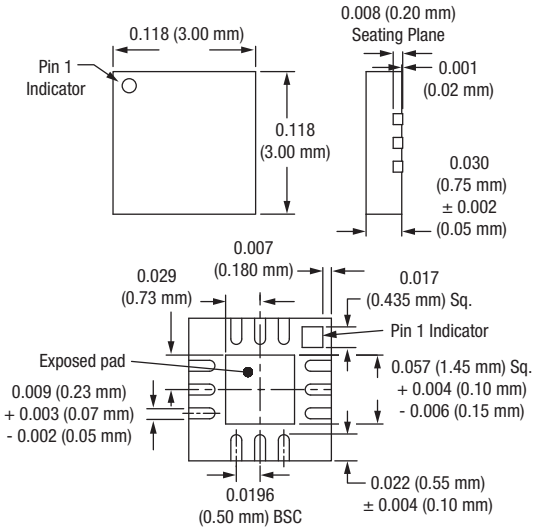


Suggested Land Pattern

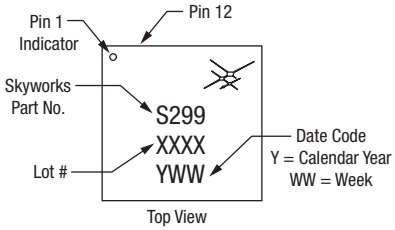


QFN (3 x 3)

QFN-12



Part Marking



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0222

DATA SHEET

AS196-307, AS196-307LF: GaAs IC High-Isolation SPDT Nonreflective Switch with Driver LF–6 GHz

Features

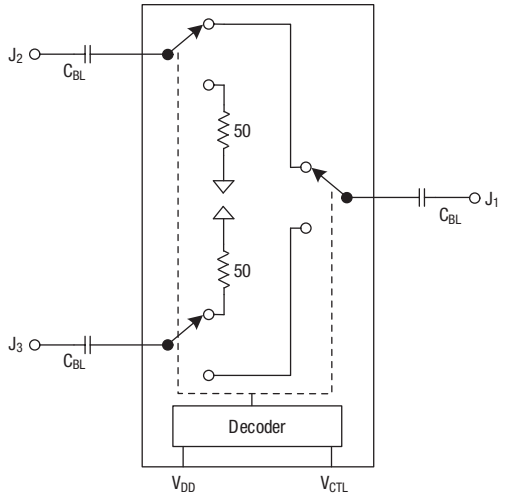
- Positive voltage control (0/3 to 0/5 V)
- High isolation (55 dB @ 0.9 GHz and 1.9 GHz)
- LPCC 4 x 4 mm package
- Integrated silicon CMOS driver
- Nonreflective
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS196-307 is a GaAs FET IC SPDT nonreflective switch packaged in a 16-lead exposed pad plastic package for low-cost, high-isolation commercial applications. Ideal building block for base station applications where synthesizer isolation is critical. Typical applications include GSM, PCS, WCDMA, 2.4 and 5.8 GHz ISM and wireless local loop.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



C_{BL} = 47 pF for operation > 500 MHz.

Electrical Specifications (0, 5 V) -40 °C to +85 °C

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	LF–2 GHz		0.9	1.15	dB
	LF–3 GHz		1.0	1.25	dB
	LF–4 GHz		1.2	1.40	dB
	LF–6 GHz		1.6	2.00	dB
Isolation[2]	LF–2 GHz	50	55		dB
	LF–3 GHz	43	50		dB
	LF–4 GHz	35	40		dB
	LF–6 GHz	25	30		dB
VSWR (on state)	LF–2 GHz		1.3:1	1.5:1	
	LF–6 GHz		1.3:1	1.6:1	
VSWR (off state)	0.5–6 GHz		1.35:1	1.7:1	

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Backside of exposed pad must be connected to RF ground to obtain specified isolation.

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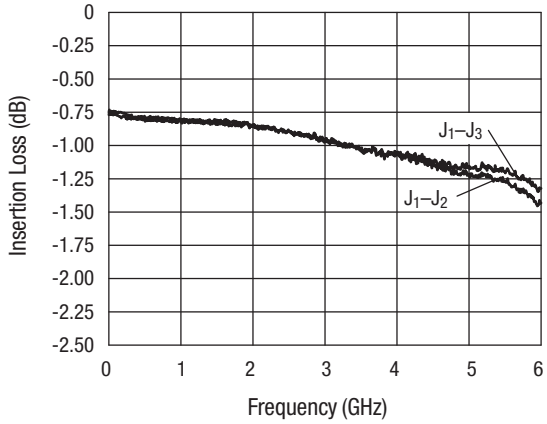
EX-1042
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0223

Operating Characteristics (0, 5 V) -40 °C to +85 °C

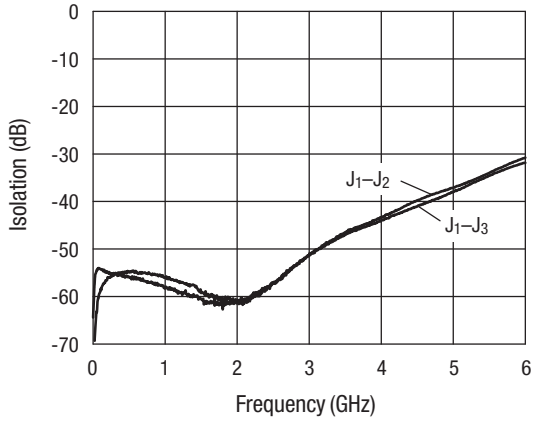
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics[1]						
Rise, fall	10/90% or 90/10% RF			30		ns
On, off	50% CTL to 90/10% Rf			50		ns
Video feedthru	T_{RISE} = 3 ns, BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{CTL} = 0/3 V	0.9–6 GHz	17	21		dBm
	V_{CTL} = 0/5 V	0.9–6 GHz	24	27		dBm
Intermodulation intercept point (IP3)	For two-tone input power +8 dBm					
	V_{CTL} = 0/3 V	0.9–6 GHz	30	38		dBm
	V_{CTL} = 0/5 V	0.9–6 GHz	38	46		dBm
Thermal resistance				25		°C/W
Control voltage	Low (“0”)		0		0.5	V
	High (“1”)		V_{DD}–0.6		V_{DD}	V
Control current	V_{CTL} = “0” or “1”. V_{DD} = 2.6 to 5 V			5		µA
Supply voltage	V_{DD}		2.6	3	5	V
Supply current	V_{DD} = 3 V			10	50	µA
	V_{DD} = 5 V			20	100	µA

1. V_{DD} must be powered on by a minimum of 10 ns prior to V_{CTL}.

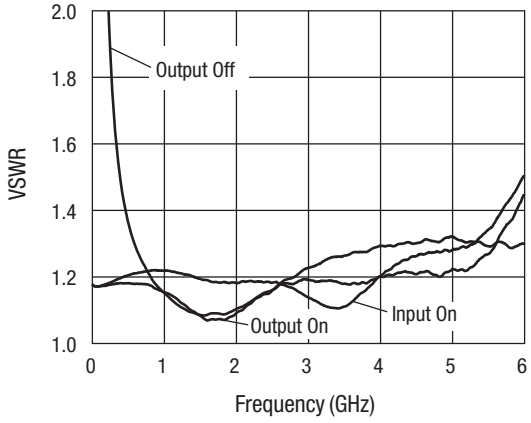
Typical Performance Data (0, 5 V)



Insertion Loss, 25 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V

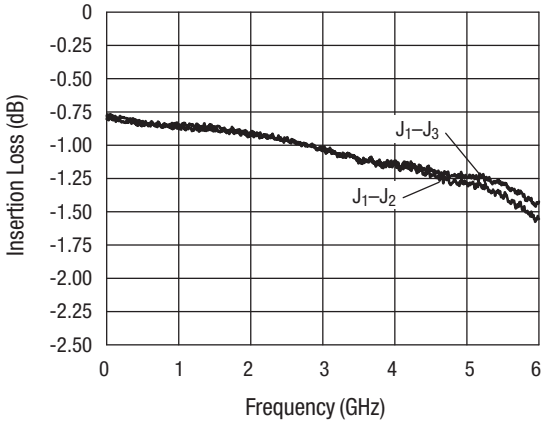


Isolation, 25 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V

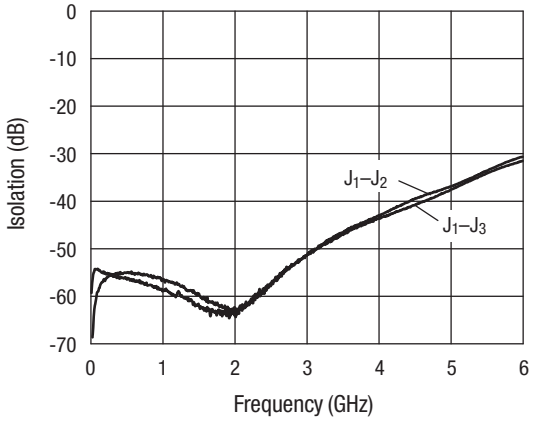


VSWR, 25 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V

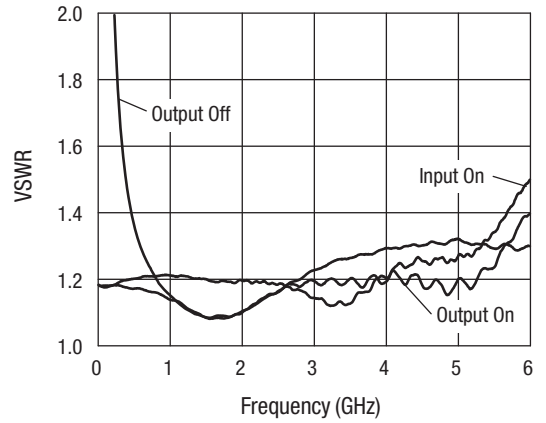
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0224



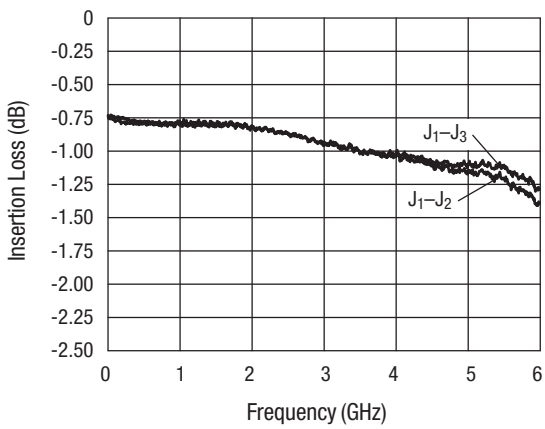
Insertion Loss, 85 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V



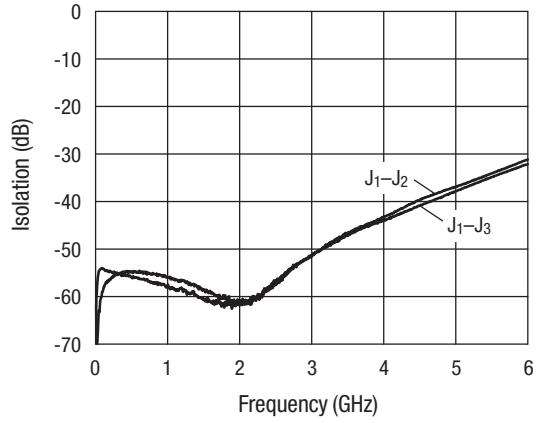
Isolation, 85 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V



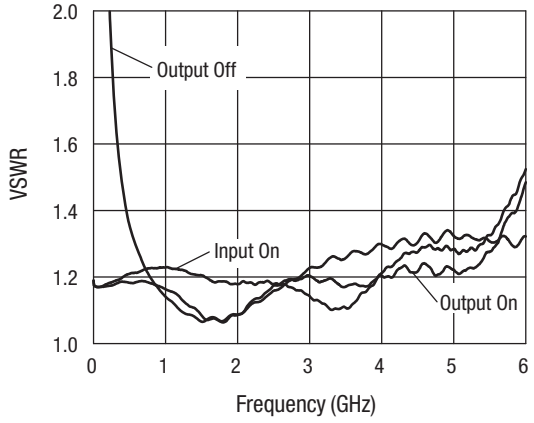
VSWR, 85 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V



Insertion Loss, -40 °C
V_{DD} = 5 V, V = 0/5 V



Isolation, -40 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V



VSWR, -40 °C
V_{DD} = 5 V, V_{CTL} = 0/5 V

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0225

Compression Point vs. Voltage and Temperature

Control Voltage (V)	Temperature (°C)	Input Power @ 1 dB Compression (dBm)	Input Power @ 0.1 dB Compression (dBm)
3	-40	20.5	16.5
3	25	20	15.3
3	85	19	14
5	-40	28.5	23
5	25	28	23
5	85	27.5	23

Frequency: 500 MHz.

Absolute Maximum Ratings

Characteristic	Value
RF input power	1 W max. > 500 MHz, 0/8 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

IP3 vs. Voltage and Temperature

Control Voltage (V)	Temperature (°C)	IP3 @ 5 dBm Each T one (dBm)
3	-40	45.5
3	25	45
3	85	34
5	-40	45.5
5	25	45.5
5	85	40.5

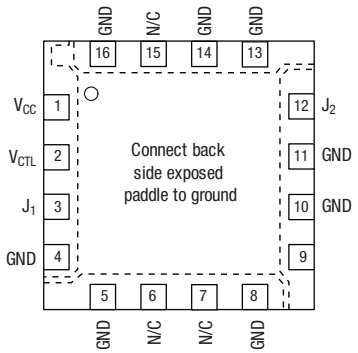
Two tone input power: 5 dBm each tone.
Tone frequencies: 900 and 901 MHz.

Truth Table

V_{CTL}	J_1–J_2	J_1–J_3
0	Insertion loss	Isolation
1	Isolation	Insertion loss

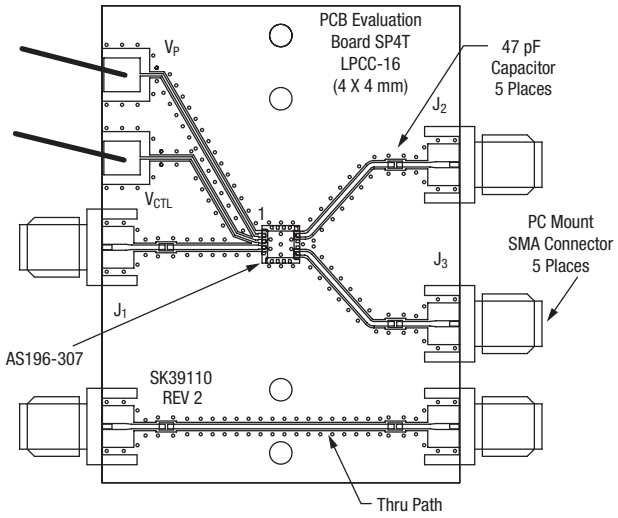
"0" = 0–0.5 V.
"1" = 3.5–5 V.
V_{DD} = 5 V.

Pin Out (Top View)



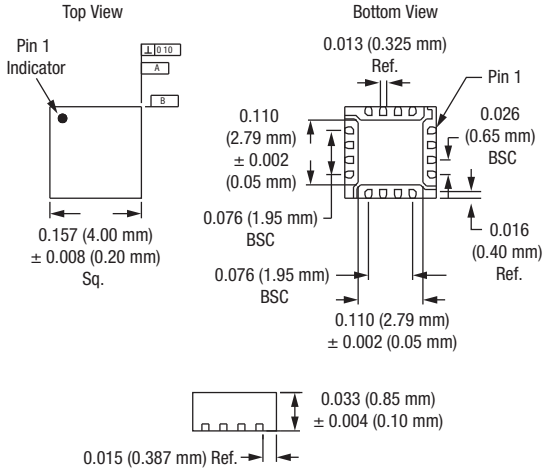
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0226

Evaluation PCB



PCB# SK39110. Material: FR4.
The circuit board used in the final application should employ RF circuit design techniques. RF signal lines should have 50 Ω impedance. The package bottom ground plane should be connected directly to PCB ground plane. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation circuit board shown is available upon request.

LPCC 4 x 4 (-307)



EX-1042
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0227

SKYWORKS®

DATA SHEET

AS229-350, AS229-350LF: GaAs IC SPDT Nonreflective Switch 300 kHz–6 GHz

Features

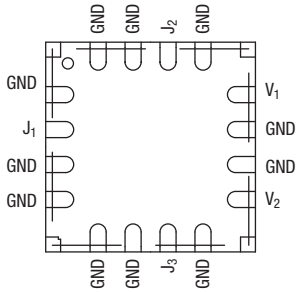
- Low DC power consumption
- High isolation, nonreflective
- Broadband 300 kHz–6 GHz
- Excellent intermodulation products
- Small, low-cost plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS229-350 is an IC FET SPDT switch in a low-cost plastic package. It features nonreflective matching at each output, and broadband performance, with very low DC power consumption. This switch can be used in many analog and digital wireless communication systems.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



Exposed paddle should be grounded.

Electrical Specifications at 25 °C

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–1 GHz		0.8	1.0	dB
	300 kHz–2 GHz		0.9	1.2	dB
	300 kHz–4 GHz		1.4	1.5	dB
	300 kHz–6 GHz		1.8	2.0	dB
Isolation	300 kHz–1 GHz	51	55		dB
	300 kHz–2 GHz	47	50		dB
	300 kHz–4 GHz	35	40		dB
	300 kHz–6 GHz	20	25		dB
Return loss	300 kHz–1 GHz		20		dB
	300 kHz–2 GHz		20		dB
	300 kHz–4 GHz		10		dB
	300 kHz–6 GHz		12		dB

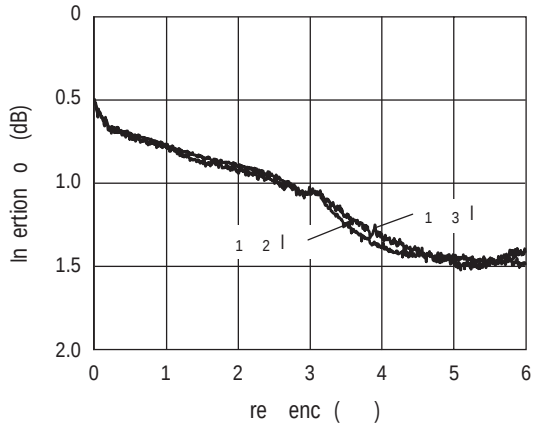
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.

EX-1042
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0228

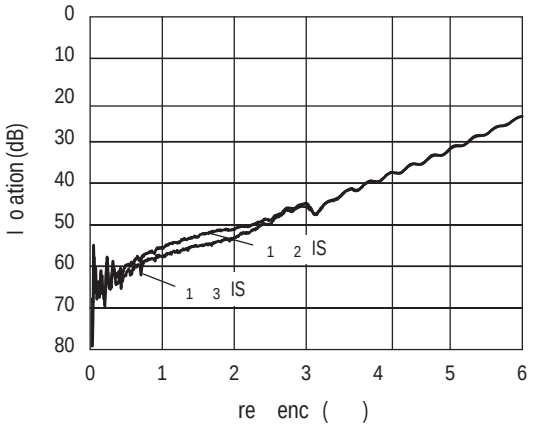
Operating Characteristics at 25 °C

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF)			3		ns
On, off	50% CTL to 90/10% RF)			6		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			15		mV
Input power for 1 dB compression		0.5–6 GHz 0.05 GHz		24 16		dBm dBm
Intermodulation intercept point (IP3)	For two-tone input power 13 dBm	0.5–6 GHz		46		dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to -0.2 V @ 20 µA max. V_{HIGH} = -5 V @ 50 µA to -8 V @ 200 µA max.					

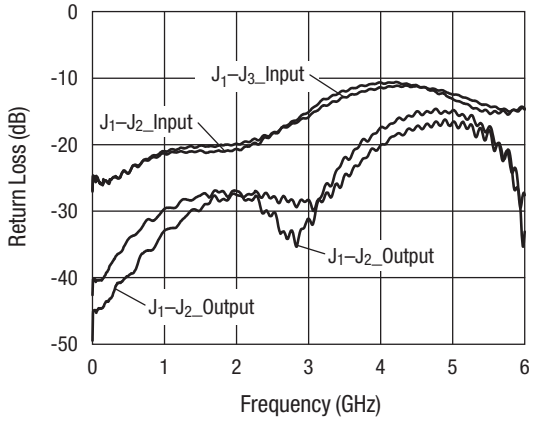
Typical Performance Data



Insertion oss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

EX-1042
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0229

Absolute Maximum Ratings

Characteristic	Value
RF input power (RF In)	2 W max. > 500 MHz 0/-8 V Control
Control voltage (V_C)	-0.2 V, -10 V
Operating temperature (T_{OP})	-40 °C to +85 °C
Storage temperature (T_{ST})	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

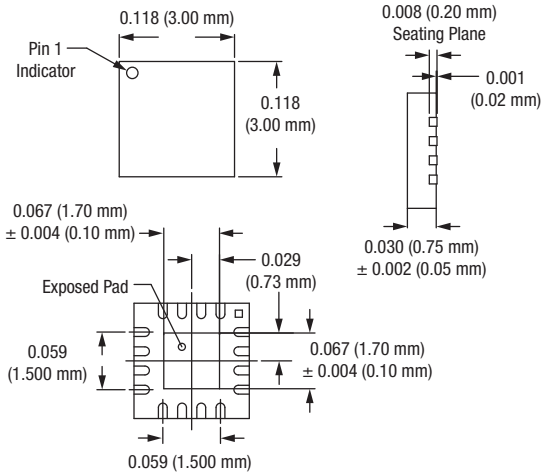
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Truth Table

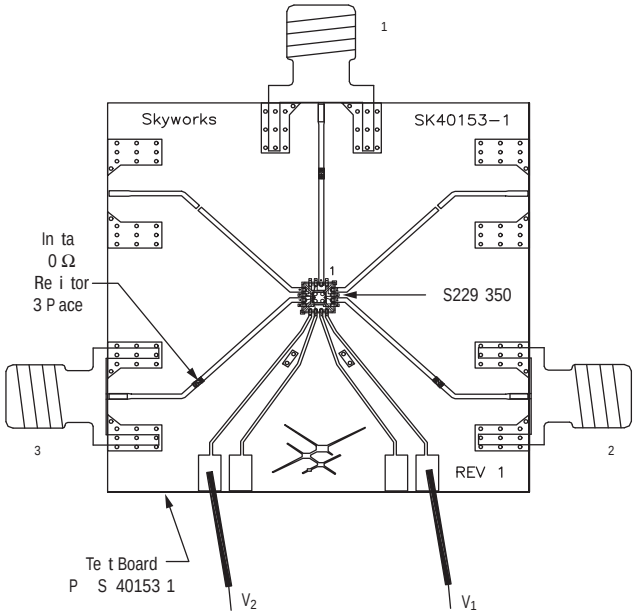
V_1	V_2	J_1–J_2	J_1–J_3
-5	0	Isolation	Insertion Loss
0	-5	Insertion Loss	Isolation

All other conditions not recommended.

-350 (QFN 3 x 3)



Evaluation PCB



Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0230

DATA SHEET

AS230-348, AS230-348LF: SPDT 7 W T/R Switch 300 kHz–6 GHz

Features

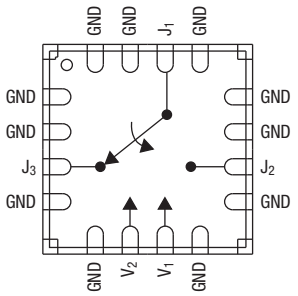
- Low DC power consumption
- Low insertion loss
- High linearity (63 dBm IP3)
- T/R switch
- Small low-cost plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS230-348 is an IC FET SPDT reflective switch in a low-cost plastic package. It features extremely high linearity, low insertion loss, with very low DC power consumption. Some standard implementations include antenna changeover, T/R and diversity switching over 2 W. This switch can be used in many analog and digital wireless communication systems.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



Exposed paddle should be grounded.
DC blocking capacitors (C_{BL}) are required on RF lines for positive voltage operation.

Electrical Specifications at 25 °C

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–1 GHz		0.8	1.0	dB
	300 kHz–2 GHz		0.9	1.1	dB
	300 kHz–4 GHz		1.0	1.2	dB
	300 kHz–6 GHz		1.2	1.4	dB
Isolation	300 kHz–1 GHz	28	30		dB
	300 kHz–2 GHz	23	25		dB
	300 kHz–4 GHz	14	16		dB
	300 kHz–6 GHz	13	15		dB
Return loss[3]	300 kHz–1 GHz		22		dB
	300 kHz–2 GHz		22		dB
	300 kHz–4 GHz		15		dB
	300 kHz–6 GHz		20		dB

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

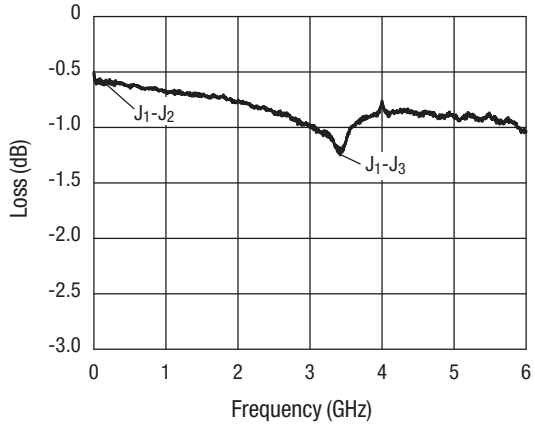
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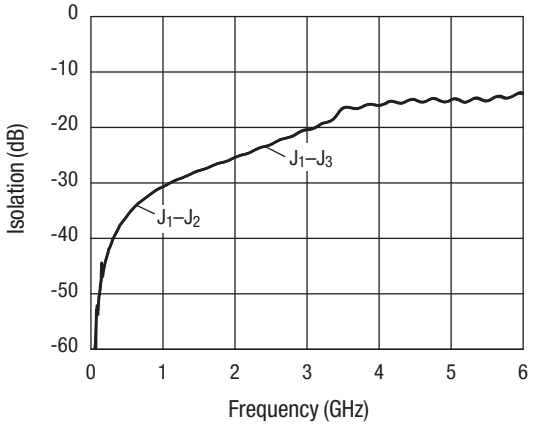
Operating Characteristics at 25 °C

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			6		ns
On, off	50% CTL to 90/10% RF			12		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			30		mV
Input power for 1 dB compression	@ -5 V	0.9 GHz		35		dBm
	@ -10 V	0.9 GHz		40		dBm
Intermodulation intercept point (IP3)	For two-tone input power 13 dBm, V_{HIGH} = -10 V	0.9 GHz		63		dBm
Thermal resistance				45		°C/W
Control voltages	V_{LOW} = -12 V ≤ V_{LOW} ≤ 0 V, 500 µA max. V_{HIGH}= 0 V ≤ V_{HIGH} ≤ 12 V, 500 µA max. Differential = 5 V ≤ (V_{HIGH}– V_{LOW}) < 12 V					

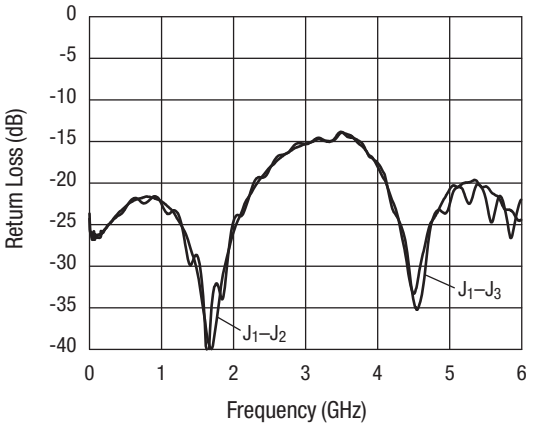
Typical Performance Data



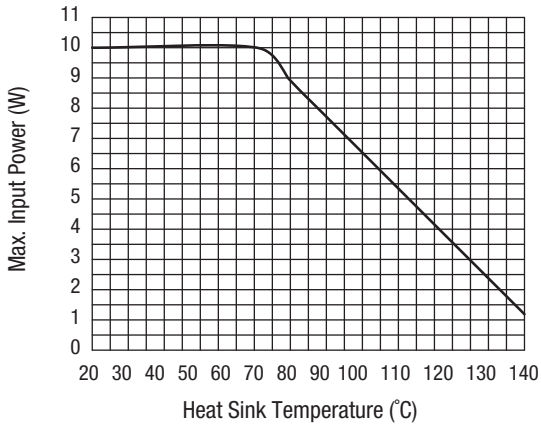
Insertion Loss



Isolation

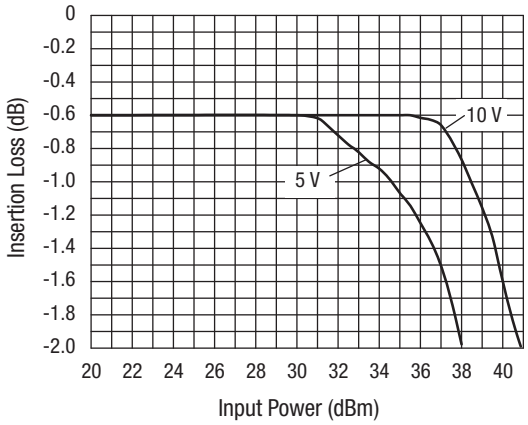


Return Loss in Insertion Loss State



Temperature Derating Curve (0, 10 V)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0232



Compression at 900 MHz 25 °C

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	V_{LOW}	Insertion loss	Isolation
V_{LOW}	V_{HIGH}	Isolation	Insertion loss

All other conditions not recommended.
V_{LOW} = 0 to -12 V.
V_{HIGH} = 0 to 12 V.
Differential = 5 V ≤ (V_{HIGH}– V_{LOW}) < 12 V.

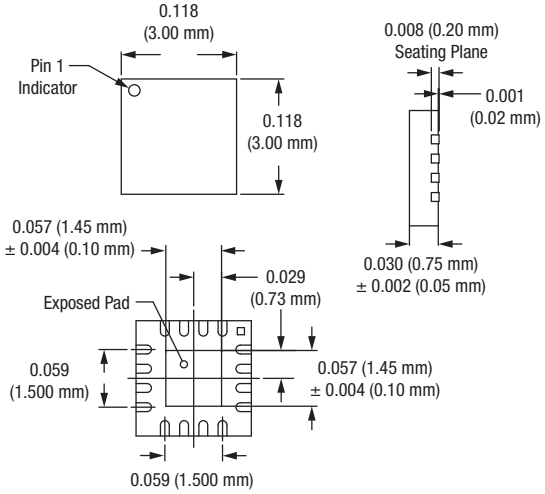
Absolute Maximum Ratings

Characteristic	Value
RF input power (RF In)	8 W max. > 900 MHz 0/-10 V control
Control voltage (V_C)	+0.2 V, -12 V
Operating temperature (T_{OP})	-40 °C to +85 °C
Storage temperature (T_{ST})	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

-348 (QFN 3 x 3)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0233

DATA SHEET

SKY13274-349LF: PHEMT SP2T Switch 0.5–6.0 GHz

Features

- Positive low voltage control (0/+3 V)
- Low insertion loss (0.8 dB typ. @ 6 GHz)
- High Rx isolation (28 dB @ 6 GHz)
- Tx port termination
- Miniature QFN-8 pin plastic package (2 x 2 mm)
- PHEMT process
- Lead (Pb)-free, RoHS-compliant MSL-1 @ 240 °C per JEDEC J-STD-020

Description

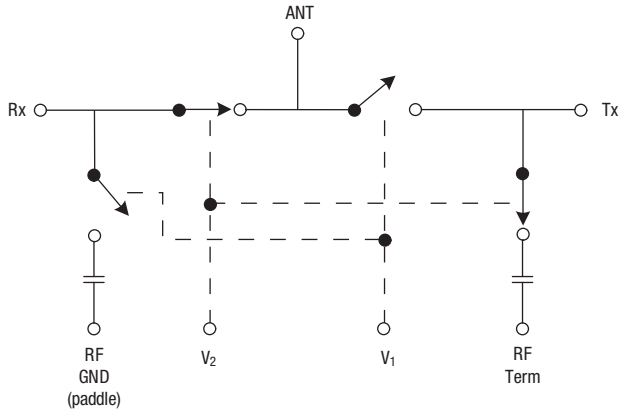
The SKY13274-349LF is a PHEMT AlGaAs single-pole, double-throw switch designed for use as a transmit receive (TR) switch for ultra-wideband (UWB) transceivers. This switch offers excellent insertion loss and isolation over wide bandwidth. It features a terminated transmit input port, which is provided via an external termination resistor for added versatility. The receiver output port is reflective. The switch is controlled with single-polarity control voltage of 3 V and 0 V, and is also compatible with control voltage as high as 7 V.

This switch is packaged in the surface mount QFN-8 package, which is lead (Pb)-free and meets all current RoHS requirements.

NEW

Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0234

Electrical Specifications at 25 ºC

Z_0 = 50 Ω, V_{CTL} = 0/3 V, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	Tx-Ant, Rx-Ant	0.5–3.0 GHz 3.0–6.0 GHz		0.5 0.8	0.7 1.0	dB dB
Isolation	Tx-Ant	0.5–3.0 GHz 3.0–6.0 GHz	22 14	25 17		dB dB
	Rx-Ant	0.5–3.0 GHz 3.0–6.0 GHz	27 23	30 26		dB dB
Return loss	Tx-Ant, Rx-Ant (insertion loss)	0.5–3.0 GHz 3.0–6.0 GHz		20 15		dB dB
	Tx-Ant (isolation)	0.5–3.0 GHz 3.0–6.0 GHz		20 15		dB dB
	Rx-Ant (isolation)	0.5–6.0 GHz		Reflective		dB

Operating Characteristics at 25 ºC

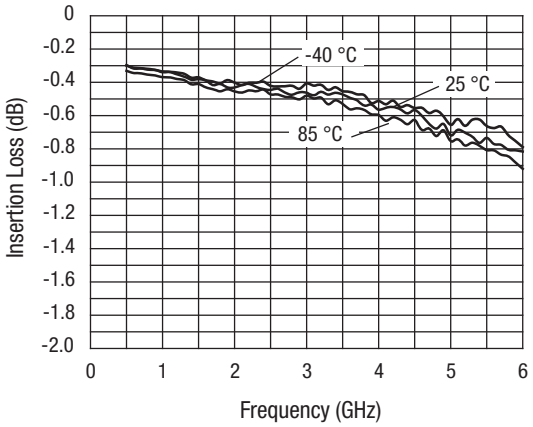
Z_0 = 50 Ω, V_{CTL} = 0/3 V, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise	10/90% RF			100		ns
Fall	90/10% RF			10		ns
On	50% CTL to 90% RF			100		ns
Off	50% CTL to 10% RF			20		ns
Input power for -0.1 dB compression	V_{CTL} = 0/3 V	0.5–3 GHz		25		dBm
Input Intermodulation intercept point (IIP3)	2-tone, Δf = 5 MHz, V_{CTL} = 0/3 V	900 MHz		45		dBm
Control voltages	Low (V_{LOW}) High (V_{HIGH})		0 2.7		0.2 7.0	V V
Control Port Current	V_{CTL} = 3 V V_{CTL} = 0 V				50 20	µA µA

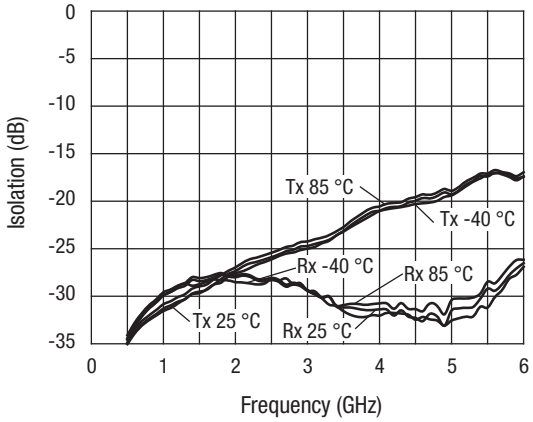
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0235

Typical Performance Data

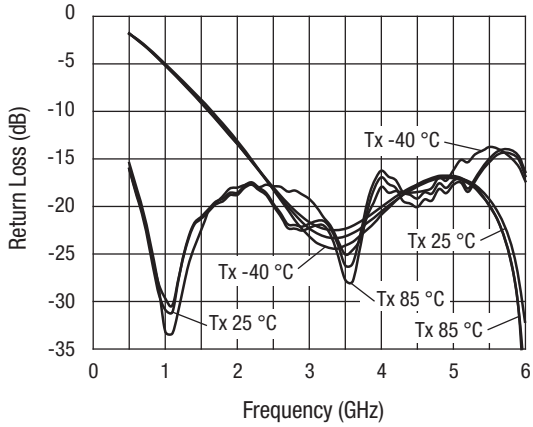
Z_0 = 50 Ω, V_{CTL} = 0/3 V, unless otherwise noted



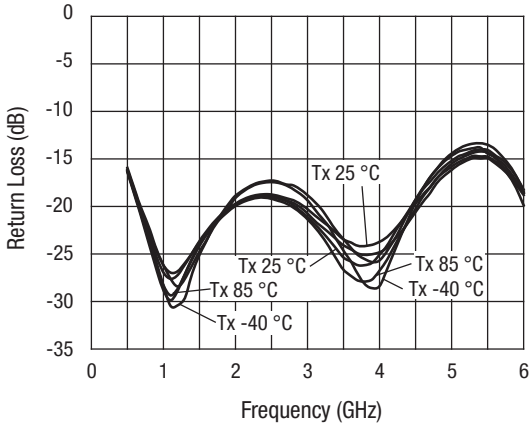
Insertion Loss vs. Frequency



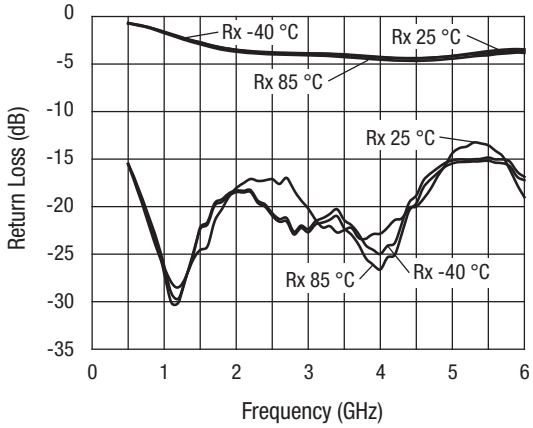
Isolation vs. Frequency



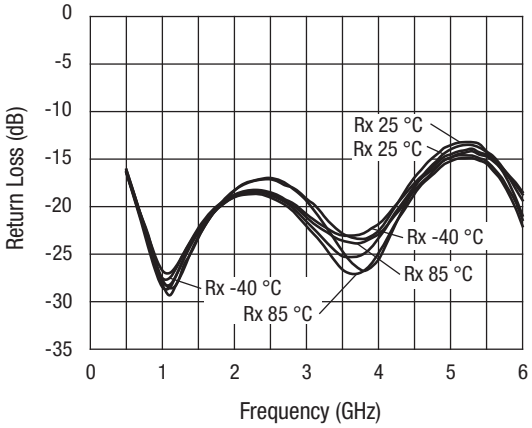
Return Loss Tx Isolation State vs. Frequency



Return Loss Tx Ins. Loss State vs. Frequency



Return Loss Rx Isolation State vs. Frequency



Return Loss Rx Ins. Loss State vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0236

Absolute Maximum Ratings

Characteristic	Value
RF input power	1 W > 500 MHz 0/+7 V control
Control voltage	-0.2 V, +7 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C
Θ_{JC}	45 °C/W

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

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 must be employed at all times.*

Applications

The SKY13274-349LF is designed for use as an UWB TR switch for signal frequencies up to 6 GHz. When the switch is in its receive state with the voltage at pin 1 (V_1) low and the voltage at pin 4 (V_2) high, the Tx input port is terminated via an external resistor connected between pin 5 (R1) and ground. A 39 Ω external resistor in this position produces a 50 Ω (nominal) impedance looking into pin 6.

DC blocking capacitors are required at each of the RF ports. The nominal value for these capacitors is 39 pF This value should be increased for operation with RF at frequencies below 500 MHz.

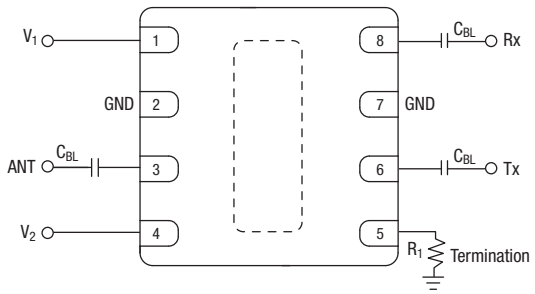
The exposed paddle on the back side of the package must be grounded for proper operation.

Truth Table

V_1	V_2	Rx-Ant	Tx-Ant
Low	High	Ins. Loss	Isolation
High	Low	Isolation	Ins. Loss
Low	Low	Not recommended(1)	
High	High	Not recommended(1)	

Low = 0–0.2 V.
High = 3 V.
1. Switch is in an undefined state.

Pin Out (Top View)



C_{BL} = 39 pF for operation >500 MHz.
R_1 = 39 Ω.
Exposed paddle on bottom of package needs to be connected to ground.

Pin Descriptions

Pin Number	Pin Name	Description
1	V_1	Control voltage 1 - Control Voltage Input #1. The logic level voltage applied to this pin, along with the level voltage applied to pin 4, determines the states of the RF paths between the Tx, Rx and Ant ports.
2	GND	Equipotential point - Internal circuit common which must be connected to the pcb ground or common via the lowest possible impedance.
3	Ant	RF input/output.
4	V_2	Control voltage 2 - Control Voltage Input #2. The logic level voltage applied to this pin, along with the level voltage applied to pin 1, determines the states of the RF paths between the Tx, Rx and Ant ports.
5	Termination	An external termination resistor must be added to this pin for the Tx port to be matched when Tx-Ant path is in its isolation state.
6	Tx	RF input/output.
7	GND	Equipotential point - Internal circuit common which must be connected to the pcb ground or common via the lowest possible impedance.
8	Rx	RF input/output.

Recommended Solder Reflow Profiles

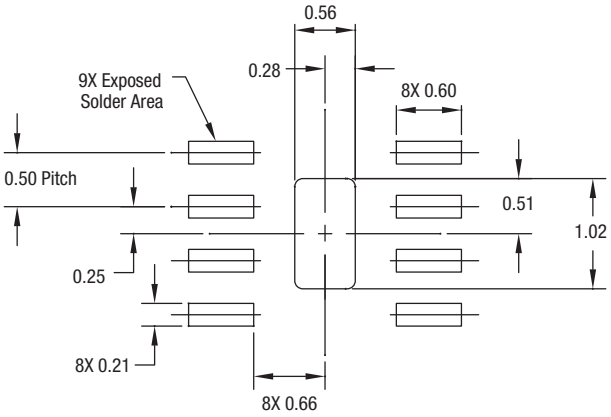
Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

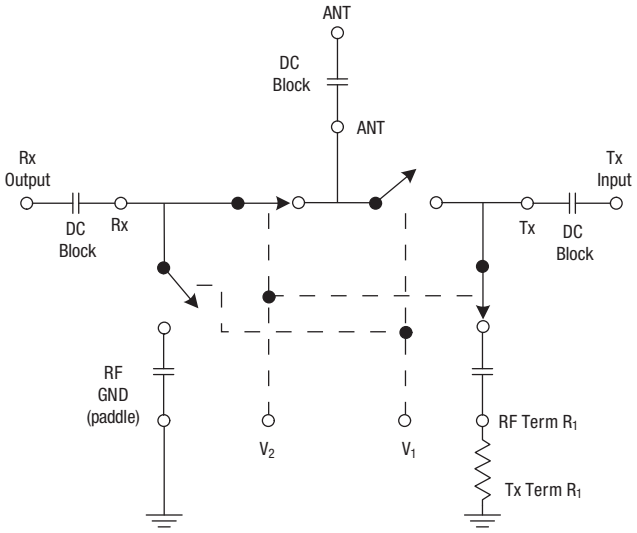
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0237

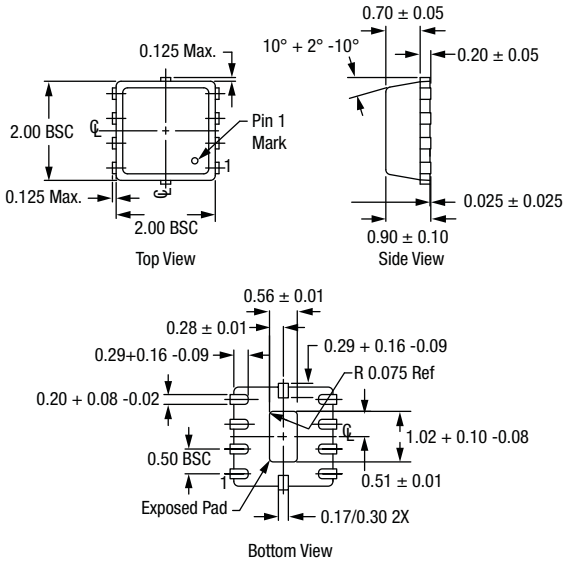
Suggested Land Pattern



TR Switch



QFN-8



All dimensions are in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0238

DATA SHEET

AS225-313, AS225-313LF: PHEMT GaAs IC 1 W Low Loss 0.1–6 GHz SPDT Switch

Applications

- WLAN 802.11a, b, g

Features

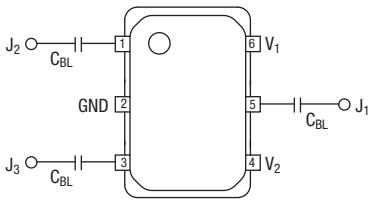
- Positive low voltage control (0/3 V)
- Low insertion loss (0.6 dB, 0.1–6 GHz)
- High linearity (IIP3 = 53 dBm @ 3 V)
- Miniature QFN-6 pin plastic package (2 mm x 3 mm)
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS225-313 is a 0.1–6 GHz PHEMT GaAs IC SPDT antenna switch. Designed for WLAN applications, this device is capable of switching 1 W microwave signals with 3 V control voltage while maintaining high-linearity performance. The switch covers the entire 802.11a, b and g frequency ranges. The low-loss, high-isolation, high-inearity and low-cost features make this switch ideal for Wireless LAN systems.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 15 pF.

Electrical Specifications at 25 °C

Z_0 = 50 Ω, V_{CTRL} = 0/3 V, unless otherwise noted

Parameter	Test Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	J_1–J_2, J_1–J_3	0.10–6.00 GHz		0.60	0.75	dB
		2.40–2.50 GHz		0.50	0.65	dB
		5.15–5.85 GHz		0.60	0.70	dB
Isolation	J_1–J_2, J_1–J_3	0.10–6.00 GHz	18	20		dB
		2.40–2.50 GHz	18	20		dB
		5.15–5.85 GHz	19	21		dB
Return loss	J_1–J_2, J_1–J_3	0.10–6.00 GHz	18	20		dB
		2.40–2.50 GHz	23	25		dB
		5.15–5.85 GHz	21	23		dB

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0239

Operating Characteristics at 25 °C

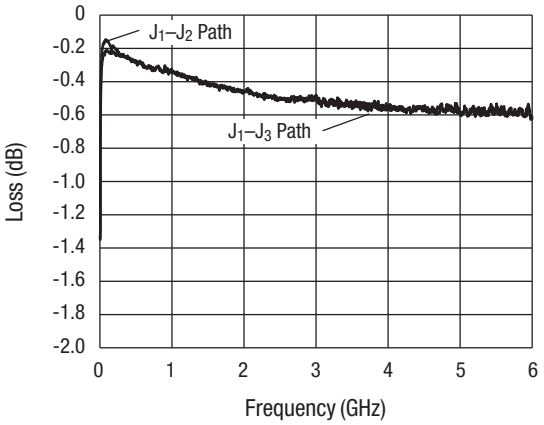
Z_O = 50 Ω, V_{CTRL} = 0/3 V, C_{BLOCK} = 15 pF, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			20		ns
On, off	50% CTL to 90/10% RF			35		ns
$P_{1\ dB}$	@ 3 V	5200 MHz		30		dBm
	@ 5 V	5200 MHz		34		dBm
2nd harmonic	P_{IN} = 22 dBm, V_C = 3 V	2450 MHz		70		dBc
	V_C = 5 V	2450 MHz		75		dBc
3rd harmonic	P_{IN} = 22 dBm, V_C = 3 V	2450 MHz		68		dBc
	V_C = 5 V	2450 MHz		70		dBc
Input IP3	Two-tone 15 dBm, 5 MHz spacing					
	V_{CTL} = 0/3 V	5200 MHz		53		dBm
	V_{CTL} = 0/5 V	5200 MHz		55		dBm
Control voltage	$V_{C\ HIGH}$		2.5	3.00	5.00	V
	$V_{C\ LOW}$			-0.25	0.25	V
Gate leakage	V_C = 3 V			10	100	µA
	V_C = 5 V			15	200	µA

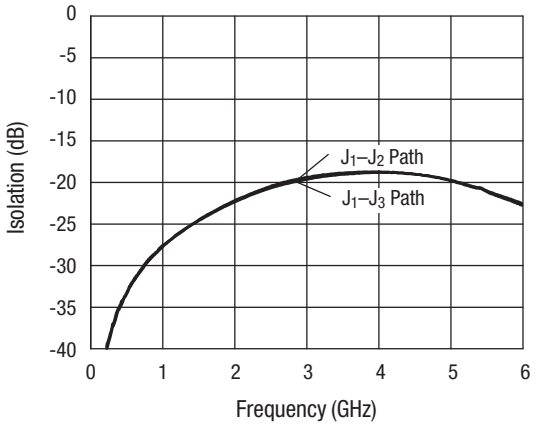
EX-1042
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0240

Typical Performance Data

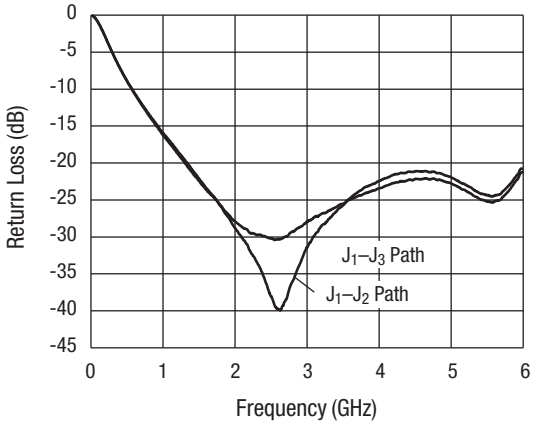
Z_O = 50 Ω, V_{CTRL} = 0/3 V, C_{BLOCK} = 15 pF, unless otherwise noted



Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0241

Absolute Maximum Ratings

Characteristic	Value
Max input power @ 0/3 V	32 dBm
Max input power @ 0/5 V	35 dBm
Operating voltage	8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

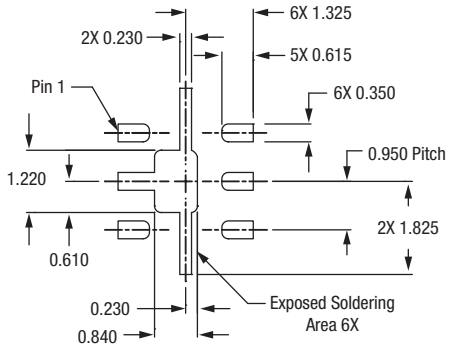
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Land Pattern



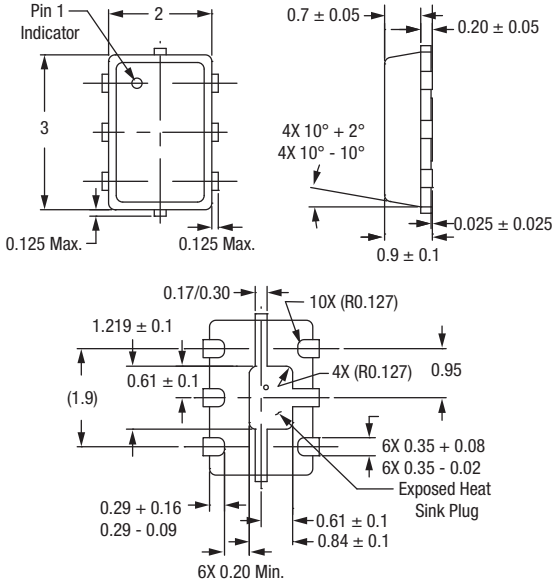
Dimensions in mm.

Truth Table

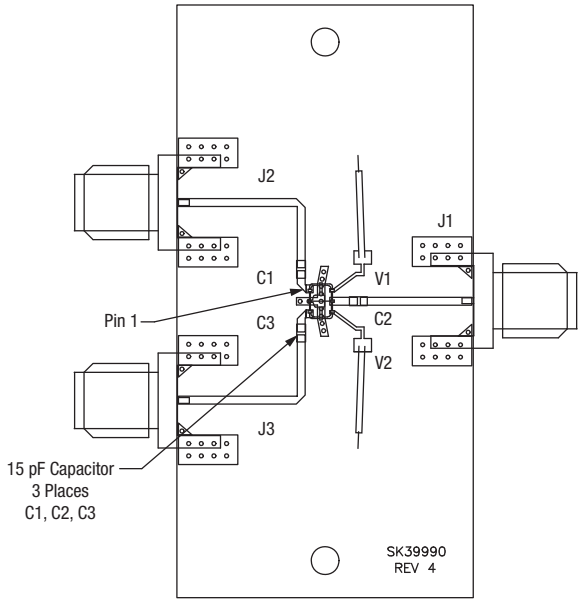
V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.5 to 5 V.

QFN-6



Evaluation Board



EX-1042
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0242

DATA SHEET

SKY13268-344LF: GaAs SPDT Switch 300 kHz–3 GHz Medium Power

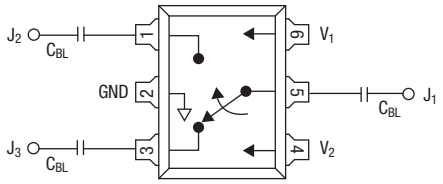
Applications

- Transceiver transmit-receive switching in GSM, CDMA, WCDMA, WLAN, Bluetooth®, Zigbee®, land mobile radio base stations or terminal equipment
- General-purpose medium power switch in telecommunications applications

Features

- Broadband: 300 kHz–3 GHz
- Low insertion loss: 0.3 dB @ 900 MHz
- $P_{1\ dB}$: 30 dBm typical @ 3 V
- Low distortion: IP3 43 dBm @ 3 V
- Low current consumption: < 100 µA @ 3 V
- Ultraminiature SOT-666 6-lead package
- Available lead (Pb)-free, RoHS-compliant, and Green MSL-1 @ 260 °C per JEDEC J-STD-020

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 100 pF for operation >500 MHz.

Description

The SKY13268-344LF is a monolithic SPDT switch, fabricated using Skyworks proprietary GaAs pHEMTs as the switching elements. This wideband switch operates with RF signals from 300 kHz to 3 GHz. The RF signal paths within the SKY13268-344LF are fully bilateral. Ports J_2 and J_3, RF input/output terminals are reflective.

Switching is controlled via two control voltage inputs, which are compatible with CMOS logic levels. Depending upon the logic voltage level applied to the control voltage pin, the common RF pin, J_1, is connected to one of two switched RF pins (J_2 or J_3) via a low insertion loss path, while the path between the RF common and the other RF pin is in its high-isolation state.

DC power consumption is very low, 100 µA maximum with control voltage of 3 V. The switch can operate over the temperature range of -40 °C to +85 °C.

An evaluation board is available upon request.

NEW

Skyworks Green products are lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant, conform to the EIA/EICTA/JEITA Joint Industry Guide (JIG) Level A guidelines, and are free from antimony trioxide and brominated flame retardants.

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0243

Electrical Specifications

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_O = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	300 kHz–1 GHz 1–2 GHz 2–3 GHz		0.3 0.4 0.4	0.4 0.5 0.6	dB dB dB
Isolation	300 kHz–1 GHz 1–2 GHz 2–3 GHz	20 20 20	25 25 23		dB dB dB
VSWR	300 kHz–1 GHz 1–2 GHz 2–3 GHz		1.3:1 1.3:1 1.3:1	1.4:1 1.4:1 1.4:1	

Operating Characteristics

V_{CTL} = 0 V/3 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_O = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise, fall On, off Video feedthru	 10/90% or 90/10% RF 50% CTL to 90/10% RF T_{RISE} = 1 ns, BW = 500 MHz			 36 58 25		 ns ns mV
Input power for 1 dB compression	V_{LOW} = 0 V, V_{HIGH} = 3 V V_{LOW} = 0 V, V_{HIGH} = 5 V	0.5–3 GHz 0.5–3 GHz		30 34		dBm dBm
Intermodulation intercept point (IP3)	For two-tone input power 5 dBm V_{LOW} = 0 V, V_{HIGH} = 3 V V_{LOW} = 0 V, V_{HIGH} = 5 V	 0.5–3 GHz 0.5–3 GHz		 43 50		 dBm dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max.					

Absolute Maximum Ratings

Characteristic	Value
Control voltage range	$-0.2 \le V_C \le 8$ V
RF input power	1 W for f < 500 MHz, 6 W for f > 500 MHz, V_{CTL} = 0/7 V
Storage temperature range	-65 °C to +150 °C
Operating temperature range	-40 °C to +85 °C

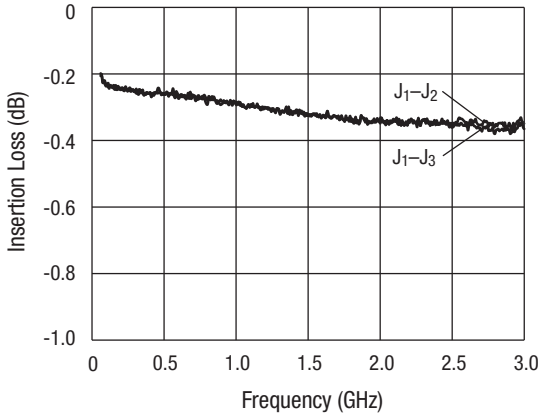
Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

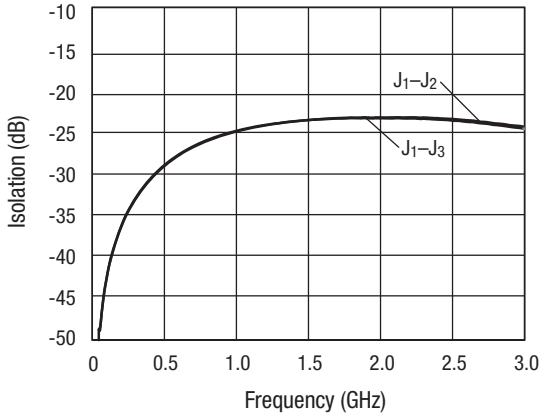
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0244

Typical Performance Data

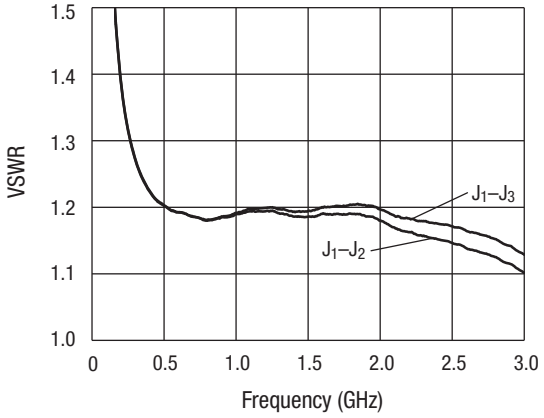
V_{CTL} = 0 V/3 V, T = 25 °C, Z_0 = 50 Ω, unless otherwise noted



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
V_{HIGH}	0	Isolation	Insertion loss
0	V_{HIGH}	Insertion loss	Isolation
0	0	Not recommended	Not recommended
V_{HIGH}	V_{HIGH}	Not recommended	Not recommended

3 V ≤ V_{HIGH} ≤ 5 V.

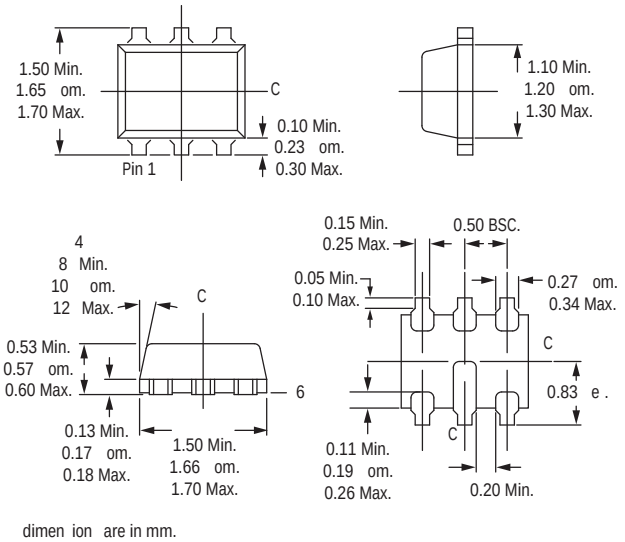
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

SOT-666 Package Outline



dimen ion are in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0245

Pin Descriptions

Pin Number	Pin Name	Description
1	J_2	RF input/output – RF input or output port which is either connected via a low insertion loss path to RF common (J_1) or isolated from RF common, according to the logic levels applied to V_1 and V_2
2	GND	Equipotential point – Equipotential point for control voltage and RF circuits. Must be connected to PCB ground via lowest possible impedance
3	J_3	RF input/output – RF input or output port which is either connected via a low insertion loss path to RF common (J_1) or isolated from RF common, according to the logic levels applied to V_1 and V_2
4	V_2	Control voltage – Control voltage input #2
5	J_1	RF common input/output – RF input/output port that is connected via low insertion loss path to either RF1 or RF2, depending upon the voltage applied to control voltage pin
6	V_1	Control voltage – Control voltage input #1

Evaluation Board

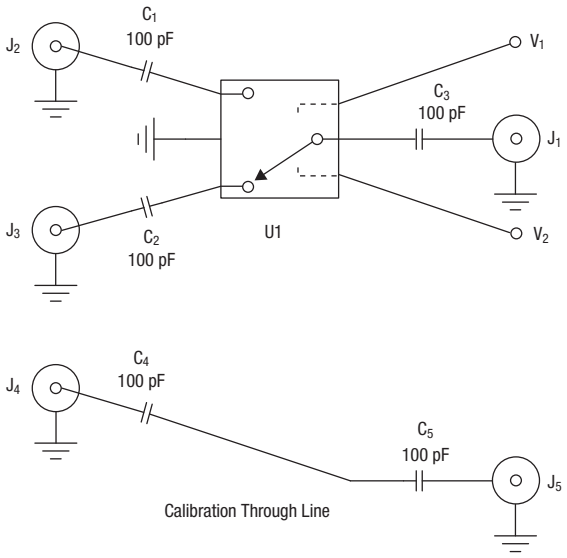
The evaluation board for SKY13268-344LF allows the part to be fully exercised. The insertion loss of the transmission lines between J_1- U1 and U1 - J_2/J_3 can be determined by measuring the performance of the calibration through-line, which contains two DC block capacitors in identical positions to the DC blocks present in the main circuit.

The state of the SKY13268-344LF is controlled by applying the appropriate logic level voltages to ports V_1 and V_2, per the Truth Table.

Evaluation Board Components

Component	Description	Default
C_1–C_5	DC blocking capacitor	100 pF, size 0402
U1	SKY13268-344 GaAs SPDT	
J_1, J_2, J_3, J_4, J_5	SMA connectors	

SKY13268-344LF Evaluation Circuit



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0246

DATA SHEET

SKY13286-359LF: GaAs High Isolation SPDT Absorptive Switch 100 MHz–6 GHz

Features

- Single positive voltage control (0/3 to 0/5 V)
- High isolation 64 dB at 1 GHz and 2 GHz
- Integrated silicon CMOS driver
- Absorptive
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

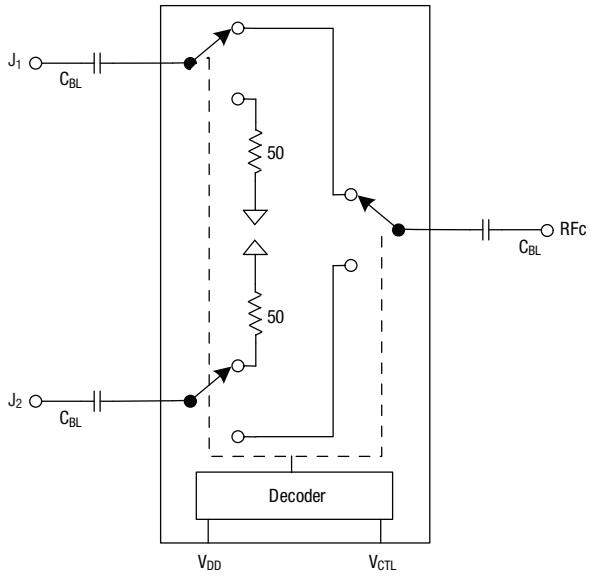
Description

The SKY13286-359LF is a pHEMT GaAs FET IC high isolation absorptive switch packaged in a 16-lead exposed pad plastic package for low-cost commercial applications. It is an ideal building block for base station applications where synthesizer isolation is critical. Typical applications include GSM, PCS, WCDMA, 2.4 and 5.8 GHz ISM and wireless local loop.

An evaluation board is available upon request.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



Electrical Specifications

V_{CTL} = 0 V/3V, V_{DD} = 5 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.1–2.0 GHz		0.8	1.10	dB
	2.0–3.0 GHz		0.8	1.25	dB
	3.0–4.0 GHz		1.0	1.35	dB
	4.0–6.0 GHz		1.5	1.80	dB
Isolation	0.1–2.0 GHz	60	62		dB
	2.0–3.0 GHz	58	62		dB
	3.0–4.0 GHz	55	58		dB
	4.0–6.0 GHz	40	42		dB
Return loss (insertion loss state) Lower frequency return loss is dependent on DC blocks	0.1–2.0 GHz	10	22		dB
	2.0–3.0 GHz	15	22		dB
	3.0–4.0 GHz	13	18		dB
	4.0–6.0 GHz	10	12		dB
Return loss (isolation state) Lower frequency return loss is dependent on DC blocks	0.5–2.0 GHz	10	12		dB
	2.0–3.0 GHz	12	15		dB
	3.0–4.0 GHz	12	15		dB
	4.0–6.0 GHz	11	13		dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0247

Operating Characteristics

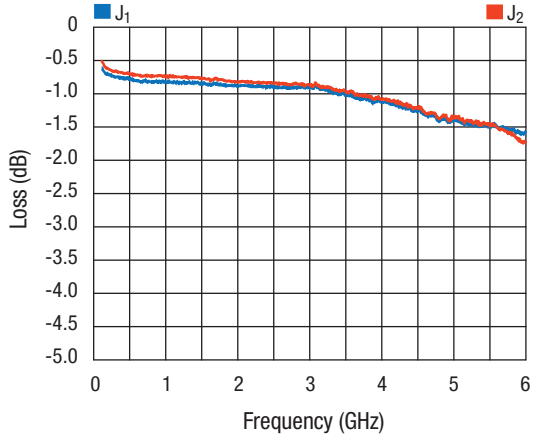
V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			30		ns
On, off	50% CTL to 90/10% RF			50		ns
Video feedthru	T_{RISE} = 3 ns, Measurement BW = 500 MHz			25		mV
Input power for 1 dB compression	V_{DD} = 3 V	0.7–2.0 GHz		23		dBm
	V_{DD} = 5 V	0.7–2.0 GHz	26	30		dBm
Intermodulation intercept point (IP3)	For two-tone input power 8 dBm/tone 1 MHz Spacing					
	V_{DD} = 3.3 V	0.7–1.0 GHz		49		dBm
	V_{DD} = 5 V	0.7–1.0 GHz	45	47		dBm
	V_{DD} = 3.3 V	1.0–2.0 GHz		43		dBm
	V_{DD} = 5 V	1.0–2.0 GHz	45	46		dBm
Control voltages[1,2]	$V_{CTL\ LOW}$		0		0.5	V
	$V_{CTL\ HIGH}$		2.7		V_{DD}	V
Supply current	V_{DD} = 5 V				100	µA
Control current	V_{CTL} = LOW, V_{CTL} = HIGH			5		µA
Supply voltage			2.7		5	

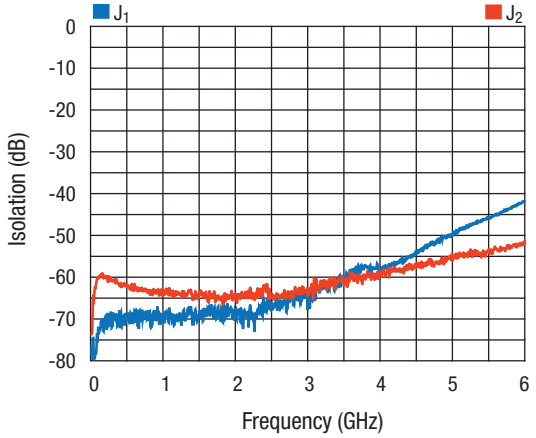
1. V_{DD} must be powered on prior to a V_{CTL} high signal. A latch up condition may occur if a logic high signal is applied prior to the V_{DD} voltage.
2. Control voltages switch the V_{DD} voltage to the GaAs switch.

Typical Performance Data

V_{CTL} = 0 V/3V, V_{DD} = 5 V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

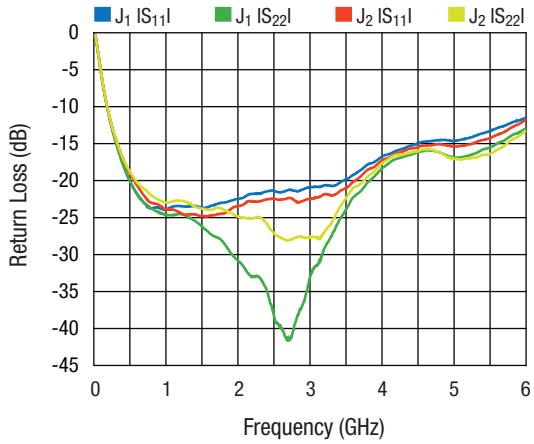


Insertion Loss vs. Frequency

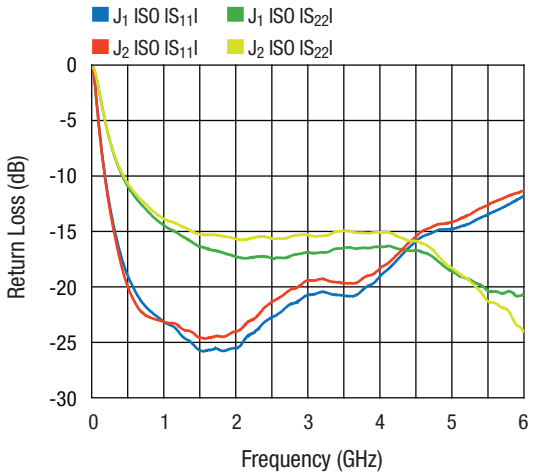


Isolation vs. Frequency

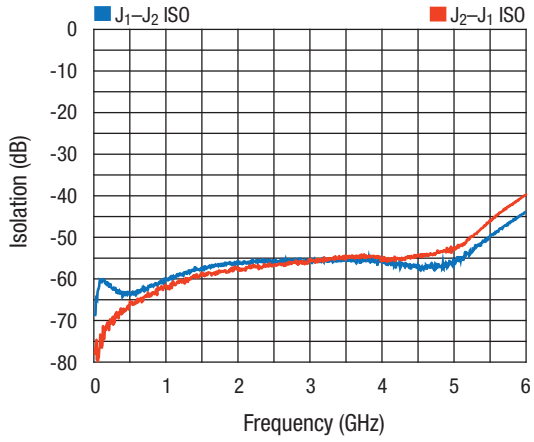
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0248



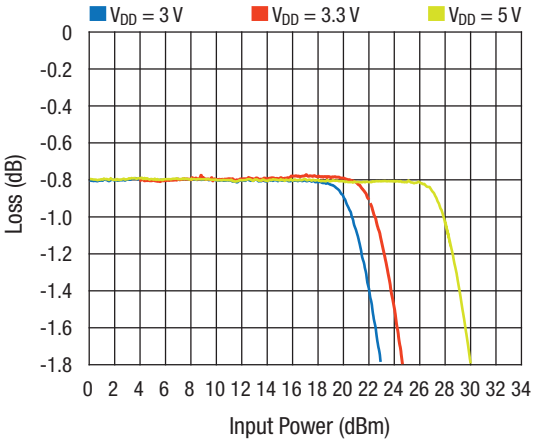
Return Loss vs. Frequency Insertion Loss State



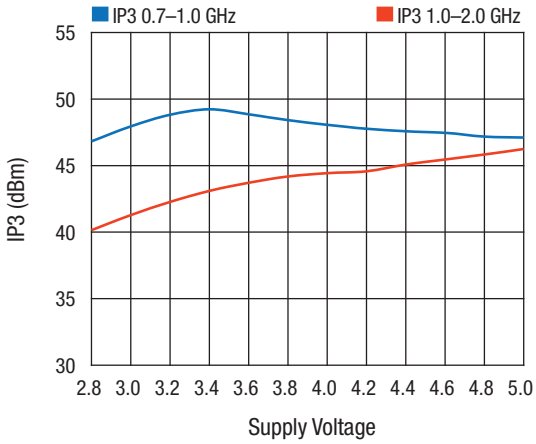
Return Loss vs. Frequency Isolation State



Output to Output Isolation



Insertion Loss vs. Input Power vs. V_{DD} Voltage



IP3 vs. V_{DD} Supply Voltage

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0249

Truth Table

V_{CTL}	RFc–J_1	RFc–J_2
0	Insertion loss	Isolation
1	Isolation	Insertion loss

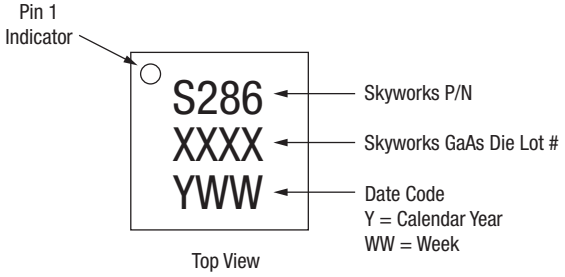
Absolute Maximum Ratings

Characteristic	Value
V_{DD} voltage range	$2.7 \leq V_{DD} \leq 5.5$ V
RF input power	1 W, f > 500 MHz
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

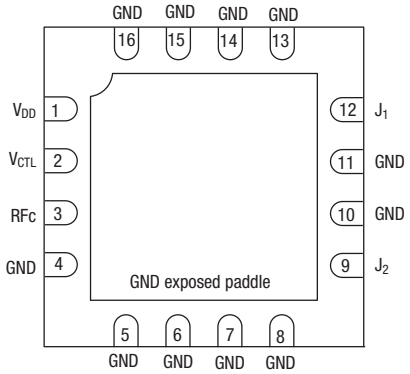
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Part Marking



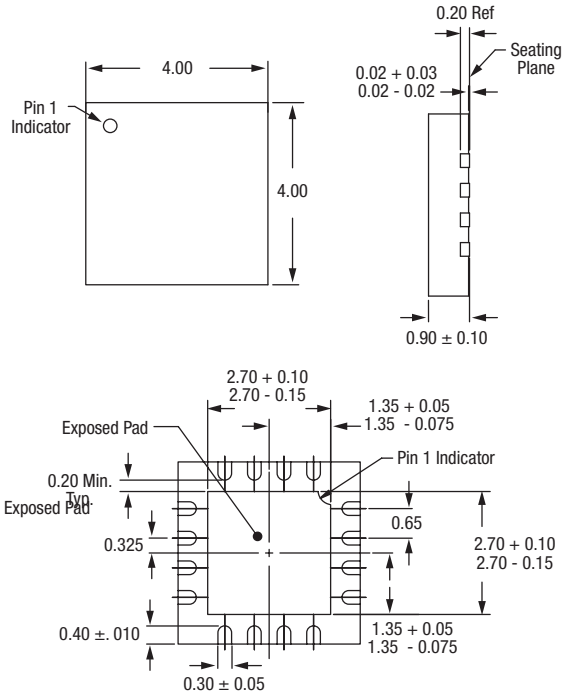
Pin Out (Top View)

"X-ray" of pads on bottom of package



DC blocking capacitors required on all RF lines (RFc, J_1, J_2).

Package Outline



Dimensions in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0250

DATA SHEET

SKY13276-334: PHEMT GaAs IC 1 W Low Loss 0.1–6 GHz SPDT Switch

Applications

- WLAN 802.11a, b, g, n

Features

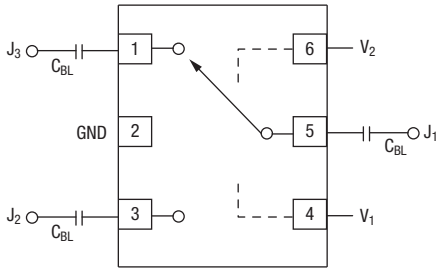
- Positive low voltage control (0/3 V)
- Low insertion loss (0.7 dB, 0.1–6 GHz)
- High linearity (IIP3 = 53 dBm @ 3 V)
- 1.5 x 1.2 x 0.8 Land Grid Array (LGA) package
- PHEMT process
- Lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13276-334 is a 0.1–6 GHz PHEMT GaAs Single Pole Double Throw (SPDT) antenna switch. Designed for WLAN applications, this device is capable of switching 1 W microwave signals with 3 V control voltage while maintaining high-linearity performance. The switch covers the entire 802.11a, b and g frequency ranges, the public service band at 4.9 GHz, as well as several ISM bands and WiMAX bands. The low loss, high-isolation, high-linearity and low-cost features make this switch ideal for transmit/receive or antenna diversity switching in these applications.

The part is packaged in an ultraminiature 6-pin 1.5 x 1.2 x 0.8 mm Land Grid Array (LGA) package which is fully compliant with current RoHS requirements.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 47 pF for operation >500 MHz.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C

Z_0 = 50 Ω, V_{CTRL} = 0/3 V, unless otherwise noted

Parameter	Test Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	J_1–J_2, J_1–J_3	1.00–6.00 GHz		0.70	0.85	dB
		2.40–2.50 GHz		0.60	0.70	dB
		5.15–5.85 GHz		0.70	0.80	dB
Isolation	J_1–J_2, J_1–J_3	1.00–6.00 GHz	16	20		dB
		2.40–2.50 GHz	18	20		dB
		5.15–5.85 GHz	16	21		dB
Return loss	J_1–J_2, J_1–J_3	1.00–6.00 GHz	15	20		dB
		2.40–2.50 GHz	23	25		dB
		5.15–5.85 GHz	18	23		dB

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0251

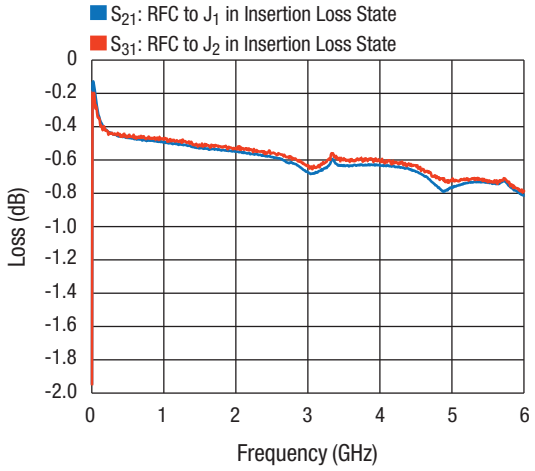
Operating Characteristics at 25 °C

Z_0 = 50 Ω, V_{CTRL} = 0/3 V, unless otherwise noted

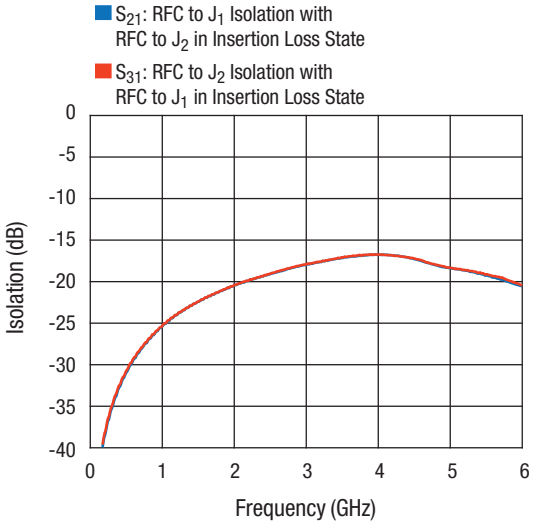
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
$P_{1\ dB}$	@ 3 V @ 5 V	5200 MHz 5200 MHz		30 34		dBm dBm
2nd harmonic	P_{IN} = 22 dBm, V_C = 3 V V_C = 5 V	2450 MHz 2450 MHz		-70 -75		dBc dBc
3rd harmonic	P_{IN} = 22 dBm, V_C = 3 V V_C = 5 V	2450 MHz 2450 MHz		-68 -70		dBc dBc
Input IP3	Two-tone 15 dBm, 5 MHz spacing V_{CTL} = 0/3 V V_{CTL} = 0/5 V	 5200 MHz 5200 MHz		 53 55		 dBm dBm
Control voltage	$V_{C\ HIGH}$ $V_{C\ LOW}$		2.5	3.00 -0.25	5.00 0.25	V V
Gate leakage	V_C = 3 V V_C = 5 V			10 15	100 200	µA µA

Typical Performance Data

Z_0 = 50 Ω, V_{CTRL} = 0/3 V, unless otherwise noted

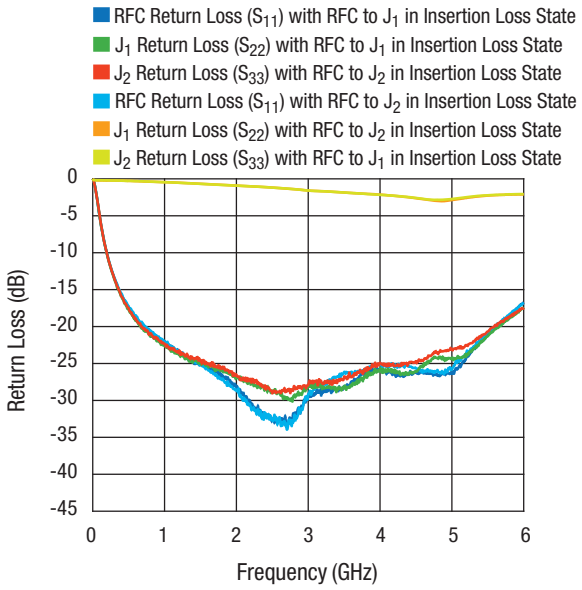


Insertion Loss vs. Frequency



Isolation vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0252



Return Loss vs. Frequency

Absolute Maximum Ratings

Characteristic	Value
Max input power @ 0/3 V	32 dBm
Max input power @ 0/5 V	35 dBm
Operating voltage	8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

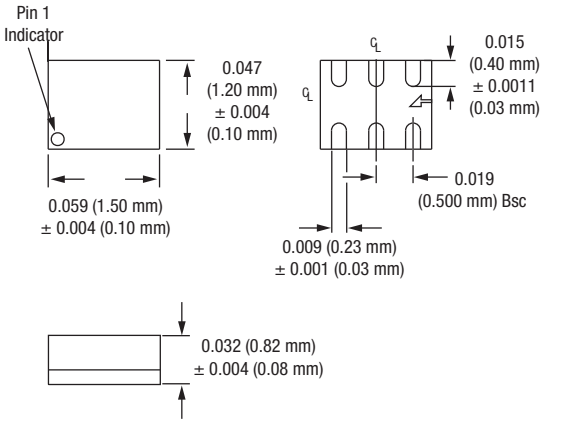
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.5 to 5 V.

LGA-6 (1.5 x 1.2 mm)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0253

DATA SHEET

AS200-313, AS200-313LF: PHEMT GaAs IC 2 W High-Linearity 5–6 GHz T/R Switch

Applications

- T/R switch in WLAN 802.11a systems

Features

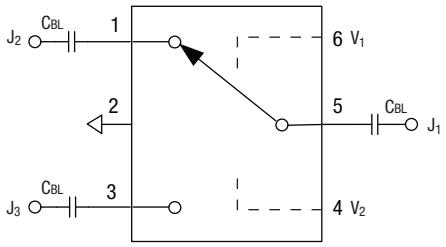
- Operating frequency 5–6 GHz
- High linearity 50 dBm IIP3
- High power $P_{-1\ dB} > 33$ dBm
- Low positive control voltage 3 V
- Low-cost, ultrasmall QFN package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS200-313 is a 5–6 GHz PHEMT GaAs switch. Designed for transmit-receive applications, this device is capable of switching 2 W microwave signals with 3 V control while maintaining high-linearity performance. The switch covers the entire 802.11a frequency ranges of 5.15–5.825 GHz. The low-loss, high-isolation, high-linearity and low-cost features make it ideal for wireless LAN systems in the 802.11a frequency band.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Simplified Block Diagram



Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	5.0–6.0 GHz		1.3	1.5	dB
	5.0–5.4 GHz		1.3	1.5	dB
	5.5–6.0 GHz		1.3	1.5	dB
Isolation	5.0–6.0 GHz	26	30		dB
	5.0–5.4 GHz	26	30		dB
	5.5–6.0 GHz	26	30		dB
Return loss[3]	5.0–5.4 GHz	10	15		dB
	5.5–6.0 GHz	10	15		dB

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

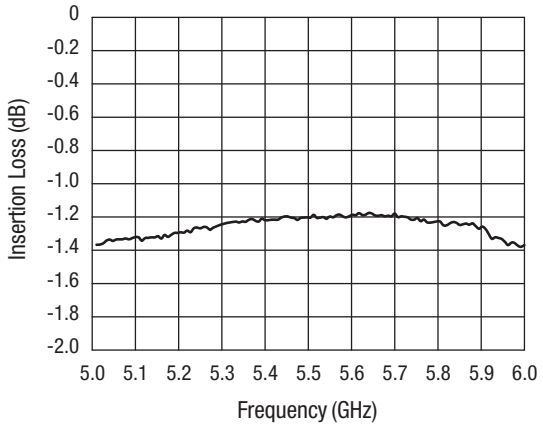
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0254

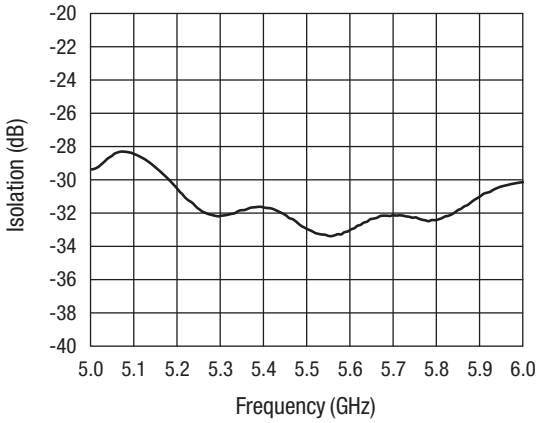
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			20		ns
On, off	50% CTL to 90/10% RF			50		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for -0.1 dB compression	V_{CTL} = 0/3 V	5.2 GHz		33		dBm
Harmonics H_2, H_3	P_{IN} = 30 dBm	5.2 GHz		-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 2.5 V @ 100 µA max. to 5 V @ 200 µA max.					

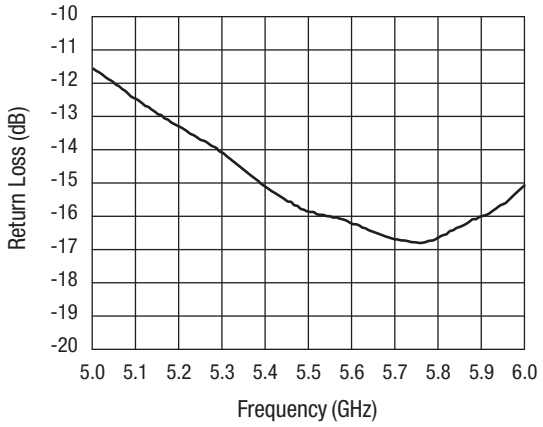
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0255

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W max. > 900 MHz 0/7 V control
Control voltage	-0.2 V, +7 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

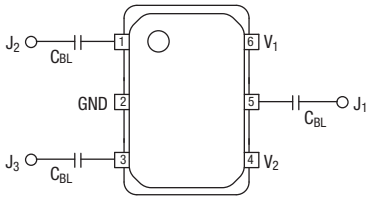
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Pin Out (Top View)



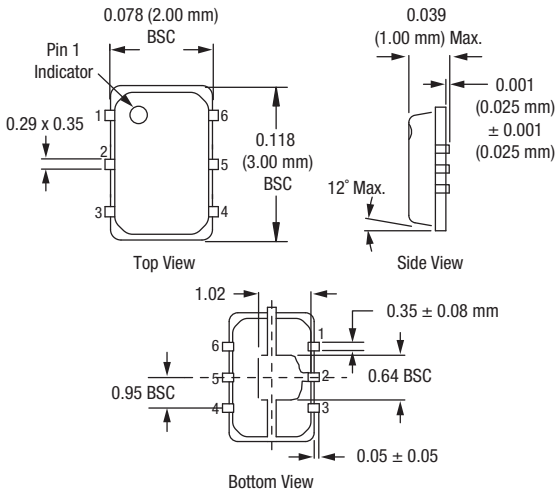
DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 15 pF.

Truth Table

V_1	V_2	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended.
V_{HIGH} = 2.5 to 5 V.

QFN-6



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0256

DATA SHEET

SKY13306-313LF: GaAs SPDT Switch 100 MHz–6 GHz

Features

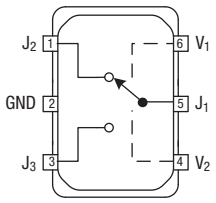
- Broadband: 100 MHz – 6 GHz
- Very low insertion loss: 0.5 dB typ. 2.4–2.5 GHz
- High linearity: IIP3 = 53 dBm typ. 3 V
- Low current consumption: <50uA @ 3 V
- Miniature QFN-6 2 x 3 mm package
- Lead (Pb)-free and RoHS-compliant MSL1 @ 260 C per JEDEC J-STD-020

Description

The SKY13306-313LF is an IC FET SPDT switch in a low-cost miniature QFN- 6 plastic package. The SKY13306-313LF features low insertion loss, excellent linearity and positive voltage operation with very low DC power consumption. This general purpose switch can be used in a variety of telecommunications applications, and was designed for use as a transmit-receive switch for WLAN applications such as 802-11a/b/g. The QFN-6 package is lead (Pb)-free and meets all current requirements for RoHS.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



Product is in development stages, performance is based on simulation, and pin out and package are advanced and may change.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0257

Electrical Specifications

T = 25 °C, V_{CTL} = 0/3 V, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	J_1–J_2, J_1–J_3	0.10 GHz–6.00 GHz 2.40 GHz–2.50 GHz 3.40 GHz–3.60 GHz 5.15 GHz–5.85 GHz		0.6 0.5 0.5 0.6	0.9 0.7 0.7 0.8	dB dB dB dB
Isolation	J_1–J_2, J_1–J_3	0.10 GHz–6.00 GHz 2.40 GHz–2.50 GHz 3.40 GHz–3.60 GHz 5.15 GHz–5.85 GHz	21 22 23 21	25 25 26 24		dB dB dB dB
Return loss	Insertion loss state	0.10 GHz–6.00 GHz 2.40 GHz–2.50 GHz 3.40 GHz–3.60 GHz 5.15 GHz–5.85 GHz		15 25 16 15		dB dB dB dB
Input power for 0.1 dB compression		2.4 GHz–2.5 GHz		35		dBm
2nd Harmonic	P_{IN} = 22 dBm	2.45 GHz		-70		dBc
3rd Harmonic	P_{IN} = 22 dBm	2.45 GHz		-68		dBc
Input 3rd order intercept point	Two tones, 15 dBm each tone, 5 MHz spacing	5.2 GHz		53		dBm
Control voltage V_{HIGH} V_{LOW}			 2.7 -0.25		 5 0.25	 V V
Control port current	V_{CTL} = 3 V V_{CTL} = 5 V V_{CTL} = 0 V			10 15 10	100 200 50	µA µA µA

Absolute Maximum Ratings

Characteristic	Value
RF input power @ 0,5 V	36.5 dBm @ 25 °C
RF input power @ 0,3 V	36 dBm @ 25 °C
Control voltage	-0.2 V ≤ V_{CTL} ≤ 6 V
Operating temperature range	-40 °C to +85 °C
Storage temperature range	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Truth Table

V_1(1)	V_2(1)	J_1–J_2	J_1–J_3
0	V_{HIGH}	Isolation	Insertion loss
V_{HIGH}	0	Insertion loss	Isolation

All other conditions not recommended. No damage to the switch will occur if a non-recommended combination of control voltages is present. The switch will not provide full isolation or minimum insertion loss under such conditions.
1. 2.7 V ≤ V_{HIGH} ≤ 5 V.

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

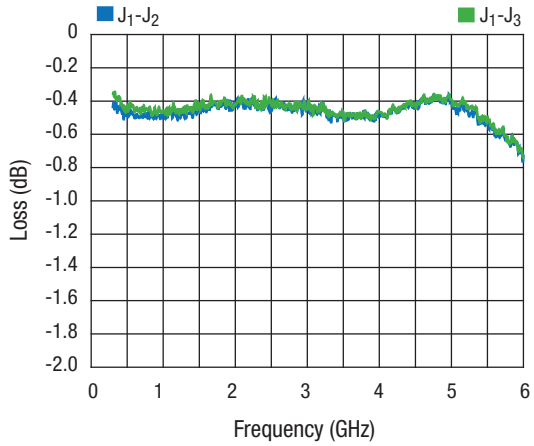
Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

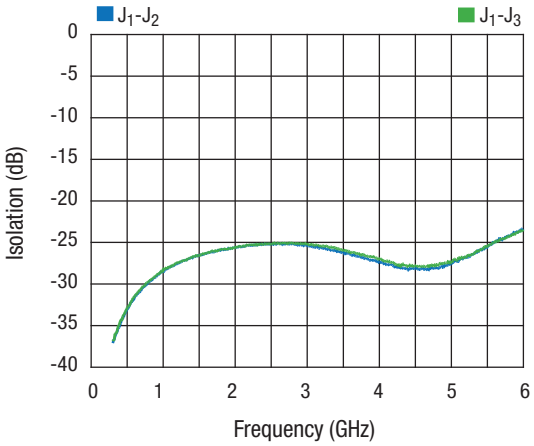
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0258

Typical Performance Data

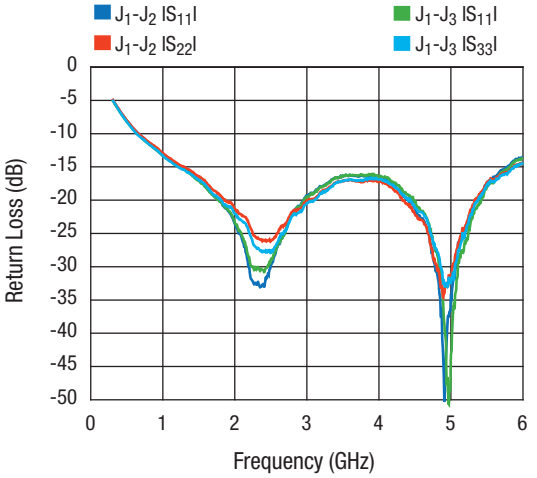
T = 25 °C, V_{CTL} = 0/3 V, Z_O = 50 Ω, unless otherwise noted



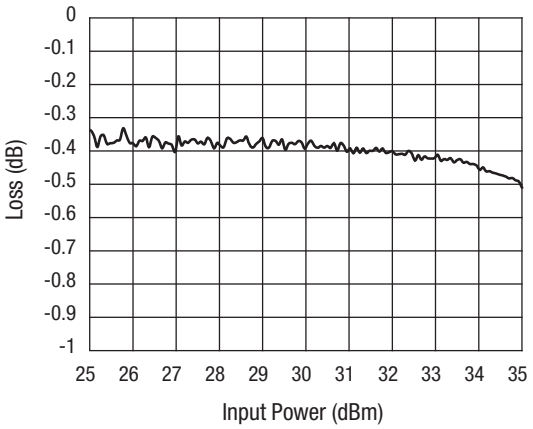
Typical Insertion Loss



Typical Isolation



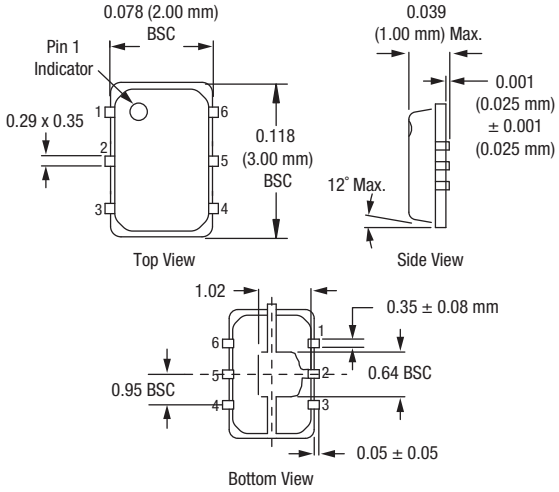
Typical Return Loss Insertion Loss State



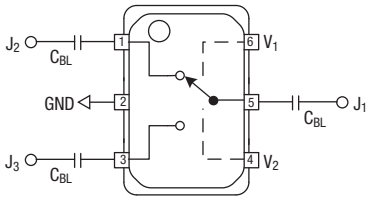
Typical Compression at 2.4 GHz

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0259

QFN-6



Pin Out and Suggested Circuit



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 15 pF.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0260

DATA SHEET

AS172-73, AS172-73LF: PHEMT GaAs IC Transfer Switch 300 kHz–2 GHz

Features

- High linearity (50 dBm IP3 @ 0.9 GHz) @ 3 V
- Low insertion loss (0.4 dB @ 0.9 GHz)
- Isolation (20 dB @ 0.9 GHz)
- Simultaneous T/R switching
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

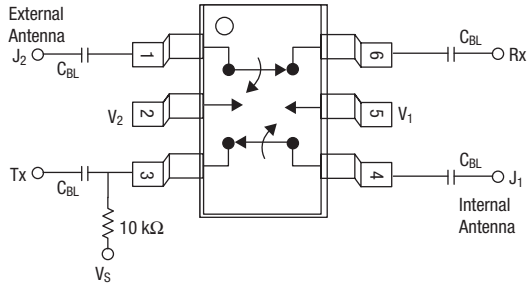
Description

The AS172-73 is a PHEMT GaAs IC 4 port switch designed to combine T/R and antenna changeover switching capability within one device. This switch has two controls and is ideal for applications requiring low power consumption. The AS172-73 has excellent performance to 2 GHz, making it suitable for dual-band handset designs.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out

Positive Operation



DC blocking capacitors (C_{BL}) and biasing resistor must be supplied externally for positive voltage operation.
C_{BL} = 100 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Frequency	Tx–J_1 or Rx–J_1 Min.	Typ.	Max.	Unit
Insertion Loss[2]	300 kHz–0.5 GHz		0.30	0.4	dB
	300 kHz–1.0 GHz		0.40	0.5	dB
	300 kHz–2.0 GHz		0.95	1.2	dB
Isolation	300 kHz–0.5 GHz	23	25		dB
	300 kHz–1.0 GHz	16	18		dB
	300 kHz–2.0 GHz	11	13		dB
VSWR[3]	300 kHz–1.0 GHz		1.1:1		
	300 kHz–2.0 GHz		1.4:1		

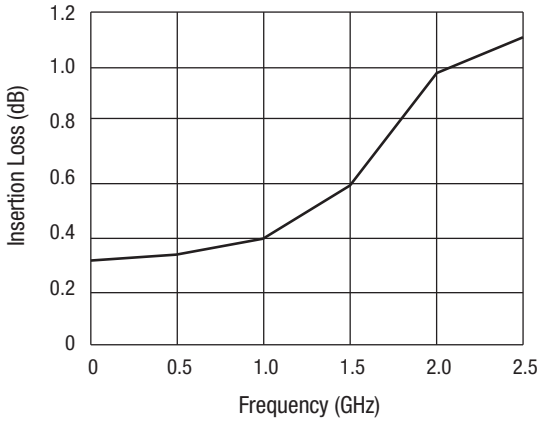
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0261

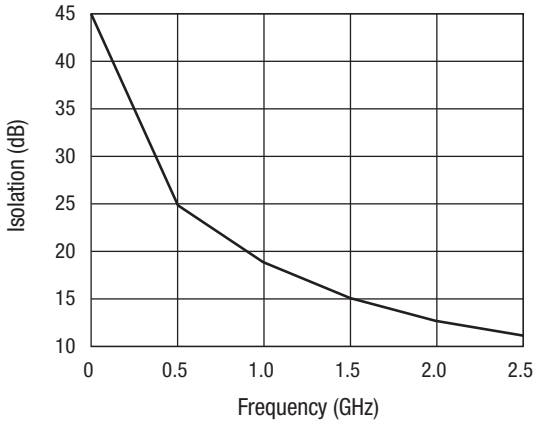
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			50		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input Power for 1 dB compression	V_{CTL} = 0/3 V	0.5–2 GHz		34		dBm
Intermodulation intercept point (IP3)	For two-tone input power 15 dBm V_{CTL} = 0/3 V	0.5–2 GHz		50		dBm
2nd harmonic	30 dBm	1 GHz		-72		dBc
3rd harmonic	30 dBm	1 GHz		-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 3 V @ 100 µA max. to 5 V @ 200 µA max. $V_S = V_{HIGH} \pm 0.2$ V					

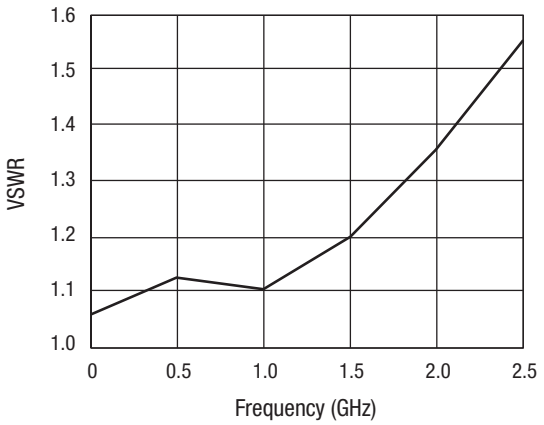
Typical Performance Data (0, 3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0262

Absolute Maximum Ratings

Characteristic	Value
RF input power	2 W > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-50 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

Negative Operation

V_1	V_2	$Tx–J_2, Rx–J_1$	$Tx–J_1, Rx–J_2$
0	-3	Insertion loss	Isolation
-3	0	Isolation	Insertion loss

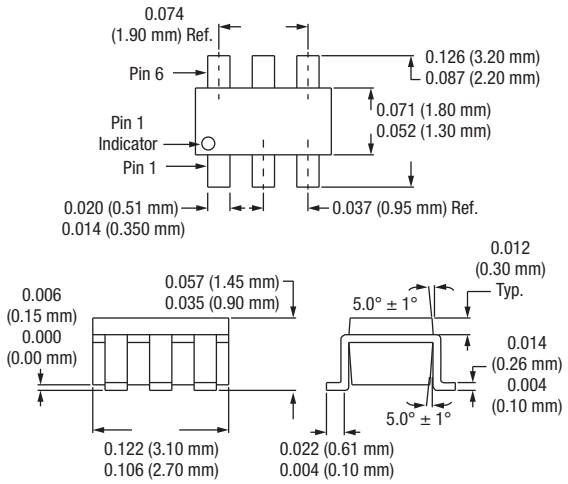
All other conditions not recommended.

Positive Operation

V_1	V_2	$Tx–J_2, Rx–J_1$	$Tx–J_1, Rx–J_2$
V_{HIGH}	0	Insertion loss	Isolation
0	V_{HIGH}	Isolation	Insertion loss
All other conditions		Not recommended	

All other conditions not recommended.
V_{HIGH} = 3 to 8 V ($V_S = V_{HIGH} \pm 0.2$ V).

SOT-6



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0263

DATA SHEET

AS218-321, AS218-321LF: PHEMT GaAs IC High-Power Transfer Switch 0.1–6 GHz

Applications

- WLAN 802.11a, b, g diversity

Features

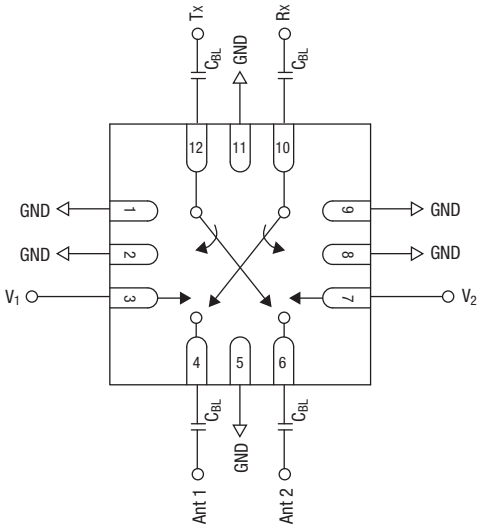
- Operating frequency 0.1–6 GHz
- Positive low voltage control (0/3 V operation)
- Low insertion loss
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 250 °C per JEDEC J-STD-020

Description

The AS218-321 is a broadband transfer switch designed to combine T/R and antenna diversity switching functions on a single IC. The device is designed to handle high power and maintain high linearity at low control voltages. This low-cost switch is ideal for Wi-Fi systems and is capable of covering both the 2.4 and 5 GHz bands.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) required on RF ports.
C_{BL} = 15 pF.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1, 4]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	Ant 1, Ant 2 to Tx, Rx	0.10–6.00 GHz		1.6	1.8	dB
		2.40–2.50 GHz		1.2	1.4	dB
		5.15–5.85 GHz		1.4	1.6	dB
Isolation	Ant 1, Ant 2 to Tx, Rx	0.10–6.00 GHz	17	19		dB
		2.40–2.50 GHz	26	28		dB
		5.15–5.85 GHz	17	19		dB
Return loss[3]	Ant 1, Ant 2 to Tx, Rx	0.10–6.00 GHz		10		dB
		2.40–2.50 GHz		15		dB
		5.15–5.85 GHz		20		dB

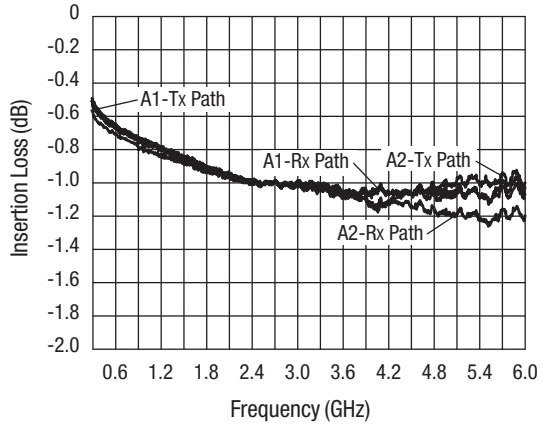
1. All measurements made in a 50 Ω system.
2. Insertion loss changes by 0.003 dB/C.
3. Return loss for insertion loss state.
4. Tx and Rx paths can be used interchangeably.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0264

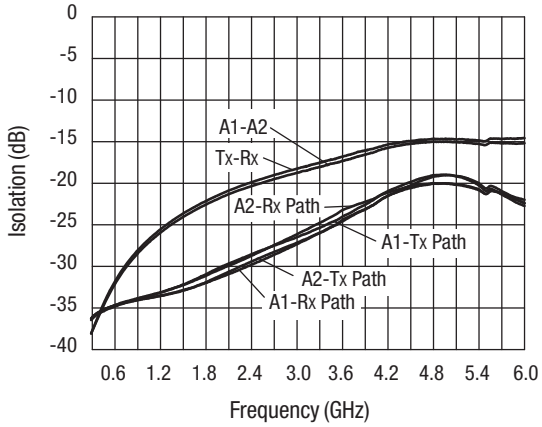
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
2nd and 3rd harmonic	23 dBm input @ 0,3 V	2–6 GHz		63		dBc
$P_{1\ dB}$		2–6 GHz		33		dBm
IIP3	20 dBm per tone 22 dBm per tone	2–3 GHz 5–6 GHz		54 47		dBm dBm
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0–0.2 V @ 20 µA max. V_{HIGH} = 3–5 V @ 200 µA max.					

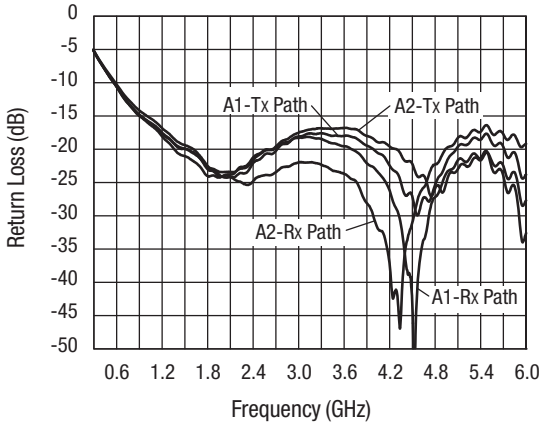
Typical Performance Data (0, +3 V)



Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

Absolute Maximum Ratings

Characteristic	Value
RF input power	35 dBm > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0265

Truth Table

V_1	V_2	Insertion Loss Path
0	1	Ant 1 to Tx, Ant 2 to Rx
1	0	Ant 2 to Tx, Ant 1 to Rx
0	0	Allowed but not recommended
1	1	Allowed but not recommended

"1" = 3 to 5 V.
"0" = 0 to 0.2 V.

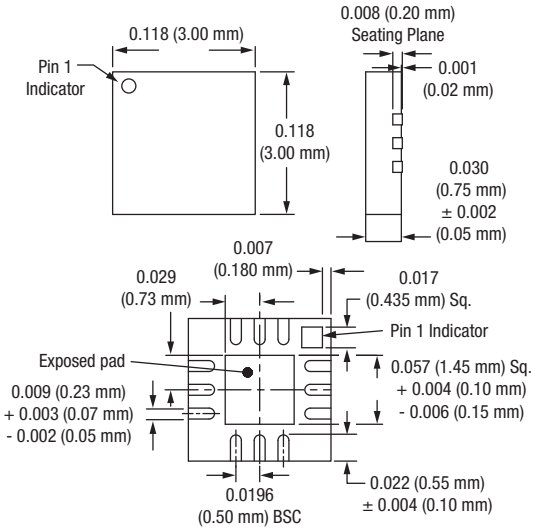
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

QFN-12



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0266

DATA SHEET

AS236-321, AS236-321LF: PHEMT GaAs IC High-Power 4-CTL DPDT Switch LF–6 GHz

Features

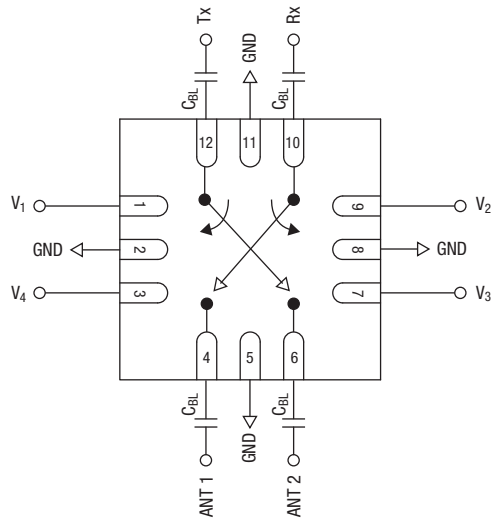
- Application 802.11a (5.2–5.8 GHz) and 802.11b, (2.4 GHz) diversity
- Operating frequency LF–6 GHz
- Positive low voltage control (0/3 V operation)
- Low insertion loss, less than 1.2 dB, LF–6 GHz
- High linearity 57 dBm IIP3
- Miniature QFN-12 plastic package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 250 °C per JEDEC J-STD-020

Description

Skyworks AS236-321 is a broadband DPDT switch designed to combine T/R and antenna diversity switching functions on a single IC. The device is designed to handle high power and maintain high linearity at low control voltages. This-low cost switch is ideal for Wi-Fi systems and is capable of covering both the 2.4 GHz and 5 GHz bands.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



DC blocking caps (C_{BL}) must be supplied externally.
C_{BL} = 15 pF for operation > 2 GHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1, 4]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	Between any pair of ports	2.4–2.5 GHz 5.0–6.0 GHz		0.95 1.15	1.1 1.3	dB dB
Isolation	A1–Tx, A2–Rx, A2–Tx, or A1–Rx	2.4–2.5 GHz 5.0–6.0 GHz	20 13	22 15		dB dB
	A1–A2 or Tx–Rx	2.4–2.5 GHz 5.0–6.0 GHz	20 15	22 17		dB dB
Return loss[3]		2.4–2.5 GHz 5.0–6.0 GHz		24 18		dB dB

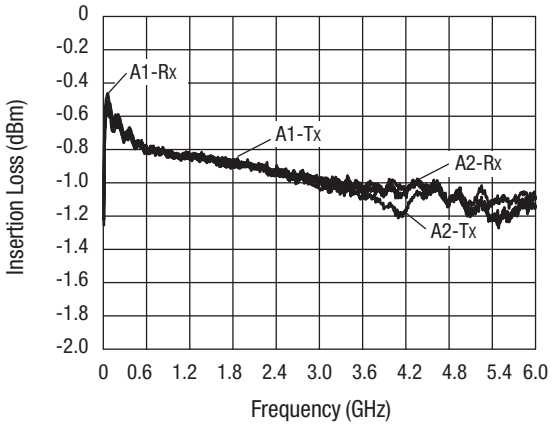
1. All measurements made in a 50 Ω system.
2. Insertion loss changes by 0.003 dB/C.
3. Return loss for insertion loss state.
4. Tx and Rx paths can be used interchangeably.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0267

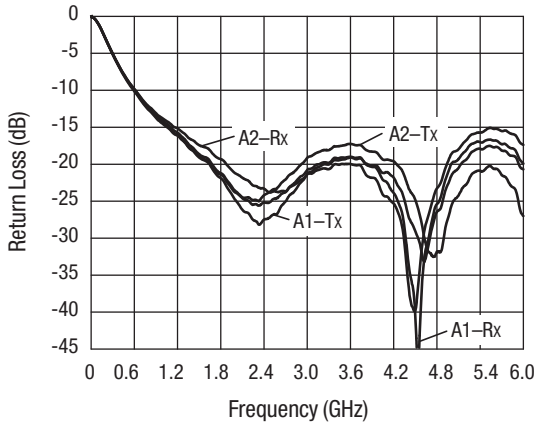
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise, fall On, off Video feedthru	 10/90% or 90/10% RF) 50% CTL to 90/10% RF)			 20 50 50		 ns ns mV
IIP3	V_{CTL} = 0/3 V	2.4 GHz 5.2 GHz		57 56		dBm dBm
	V_{CTL} = 0/5 V	2.4 GHz 5.2 GHz		60 57		dBm dBm
$P_{1\ dB}$	V_{CTL} = 0/3 V	2.4–5.875 GHz		34		dBm
Gate leakage current	V_{CTL} = 0/3 V			10	50	µA
Thermal resistance				25		°C/W
Control voltages			2.5	3	5	V

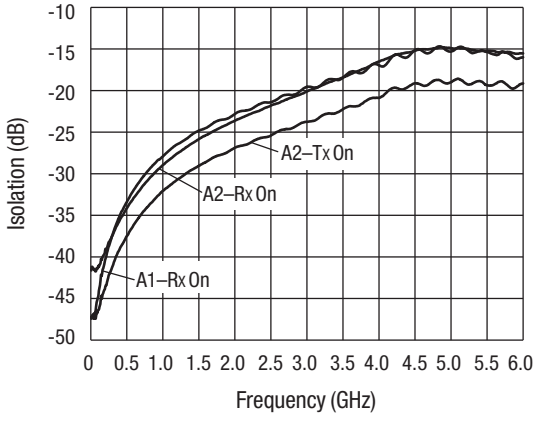
Typical Performance Data



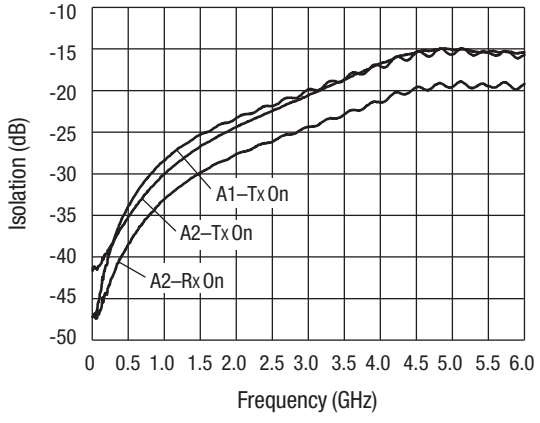
Insertion Loss vs. Frequency



Return Loss vs. Frequency

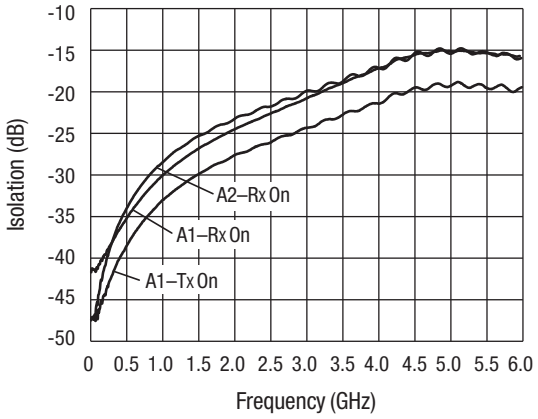


A1–Tx Path Isolation

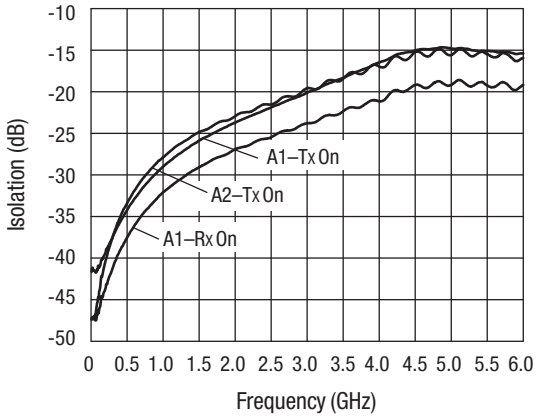


A1–Rx Isolation

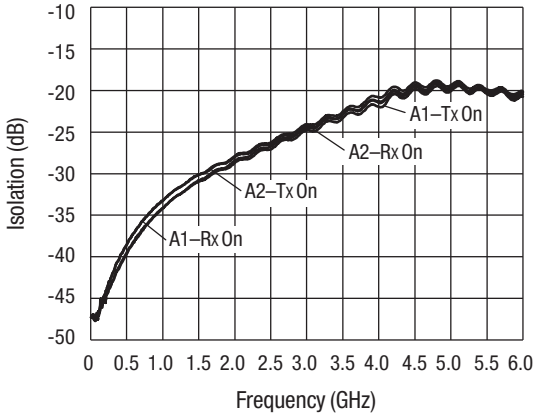
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0268



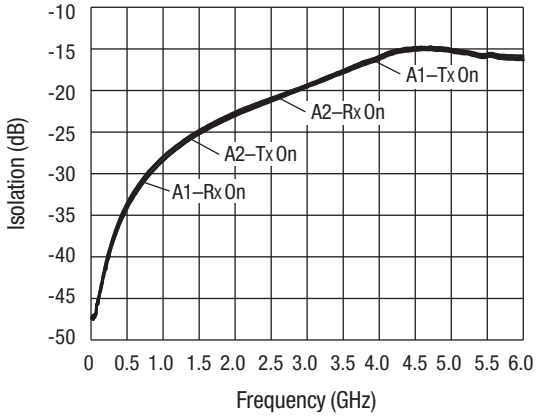
A2–Tx Isolation



A2–Rx Isolation



A1–A2 Isolation



Tx–Rx Isolation

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0269

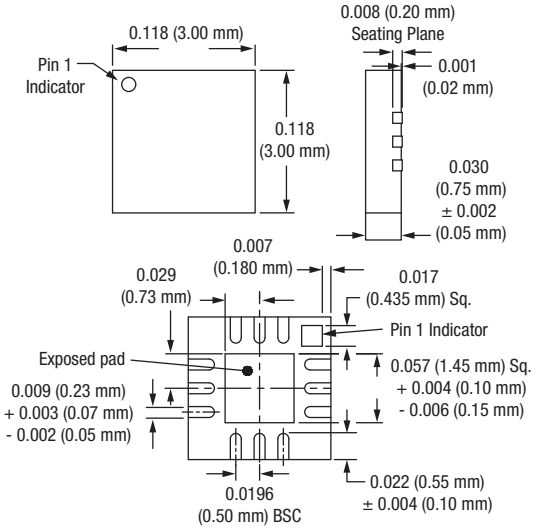
Absolute Maximum Ratings

Characteristic	Value
RF input power	35 dBm > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

QFN-12

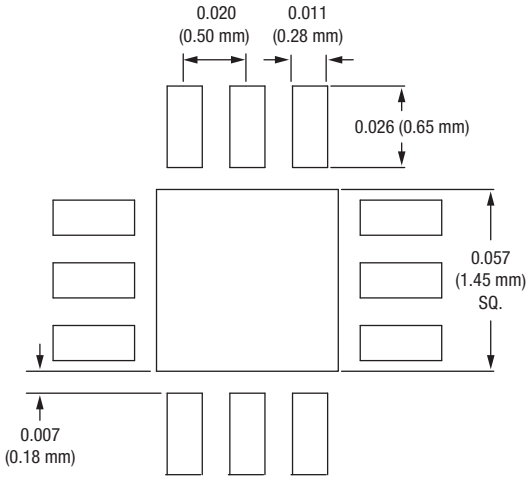


Truth Table

V_1	V_2	V_3	V_4	A1–Tx	A2–Rx	A2–Tx	A1–Rx
1	0	0	0	IL	ISO	ISO	ISO
0	1	0	0	ISO	IL	ISO	ISO
0	0	1	0	ISO	ISO	IL	ISO
0	0	0	1	ISO	ISO	ISO	IL

All other conditions not recommended.

Solder Land Pattern



Dimensions in inches (mm).

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0270

DATA SHEET

SKY13267-321, SKY13267-321LF
GaAs T/R Diversity Switch LF–6 GHz

Applications

- 802.11a/b/g transmit/receive diversity switch

Features

- Broadband: LF–6 GHz
- Very low insertion loss: 0.8 dB typ. @ 5.2 GHz
- $P_{1\ dB}$: +30 dBm typical @ 3 V
- Low distortion: IP3 44 dBm typical @ 3 V
- Low current consumption: < 15 µA @ 3 V
- Miniature QFN-12 package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13267-321 is a monolithic DPDT switch fabricated using Skyworks proprietary GaAs PHEMTs as the switching elements. This wideband switch operates with RF signals from LF–6 GHz. The RF signal paths within the SKY13267-321 are fully bilateral.

Switching is controlled via two control voltage inputs, which are compatible with CMOS logic levels. Depending upon the logic voltage level applied to the control voltage pins, the Tx input pin is connected to one of two antenna ports (ANT1 or ANT2) via a low insertion loss path, while the path between the Rx pin is connected to the other antenna port. When the control voltages are toggled, the connections between the Tx input and Rx output pins and the antenna ports are toggled as well.

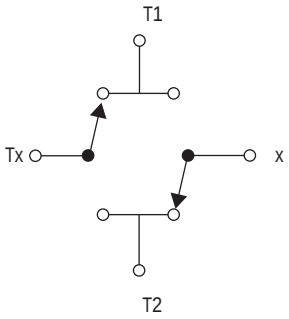
DC power consumption is very low, 15 µA maximum with control voltage of 5 V. The switch can operate over the temperature range of -40 °C to +85 °C.

This part is available in a lead (Pb)-free and RoHs-compliant package as part number SKY13267-321LF.

An evaluation board is available upon request.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Block Diagram



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0271

Electrical Specifications

V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	ANT1, ANT2 to Tx, Rx ports	2.400–2.500 GHz 5.150–5.350 GHz 5.725–5.825 GHz		0.7 0.8 0.9	1.0 1.1 1.2	dB dB dB
Isolation	ANT1, ANT2 to Tx, Rx ports	2.400–2.500 GHz 5.150–5.350 GHz 5.725–5.825 GHz	30 23 21	32 25 23		dB dB dB
	ANT1 to ANT2, Tx to Rx ports	2.400–2.500 GHz 5.150–5.350 GHz 5.725–5.825 GHz		23 20 20		dB dB dB
Return loss	ANT1, ANT2 to Tx, Rx ports	2.400–2.500 GHz 5.150–5.350 GHz 5.725–5.825 GHz		22 19 17		dB dB dB

Operating Characteristics

V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise, fall On, off Video feedthru	 10/90% or 90/10% RF 50% V_{CTL} to 90/10% RF T_{RISE} = 1 ns, BW = 500 MHz			 20 40 50		 ns ns mV
Error vector magnitude	802.11a, OFDM, 64 QAM, 54 MBPS, $P_{IN} \leq$ 27 dBm	5.8 GHz		≤1		%
Input third order intermodulation intercept	For two input tones. 15 dBm each tone, 5 MHz spacing, V_{HIGH} = 3 V	2.4 GHz 5.2 GHz		49 44		dBm dBm
Thermal resistance				25		°C/W
Control voltage	V_{LOW} = 0 V @ 10 µA max. V_{HIGH} = 3 V to 5 V @ 15 µA max.					

Absolute Maximum Ratings

Characteristic	Value
Control voltage range	$-0.2 \leq V_C \leq 8$ V
RF input power @ 0/3V RF input power @ 0/5V	32 dBm 34 dBm
Storage temperature range	-65 °C to +150 °C
Operating temperature range	-40 °C to +85 °C
Electrostatic discharge (ESD) - Human Body Model (HBM)	Class 0

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

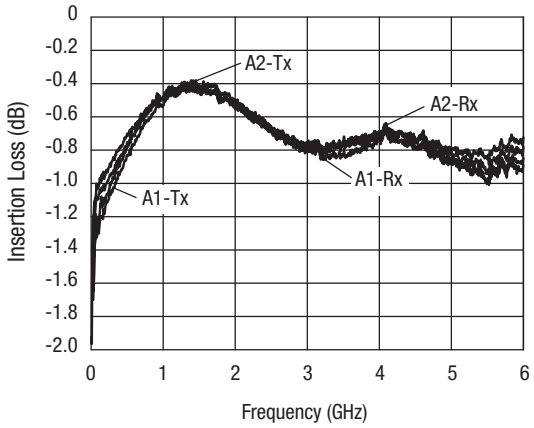
Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

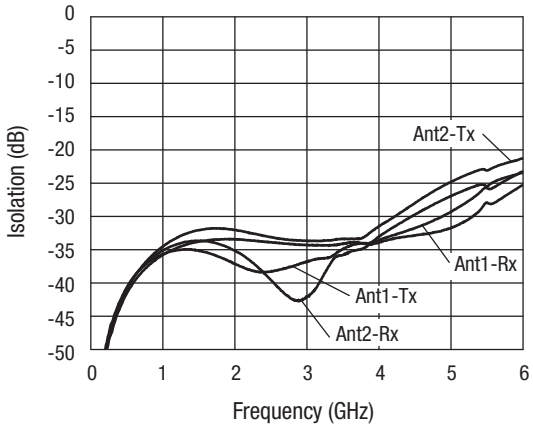
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0272

Typical Performance Data

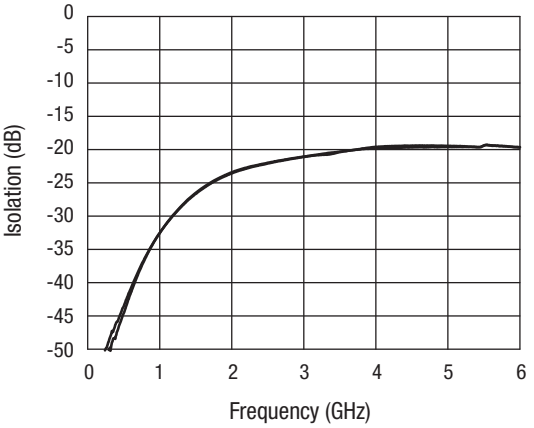
V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_O = 50 Ω, unless otherwise noted



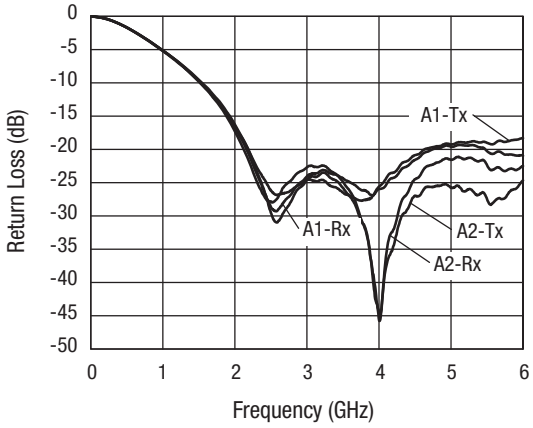
Insertion Loss vs. Frequency



Isolation vs. Frequency



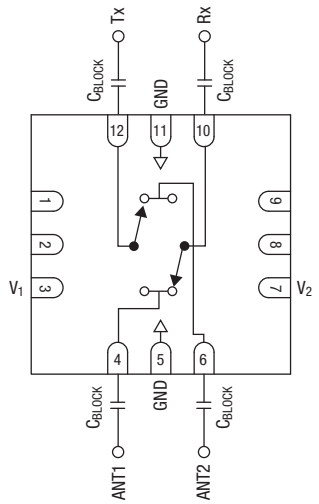
Isolation / nt nt vs. Frequency



Return Loss vs. Frequency

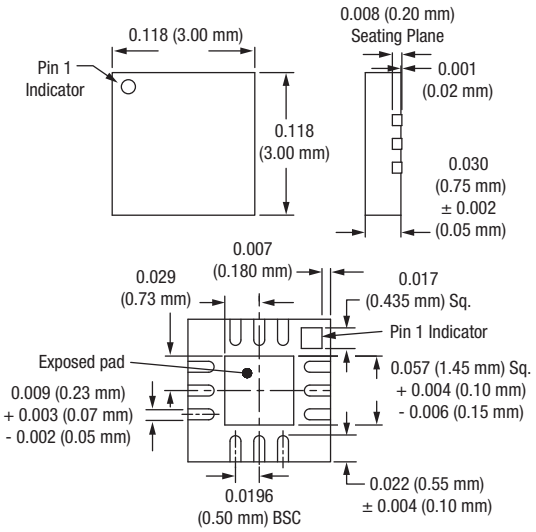
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0273

Pin Out Top View



C_{BLOCK} = 4.7 pF

QFN-12 Package Outline



Truth Table

V_1	V_2	Low Insertion Loss Paths
V_{LOW}	V_{HIGH}	ANT1 - Tx, ANT2 - Rx
V_{HIGH}	V_{LOW}	ANT2 - Tx, ANT1 - Rx
V_{LOW}	V_{LOW}	Not allowed
V_{HIGH}	V_{HIGH}	Not allowed

V_{LOW} = 0 V to 0.2 V.
V_{HIGH} = 3 V to 5 V.

Pin Descriptions

Pin Number	Pin Name	Description
1, 2, 8, 9		Not connected
3	V_1	Control voltage 1 – Control voltage input #1. The logic level voltage applied to this pin, along with the level voltage applied to pin 7, determines the states of the RF paths between the Tx, Rx, ANT1 and ANT2 ports
4	ANT1	RF input/output – RF input/output port which is either connected via a low insertion loss path to the Tx or Rx port, according to the logic levels applied to V_1 and V_2
6	ANT2	RF input/output – RF input/output port which is either connected via a low insertion loss path to the Tx or Rx port, according to the logic levels applied to V_1 and V_2
5, 11	GND	Equipotential point - Internal circuit common, which must be connected to the pcb ground or common via the lowest possible impedance
7	V_2	Control voltage 2 – Control voltage input #2. The logic level voltage applied to this pin, along with the level voltage applied to pin 3, determines the states of the RF paths between the Tx, Rx, ANT1 and ANT2 ports
10	Rx	RF output – RF output port which is typically connected to the input of a receiver signal path
12	Tx	RF input – RF input port which is typically connected to the output of a transmitter signal path

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0274

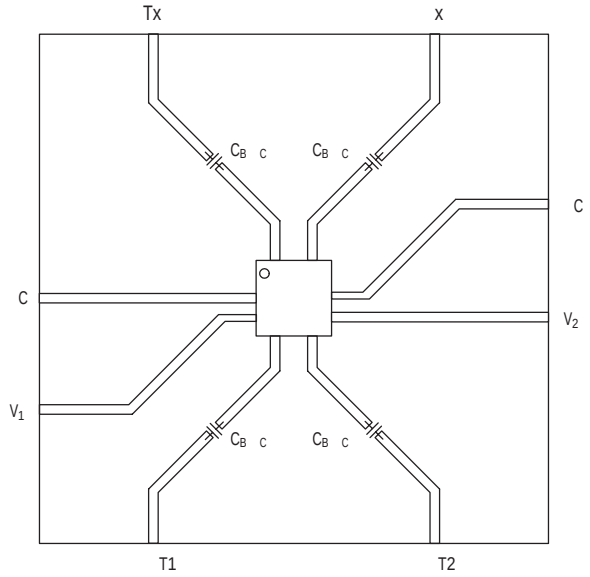
Evaluation Board

The evaluation board for SKY13267-321 allows the part to be fully exercised. Note that blocking capacitors are required on each RF port (Tx, Rx, ANT1 and ANT2).

The state of the SKY13267-321 is controlled by applying the appropriate logic level voltages to ports V_1 and V_2 (see Truth Table in this document).

Evaluation Board Components

Component	Description	Default
C_{BLOCK}	DC blocking capacitor	4.7 pF, size 0402
U1	SKY13267-321 GaAs T/R-diversity switch	
Tx, Rx, ANT1, ANT2	SMA connectors	



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0275

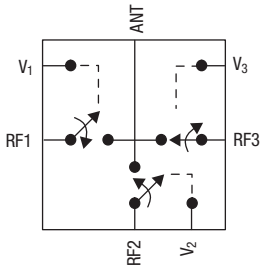
PRELIMINARY DATA SHEET

AS202-321, AS202-321LF: PHEMT GaAs IC High-Power SP3T Switch LF–2 GHz

Features

- Positive low voltage control (0/2.75 V operation)
- Low insertion loss (< 0.8 dB @ 2 GHz)
- High isolation (25 dB at 1 and 2 GHz)
- Excellent harmonics performance (-65 dBc @ 2.75 V 1 GHz, P_{IN} = 34 dBm)
- Miniature QFN-12 plastic package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Functional Block Diagram



Description

The AS202-321 is a PHEMT GaAs IC SP3T antenna switch operating in the 900 MHz and 1800 MHz frequency bands. Switching between the antenna and Tx/Rx ports is accomplished with 3 control inputs. When the control inputs are driven with the appropriate voltages, a low insertion loss path is provided from an antenna port to an Rx or Tx port, while the other ports have high attenuation.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C (0, 2.75 V)

Z_0 = 50 Ω, unless otherwise noted

Parameter		Frequency	Min.	Typ.	Max.	Unit
Insertion loss	Ant-RF1, RF2, RF3	LF–0.5 GHz		0.55	0.75	dB
		LF–1.0 GHz		0.60	0.80	dB
		LF–2.0 GHz		0.80	1.10	dB
Isolation	Ant-RF1, RF2, RF3	LF–0.5 GHz	25	28		dB
		LF–1.0 GHz	22	25		dB
		LF–2.0 GHz	22	25		dB
Return loss	Ant-RF1, RF2, RF3	LF–0.5 GHz		18		dB
		LF–1.0 GHz		18		dB
		LF–2.0 GHz		14		dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0276

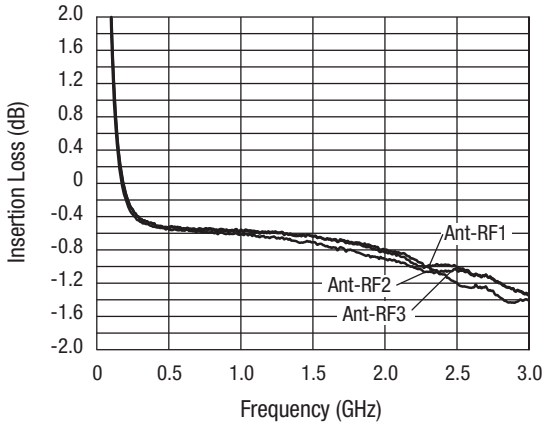
Operating Characteristics at 25 °C (0, 2.75 V)

Z_0 = 50 Ω, unless otherwise noted

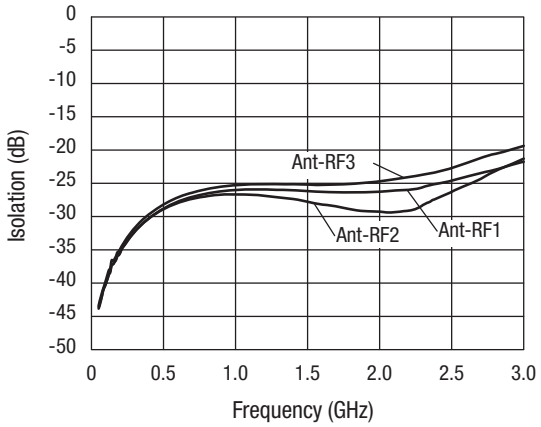
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
2nd harmonic	34 dBm In @ 2.75 V	1 GHz		-72		dBc
3rd harmonic	34 dBm In @ 2.75 V	1 GHz		-65		dBc
2nd harmonic	32 dBm In @ 2.75 V	2 GHz		-70		dBc
3rd harmonic	32 dBm In @ 2.75 V	2 GHz		-65		dBc
Gate leakage current	34 dBm In @ 2.75 V				0.03	mA
Thermal resistance				25		°C/W
Control voltages	V_{HIGH} V_{LOW}		-0.25 2.60	0 2.75	0.25 5.00	V V

Typical Performance Data (0, 2.75 V, C_{BL} = 47 pF)

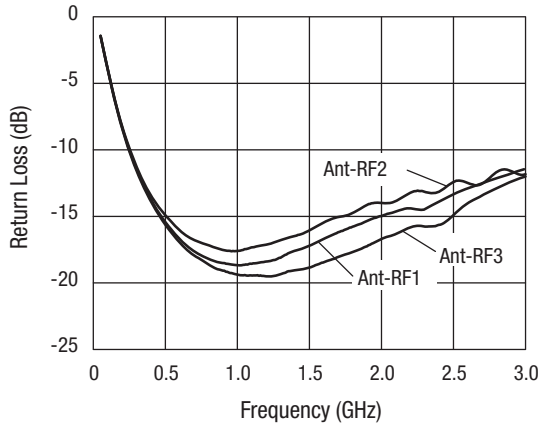
Z_0 = 50 Ω, unless otherwise noted



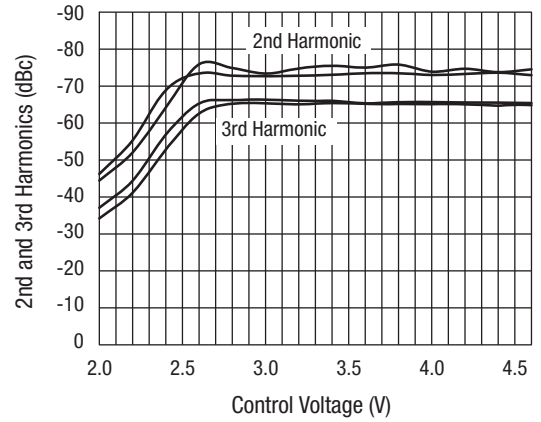
Insertion Loss vs. Frequency



Isolation vs. Frequency



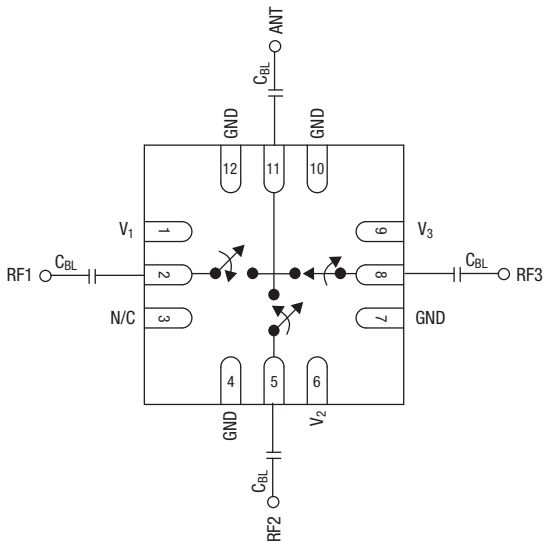
Return Loss vs. Frequency



2nd and 3rd Harmonics vs. Control Voltage

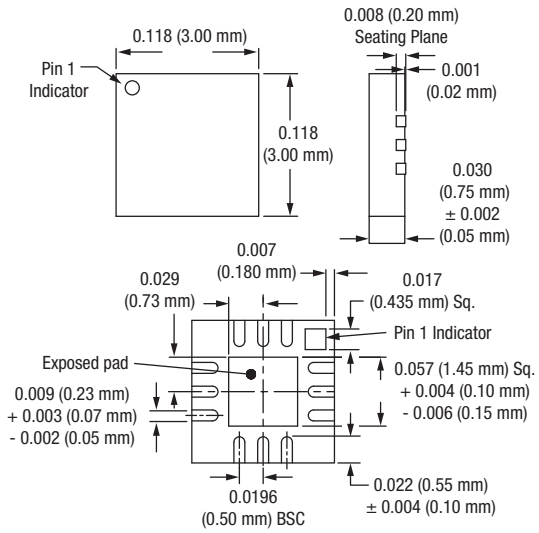
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0277

Pin Out



LF blocks required. C_{BL} = 47 pF for operation >500 MHz.

QFN-12



Truth Table

V_1	V_2	V_3	Ant-RF1	Ant-RF2	Ant-RF3
V_{HIGH}	V_{LOW}	V_{LOW}	Ins. loss	Isolation	Isolation
V_{LOW}	V_{HIGH}	V_{LOW}	Isolation	Ins. loss	Isolation
V_{LOW}	V_{LOW}	V_{HIGH}	Isolation	Isolation	Ins. loss

All other conditions not recommended.
V_{LOW} = 0–0.2 V.
V_{HIGH} = 2.75–5 V.

Absolute Maximum Ratings

Characteristic	Value
RF input power	4 W > 0.5 GHz 0/6 V control
Control voltage	6 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

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Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0278

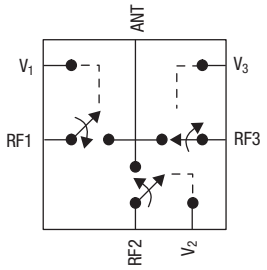
DATA SHEET

AS227-321LF: PHEMT GaAs IC High-Power SP3T Switch 300 kHz–2 GHz

Features

- Positive low voltage control (0/2.75 V operation)
- Low insertion loss (0.5 dB typ. @ 1 GHz)
- High isolation (26 dB typ. @ 1 GHz)
- Excellent IIP3 (63 dBm @ 2.75 V, 27 dBm/tone)
- Miniature QFN-12 plastic package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Functional Block Diagram



Description

The AS227-321LF is a PHEMT GaAs IC SP3T antenna switch operating in the 900 MHz and 1800 MHz frequency bands. Switching between the antenna and Tx/Rx ports is accomplished with 3 control inputs. When the control inputs are driven with the appropriate voltages, a low insertion loss path is provided from an antenna port to an Rx or Tx port, while the other ports have high attenuation.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 °C

V_{CTL} = 0/2.75 V, Z_0 = 50 Ω, unless otherwise noted

Parameter		Frequency	Min.	Typ.	Max.	Unit
Insertion loss	Ant-RF1, RF2, RF3	300 kHz–0.5 GHz		0.45	0.6	dB
		300 kHz–1.0 GHz		0.50	0.7	dB
		300 kHz–2.0 GHz		0.70	0.9	dB
Isolation	Ant-RF1, RF2, RF3	300 kHz–0.5 GHz	30	32		dB
		300 kHz–1.0 GHz	24	26		dB
		300 kHz–2.0 GHz	18	20		dB
Return loss	Ant-RF1, RF2, RF3	300 kHz–0.5 GHz		18		dB
		300 kHz–1.0 GHz		18		dB
		300 kHz–2.0 GHz		14		dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0279

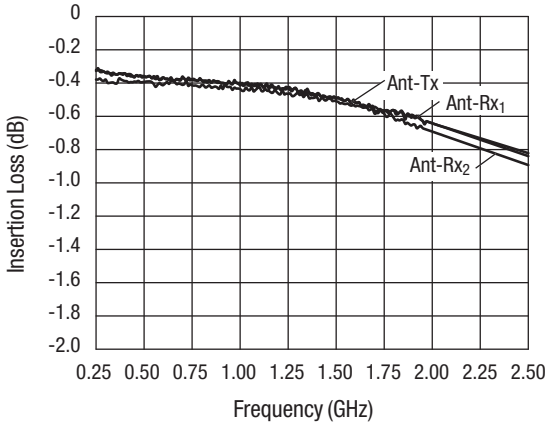
Operating Characteristics at 25 °C

V_{CTL} = 0/2.75 V, Z_0 = 50 Ω, unless otherwise noted

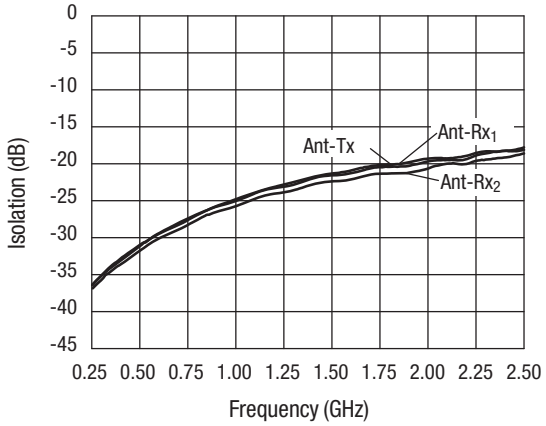
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Input Third Order Intercept (IIP3)	P_{IN} = 27 dBm, each tone	824/869 MHz		63		dBm
2nd/3rd harmonic	P_{IN} = 34.5 dBm	900 MHz		-65		dBc
Gate leakage current	P_{IN} = 34 dBm, V_{CTL} = 2.75 V			50		µA
Thermal resistance				25		°C/W
Control voltages	V_{LOW} V_{HIGH}		-0.25 2.60	0 2.75	0.25 5.00	V V

Typical Performance Data

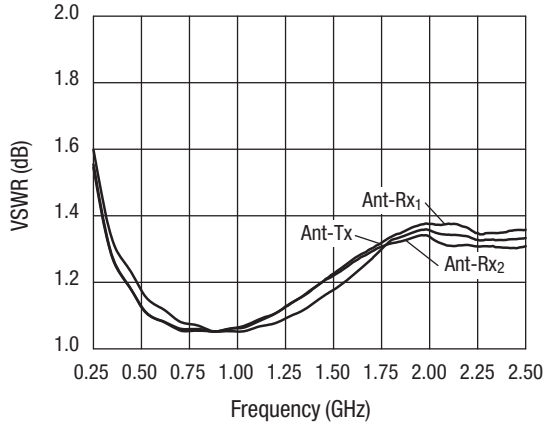
T_A = 25 °C, V_{CTL} = 0/2.75 V, Z_0 = 50 Ω, unless otherwise noted



Insertion Loss vs. Frequency



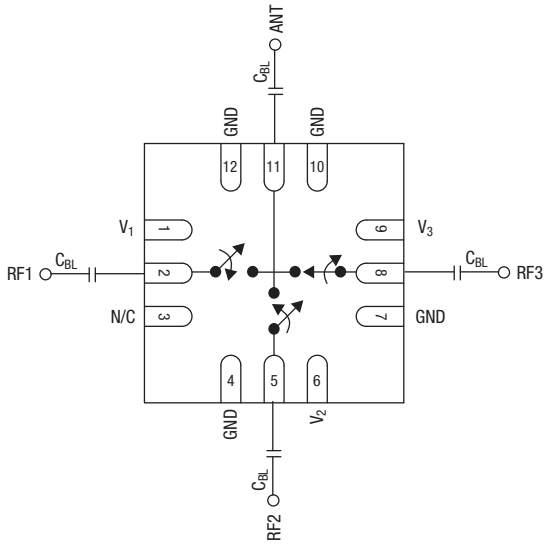
Isolation vs. Frequency



VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0280

Pin Out (Top View)



DC blocks required. C_{BL} = 47 pF for operation >500 MHz.

Absolute Maximum Ratings

Characteristic	Value
RF input power	4 W > 0.5 GHz 0/6 V control
Control voltage	6 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

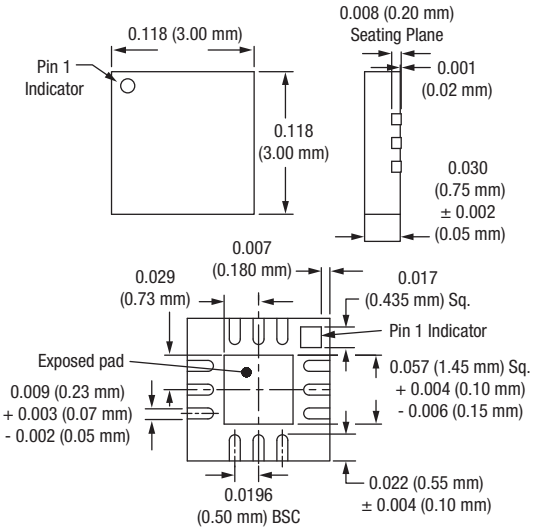
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Truth Table

V_1	V_2	V_3	Ant-RF1	Ant-RF2	Ant-RF3
V_{HIGH}	V_{LOW}	V_{LOW}	Ins. loss	Isolation	Isolation
V_{Low}	V_{HIGH}	V_{LOW}	Isolation	Ins. loss	Isolation
V_{LOW}	V_{LOW}	V_{HIGH}	Isolation	Isolation	Ins. loss

All other conditions not recommended.
V_{LOW} = 0–0.2 V.
V_{HIGH} = 2.75–5 V.

QFN-12



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0281

DATA SHEET

SKY13277-355LF: GaAs SP3T Absorptive Switch 500 MHz–2.5 GHz

Features

- Positive voltage control (0/3 V typ.)
- High isolation 62 dB at 1 GHz
- Integrated silicon CMOS driver
- Isolated ports are absorptive
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260°C per JEDEC J-STD-020

Description

The SKY13277-355LF is a pHEMT GaAs FET IC high isolation absorptive single-pole 3-throw switch packaged in a 20-lead exposed-pad plastic package for low-cost commercial applications. This switch controls signals from 500 MHz to 2.5 GHz. The switch is ideal for cellular base station switch matrices and other applications that require good RF impedance match independent of switch state.

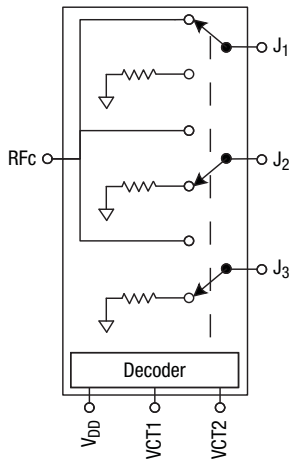
The SKY13277-355LF comprises a pHEMT switch die and a Si CMOS controller die. The switch die contains integral terminating resistors that present an absorptive load to the external circuit when the switch path is in its isolation state. The controller die has three inputs: supply voltage (V_{DD}) and two logic control bits that select the state of the pHEMT switch die. External DC block capacitors are required on all RF ports.

The SKY13277-355LF operates from -40 °C to 85 °C.

A populated evaluation board is available.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Diagram



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0282

Electrical Specifications at 25 °C

V_{DD} = 5 V, V_{CTL} = 0/5 V, T = 25 C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.5–1.0 GHz 1.0–2.0 GHz 2.0–2.5 GHz		0.9 1.1 1.3	1.1 1.3 1.5	dB dB dB
Isolation	0.5–1.0 GHz 1.0–2.0 GHz 2.0–2.5 GHz	60 53 49	62 57 55		dB dB dB
Return loss insertion loss state	0.5–1.0 GHz 1.0–2.0 GHz 2.0–2.5 GHz	11 9 8	15 12 11		dB dB dB
Return loss isolation state	0.5–1.0 GHz 1.0–2.0 GHz 2.0–2.5 GHz	11 10 8	15 14 13		dB dB dB

Operating Characteristics at 25 °C

V_{DD} = 5 V, V_{CTL} = 0/5 V, T = 25 C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, unless otherwise noted

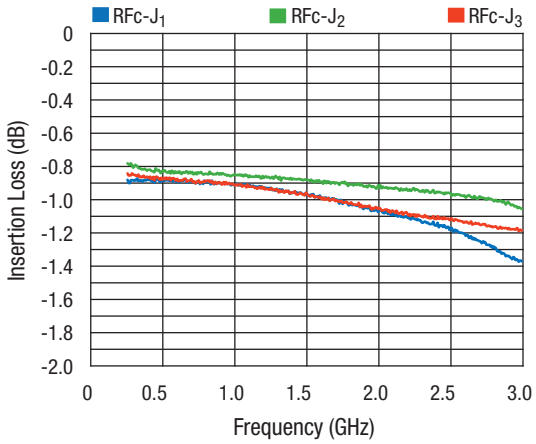
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise/fall time On/off time	 10/90% or 90/10% RF 50% V_{CTL} to 90/10% RF			 5 15		 ns ns
Input power for 1 dB compression	V_{DD} = 5 V	0.5–2.5 GHz		30		dBm
Intermodulation Intercept Point (IP3)	For two tone input power 13 dBm/tone 1 MHz spacing, V_{DD} = 5 V	0.5–2.5 GHz		43		dBm
Control voltages	V_{CTLLOW} $V_{CTLHIGH}$		0 2.4		0.5 V_{DD}	V V
Control port current	V_{CTLLOW}, $V_{CTLHIGH}$			5		µA
Supply voltage (V_{DD})			2.75		5.5	V
Supply current (I_{DD})	V_{DD} = 3 V			50		µA

1. V_{DD} must be powered on prior to a V_{CTL} high signal. A latch up condition may occur if a logic high signal is applied prior to the V_{DD} voltage.
2. Control voltages switch the V_{DD} voltage to the GaAs switch.

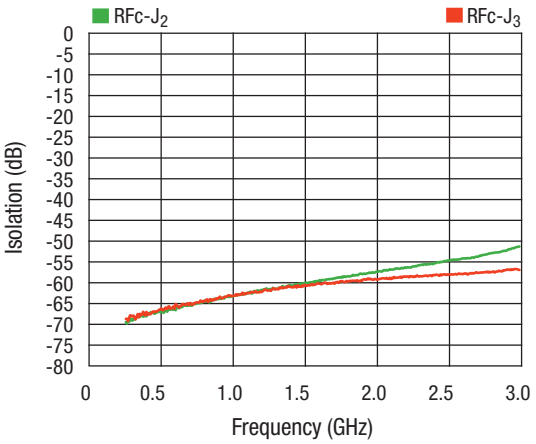
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0283

Typical Performance Data

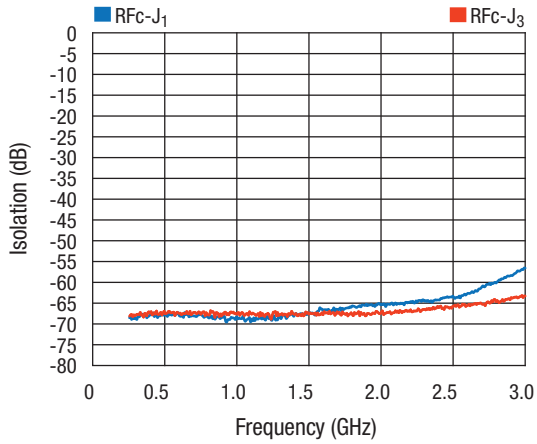
V_{DD} = 5 V, V_{CTL} = 0/5 V, T = 25 C, P_{INPUT} = 0 dBm, C_{BLOCK} = 47 pF, Z_0 = 50 Ω, unless otherwise noted



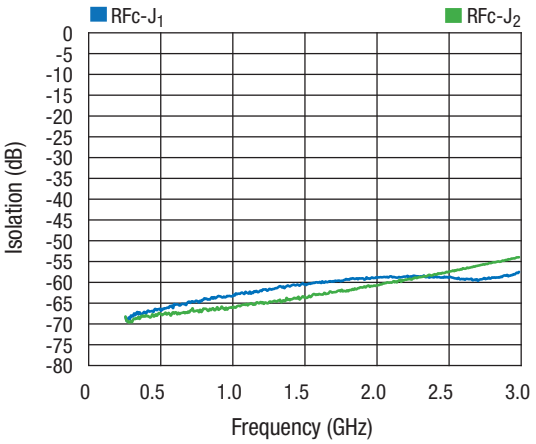
Typical Insertion Loss



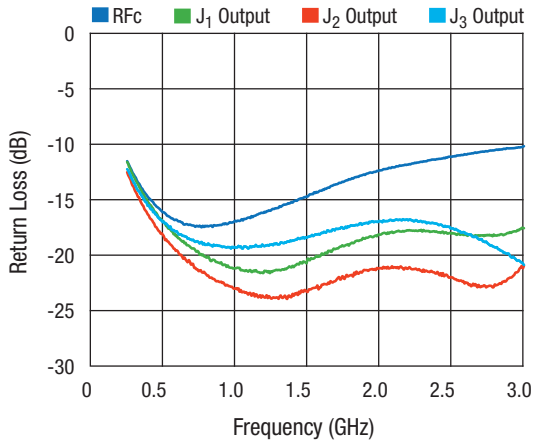
Typical Isolation RFc-J_1 Ins. state



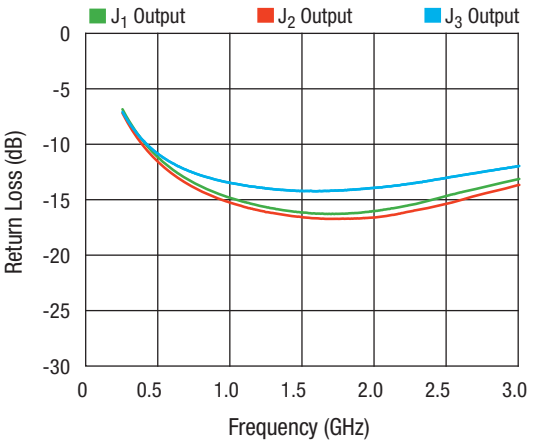
Typical Isolation RFc-J_2 Ins. state



Typical Isolation RFc-J_3 Ins. state



Typical Return Loss Ins. State



Typical Return Loss Isolation States

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0284

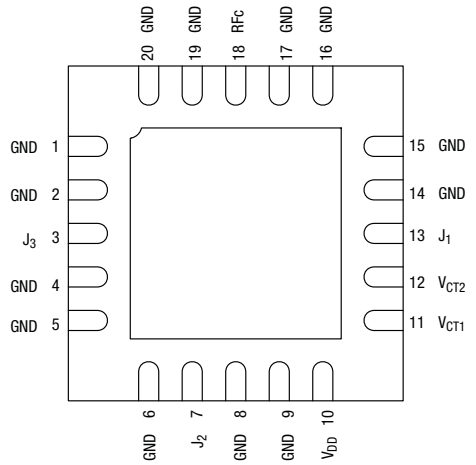
Absolute Maximum Ratings

Characteristic	Value
RF input power @ 5.5 V	32 dBm, f > 500 MHz
V_{DD} voltage range	$2.75 \leq V_{DD} \leq 5.5$ V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum ratings. Exceeding any of the absolute maximum/minimum ratings may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Pin Out (Top View)



DC blocks are required on RFc, J_1, J_2, J_3.

Truth Table

VCT1	VCT2	RFC to J_1	RFC to J_2	RFC to J_3
0	0	Insertion loss	Isolation	Isolation
1	0	Isolation	Insertion loss	Isolation
0	1	Isolation	Isolation	Insertion loss
1	1	Undefined	Undefined	Undefined

"0" = 0 to 0.5 V.
"1" = 2.4 to V_{DD}.
V_{DD} = 2.75 to 5.5 V.

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

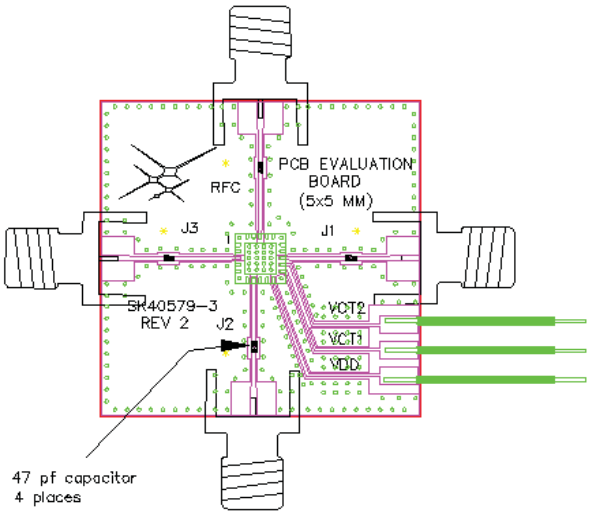
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Pin Descriptions

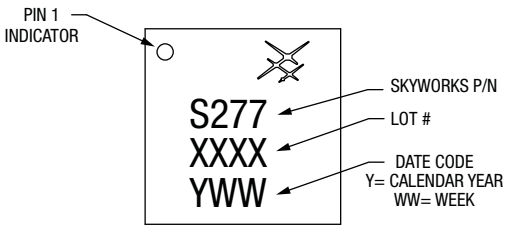
Pin Number	Pin Name	Description
1, 2, 4, 5, 6, 8, 9, 14-17, 19, 20	Gnd	Ground
3	J_3	RF port, must be DC blocked
7	J_2	RF port, must be DC blocked
10	V_{DD}	DC bias for decoder
11	V_{CT1}	DC logic pin
12	V_{CT2}	DC logic pin
13	J_1	RF port, must be DC blocked
18	RFc	RF common port, must be DC blocked
Exposed Paddle	Paddle	Ground

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0285

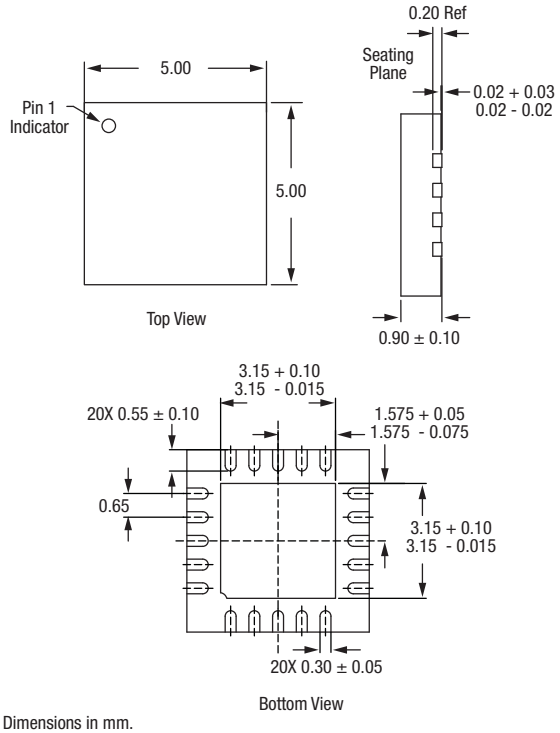
Evaluation Board



Part Marking



QFN-20 (5 x 5 mm)



Dimensions in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0286

DATA SHEET

AS219-321, AS219-321LF: PHEMT GaAs IC High-Linearity 3 V T/R SP3T Switch 0.1–2.5 GHz

Features

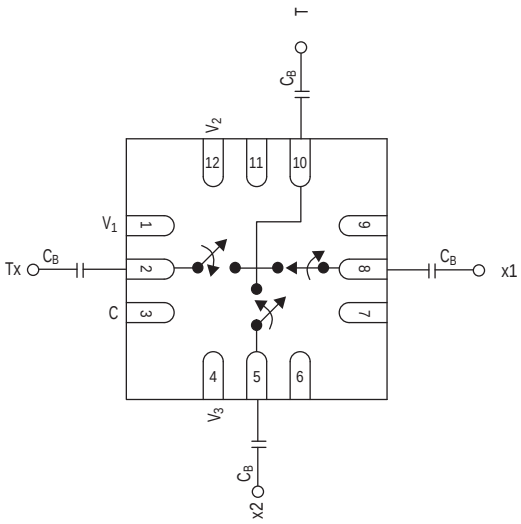
- 2.6 to 5 V linear operation
- Harmonics H_2, H_3 < -70 dBc @ P_{IN} = 34.5 dBm
- Low Tx insertion loss (0.35 dB @ 0.9 GHz)
- High Rx isolation (25 dB @ 0.9 GHz)
- Miniature QFN-12 plastic package
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS219-321 is a PHEMT GaAs IC SP3T antenna switch operating in the 900 MHz and 1800 MHz frequency bands. Switching between the antenna and Tx/Rx ports is accomplished with three control inputs. When the control inputs are driven with the appropriate voltages, a low insertion loss path is provided from an antenna port to a Tx port, while the other Rx ports have high attenuation.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out (Top View)



DC blocking capacitors (C_{BL}) must be supplied externally for positive voltage operation. C_{BL} = 47 pF for operation >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Parameter[1]	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	Ant-Rx	0.1–1.0 GHz		0.5	0.75	dB
		1.0–2.0 GHz		0.7	0.80	dB
		2.0–2.5 GHz		0.8	1.10	dB
	Ant-Tx	0.1–1.0 GHz		0.35	0.40	dB
		1.0–2.0 GHz		0.50	0.55	dB
		2.0–2.5 GHz		0.65	0.70	dB
Isolation	Ant-Rx	0.1–1.0 GHz	24	26		dB
		1.0–2.0 GHz	20	25		dB
		2.0–2.5 GHz	20	24		dB
	Ant-Tx	0.1–1.0 GHz	20	23		dB
		1.0–2.0 GHz	14	16		dB
		2.0–2.5 GHz	10	14		dB
VSWR[3]		0.1–2.5 GHz		1.1:1		dB

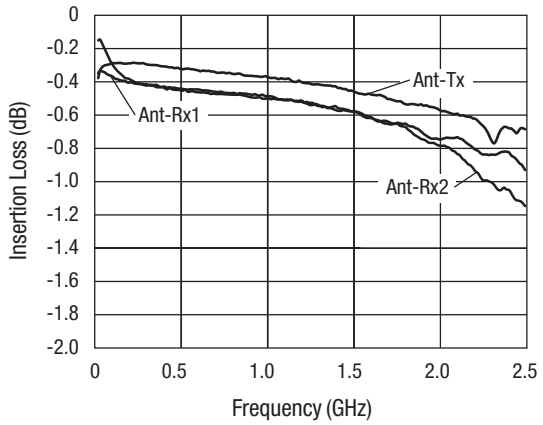
1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Insertion loss state.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0287

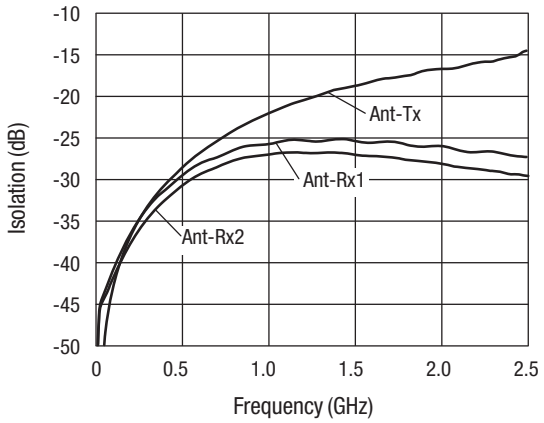
Operating Characteristics at 25 °C (0, 3 V)

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			60		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for -0.1 dB compression	0/3 V	0.9 GHz		35		dBm
Harmonics H_2, H_3 (transmit state)	P_{IN} = 34.5 dBm	0.9 GHz, 1.8 GHz		-70		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 to 0.2 V @ 20 µA max. V_{HIGH} = 2.7 V @ 100 µA max. to 5 V @ 200 µA max.					

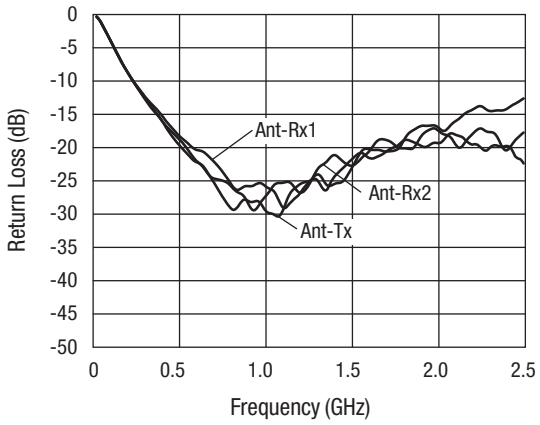
Typical Performance Data



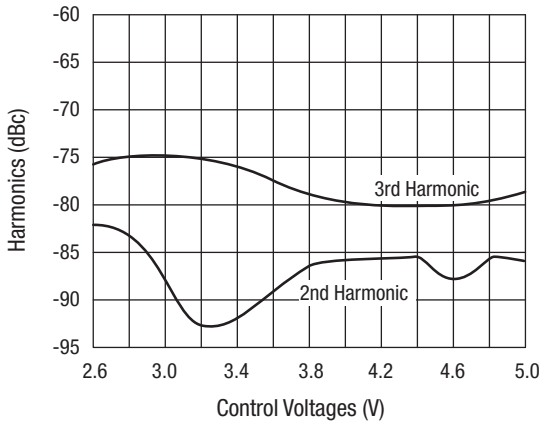
Insertion Loss vs. Frequency



Isolation vs. Frequency

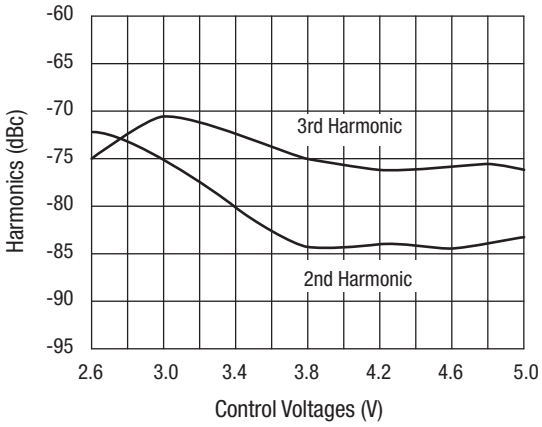


Return Loss vs. Frequency



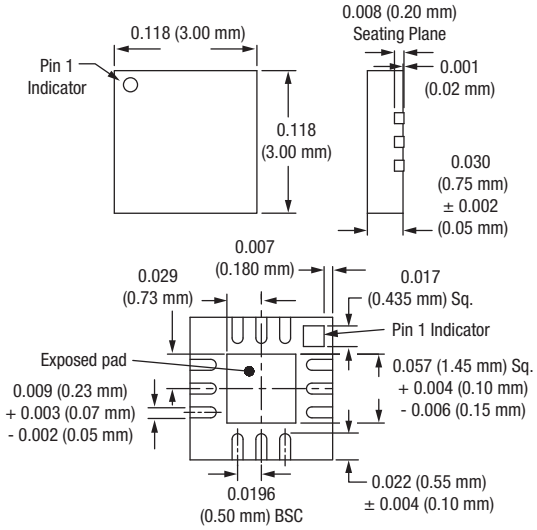
0.9 GHz Harmonics vs. Control Voltages

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0288

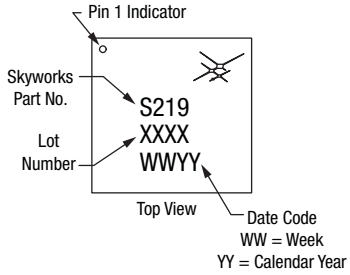


1.8 GHz Harmonics vs. Control Voltages

QFN-12



Package Marking



Truth Table

V_1	V_2	V_3	Ant-Tx	Ant-Rx1	Ant-Rx2
V_{HIGH}	V_{LOW}	V_{LOW}	Ins. loss	Isolation	Isolation
V_{LOW}	V_{HIGH}	V_{LOW}	Isolation	Ins. loss	Isolation
V_{LOW}	V_{LOW}	V_{HIGH}	Isolation	Isolation	Ins. loss

All other conditions not recommended.
V_{LOW} = 0–0.2 V.
V_{HIGH} = 2.75–5 V.

Absolute Maximum Ratings

Characteristic	Value
RF input power	6 W > 500 MHz 0/7 V control
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0289

DATA SHEET

SKY13251-349, SKY13251-349LF: SP3T Switch for Bluetooth® and 802.11b, g

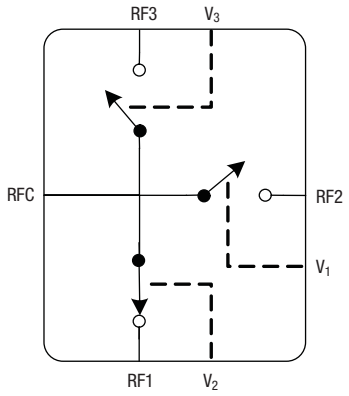
Applications

- 802.11b, g
- Bluetooth®
- Zigbee™
- TDMA/GSM/EDGE CDMA/WCDMA
- Other short-range wireless applications

Features

- Positive low voltage control (0/+2.4 V)
- Low insertion loss (<0.5 dB @ 2.5 GHz)
- High isolation RF2, RF3 paths (29 dB @ 2.5 GHz and 27 dB @ 2.5 GHz)
- Miniature QFN-8 lead exposed paddle 2 x 2 mm
- PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Simplified Block Diagram



NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Description

The SKY13251-349 is a PHEMT GaAs IC SP3T switch in a 2 x 2 mm QFN-8E package. The high isolation, low loss, small size and low cost features make this switch ideal for isolating Bluetooth® from 802.11b, g and designs that require combining TDMA, GSM, EDGE, CDMA, WCDMA with other short-range wireless applications. This switch is also available in a lead (Pb)-free package that is fully compliant with current RoHS requirements.

The SKY12351-349 employs an asymmetrical design for improved performance as a transmit-receive switch. The path between the RF common (RFC) and RF1 is optimized for low loss transmit use, while the remaining two paths, RFC to RF2 and RFC to RF3, are optimized to produce higher isolation in receiver signal paths.

A fully populated evaluation board is available.

Innovation to Go™
Now available for purchase online.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0290

Electrical Specifications at 25 ºC (0, +3 V)

Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	RFC-RF1	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz		0.35 0.40 0.45	0.40 0.50 0.60	dB dB dB
	RFC-RF2, RF3	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz		0.35 0.50 0.60	0.40 0.60 0.70	dB dB dB
Isolation	RFC-RF1	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz	22 15 12	24 18 15		dB dB dB
	RFC-RF2, RF3	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz	25 23 23	29 27 27		dB dB dB
Return loss (insertion loss state)	RFC-RF1	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz		24 25 25		dB dB dB
	RFC-RF2, RF3	LF–1.0 GHz 1.0–2.0 GHz 2.0–3.0 GHz		22 19 20		dB dB dB

LF = low frequency.
The low frequency limit is set by the value of the DC blocking capacitors used external to the part.

Operating Characteristics at 25 ºC (0, +3 V)

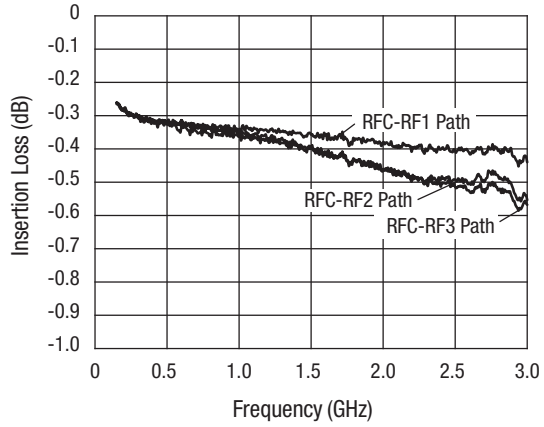
Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise	10% to 90% RF			50		ns
Fall	90% to 10% RF			25		ns
On	50% V_{CTL} to 90% RF			50		ns
Off	50% V_{CTL} to 10% RF			50		ns
Input power for -1.0 dB compression	V_{CTL} = 0/3 V	0.5–3 GHz		25		dBm
Intermodulation intercept point (IP3)	Two-tones 900 MHz, 5 MHz spacing +10 dBm each tone	0.5–3 GHz		46		dBm
Control voltages High Low			 2.3 0		 5.5 0.2	 V V
Control port input current	V_{CTL} = 3 V V_{CTL} = 0 V				100 20	µA µA

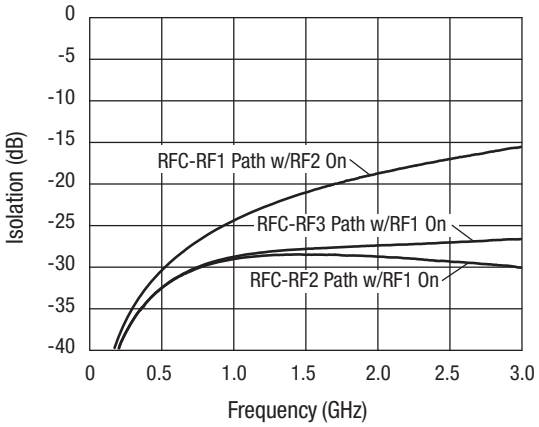
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0291

Typical Performance Data

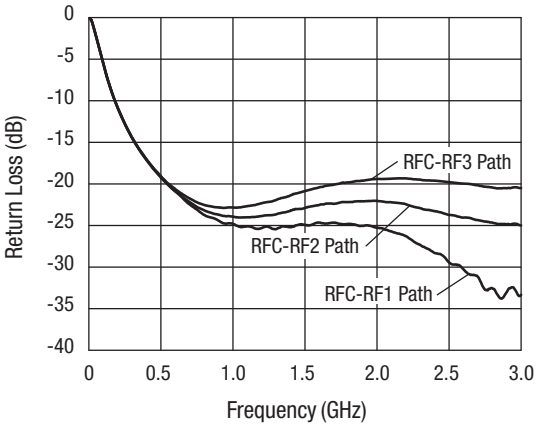
Z_0 = 50 Ω, T_A = 25 °C, unless otherwise noted



Insertion Loss vs. Frequency



Isolation vs. Frequency



Return Loss vs. Frequency

Absolute Maximum Ratings

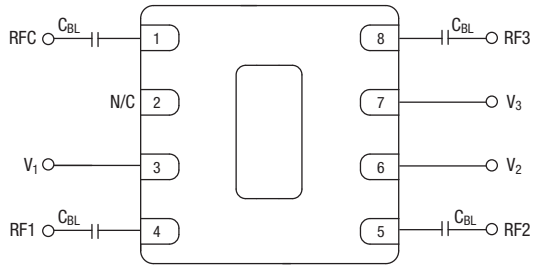
Characteristic	Value
RF input power (V_{CTL} = 0/7 V)	1 W, f > 500 MHz 0.5 W, f < 500 MHz
Control voltage	-0.2 V, +8 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C
Θ_{JC}	45 °C/W

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0292

Pin Out (Top View)



C_{BL} = 47 pF for operation >500 MHz.
Exposed paddle must be grounded.

Truth Table

V_1	V_2	V_3	RFC-RF1	RFC-RF2	RFC-RF3
1	0	0	Isolation	Insertion loss	Isolation
0	1	0	Insertion loss	Isolation	Isolation
0	0	1	Isolation	Isolation	Insertion loss

All other logic conditions put the switch in an undefined state.
"0"= 0 to 0.2 V.
"1"=2.3 to 5.5 V.

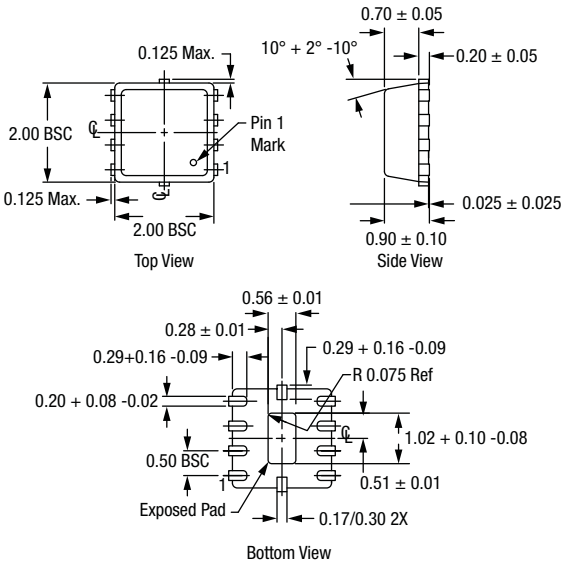
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

QFN 8E 2 x 2 (-349)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0293

DATA SHEET

SKY13296-340LF: GaAs SP4T Absorptive Switch 20 MHz–2.5 GHz

Features

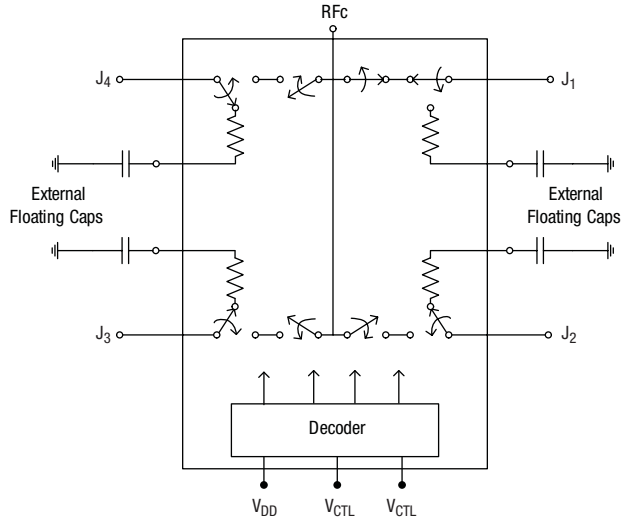
- Positive voltage control (0/3 V to 0/5 V)
- High isolation 35 dB at 1 GHz
- Integrated silicon CMOS driver
- Isolated ports are absorptive
- Use of external DC blocks to allow good return loss to low frequency
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13296-340LF is a pHEMT GaAs FET IC high isolation, absorptive single-pole four-throw switch packaged in a lead (Pb)-free, 4 x 4 mm, 20-lead exposed-pad plastic package for low-cost commercial applications. The use of external DC blocking capacitors on the RF ports and in series with the internal RF terminations enables the user to extend the range of good return loss to arbitrarily low frequency. This switch is an ideal building block for filter bank switching.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Functional Diagram



Electrical Specifications

V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, C_{BLOCK} = 1000 pF, C_{BYPASS} = 1000 pF, unless otherwise noted

Parameter	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	0.02–1.00 GHz		0.4	0.6	dB
	1.00–2.00 GHz		0.6	0.8	dB
	2.00–2.50 GHz		0.7	1.1	dB
Isolation	0.02–1.00 GHz	35	40		dB
	1.00–2.00 GHz	25	30		dB
	2.00–2.50 GHz	21	26		dB
Return loss (Insertion loss state)	0.02–1.00 GHz	12	18		dB
Lower freq. return loss is dependent on DC blocks	1.00–2.00 GHz	9	13		dB
	2.00–2.50 GHz	7	13		dB
Return loss (Isolation state)	0.02–1.00 GHz	9.5	14		dB
Lower freq. return loss is dependent on DC blocks and floating caps	1.00–2.00 GHz	8.0	11		dB
	2.00–2.50 GHz	7.0	9		dB

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0294

Operating Characteristics

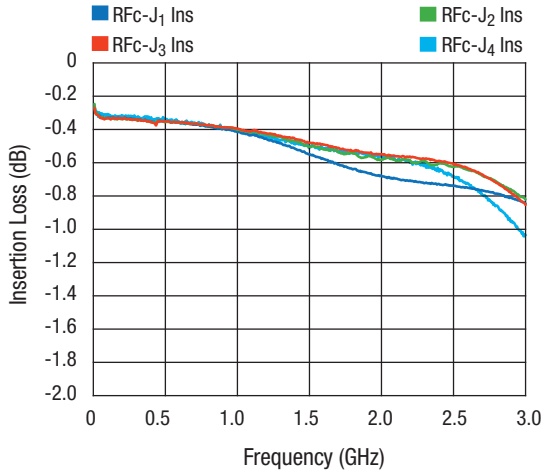
V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, C_{BLOCK} = 1000 pF, C_{BYPASS} = 1000 pF, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise/fall time On/Off time	 10/90% or 90/10% RF 50% V_{CTL} to 90/10% RF			 25 50		 ns ns
Input power for 0.1 dB compression	V_{DD} = 3 V	870 MHz	13	16		dBm
Intermodulation intercept point (IP3)	For two tone input power 8 dbm/tone 1 MHz spacing, V_{DD} = 3 V	900 MHz		40		dBm
Control voltages[1]	$V_{CTL\ LOW}$ $V_{CTL\ HIGH}$		0 2.75		0.2 V_{DD}	V V
Supply voltage (V_{DD})			3		5.5	V
Supply currents	V_{DD} = 3 V $V_{CTL\ LOW}$, $V_{CTL\ HIGH}$			5 5		uA uA

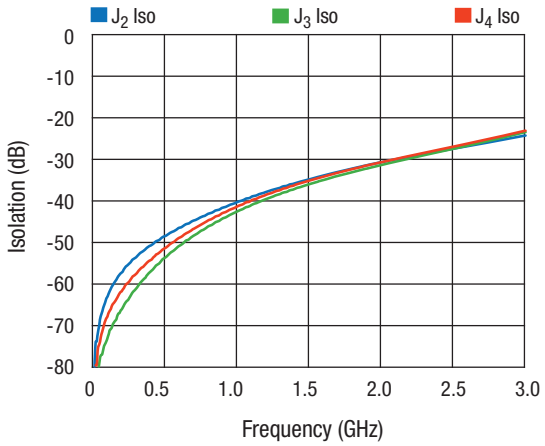
1. Control voltages switch the V_{DD} voltage to the GaAs switch.
V_{DD} must be powered on prior to a V_{CTL} high signal. A latch up condition may occur if a logic high signal is applied prior to the V_{DD} voltage.

Typical Performance Data

V_{CTL} = 0 V/3V, T = 25 °C, P_{INPUT} = 0 dBm, Z_0 = 50 Ω, C_{BLOCK} = 1000 pF, C_{BYPASS} = 1000 pF, unless otherwise noted

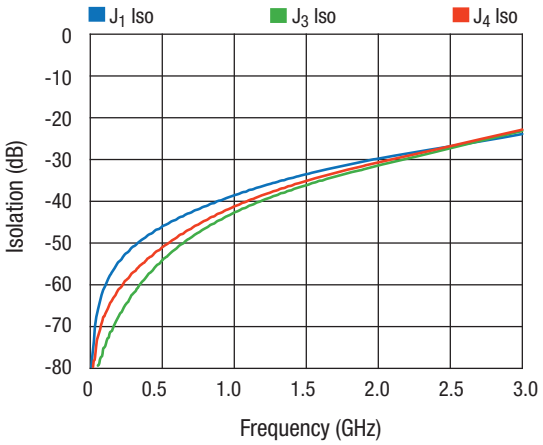


Typical Insertion Loss

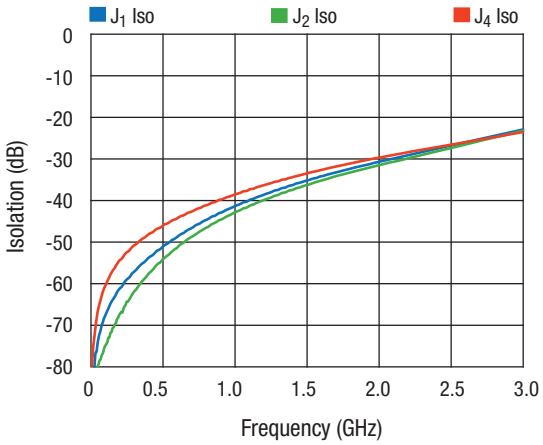


Typical Isolation RFc-J_1 Path On

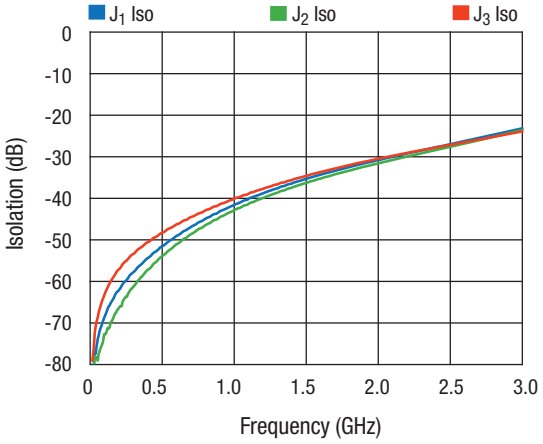
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0295



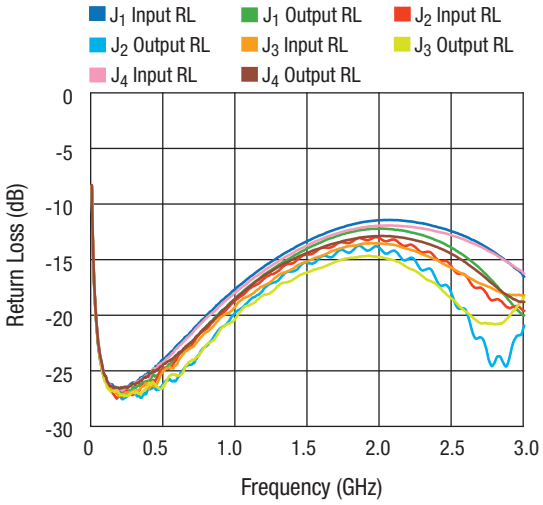
Typical Isolation RFc-J_2 Path On



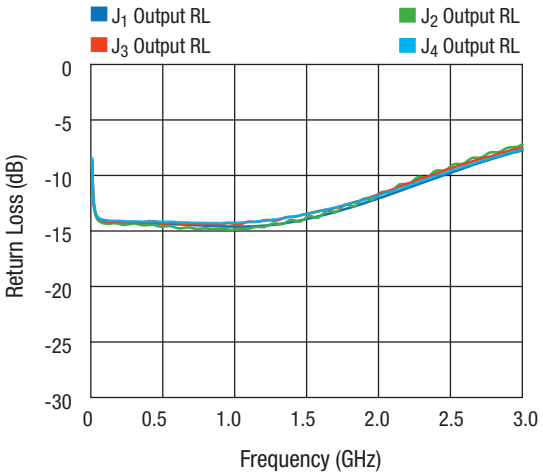
Typical Isolation RFc-J_3 Path On



Typical Isolation RFc-J_4 Path On



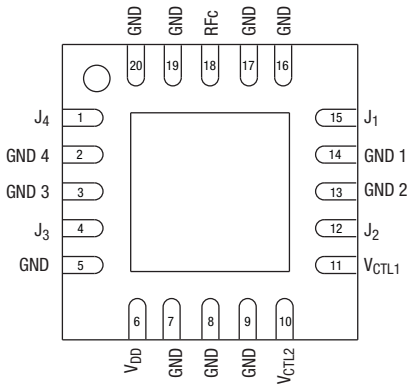
Typical Return Loss Insertion Loss States



Typical Return Loss Isolation States

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0296

Pin Out
(Top View X-ray of Pads on Bottom of Package)



DC blocks are required on RFc, J_1, J_2, J_3, J_4.
Floating caps are required on Gnd 1, Gnd 2, Gnd 3, Gnd 4.

Truth Table

V_{DD}	$V_{CTL\ 1}$	$V_{CTL\ 2}$	RFc-J_1	RFc-J_2	RFc-J_3	RFc-J_4
1	0	0	Ins. Loss	Isolation	Isolation	Isolation
1	1	0	Isolation	Ins. Loss	Isolation	Isolation
1	0	1	Isolation	Isolation	Ins. Loss	Isolation
1	1	1	Isolation	Isolation	Isolation	Ins. Loss

V_{DD} must be powered on prior to a VCTL high signal.
"0" = 0 to 0.2 V.
"1" = 2.75 to V_{DD} V.
V_{DD} = 3 V to 5 V.

Absolute Maximum Ratings

Characteristic	Value
V_{DD} voltage range	$2.75 \leq V_{DD} \leq 5.5$ V
RF input power @ 5.5 V	1 W, f > 500 MHz
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

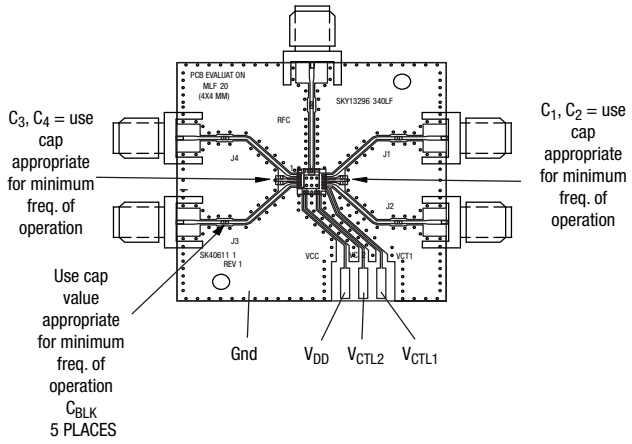
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

Pin Assignments

Pin	Symbol	Description
1	J_4	RF port. Must be DC blocked with a capacitor appropriate for lowest frequency of operation
2	GND 4	AC Ground for J_4 RF port. Must be DC blocked using a capacitor appropriate for lowest frequency of desired input return loss on J_4 port
3	GND 3	AC Ground for J_3 RF port. Must be DC blocked using a capacitor appropriate for lowest frequency of desired input return loss on J_3 port
4	J_3	RF port. Must be DC blocked with a capacitor appropriate for lowest frequency of operation
5	GND	DC Ground
6	V_{DD}	Supply voltage for decoder
7	GND	DC Ground
8	GND	DC Ground
9	GND	DC Ground
11	$V_{CTL\ 1}$	DC control voltage applied to decoder
10	$V_{CTL\ 2}$	DC control voltage applied to decoder
12	J_2	RF port. Must be DC blocked with a capacitor appropriate for lowest frequency of operation
13	GND 2	AC Ground for J_2 RF port. Must be DC blocked using a capacitor appropriate for lowest frequency of desired input return loss on J_2 port
14	GND 1	AC Ground for J_1 RF port. Must be DC blocked using a capacitor appropriate for lowest frequency of desired input return loss on J_1 port
15	J_1	RF port. Must be DC blocked with a capacitor appropriate for lowest frequency of operation
16	GND	DC Ground
17	GND	DC Ground
18	RFc	RF common port. Must be DC blocked with a capacitor appropriate for lowest frequency of operation
19	GND	DC Ground
20	GND	DC Ground
Exposed Paddle		DC Ground

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0297

Evaluation Board



C_{BLOCK} = 1000 pF for operating frequency > 20 MHz.
C_{BYPASS} C_1–C_4 = 1000 pF for operating frequency > 20 MHz.

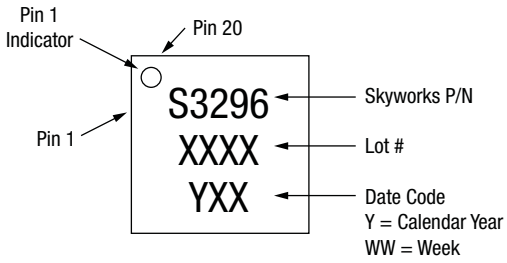
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

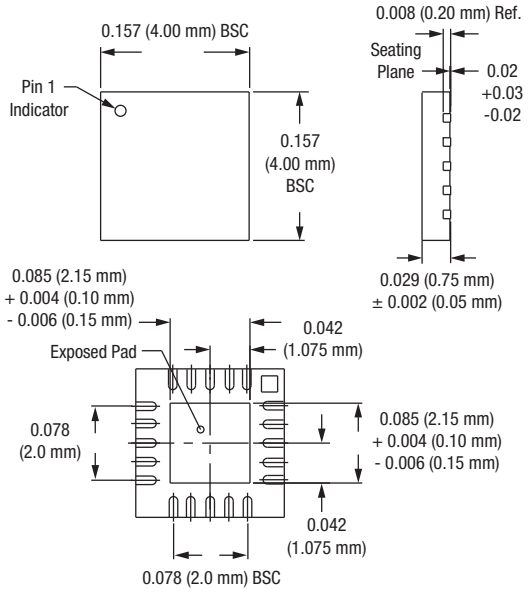
Tape and Reel Information

Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Part Marking



QFN-20 (4 x 4)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0298

DATA SHEET

AS221-306, AS221-306LF: PHEMT GaAs IC High-Power SP4T Switch 0.1–2.5 GHz

Features

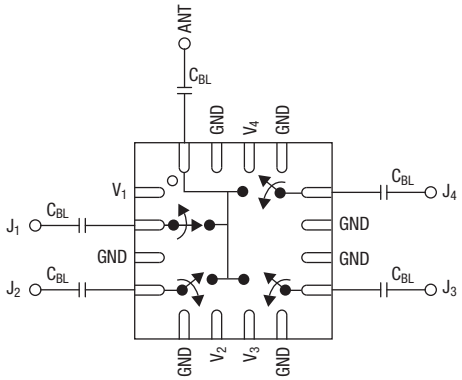
- Four symmetric RF paths
- Positive voltage control @ 2.6 V
- High IP3
- Excellent harmonic performance
- Handles GSM power Levels
- Available in QFN-16 (4 x 4 mm) package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS221-306 is a reflective SP4T switch. It is an ideal switch for higher power applications. It can be used for GSM dual-band handset applications where low loss, low current, and small size are critical parameters.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 47 pF for operating frequency >500 MHz.

Electrical Specifications at 25 °C (0, 2.6 V)

Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	Ant-J_1, J_2, J_3, J_4	0.1–0.5 GHz		0.6	0.7	dB
		0.5–1.0 GHz		0.7	0.8	dB
		1.0–2.0 GHz		0.9	1.1	dB
		2.0–2.5 GHz		1.1	1.2	dB
Isolation	Ant-J_1, J_2, J_3, J_4	0.1–0.5 GHz	30	34		dB
		0.5–1.0 GHz	25	29		dB
		1.0–2.0 GHz	19	23		dB
		2.0–2.5 GHz	18	22		dB
VSWR		0.1–1.0 GHz		1.2:1		
		1.0–2.5 GHz		1.3:1		

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0299

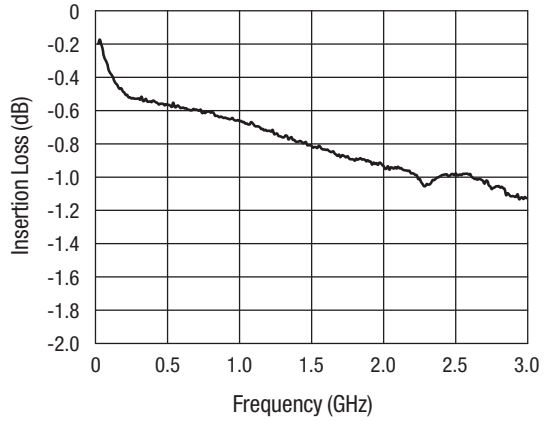
Operating Characteristics at 25 °C (0, 2.6 V)

Z_0 = 50 Ω, unless otherwise noted

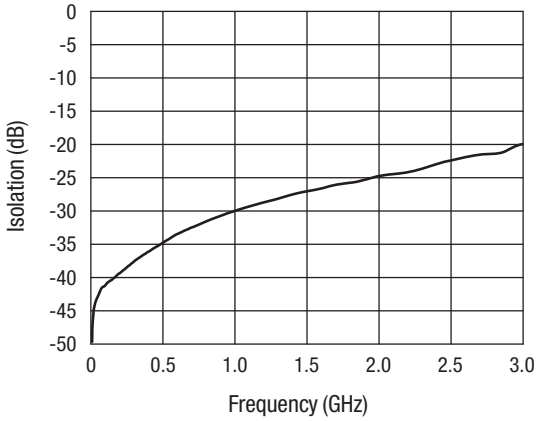
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			50		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
IP3	13 dBm/tone			55		dBm
2nd and 3rd harmonics	34 dBm input 900 MHz			-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 V_{HIGH} = 2.6 V @ 200 µA					

Typical Performance Data

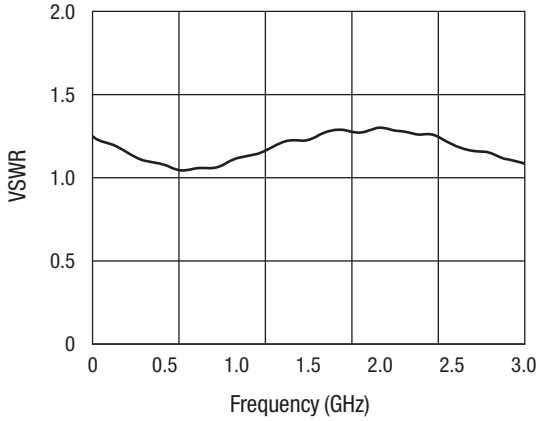
Z_0 = 50 Ω, unless otherwise noted



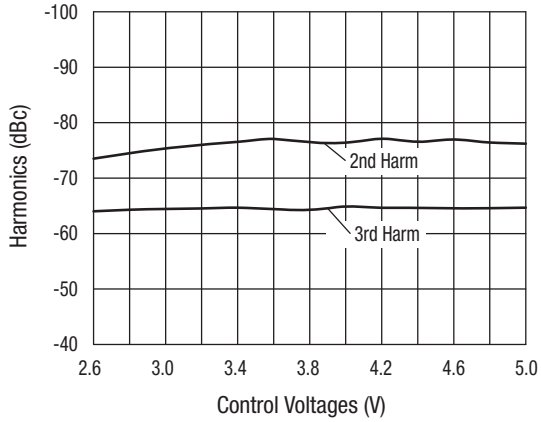
Typical Insertion Loss vs. Frequency



Typical Isolation vs. Frequency



Typical VSWR vs. Frequency



Typical Harmonics vs. Control Voltages

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0300

Absolute Maximum Ratings

Characteristic	Value
RF input power	4 W > 0.5 GHz 0/6 V control
Control voltage	6 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

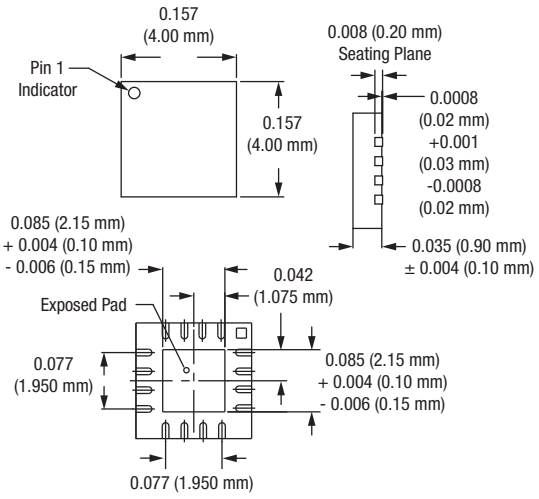
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

V_1	V_2	V_3	V_4	Ant-J_1	Ant-J_2	Ant-J_3	Ant-J_4
V_{HIGH}	V_{Low}	V_{LOW}	V_{LOW}	Ins. Loss	Isolation	Isolation	Isolation
V_{LOW}	V_{HIGH}	V_{LOW}	V_{LOW}	Isolation	Ins. loss	Isolation	Isolation
V_{LOW}	V_{LOW}	V_{HIGH}	V_{LOW}	Isolation	Isolation	Ins. loss	Isolation
V_{LOW}	V_{LOW}	V_{LOW}	V_{HIGH}	Isolation	Isolation	Isolation	Ins. loss

All other conditions not recommended.
V_{LOW} = 0.
V_{HIGH} = 2.6 V.

QFN-16 (4 x 4 mm)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0301

DATA SHEET

AS204-80, AS204-80LF: GaAs IC SP4T Nonreflective Switch With Driver 300 kHz–3.5 GHz

Features

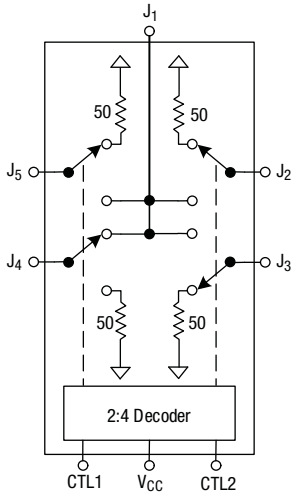
- Integrated driver 5 V supply voltage
- High isolation (45 dB @ 0.9 GHz)
- Low insertion loss (0.5 dB @ 0.9 GHz)
- SSOP-16 plastic package
- Nonreflective all ports
- ESD rated at class 1A HBM
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS204-80 is a high-isolation SP4T FET IC nonreflective switch with driver. The insertion loss is 0.5 dB and isolation is 45 dB at 0.9 GHz. The switch is ideal for cellular base station switch matrices.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Simplified Block Diagram



Electrical Specifications at 25 °C

V_{CC} = 5 V, Z_0 = 50 Ω, unless otherwise noted

Parameter[1]	Frequency	Min.	Typ.	Max.	Unit
Insertion loss[2]	300 kHz–1.0 GHz		0.4	0.6	dB
	300 kHz–2.0 GHz		0.6	0.8	dB
	300 kHz–2.5 GHz		0.7	0.9	dB
	300 kHz–3.5 GHz		0.9	1.2	dB
Isolation	300 kHz–1.0 GHz	40	45		dB
	300 kHz–2.0 GHz	30	38		dB
	300 kHz–2.5 GHz	28	32		dB
	300 kHz–3.5 GHz	22	25		dB
VSWR[3] on state	300 kHz–3.5 GHz		1.3:1		
VSWR[3] off state	0.5 GHz–3.5 GHz		1.5:1		

1. All measurements made in a 50 Ω system, unless otherwise specified.
2. Insertion loss changes by 0.003 dB/°C.
3. Input/Output.

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0302

Operating Characteristics at 25 °C

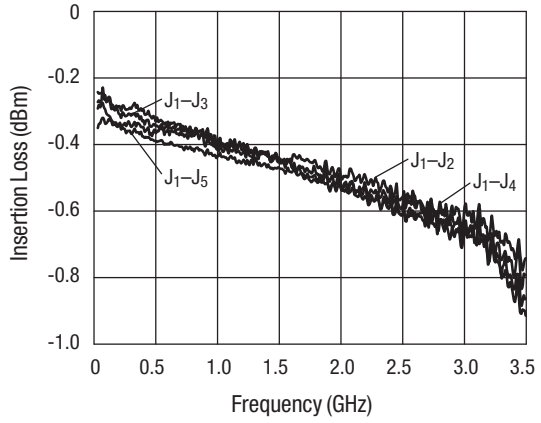
V_{CC} = 5 V, Z_0 = 50 Ω, unless otherwise noted

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			75		ns
On, off	50% CTL to 90/10% RF			125		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
Input power for 1 dB compression		0.5–2 GHz		26		dBm
Intermodulation intercept point (IP3)	For two-tone input power 13 dBm	0.5–2 GHz		40		dBm
		0.05 GHz		29		dBm
Thermal resistance				30		°C/W
Control voltages[1]	CTL1, 2 low		0		0.5	V
	CTL1, 2 high		2.4		5.0	V
Supply voltage, V_{CC}[1]			4.8		5.2	
Supply current	V_{CC} = 5 V			500		µA

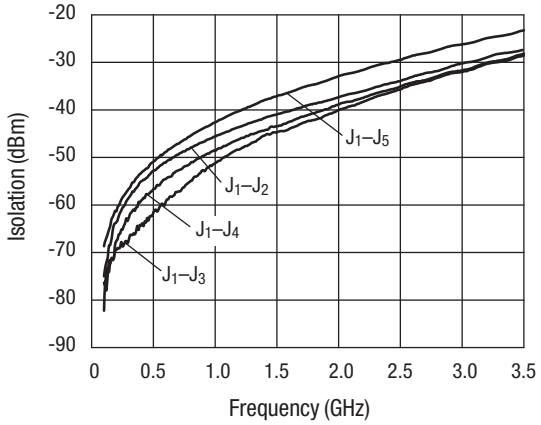
1. V_{CC} must be powered on by a minimum of 10 ns prior to V_{CTL}.

Typical Performance Data

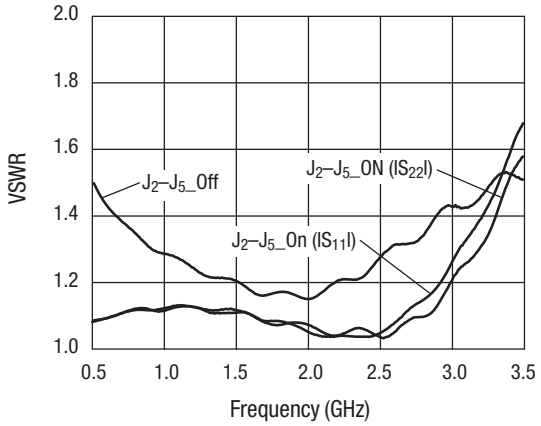
V_{CC} = 5 V, Z_0 = 50 Ω, unless otherwise noted



Insertion Loss vs. Frequency

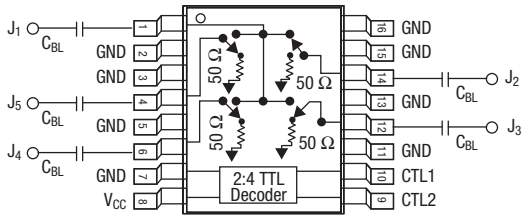


Isolation vs. Frequency



VSWR vs. Frequency

Pin Out



DC blocking capacitors (C_{BL}) required for positive voltage operation.
C_{BL} = 47 pF for operation frequency >500 MHz.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0303

Absolute Maximum Ratings

Characteristic	Value
RF input power	0.8 W > 500 MHz 0.2 W @ 50 MHz
Supply voltage	6 V
Control voltage	-0.2 V, +6 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C
ESD human body model	Class 1A

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

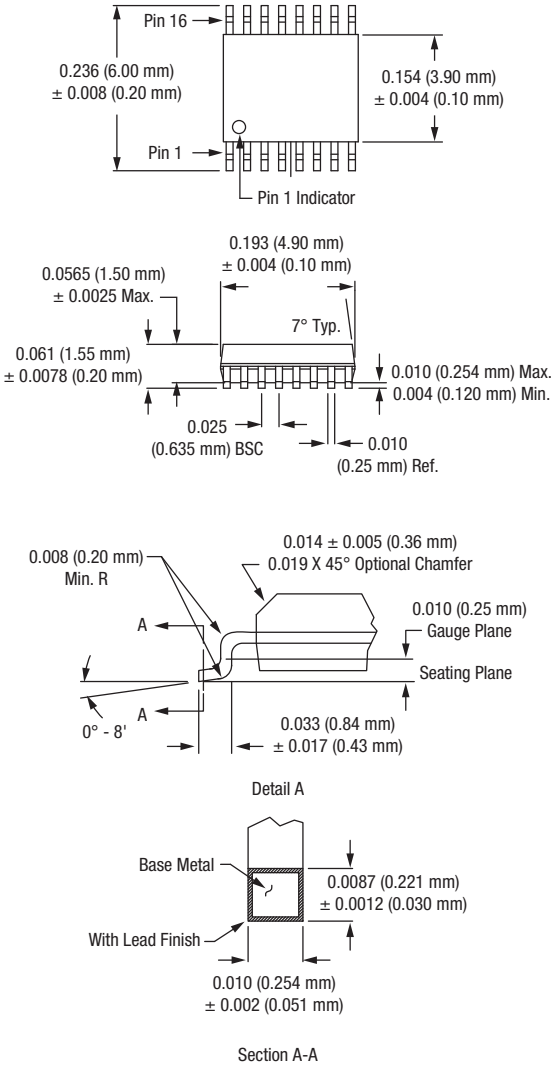
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Truth Table

Insertion Loss Path J_1 to:	Control Input	
	CTL1	CTL2
J_2	0	0
J_3	1	0
J_4	0	1
J_5	1	1

"0" = 0 to 0.5 V.
"1" = 2.4 to 5 V.

SSOP-16 (-80)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0304

DATA SHEET

AS195-306, AS195-306LF: PHEMT GaAs IC High-Power SP5T Switch 0.1–2 GHz

Features

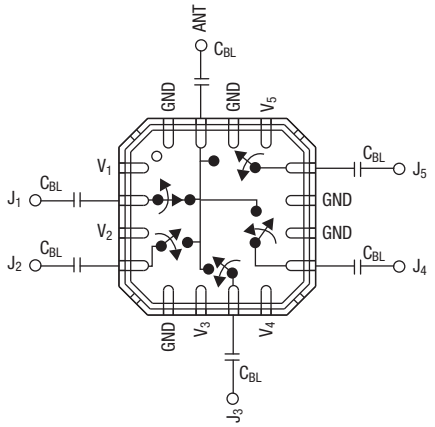
- 5 symmetric RF paths
- Positive voltage control
- High IP3
- Excellent harmonic performance
- Handles GSM power levels
- Available in QFN-16 (4 x 4 mm) package
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The AS195-306 is a reflective SP5T switch. It is an ideal switch for higher power applications. It can be used for GSM dual-band handset applications where low loss, low current and small size are critical parameters.

NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Pin Out



DC blocking capacitors (C_{BL}) must be supplied externally.
C_{BL} = 47 pF for operating frequency >500 MHz.

Electrical Specifications at 25 °C (0, 3 V)

Z_0 = 50 Ω, unless otherwise noted

Parameter		Frequency	Min.	Typ.	Max.	Unit
Insertion loss	Ant-J_1, J_2, J_3, J_4, J_5	0.1–0.5 GHz		0.5	0.7	dB
		0.5–1.0 GHz		0.6	0.8	dB
		1.0–2.0 GHz		1.0	1.1	dB
Isolation	Ant-J_1, J_2, J_3, J_4, J_5	0.1–0.5 GHz	30	35		dB
		0.5–1.0 GHz	25	27		dB
		1.0–2.0 GHz	21	23		dB
VSWR		0.1–1.0 GHz		1.4:1		
		1.0–2.0 GHz		1.6:1		

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0305

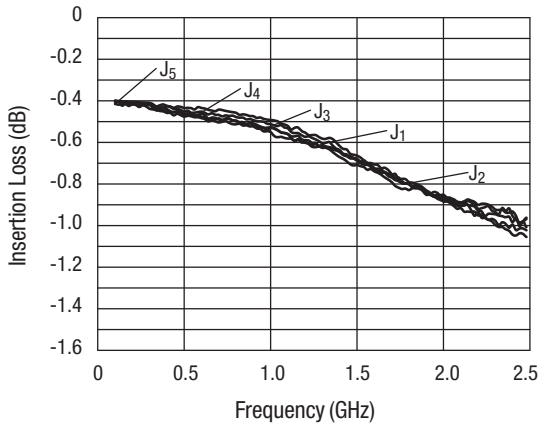
Operating Characteristics at 25 °C (0, 3 V)

Z_0 = 50 Ω, unless otherwise noted

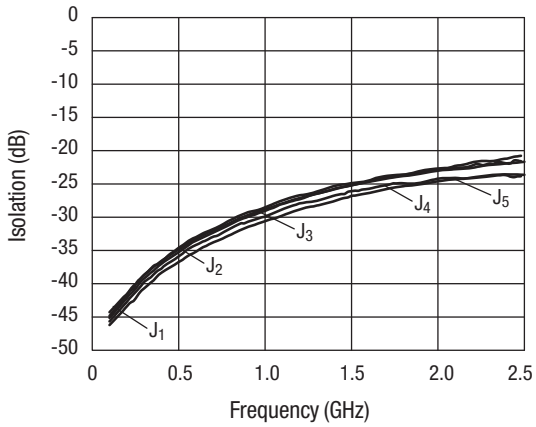
Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics						
Rise, fall	10/90% or 90/10% RF			50		ns
On, off	50% CTL to 90/10% RF			100		ns
Video feedthru	T_{RISE} = 1 ns, BW = 500 MHz			50		mV
IP3	13 dBm/tone			55		dBm
2nd and 3rd harmonics	34 dBm input 900 MHz			-65		dBc
Thermal resistance				25		°C/W
Control voltages	V_{LOW} = 0 V_{HIGH} = 3 V @ 200 µA max.					

Typical Performance Data

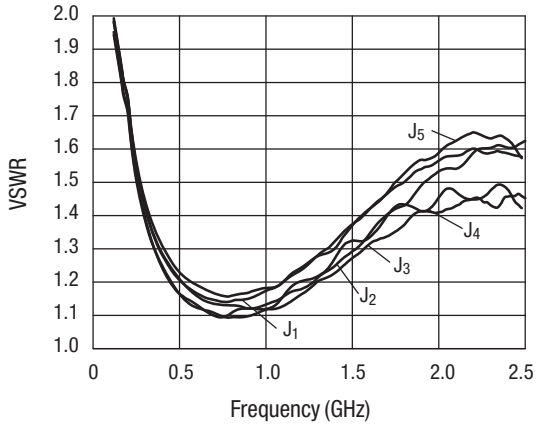
Z_0 = 50 Ω, unless otherwise noted



y ical oss ll Pat s vs. Frequency



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VSWR vs. Frequency

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0306

Absolute Maximum Ratings

Characteristic	Value
RF Input Power	36 dBm, f > 500 MHz, 27 dBm < 500 MHz, 0/8 V control 100 mW f <= 500 MHz
Control Voltage	-0.2 V, +8 V
Operating Temperature	-40 °C to +85 °C
Storage Temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) 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 must be employed at all times.*

Truth Table

V_1	V_2	V_3	V_4	V_5	Ant-J_1	Ant-J_2	Ant-J_3	Ant-J_4	Ant-J_5
V_{HIGH}	0	0	0	0	Ins. loss	Isol.	Isol.	Isol.	Isol.
0	V_{HIGH}	0	0	0	Isol.	Ins. loss	Isol.	Isol.	Isol.
0	0	V_{HIGH}	0	0	Isol.	Isol.	Ins. loss	Isol.	Isol.
0	0	0	V_{HIGH}	0	Isol.	Isol.	Isol.	Ins. loss	Isol.
0	0	0	0	V_{HIGH}	Isol.	Isol.	Isol.	Isol.	Ins. loss

All other conditions not recommended.
"0" = 0 to 0.2 V.
"V_{HIGH}" = 2.7 to 5 V.

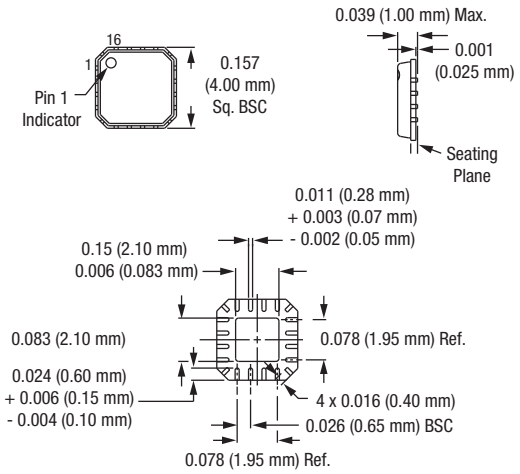
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

Refer to the "Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation" Application Note.

QFN-16 (4 x 4 mm)



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0307

DATA SHEET

SKY13309-370LF: PHEMT GaAs IC SP3T Switch 0.1–3.0 GHz

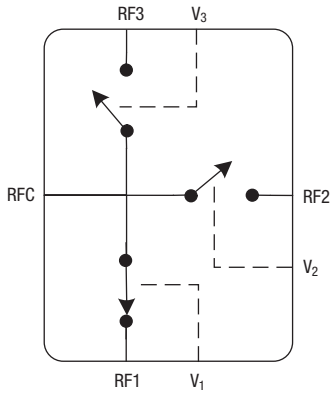
Features

- Positive low voltage control (0/3 V)
- Low insertion loss (0.5 dB at 2.5 GHz)
- High isolation (25 dB at 2.5 GHz)
- Excellent linearity performance ($P_{1\ dB}$ = 29 dBm)
- Miniature ultrathin MLP-8 pin plastic package (2 x 2 x 0.55 mm)
- Advanced PHEMT process
- Available lead (Pb)-free and RoHS-compliant MSL-1 @ 260 °C per JEDEC J-STD-020

Description

The SKY13309-370LF is a PHEMT GaAs IC SP3T antenna switch operating in the 0.1–3 GHz frequency range. Switching between the antenna and Tx/Rx ports is accomplished with 3 control voltages. The low loss, high isolation, high linearity, small size and low cost features make this switch ideal for all WLAN and Bluetooth® systems operating in the 2.4–2.5 GHz band.

Simplified Block Diagram



NEW Skyworks offers lead (Pb)-free, RoHS (Restriction of Hazardous Substances)-compliant packaging.

Electrical Specifications at 25 ºC, V_{HIGH} = 2.1–5 V

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Insertion loss	RFC–RF1, RF2, RF3	0.1–3.0 GHz 2.4–2.5 GHz		0.6 0.5	0.75 0.65	dB dB
Return loss (Insertion loss state)	RFC–RF1, RF2, RF3	0.1–3.0 GHz 2.4–2.5 GHz		20 20		dB dB
Isolation	RFC–RF1, RF2, RF3	0.1–3.0 GHz 2.4–2.5 GHz	22 22	25 25		dB dB

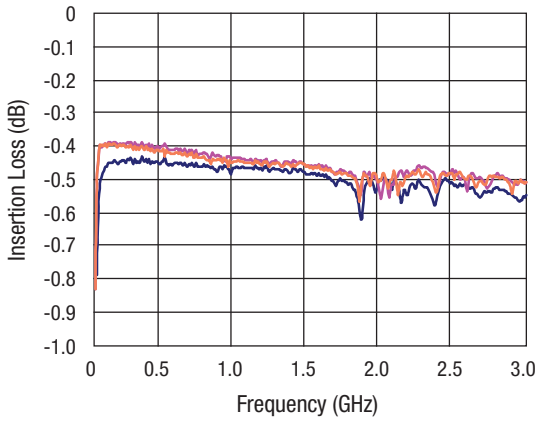
Operating Characteristics at 25 ºC

Parameter	Condition	Frequency	Min.	Typ.	Max.	Unit
Switching characteristics Rise/fall time On, off time	 10/90% or 90/10% RF 50% CTL to 90/10% RF			 30 25		 ns ns
Video feedthru				40		mV
Input power for 1 dB compression	V_{LOW} = 0 V, V_{HIGH} = 3.3 V	2450 MHz		29		dBm
Input third order intermodulation intercept	For two-tone input power 17 dBm V_{LOW} = 0 V, V_{HIGH} = 2.1 V V_{LOW} = 0 V, V_{HIGH} = 3.3 V	 2450 MHz 2450 MHz		 37 45		 dBm dBm
Control voltages	V_{LOW} = 0 to 0.25 V @ 5 µA typ. V_{HIGH} = 2.1 to 5.0 V @ 10 µA typ.			0 3.3		V V

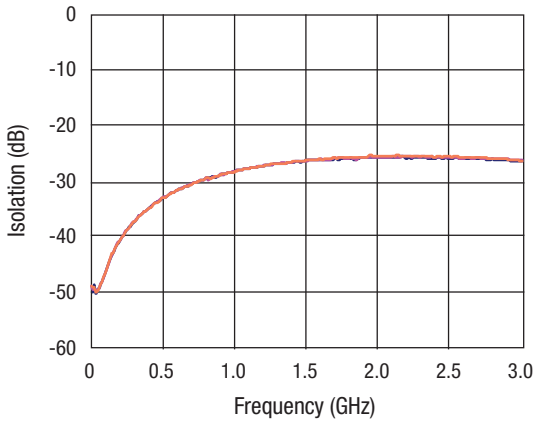
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0308

Typical Performance Data at 25° C (0, 3.3 V)

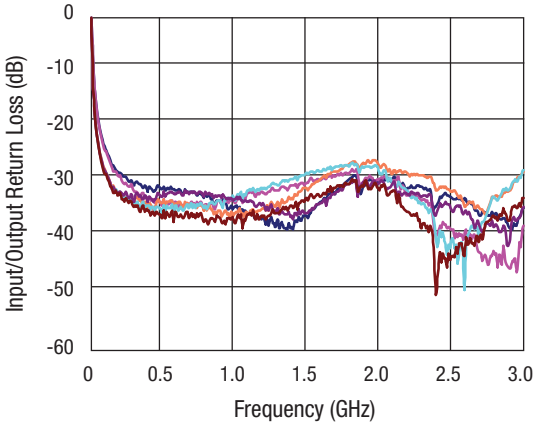
RFC–RF1 State (Data Shown on 3 Units)



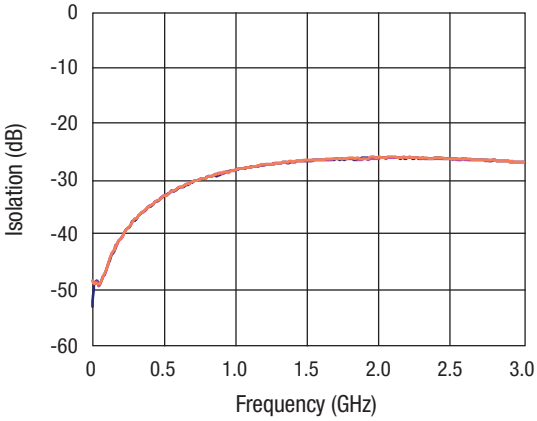
RFC to RF1 Insertion Loss



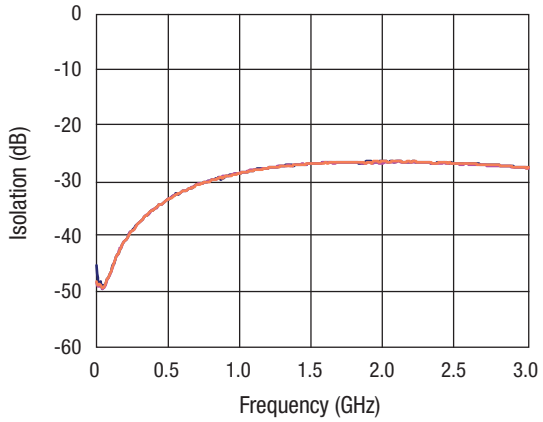
RFC to RF3 Isolation



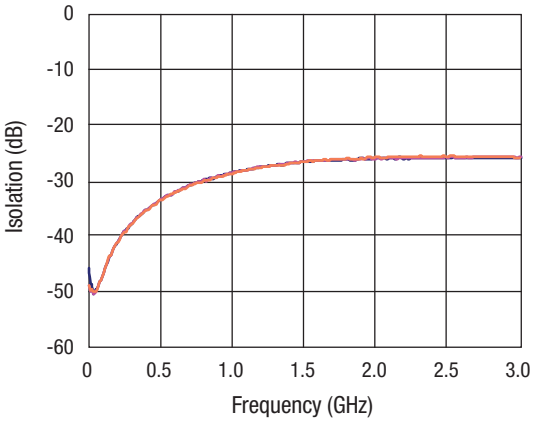
RFC to RF1 Return Loss



RFC to RF2 Isolation



RF1 to RF2 Isolation

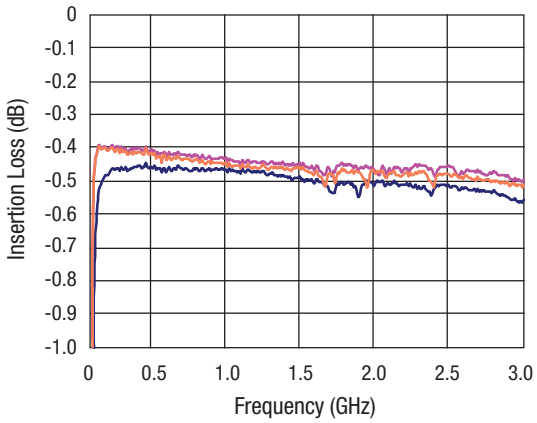


RF1 to RF3 Isolation

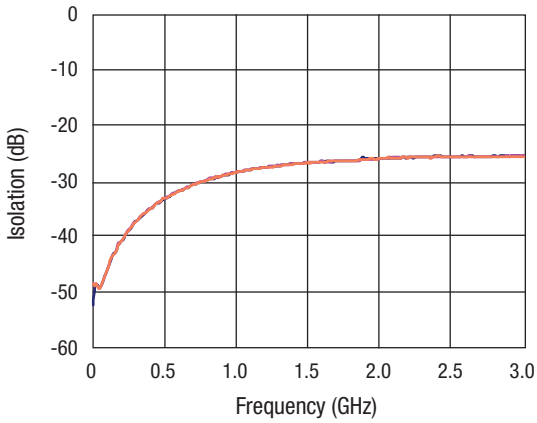
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0309

Typical Performance Data at 25° C (0, 3.3 V)

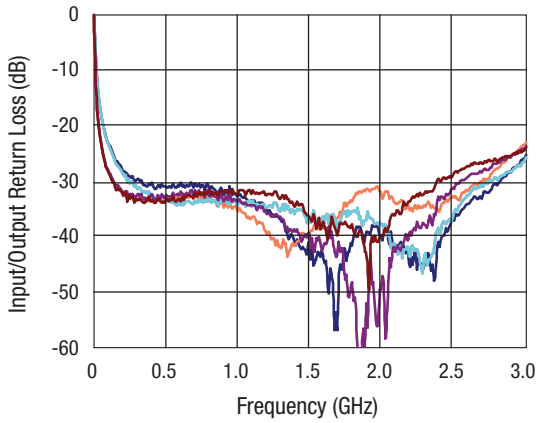
RFC–RF2 State (Data Shown on 3 Units)



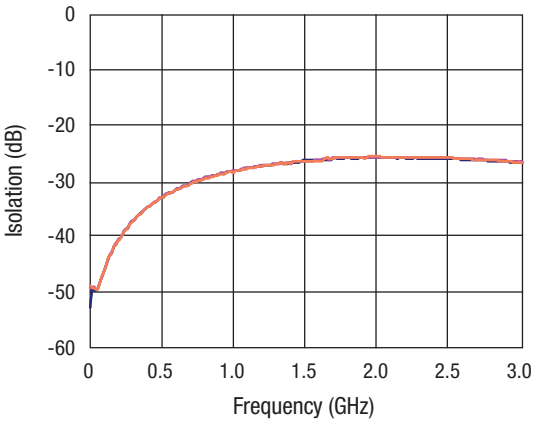
RFC to RF2 Insertion Loss



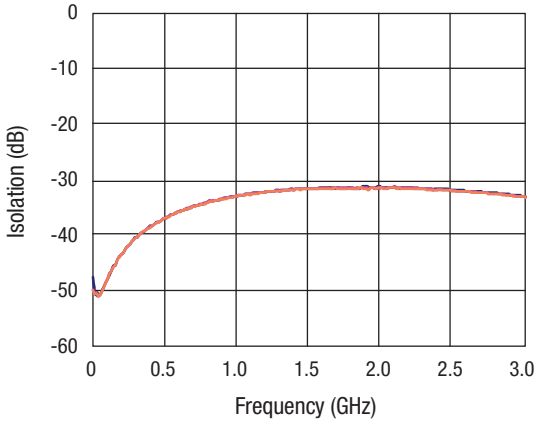
RFC to RF1 Isolation



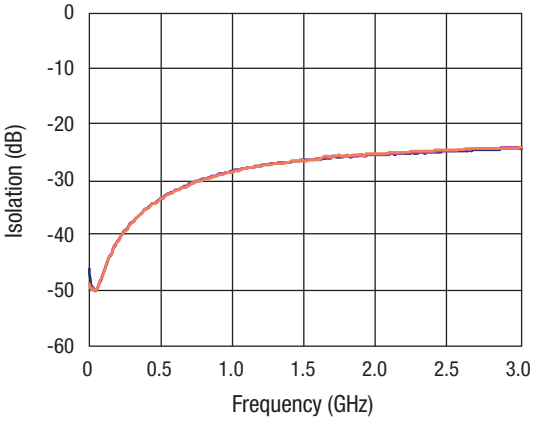
RFC to RF2 Return Loss



RFC to RF3 Isolation



RF2 to RF3 Isolation

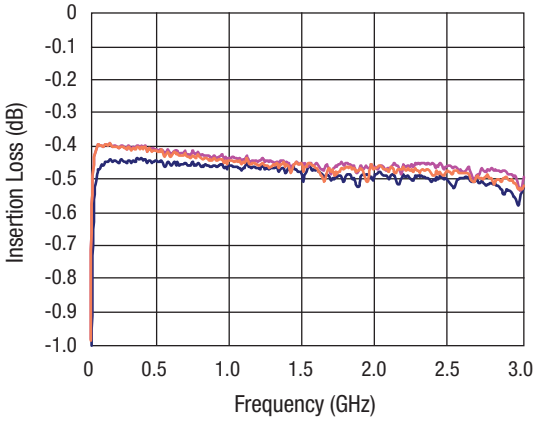


RF2 to RF1 Isolation

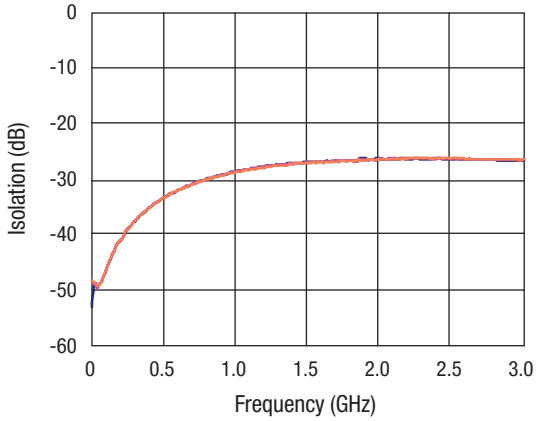
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0310

Typical Performance Data at 25° C (0, 3.3 V)

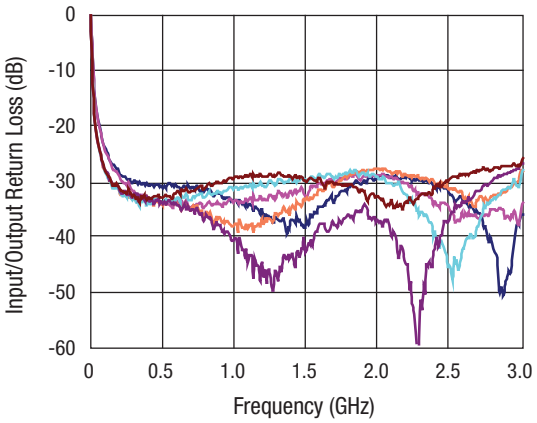
RFC–RF3 State (Data Shown on 3 Units)



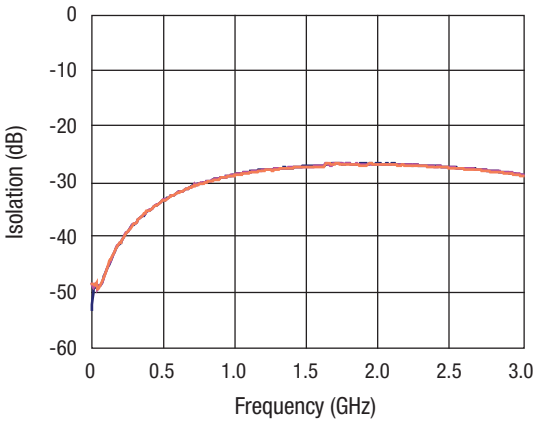
RFC to RF3 Insertion Loss



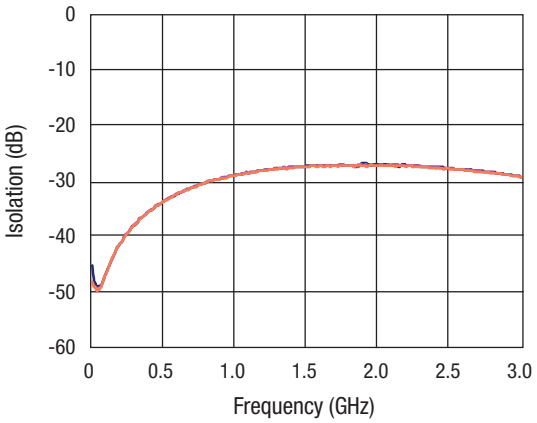
RFC to RF1 Isolation



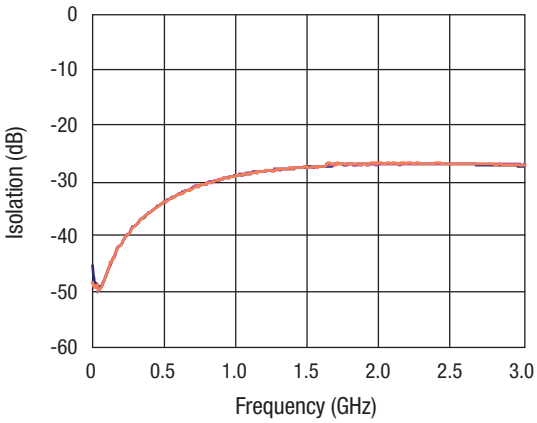
RFC to RF3 Return Loss



RFC to RF2 Isolation



RF3 to RF1 Isolation



RF3 to RF2 Isolation

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0311

Truth Table

Low Insertion Loss Path	V_1	V_2	V_3
RFC–RF1	High	Low	Low
RFC–RF2	Low	High	Low
RFC–RF3	Low	Low	High

High = 2.1 to 5 V.
Low = 0 to 0.25 V.
All other states not recommended. If a non-recommended state occurs, no damage to the switch will occur but it will be placed into an undefined state

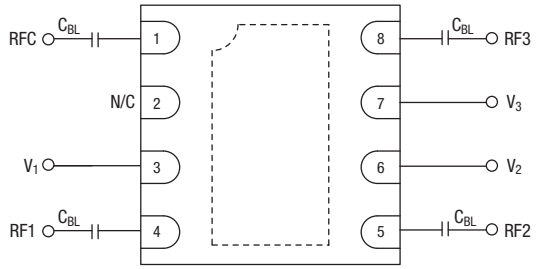
Recommended Solder Reflow Profiles

Refer to the *"Recommended Solder Reflow Profile"* Application Note.

Tape and Reel Information

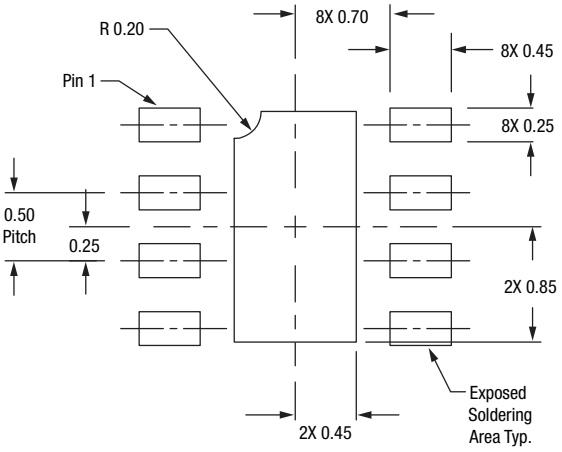
Refer to the *"Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation"* Application Note.

Pin Out (Top View)



C_{BL} = 47 pF for operation > 500 MHz.
C_{BL} = 220 pF for operation down to 50 MHz.
Higher values recommended for lower frequency operation.
Exposed paddle must be grounded.

Land Pattern



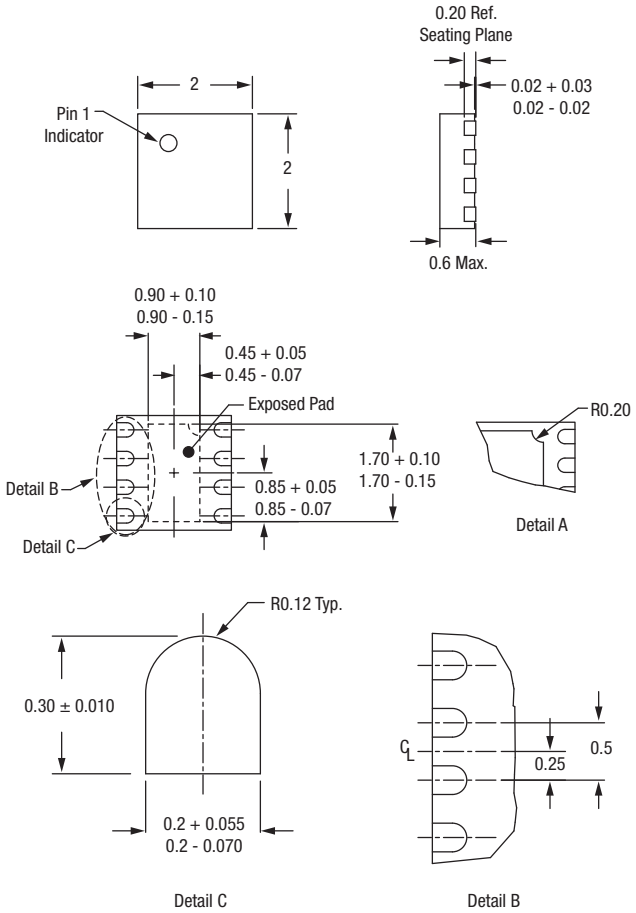
Absolute Maximum Ratings

Characteristic	Value
Max input power @ 0/3V	30 dBm
Max input power @ 0/5V	32 dBm
Operating voltage	+8.0 V
Operating temperature	-40 °C to +85 °C
Storage temperature	-65 °C to +150 °C

Performance is guaranteed only under the conditions listed in the specifications table and is not guaranteed under the full range(s) described by the Absolute Maximum specifications. Exceeding any of the absolute maximum/minimum specifications may result in permanent damage to the device and will void the warranty.

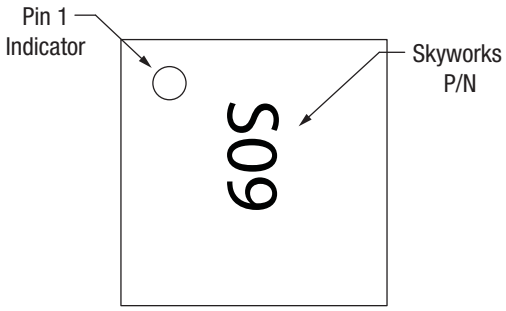
CAUTION: *Although this device is designed to be as robust as possible, ESD (Electrostatic Discharge) can damage this device. This device must be protected at all times from ESD. Static charges may easily produce potentials of several kilovolts on the human body or equipment, which can discharge without detection. Industry-standard ESD precautions must be employed at all times.*

-370

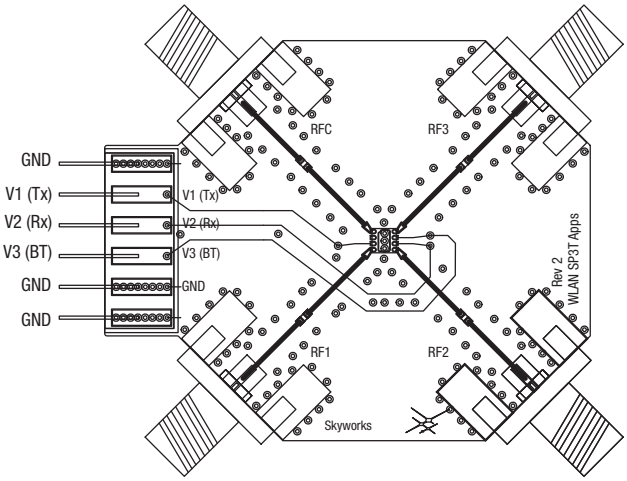


EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0312

Part Marking



Evaluation Board



EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0313

REFERENCE MATERIAL

Solder Reflow

Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation

Suggested PCB Land Pattern

Quality/Reliability

Waffle Pack Chip Carrier Handling/ Opening Procedure

Linear Products Application Notes

- APN1001—Circuit Models for Plastic PackagedMicrowave Diodes
- APN1002—Design With PIN Diodes
- APN1003—A Wideband General-Purpose PIN Diode Attenuator
- APN1004—Varactor SPICE Models for RF VCOApplications
- APN1005—A Balanced Wideband VCO for Set-Top TVTuner Applications
- APN1006—A Colpitts VCO for Wideband (0.95–2.15 GHz) Set-Top TV Tuner Applications
- APN1007—Switchable Dual-Band 170/420 MHz VCO forHandset Cellular Applications
- APN1008—T/R Switch for IMT-2000 HandsetApplications
- APN1009—A Varactor Controlled Phase Shifter for PCSBase Station Applications
- APN1010—A VCO Design for WLAN Applications in the2.4–2.5 GHz ISM Band
- APN1011—A 5–6 GHz Switch Using Low-Cost PlasticPackaged PIN Diodes
- APN1012—VCO Designs for Wireless Handset and CATVSet-Top Applications
- APN1013—A Differential VCO Design for GSM HandsetApplications
- APN1014—A Level Detector Design for Dual-Band GSM-PCS Handsets
- APN1015—A Dual-Band Switchable IF VCO forGSM/ PCS Handsets
- APN1016—A Low Phase Noise VCO Design for PCSHandset Applications
- APN1017—A CATV Attenuator Using the Single PackageSMP1307-027 PIN Diode Array
- APN5001—Theory and Application of Sampling PhaseDetector

Skyworks Sales Representatives

Skyworks Distributors

Skyworks Sales Offices

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0314

APPLICATION NOTE

Solder Reflow Information

Assembly of a surface mount device depends on many process material and equipment parameters. Two of the most common processes used are infrared (IR) and convection reflow. Skyworks products come in three different termination finishes, depending on the package.

- Au (Cu/Ni/Au) for MCM and LGA (laminate-based) packages
- SnPb (Sn 70-90%, Pb 30-10%, 300-1,000 micro-inches thick) for lead frame-based solder plated products
- Sn (100% 300-1,000 micro-inches thick) as a lead (Pb)-free replacement for SnPb

This finish is compatible with all commonly used processes. The most common attachment process is the convection reflow process.

The reflow process requires applying solder and flux in the form of a paste to the areas of the substrate or PC board where the surface mount component connections are to be made. The solder and flux are applied to the circuit by screening, stenciling, or dot placement. This paste acts as a temporary adhesive holding the device in place until reflow soldering takes place. Optionally, a chip-bonding epoxy can be used to hold the device in place.

Solder paste manufacturers generally provide a recommended profile for the specific solder being used. The manufacturer's profile or the typical solder reflow profiles table in this document can be used as a starting point for profiling the process.

Caution: *Please contact your solder paste manufacturer for exact solder profile requirements.*

When using thermocouples for profiling, it should be noted that the outside edges and corners of an assembly heat up faster than the center, and components of greater thermal mass will heat more slowly than those of lesser thermal mass.

A thermal reflow process profile typically undergoes five transitions:

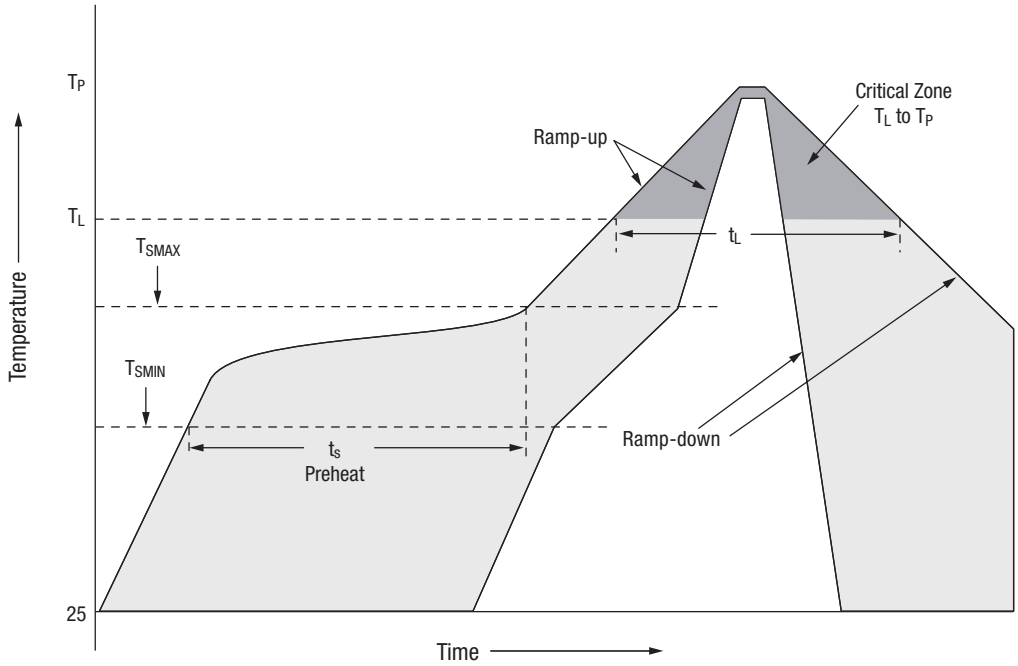
1. **Preheat** — Brings the assembly from 25 °C to preheat zone and evaporates solvents from solder paste. A slow ramp-up rate will prevent any damage due to thermal shock. The time and temperature to evaporate the solvents will depend upon the solder paste that is used.
2. **Flux Activation (Preheat–T_L)** — Dried solder paste is heated to a temperature in which the flux will react with the oxide and contaminants on the surfaces to be joined. The time and temperature should be long enough to allow the flux to fully clean these surfaces but not too long that the flux may be exhausted before soldering takes place.
3. **Thermal Equalization (Preheat–T_L)** — Achieves temperature equalization approximately 20–40 °C below the peak reflow temperature. Time and temperature will depend upon the mass and materials.
4. **Reflow (T_L–T_P)** — In this stage, the assembly is briefly brought to the temperature sufficient to produce reflow of solder.
5. **Cool Down** — This is the final stage in the solder process. Gradual cooling should be used. The end result should be as fast as possible without causing thermal shock to the components. Cool down in this manner will produce a finer grain structure in the solder joint, which will yield a more fatigue-resistant solder joint.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0315

Recommended Solder Reflow Profiles

Profile Feature	SnPb Eutectic	Lead (Pb)-Free (SnAgCu)
Ramp rate	0.5–2.0 °C/sec.	0.5–2.0 °C/sec.
Preheat (soak) Temperature min. (T_{SMIN}) Temperature max. (T_{SMAX}) Time (ts_{MIN} to ts_{MAX})	Reference solder paste manufacturer recommended profile	Reference solder paste manufacturer recommended profile
Time above liquidus (TAL) Temperature (T_L) Time (t_L)	30–90 sec.	30–90 sec.
Peak temperature (T_P)	205–220 °C	235–245 °C
Ramp-down rate	4 °C/sec. max.	4 °C/sec. max.

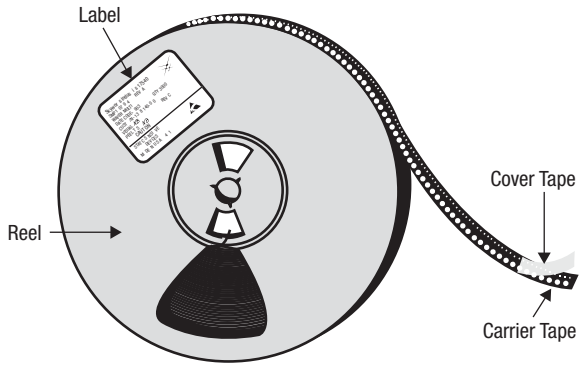
Caution: *Please contact your solder paste manufacturer for exact solder profile requirements.*



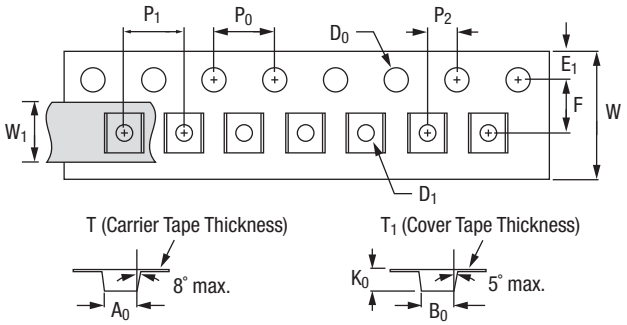
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0316

APPLICATION NOTE

Discrete Devices and IC Switch/Attenuators Tape and Reel Package Orientation



Tape Dimensions



Desc ription	Sym.	SC-79	SOD-323	SC-70	SC-88	SOT-23	SOT-143	SOT- 5
Cavity								
Length	A_0	0.90±0.05	1.45±0.10	2.25±0.10	2.25±0.10	3.15±0.10	3.099±0.10	3.15±0.10
Width	B_0	1.40±0.05	3.20±0.10	2.70±0.10	2.70±0.10	3.20±0.10	2.692±0.10	3.20±0.10
Depth	K_0	0.80±0.05	1.35±0.10	0.53±0.05	1.19±0.10	1.40±0.10	1.295±0.10	1.40±0.10
Pitch	P_1	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00± 0.10
Bottom hole diameter	D_1	0.50±0.05	1.00±0.10	0.50±0.05	1.00±0.10	1.00±0.10	1.00±0.10	1.00±0.10
Perforation								
Diameter	D_0	1.50±0.1	1.50±0.10	1.50±0.10	1.50±0.10	1.55±0.05	1.50±0.10	1.50±0.10
Pitch	P_0	4.00±0.1	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10
Position	E_1	1.75±0.1	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10
Carrier Tape								
Width	W	8.00±0.20	8.00±0.20	8.00±0.10	8.00±0.30	8.00±0.30	8.00±0.10	8.00±0.30
Thickness	T	0.229±0.02	0.254±0.013	0.30±0.05	0.254±0.013	0.254±0.013	0.254±0.013	0.20±0.03
Cover Tape								
Width	W_1	5.40±0.10	5.40±0.10	5.40±0.10	5.40±0.10	5.40±0.10	5.40±0.10	5.40±0.10
Tape thickness	T_1	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01
Distance								
Cavity to perforation (width direction)	F	3.5±0.05	3.50±0.05	3.50±0.05	3.50±0.05	3.50±0.05	3.50±0.05	3.50±0.05
Cavity to perforation (length direction)	P_2	2.0±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05

Note: All dimensions are in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0317

Description	Sym.	SOT-6	SOIC-8	MSOP-8	PLCC-28	MCM-20 6 x 6	MCM-24 8 x 7	QFN 2 X 3	QFN 3 x 3	QFN 4 x 4
Cavity										
Length	A_0	3.15±0.10	6.70±0.10	5.20±0.10	13.0±0.10	6.30±0.10	7.35±0.10	2.20±0.10	3.30±0.10	4.35±0.10
Width	B_0	3.20±0.10	5.40±0.10	3.30±0.10	13.0±0.10	6.30±0.10	8.35±0.10	3.20±0.10	3.30±0.10	4.35±0.10
Depth	K_0	1.40±0.10	2.00±0.10	1.60±0.10	4.90±0.10	1.85±0.10	2.00±0.10	1.10±0.10	1.10±0.10	1.10±0.10
Pitch	P_1	4.00±0.10	8.15±0.02	8.00±0.10	12.0±0.10	8.00±0.10	12.00±0.10	4.00±0.10	8.00±0.10	8.00±0.10
Bottom hole diameter	D_1	1.00±0.10	1.60±0.02	1.00±0.10	1.60±0.02	1.00±0.10	1.50±0.10	1.50±0.10	1.00±0.10	1.00±0.10
Perforation										
Diameter	D_0	1.50±0.10	1.60±0.03	1.50±0.10	1.60±0.03	1.50±0.10	1.55±0.10	1.50±0.10	1.50±0.10	1.50±0.10
Pitch	P_0	4.00±0.10	3.75±0.02	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10
Position	E_1	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10
Carrier Tape										
Width	W	8.00±0.30	12.00±0.30	12.00±0.30	24.00±0.30	12.00±0.30	16.00±0.30	12.00±0.30	12.00±0.30	12.00±0.30
Thickness	T	0.20±0.03	0.30±0.05	0.30±0.013	0.30±0.005	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05
Cover Tape										
Width	W_1	5.40±0.10	9.20±0.10	9.20±0.10	18.50±.010	9.20±0.10	13.30±0.10	9.20±0.10	9.20±0.10	9.20±0.10
Tape thickness	T_1	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.051±0.01	0.045±0.01	0.051±0.01	0.051±0.01	0.051±0.01
Distance										
Cavity to perforation (width direction)	F	3.50±0.05	3.50±0.05	5.60±0.05	11.50±0.10	5.50±0.10	7.50±0.05	5.50±0.05	5.50±0.10	5.50±0.10
Cavity to perforation (length direction)	P_2	2.00±0.05	2.00±0.05	4.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05	2.00±0.05

Note: All dimensions are in mm.

Description	Sym.	QFN 5 x 5	TSSOP-16	SOIC-14	SOIC-16	SSOP-16	SSOP-20	LGA-4	LGA-6	LGA-8	LGA-16
Cavity											
Length	A_0	5.25±0.10	6.80±0.10	6.50±0.10	6.50±0.10	6.70±0.10	8.20±0.10	1.57±0.10	1.40±0.10	3.25±0.10	8.40±0.10
Width	B_0	5.25±0.10	5.40±0.10	9.00±0.10	10.30±0.10	5.40±0.10	7.60±0.10	1.38±0.10	1.70±0.10	5.75±0.10	10.70±0.10
Depth	K_0	1.10±0.10	1.60±0.10	2.10±0.10	2.10±0.10	2.10±0.10	3.00±0.10	1.00±0.10	1.00±0.10	2.70±0.10	2.40±0.10
Pitch	P_1	8.00±0.10	8.00±0.10	8.00±0.10	8.00±0.10	8.15±0.02	12.00±0.10	4.00±0.10	4.00±0.10	8.00±0.10	16.00±0.10
Bottom hole diameter	D_1	1.00±0.10	1.60±0.10	1.60±0.10	1.60±0.10	1.60±0.02	1.60±0.10	0.60±0.10	1.00±0.10	1.00±0.10	1.60±0.20
Perforation											
Diameter	D_0	1.50±0.10	1.50±0.10	1.55±0.10	1.55±0.10	1.60±0.03	1.50±0.10	1.50±0.10	1.50±0.10	1.50±0.10	1.60±0.03
Pitch	P_0	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10
Position	E_1	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10
Carrier Tape											
Width	W	12.00±0.30	12.0±0.30	16.00±0.30	16.00±0.30	12.0±0.30	16.00±0.30	8.00±0.30	8.00±0.30	12.00±0.30	16.00±0.30
Thickness	T	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.30±0.05	0.35±0.05	0.30±0.005
Cover Tape											
Width	W_1	9.20±0.10	9.20±0.10	13.30±0.10	13.30±0.10	9.20±0.10	13.30±0.10	5.40±0.10	5.40±0.10	9.20±0.10	13.30±0.10
Tape thickness	T_1	0.051±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.10	0.062±0.10	0.062±0.10	0.062±0.01
Distance											
Cavity to perforation (width direction)	F	5.50±0.10	7.50±0.10	7.50±0.10	7.50±0.05	3.50±0.05	7.50±0.05	3.50±0.05	3.50±0.05	3.50±0.05	7.50±0.10
Cavity to perforation (length direction)	P_2	2.00±0.05	2.00±0.1	2.00±0.10	2.00±0.10	2.00±0.05	2.00±0.10	2.00±0.10	2.00±0.05	2.00±0.05	2.00±0.10

Note: All dimensions are in mm.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0318

Description	Sym.	SOT-89	SOT-666	3 x 3	2 x 2	MSOP-10	Micro-X	4 x 4	LQFP-32	LTCC (-108, 109)	LTCC (-116, -117)
Cavity											
Length	A_0	4.60±0.10	1.78±0.05	3.30±0.10	2.40±0.10	5.20±0.10	2.198±0.10	4.35±0.10	9.6±0.10	1.55±0.10	1.93±0.10
Width	B_0	4.90±0.10	1.78±0.05	3.30±0.10	2.40±0.10	3.30±0.10	5.769±0.10	4.35±0.10	9.6±0.10	1.96±0.10	2.24±1.10
Depth	K_0	1.96±0.10	0.69±0.05	1.10±0.10	1.20±0.10	1.60±0.10	1.648±0.10	1.10±0.20	2.2±0.10	1.13±1.10	1.13±0.10
Pitch	P_1	4.00±0.20	4.00±0.10	8.00±0.10	4.00±0.10	8.00±0.10	8.00±0.10	8.00±0.10	12.0±0.10	4.00±0.10	4.00±0.10
Bottom hole diameter	D_1	1.50±0.10	0.50±0.05	1.00±0.10	1.00±0.10	1.00±0.10	1.50+0.25	1.00±0.10	1.50±0.10	0.80±0.05	1.00+0.25
Perforation											
Diameter	D_0	1.50±0.10	1.50±0.10	1.50±01.0	1.50+0.10	1.50±0.10	1.50+0.10	1.5±01.0	1.50+0.10	1.50+0.10	1.50+0.10
Pitch	P_0	4.00±0.20	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10	4.00±0.10
Position	E_1	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10	1.75±0.10
Carrier Tape											
Width	W	12.0±0.30	8 mm	12.0±0.30	8.0+.3, -0.10	12.00±0.30	12 mm	12.0±0.30	16.0±0.30	8.00 +0.30/-0.10	8.00 +0.30/-0.10
Thickness	T	0.30±0.05	0.20±0.02	0.30±0.05	0.30±0.05	0.30±0.013	0.293±0.13	0.30±0.05	0.30±0.05	0.254±0.02	0.254±0.02
Cover Tape											
Width	W_1	9.2±0.10	5.40±0.10	9.20±0.10	5.40±0.10	9.2±0.10	9.3±0.10	9.2±0.10	13.3±.0.10	5.40±0.10	5.40±0.10
Tape thickness	T_1	0.062±0.01	0.61	0.062±0.01	0.062±0.01	0.062±0.01	0.61	0.062±0.01	0.062±0.01	0.062±0.01	0.062±0.01
Distance											
Cavity to perforation (width direction)	F	5.5±0.05	3.50±0.05	5.50±0.05	3.50±0.05	5.6±0.05	5.5±0.05	5.50±0.05	7.50±0.10	3.50±0.05	3.50±0.05
Cavity to perforation (length direction)	P_2	2.0±0.05	2.00±0.025	2.00±0.05	2.00±0.05	4.00±0.05	2.0±0.05	2.00±0.05	2.00±0.10	2.00±0.05	2.00±0.05

Note: All dimensions are in mm.

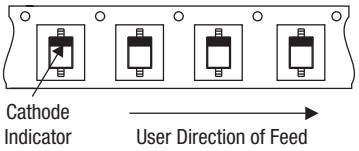
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0319

Description	Sym.	Flip Chip 540-011	Flip Chip 540-025
Cavity			
Length	A_0	0.45±0.05	0.45±0.05
Width	B_0	0.78±0.05	0.78±0.05
Depth	K_0	0.25±0.05	0.25±0.05
Pitch	P_1	2.00±0.05	2.00±0.05
Bottom hole diameter	D_1	0.15 ±0.05	0.15 ±0.05
Perforation			
Diameter	D_0	1.50±0.10	1.50±0.10
Pitch	P_0	4.00±0.10	4.00±0.10
Position	E_1	1.75±0.10	1.75±0.10
Carrier Tape			
Width	W	8.00±0.10	8.00±0.10
Thickness	T	0.25±0.05	0.25±0.05
Cover Tape			
Width	W_1	0.495±0.05	0.495±0.05
Tape thickness	T_1	0.045±0.01	0.045±0.01
Distance			
Cavity to perforation (width direction)	F	3.50±0.05	3.50±0.05
Cavity to perforation (length direction)	P_2	2.00±0.05	2.00±0.05

Note: All dimensions are in mm

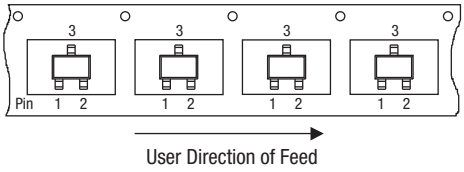
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0320

SOD-323



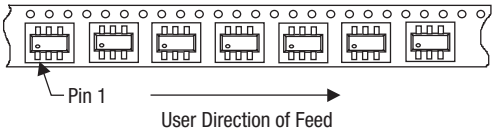
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

SC-70



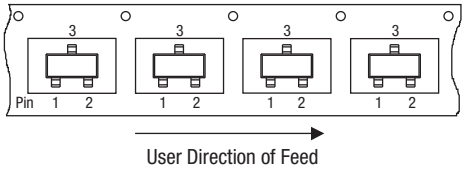
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

SOT-6 and SC-88



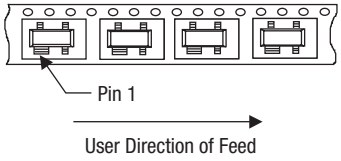
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

SOT-23



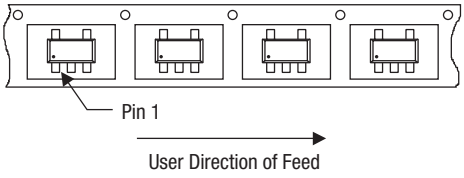
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

SOT-143



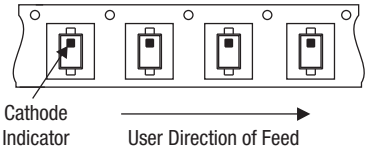
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

SOT-5



Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

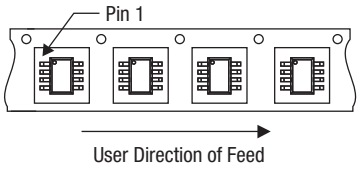
SC-79



Standard Reel Size	7"	13"
Standard Reel Quantity*	3,000	12,000

*Available through distribution.

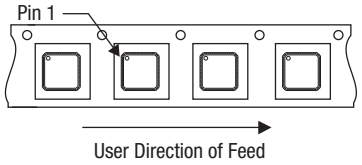
MSOP-8, MSOP-10 and SOIC-8



Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

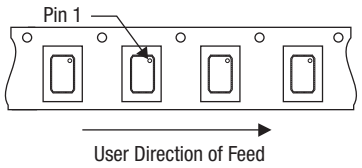
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0321

MCM-20 (6 x 6)



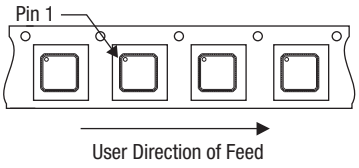
Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

MCM-24 (8 x 7)



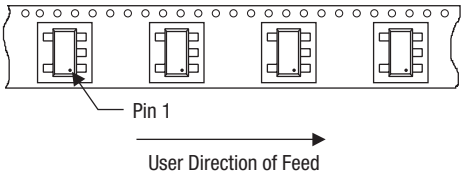
Standard Reel Size	7"	13"
Standard Reel Quantity	N/A	2,000

QFN (3 x 3), (4 x 4), (5 x 5)



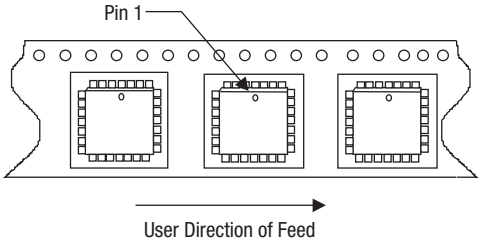
Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

SOT-89



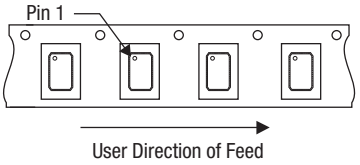
Standard Reel Size	7"	13"
Standard Reel Quantity	N/A	2,500

28-Lead PLCC



Standard Reel Size	7"	13"
Standard Reel Quantity	N/A	1,500

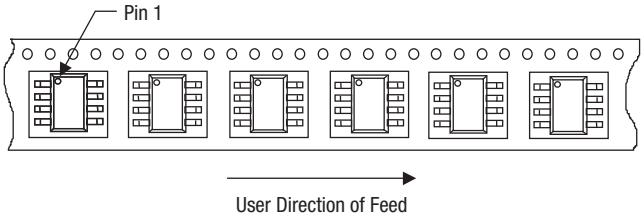
QFN (2 x 3)



Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

SOIC, MSOP, QSOP, SSOP and TSSOP Devices

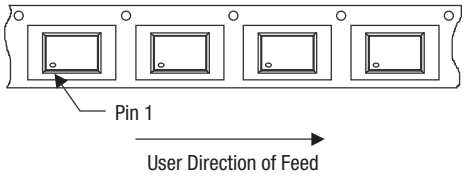
8, 10, 14, 16, 20, 28 Leads



Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

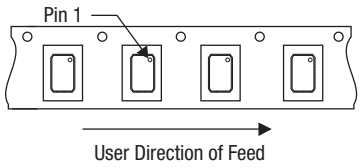
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0322

LGA-4, LGA-6 and SOT-666



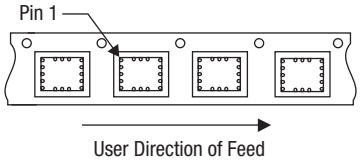
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

LGA-8 (-315)



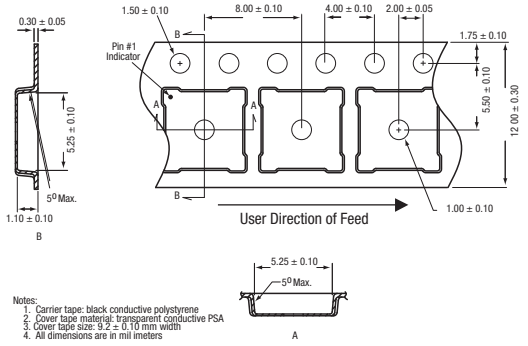
Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

LGA-16 (-500)



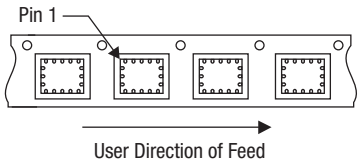
Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

QFN 32L 5 x 5 x 0.9 mm (-364)



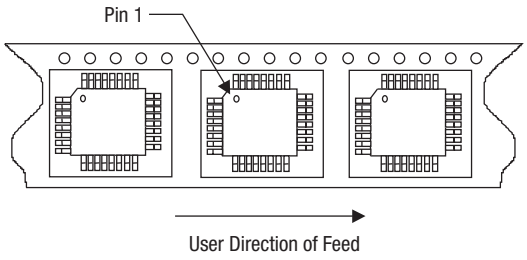
Standard Reel Size	7"	13"
Standard Reel Quantity	500	3,000

LGA-16 (-501)



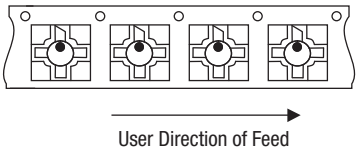
Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

32-Lead TQFP and LQFP



Standard Reel Size	7"	13"
Standard Reel Quantity	N/A	2,000

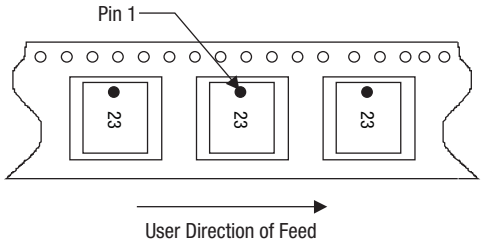
Micro X



Standard Reel Size	7"	13"
Standard Reel Quantity	1,000	3,000

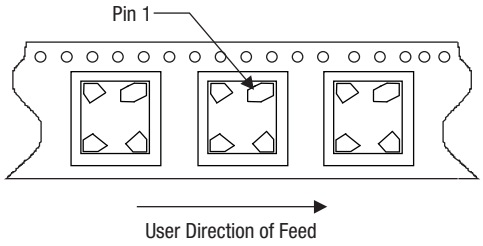
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0323

Ceramic LTCC (-108, -109)



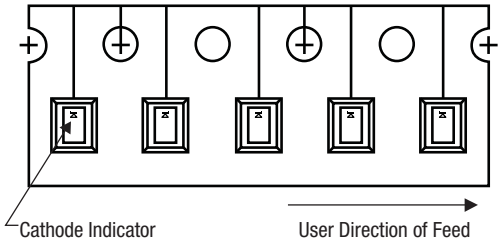
Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

Ceramic LTCC (-116, -117)

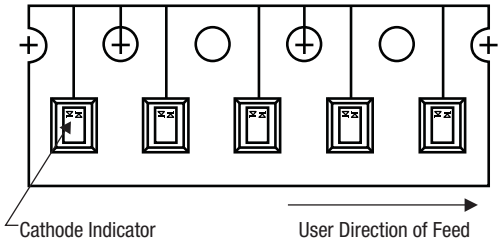


Standard Reel Size	7"	13"
Standard Reel Quantity	3,000	12,000

Flip Chip 540-011



Flip Chip 540-025



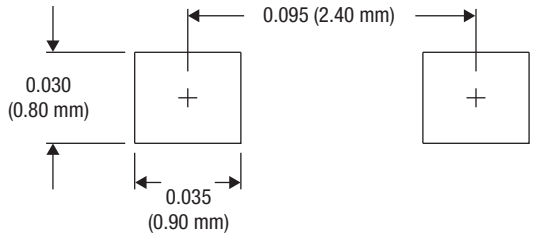
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0324

APPLICATION NOTE

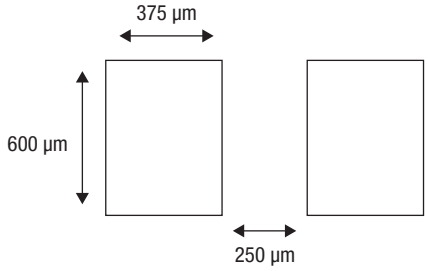
Suggested PCB Land Pattern Designs for Leaded and Leadless Packages and Detailed Surface Mount Guidelines for Leadless Packages

Below are sample printed circuit board land pattern dimensions. These are based on the IPC (Institute for Interconnecting and Packaging Electronic Circuits) surface mount design and land pattern standard: IPC-SM-782.

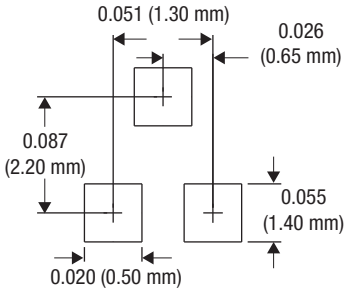
These drawings are for reference only. It is recommended that you consult with the company doing the component mounting and soldering to the printed circuit board. These companies have more information on options (various possible dimensions) of actual land patterns.



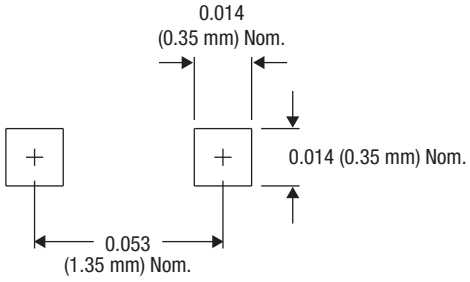
SOD-323



Chip Scale

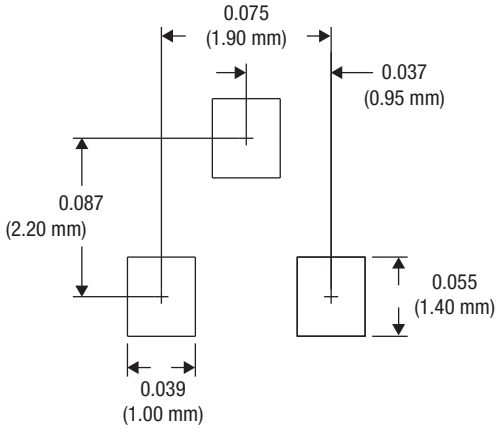


SC-70

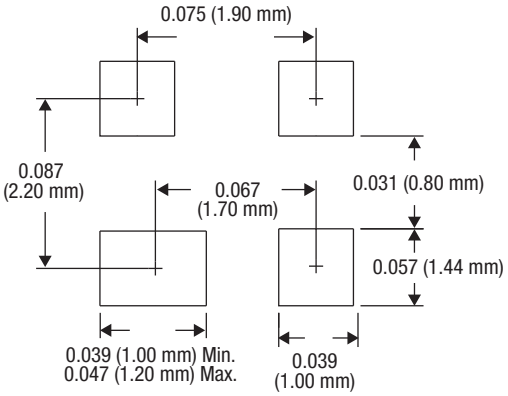


SC-79

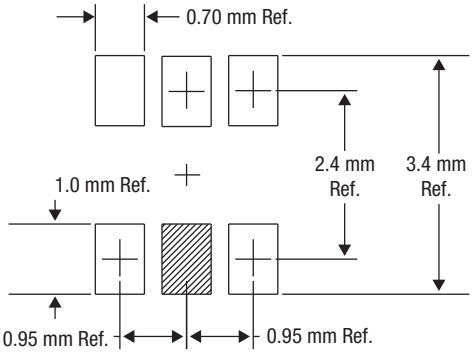
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0325



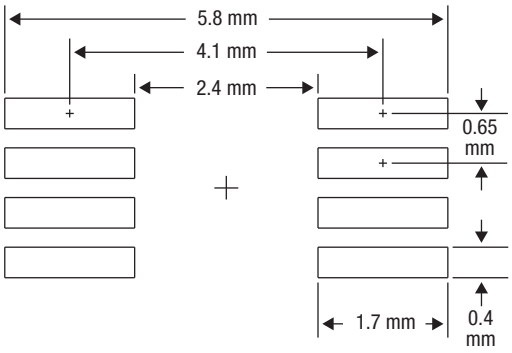
SOT-23 3-Lead



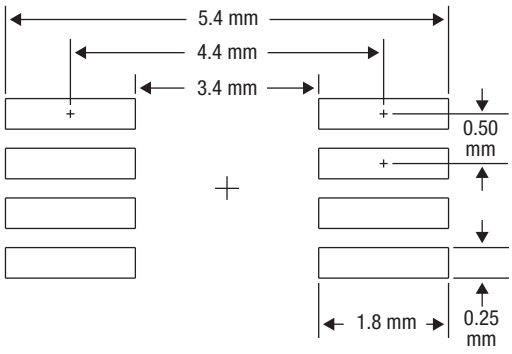
SOT-143



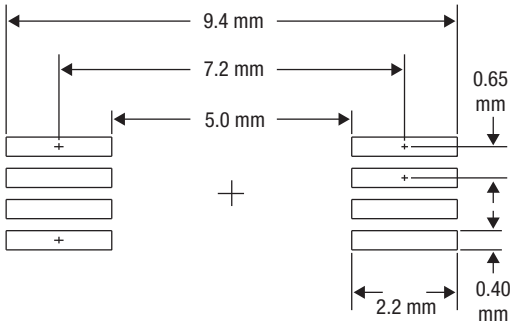
SOT-5, SOT-6



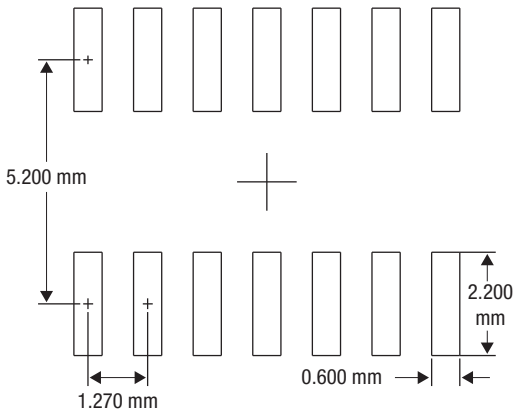
MSOP-8



MSOP-10

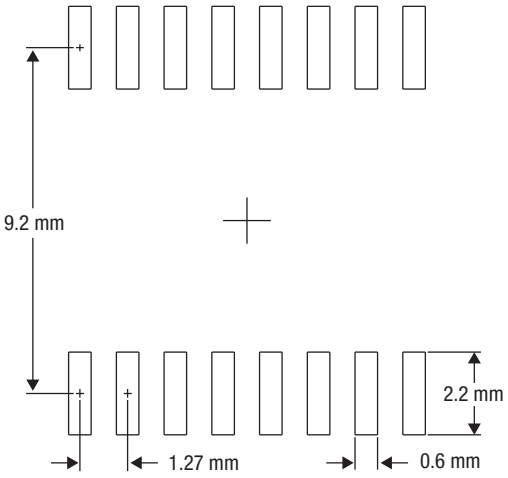


SSOP 8-Lead (5.3 mm)

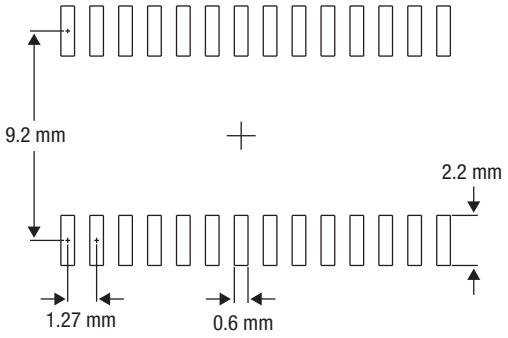


SOIC 14-Lead Narrow Body

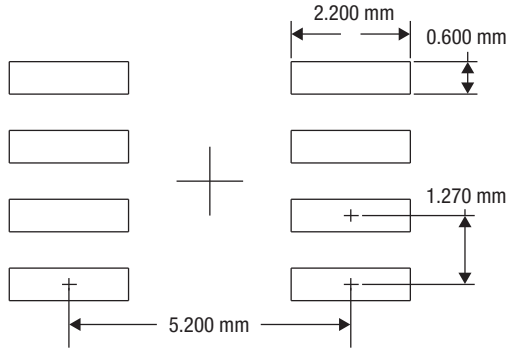
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0326



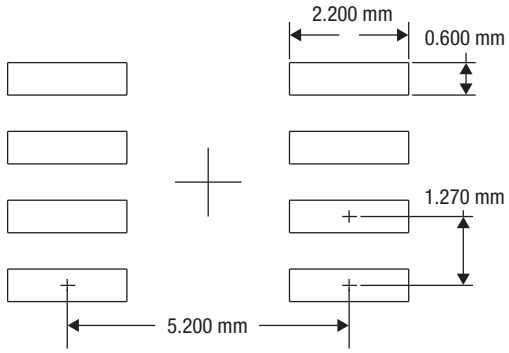
SOIC 16-Lead Wide Body



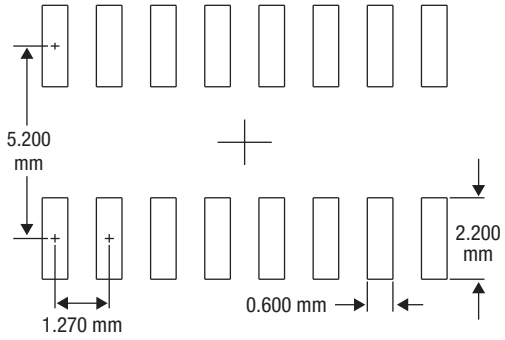
SOIC 28-Lead Wide Body



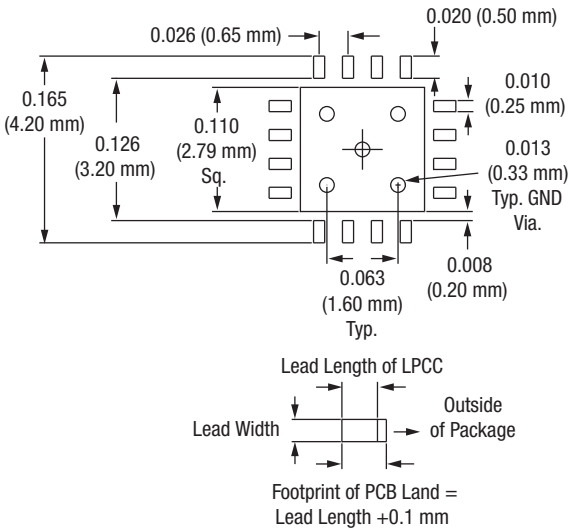
SOIC 8-Lead Narrow Body



SOIC 8-Lead

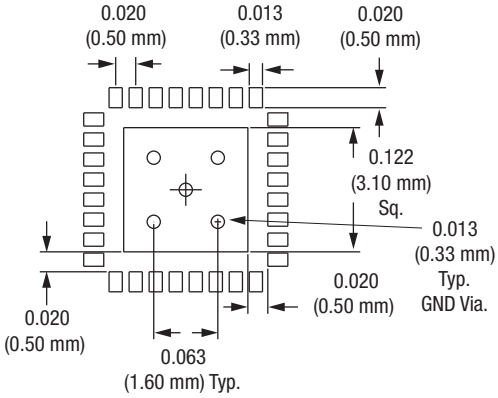


SOIC 16-Lead Narrow Body

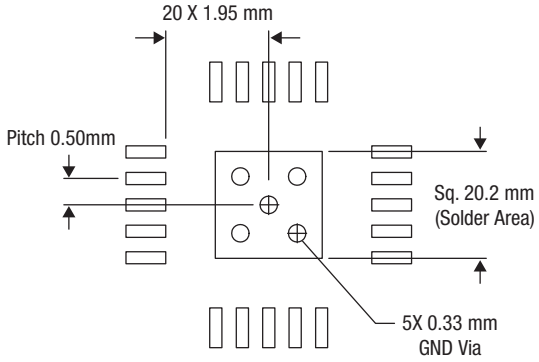


**LPCC 16-Lead 4 x 4 mm (-307)
Surface Mount Land Pattern**

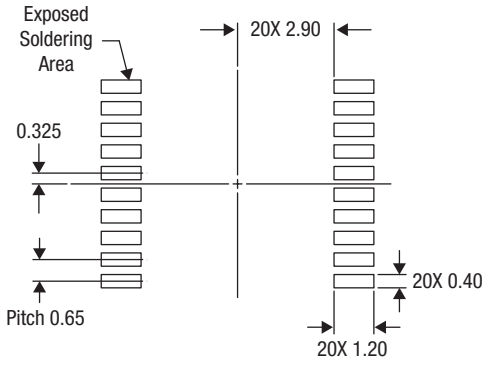
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0327



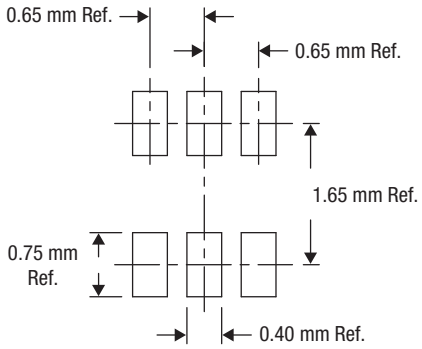
QFN 32-Lead 5 x 5 mm (-310, -364)
Surface Mount Land Pattern



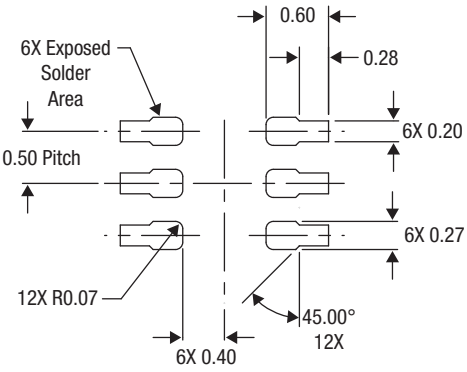
QFN 20-Lead 4 x 4 mm



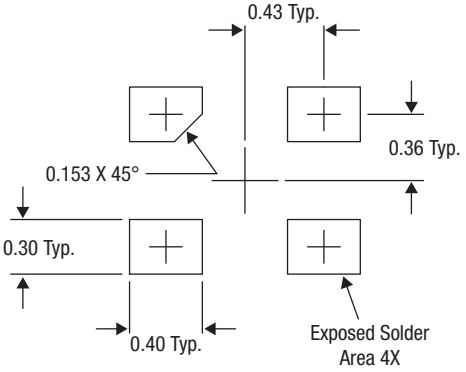
SSOP 20-Lead



SC-88 (6-Lead SC-70)

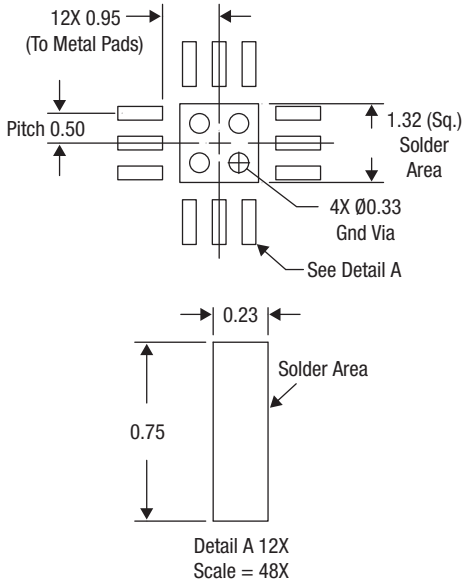


SOT-666

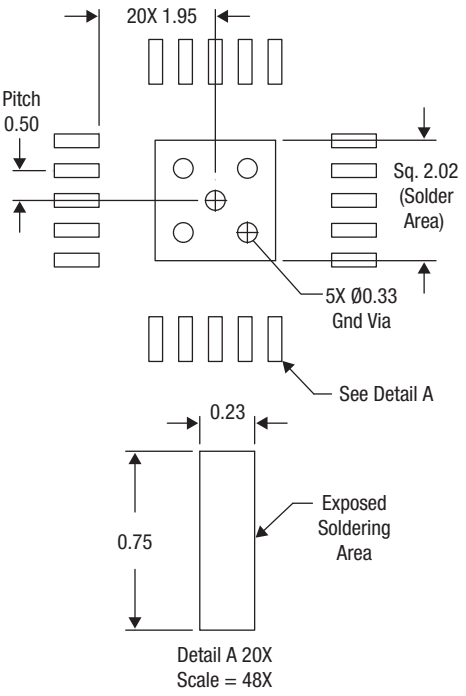


LGA

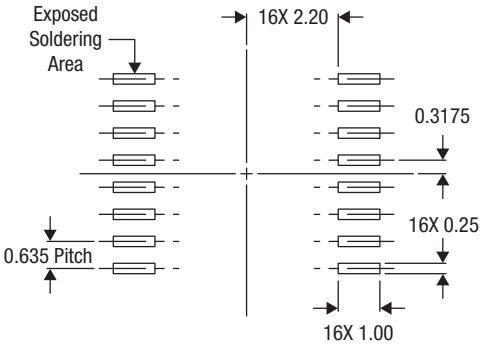
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0328



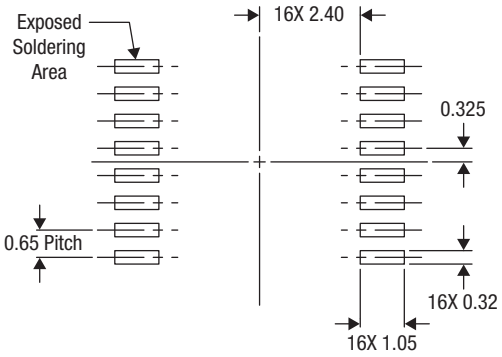
QFN (3 x 3)



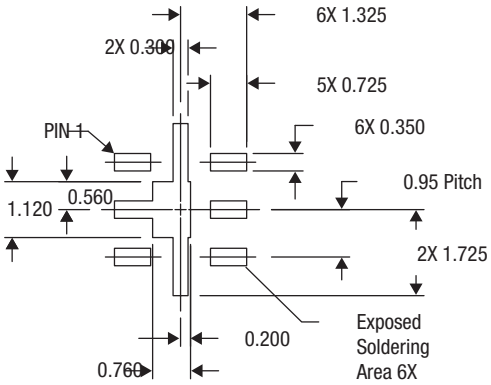
QFN 20-Lead (4 x 4) 2.1 mm Paddle



SSOP 16-Lead

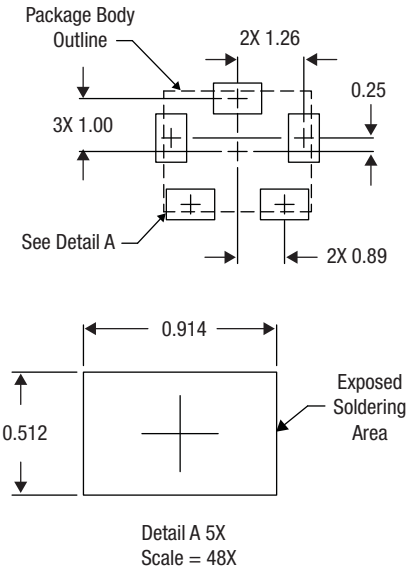


TSSOP 16-Lead Exposed Pad

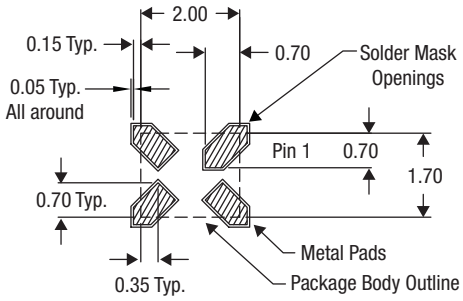


QFN 6-Lead

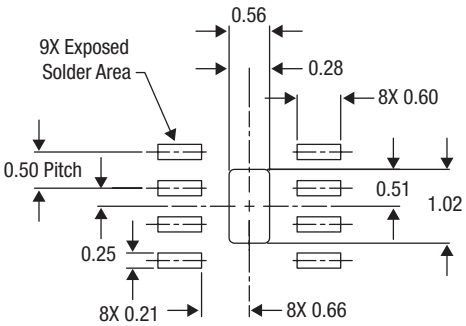
EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0329



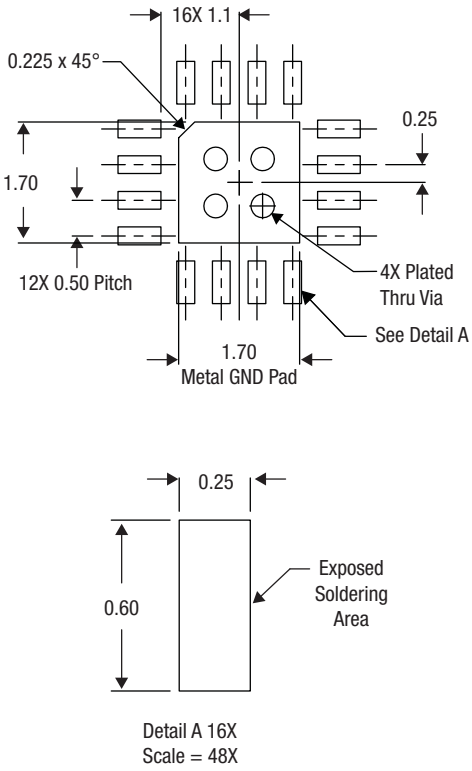
-111 SPD Surface



-116 Hermetic Ceramic Package (1.7 x 2 x 1.1 mm)



QFN 8L 2 x 2 (-349)



QFN 16-Lead (3 x 3)

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0330

Detailed Surface Mount Guidelines for Leadless Packages

Skyworks plastic encapsulated leadless style packages are being offered on several products to reduce size and weight and to improve application performance. These packages are gaining acceptance in the industry and are often referred to by such names as “QFN,” “LPCC,” “MLF” and others, and conform to JEDEC outline MO-220.

These packages use perimeter lands on the bottom of the package to provide contact to the PCB. These packages also have an exposed paddle on the bottom to provide a stable ground for optimum electrical performance of switches and attenuators, and an efficient heat path for thermal performance for amplifier products.

Within are the suggested guidelines for layout of a PCB and stencil for Skyworks 4 x 4 mm LPCC-16.

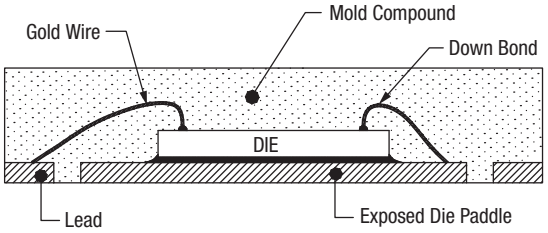
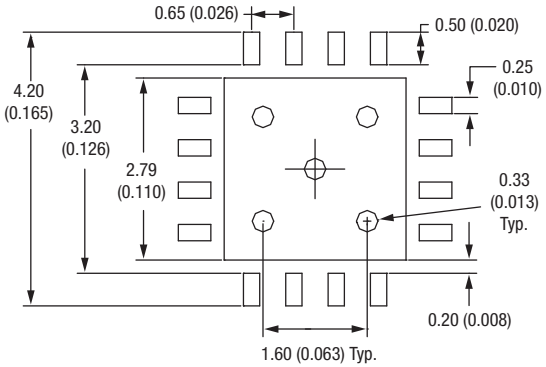


Figure 1. Package Cross Section



Dimensions in mm (in.)

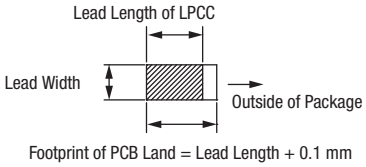


Figure 2. Surface Mount Land Pattern, LPCC 16-Lead 4 x 4 mm

PCB Design Guidelines

For the lead/terminal solder pad design, it is recommended to use a Non-Solder Mask Defined (NSMD) approach, but a small amount of solder mask should remain between the pads to avoid solder bridging between terminals. The PCB land width should match package pad width. The PCB land length should be 0.1 mm greater than the package pad length, with the extra area on the outside of the package. See Figure 2.

The ground pad on the PCB should match the size of the exposed paddle of the package and should be Solder Mask Defined (SMD). The solder mask opening should overlap the edges of the PCB ground pad by 0.065 mm (0.0025") on all four sides. The recommended design gap between the PCB ground pad and land pad is 0.15 mm minimum to avoid solder bridging and shorting. When space is available, a gap of 0.25 mm or more is preferred.

Plated thru via holes in the PCB ground pad should be 0.33 mm (0.013") in diameter and plugged. If via holes cannot be plugged, it is recommended to cap the vias on the backside of the board using solder mask material. This should allow the vias to be filled with solder during reflow.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0331

Solder Mask Design

Two types of stencil designs are used for surface mount packages:

1. Solder Mask Defined (SMD): Solder mask openings smaller than metal pads.
2. Non-Solder Mask Defined (NSMD): Solder mask openings larger than metal pads.

NSMD is recommended for the perimeter I/O lands, as this allows the solder to wrap around the sides of the metal pads on the board for a reliable solder joint.

Because the spacing between the ground pad and the land pads can be small, SMD is recommended for the ground pad to prevent solder bridging.

A stainless steel stencil, 0.125–0.150 mm (0.005–0.006") thick, is recommended for solder paste application. For better paste release, the aperture walls should be trapezoidal and the corners rounded.

For the terminal lands, the stencil opening should be 0.05 mm larger than the PCB land (0.025 mm in each direction).

For the ground pad area, it is recommended to screen the solder paste in an array of small openings rather than one large opening. The total (cumulative) area of all the openings should be approximately equal to 50% of the total ground pad area. This will ensure good solder coverage with fewer voids. See Figure 3.

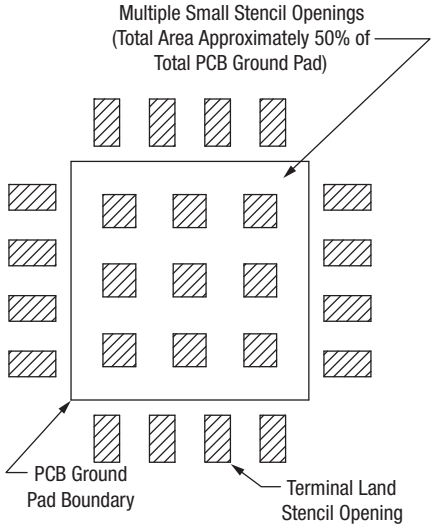


Figure 3. Recommended Stencil Design

Solder Paste and Reflow Profile

Because leadless packages have a low stand-off height and small terminal pitch, a no-clean, type-3 solder paste, and a convection/IR reflow are recommended.

Sn63 (63% Sn, 37% Pb) solder is preferred because it is a eutectic compound with a melting point of 183 °C. The reflow temperature in this case would be above 183 °C for 30–60 seconds, with a peak temperature of 205–210 °C.

If a lead-free alloy is used, such as tin/silver or tin/silver/copper, the melting points are 221 °C and 217 °C respectively. In this case, the profile would be above 221/217 °C for 30–90 seconds, with a peak temperature of 235–245 °C. Maximum temperature should not exceed 245 °C.

A typical reflow profile is presented in Figure 4, which could be used as a starting point. The actual profile used will depend on the thermal mass of the entire populated board and the solder compound used.

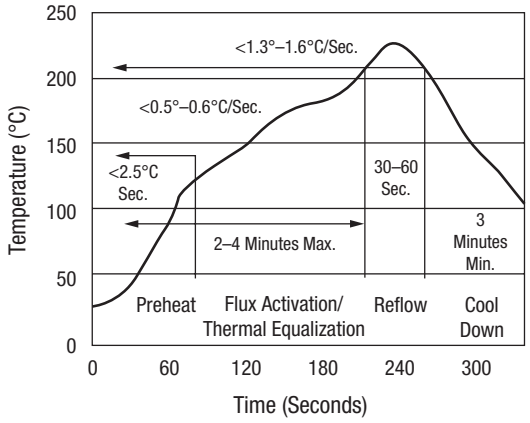


Figure 4. Typical Solder Reflow Profile

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0332

APPLICATION NOTE

High Reliability

Introduction

Skyworks, a former division of Alpha Industries, Inc. has been a major supplier of microwave devices, components, and subsystems for high reliability space and missile programs for over 20 years. Skyworks reputation for meeting stringent military requirements has enabled the company to participate in the growth of space business. This extensive experience in producing high quality, highly reliable products for military applications can be beneficial to our commercial customers as well.

Skyworks expert staff covers semiconductor wafer preparation, device assembly, and electrical and environmental testing. To be most effective, extended environmental and electrical tests should be part of a complete reliability effort which includes sound device design, high standards of workmanship during processing and assembly, and accurate documentation of customer and internal testing and reporting requirements. A team consisting of the necessary disciplines is available to determine the manufacturing procedure and testing requirements of the customer application. This customer service ensures delivery of Skyworks products with the highest reliability.

For the additional demands of space qualified high reliability diodes, where MTTF data is required, high temperature inert gas ovens have been added to the environmental test lab facility to permit MTTF data determination. This and other specialized testing can be ordered by the customer. The standard testing program and test descriptions follow.

Reliability Testing Programs

Environmental and electrical tests are used to improve and verify the reliability of microwave products. Specific tests or testing sequences may be performed for a variety of reasons. There are several categories of tests that can be performed. The most frequently performed categories are described below.

Quality Conformance Testing

Quality conformance testing (also called lot acceptance testing), is testing performed either on a sample or on 100% of the lot to determine that the devices meet specified electrical and mechanical requirements.

Qualification Testing

One basic type of testing is qualification testing. This type of testing is used to determine that the manufacturer of a device can supply devices that meet the full electrical and environmental capability requirements of the customer's specification. In MIL type specifications this testing is required before a device manufacturer is placed on a QPL (Qualified Products List). The actual tests performed are the same Group A, B and C Tests mentioned below in the Reliability Verification Sampling section along with some additional tests.

Screening

Screening, a second basic type of testing, is often performed in addition to but prior to quality conformance testing. Screening weeds out early failures and eliminates marginal devices, thus producing a lot with greater uniformity and fewer field failures. Consequently, screening tests are increasingly used for devices intended for critical uses. Most new MIL specifications (JAN-Tx specifications) incorporate screening requirements.

There is no universal screening test or sequence of tests. There are certain sequences of screening tests that are widely used. MIL-S-19500, the general specification for diodes and transistors, has preferred screening sequences of increasing levels of reliability assurance for JAN-Tx, JAN-TxV and the new JANS types. MIL-STD-883, the military standard for test methods for hybrid circuits, also contains preferred sequences of screening tests which have been used for discrete devices.

Reliability Verification Sampling

Group A, B and C testing, mentioned above in the Quality Conformance Testing section, are categories of test sequences designed to verify product reliability. Group A tests are electrical tests selected to verify the specified performance of the lot. These tests may be done 100% or on a sample basis. Group A tests are performed at the end of the manufacturing cycle and at the conclusion of any 100% extended testing, such as screening.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0333

Group B testing and Group C testing are environmental and electrical stress testing programs performed on a sample of a lot which has already passed a Group A test sequence. Group B and C tests measure the capability of the device to operate satisfactorily after exposure to electrical load conditions at elevated temperatures and environmental stresses such as temperature cycling, mechanical shock, and vibration.

Specific Types of Tests

The various reliability tests can be grouped by the nature of the tests and the characteristics of the device they are designed to evaluate. These groupings are

- Thermal tests (including burn-in)
- Mechanical tests (e.g., constant acceleration)
- Packaging integrity tests (e.g., leak test)
- Visual and radiographic examination

Thermal Tests

The rationale behind thermal screening tests is that applied temperature and/or electrical stress will cause latent defects such as poor semiconductor passivation or poor metallization to become actual defects.

High-Temperature Storage/Stabilization Bake

High-temperature storage is a simple form of accelerated life testing. The time is usually 24 to 96 hours in non-operating condition. The temperature used varies from 100 °C to 200 °C depending on device construction.

Temperature Cycle/Thermal Shock

This test consists of subjecting devices to repeated alternate exposures to high and low temperature. Normally the devices are kept in air, but on some devices—particularly those with glass bodies—the devices may be immersed alternately in hot and cold liquids. The repeated rapid change in temperature (usually -65 °C to +175 °C in air or 0 °C in liquid) will cause mechanical stresses in glass to metal or ceramic to metal package seals, and deterioration in semiconductor metallization and bonding. Temperature cycling should therefore be followed by package leak testing as well as electrical testing.

Burn-In

For most devices, burn-in is the most meaningful test. During the burn-in, electrical stress is applied to the unit at either room temperature or at a specified (elevated) temperature. The burn-in period can vary from 24 to 1,000 hours. The type of electrical stress applied depends on the device. Commonly used burn-in conditions are reverse bias, forward bias, or an AC signal consisting of forward current and reverse voltage (usually switched at a 60 Hz rate). High temperature forward or reverse bias tests are called HTFB, or HTRB, respectively. The typical burn-in temperature is specified from 25 °C to 150 °C, although higher temperature burn-ins are possible in special cases, such as high reliability space application.

Mechanical Stress Tests

Mechanical stress tests subject devices to a high mechanical stress which tests bond integrity (among other things) and ensures product reliability under worst-case field operation.

Constant Acceleration

This is the most widely used mechanical test. Usually it is applied to one axis of the device for one minute at a stress level of 20,000 Gs. This test is not a simulation of ordinary field environments where only a few Gs of acceleration may be experienced. It is, rather, a workmanship test. Experience indicates that devices with good bonds will successfully withstand exposure to high G levels, and devices with poor bonds will not.

The constant acceleration test has two limitations. The first is that as devices are made smaller in volume and mass, the effect of constant acceleration becomes diminished, and the test is less effective. The second limitation is that some devices, such as pressure contact diodes, have no bond to the semiconductor. The constant acceleration test, if used on these devices, is ineffective or even destructive.

Shock Tests

Mechanical shock (typically consisting of 0.5 to 1.0 millisecond pulses of 500 to 1500 Gs) is occasionally used as a screening test. It is particularly suitable for evaluating the mechanical ruggedness of pressure contact devices, in place of the constant acceleration test used on bonded devices.

Vibration Tests

Vibration tests may be performed with the following conditions—variable sinusoidal frequency, random frequency or fixed frequency (known as vibration fatigue). Because of their small mass and dimensions, microwave semiconductors are capable of withstanding, without change, any ordinary field vibration environments. Therefore, vibration is not commonly used in screening.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0334

Packaging Integrity Tests

Fine and Gross Leak Tests

Leak testing is the most common package integrity test and should be done after mechanical and thermal cycle tests so that package damage may be detected. Normally, both fine and gross leak tests are performed on packaged devices.

Leak testing is most appropriate for devices with high resistivity semiconductor material such as PIN devices or high breakdown voltage devices. Low resistivity or low voltage devices such as point contact and Schottky diodes do not require leak testing for most applications.

Leak testing relies on the storage of a tracer fluid or gas in the internal cavity of the device being tested. As semiconductor device packages become smaller, the sensitivity of the leak test is decreased. With cavityless devices such as encapsulated beam-lead diodes, no leak testing can be done.

Leak testing requires careful consideration of the available test methods in order to be effective.

The two fine leak test methods use radioactive gas of helium as tracer gas. The radioactive method is more sensitive but, because of the requirement for AEC licensed equipment and personnel, this fine leak test method is performed at subcontract facilities. The helium gas method is, therefore, commonly used for fine leak testing. It should be noted that the helium method of fine leak testing has some limitations, as it cannot be used with epoxy sealed units or with some types of ceramics which absorb the helium tracer gas and cause spurious test results.

Gross leak test methods include various hot liquids and penetrant dyes. Penetrant dyes are suitable for glass bodied devices, and the heated fluorocarbon method is most suitable for opaque devices.

Humidity Tests

With cavityless or small-cavity devices, a substitute for leak testing is humidity testing. MRT (Moisture Resistance Test) and salt atmosphere test are used to identify problems with corrosion of metallic surfaces, integrity of electric plating, and electrolysis of dissimilar metals. Since the humidity tests are destructive tests, they can only be done on a sample basis. However, a relatively small sample can provide an indication of the package integrity on a device intended for a critical application.

Visual and Radiographic Inspection

Visual Inspection

Visual inspection before sealing (or immediately after sealing for glass bodied devices) is one of the most commonly used screening tests. This test is included in MIL specifications (JAN-TxV) and is required on many new programs. Although there are elaborate inspection criteria specified in the test methods of MIL-STD-750 and MIL-STD-883, these criteria are not written specifically for microwave devices. For maximum value or precap visual inspection, a set of criteria designed for the specific device should be prepared and approved by both supplier and user before inspection of the devices. Visual inspection will indicate general quality of workmanship as well as the presence of any potential defects such as loose conductive material or foreign matter that might cause semiconductor deterioration after sealing.

Radiographic Examination

An alternate or supplement to precap visual inspection is radiographic examination. This method is valuable in that there is a record of the inspection results. For many devices the method lacks sensitivity. This is particularly true of devices with small cavities and self-contained heat sinks where the opaque heat sink material masks the cavity.

Silicon is transparent to X-Ray, but solder, gold and other high-density materials show up readily. Detection of such material in a loose condition and identification of structural defects are the main goals of this type of inspection.

SEM Inspection

A special type of physical examination is performed with the SEM (Scanning Electron Microscope). This test method is destructive, but it is valuable in evaluating metallization characteristics of sample semiconductor chips for wafer approval. The SEM method of examinations is also valuable in failure analysis of devices for observation and recording of defects.

Individual Device Rejection Criteria after Testing

For some tests such as leak testing or radiographic testing, inspection criteria are included in the test method. Most other test methods will require an electrical test to be performed after the environmental stress. The choice of tests governs the sensitivity and expense of the tests. The simplest criterion is that of Go-No-Go testing to fixed limits after stress testing. The basic assumption is that devices will be either good devices or catastrophic failures.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0335

A more sophisticated criterion is noting the change in one or more electrical parameters of a device tested before and after the environmental stress, and discarding those devices that change more than a predetermined amount (or delta limit). The assumption here is that some devices in the lot will change significantly but not catastrophically. When only a few devices from the lot change, they should be rejected because they are in some way different from the rest of the lot, even though they still meet the electrical limits of the basic specification. The increase in test sensitivity is matched by an increase in test cost because all devices must retain identity through the testing cycle, electrical test measurements must be recorded, and deltas must be calculated. A theoretical defect of this criterion is that there is not extensive knowledge of the device being tested, the delta limit may be too tight, thus rejecting good, stable devices, or too loose and thus accepting poor, unstable devices. A refinement of the delta method suitable for large lots undergoing screening tests for critical applications is to determine delta criteria based on the behavior of the lot being tested. Such a method requires close monitoring of test results during the test program as well as extensive experience with the device being tested.

Lot Rejection Criteria after Testing

Rejection criteria for individual devices within a lot were discussed above. A common lot rejection criterion is the PDA (Percent Defective Allowed). Lots whose percent defective is greater than the specified PDA are rejected on the assumption that good devices from a lot with a higher percentage of defects are potentially less reliable than good devices from a lot with a low percentage of defects.

Test Sequence

The sequence of screening tests is critical and is usually specified in MIL type specifications. The sequence specified in MIL-S-19500 for example is

1. Precap visual inspection
2. Thermal stress (stabilization bake, temperature cycling)
3. Mechanical stress (constant acceleration)
4. Leak tests
5. Burn-in
6. Radiographic and external; VuExternal visual examination

The rationale for this sequence is that mechanical stress should be applied after any structural weakening due to thermal stress. Leak testing should monitor the effects of thermal and mechanical stresses on the device. Final physical examination of the device should be after all other testing.

Semiconductor Chip and Beam-Lead Screening

Unmounted semiconductor chips and beam leads are screened for the same reasons as discrete diodes. The 100% screening tests that are performed on them are limited in number for two reasons. First, since the chips and beam leads are unmounted, no screening tests are necessary for package characteristics tests. Therefore, diode package leak tests or mechanical tests such as constant acceleration are not required. Second, because of the difficulty of making good electrical contact to unmounted chips and beam leads, burn-in cannot be performed.

The standard 100% chip and beam-lead screening tests are, therefore, stabilization bake, temperature cycle, and visual inspection. Test conditions are the same as described above for discrete diodes.

In addition to the 100% testing on individual chips and beam-leads, there may be tests performed on a sample basis. These tests are destructive and are done to evaluate the wafer from a particular lot from which they are taken. Wafer evaluation tests include electrical tests, chip and beam-lead mountability tests and life tests. Electrical tests include such measurements as high frequency performance, which cannot be readily or accurately measured on chips and beam leads. A sample of them is mounted in diode packages in order to make these measurements.

Chip and beam-lead mountability tests are made in order to insure that they may be securely bonded to the substrate and that wire or ribbon may be bonded to the diode chip junction area. These tests are performed by mounting the chip or beam lead on a test substrate and then determining the breaking strength of the chip or beam lead to the substrate or ribbon to chip bond.

Screening Cycles for Specific Devices

The screening cycle for a specific device should be specified only after the consideration of many factors. The application will determine the reliability level needed, the level of environmental stresses expected, and the feasibility of replacement in case of failure. The design and construction of the device will determine what potential failure mechanisms must be monitored. For example, screening cycles will vary depending on whether the device is a gallium arsenide varactor diode, a beam-lead Schottky diode, a PIN diode or a point contact diode.

Skyworks has prepared recommended screening cycles for general use for a wide variety of microwave semiconductor devices. The recommended screening cycles are based on over 20 years of high reliability diode screening experience on American and European space programs and many missile and aerospace programs.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0336

Beyond the basic catalog-part, three levels of product assurance screening are provided as standard: Tx, TxV, and S. The S level screening is the most stringent. The TxV adds a pre-cap visual inspection to the Tx screening routines. In addition, Group B and C Inspections can be performed. These sequences provide for extended environmental and electrical testing on a random sample of lot.

A selection of any one of these screening and testing options can be made by adding Tx, TxV, or S to the catalog part number. Tables 1 through 9 delineate the standard screening and testing sequences provided for parts with the appropriate suffix. Skyworks product line engineers are available to assist the customer in the selection of screening and extended testing requirements.

Quality Philosophy

Skyworks unparalleled commitment to the Total Quality Management philosophy has led to significant improvement in manufacturing operations. Continuous improvement via an empowered workforce concentrated around a teamwork approach is the operational philosophy adopted at Skyworks. Each individual understands that quality is their responsibility, and that they have significant input toward improving not only their specific function in the company, but toward improving the entire company.

Problem-solving teams dedicated to continuously improving specific operations are imminent, while system and business strategy evaluation is performed through a vibrant reengineering program.

Skyworks believes training is paramount to the continuous improvement process, and an exhaustive training program has been established at all levels of the organization.

Quality System

Skyworks is ISO 9001 certified. Although primarily an MIL-I-45208 facility, Skyworks has successfully implemented MIL-Q-9858 system requirements to satisfy various customer needs. Skyworks calibration system meets the requirements of MIL-STD-45662.

Skyworks has established isolated manufacturing cells which meet Class 0 Electrostatic Discharge requirements (devices susceptible to damage at less than 200 volts). In addition, Skyworks GaAs MMIC products group has developed MMIC controls greatly enhancing the device's survivability to increased electrostatic discharge.

Skyworks also incorporates a vibrant statistical process control program, providing training to all personnel on theory and usage of control data and chart plotting to consistently monitor process performance and capability.

Table 1. Semiconductor Package Diode 100% Process Conditioning Screening

Test Inspection Note 1	MIL-STD-750 Method	Level Requirements		
		S	TxV	Tx
Internal Visual	2074 or 2073	100%	100%	N/A
Temperature Storage	1032	100%	100%	100%
Temperature Cycle	1051	100%	100%	100%
Acceleration	2006	100%	100%	100%
PIND	2052	100%	N/A	N/A
FIST	2081	100%	N/A	N/A
BIST	2082	100%	N/A	N/A
Fine Leak	1071	100%	100%	100%
Gross Leak	1071	100%	100%	100%
Electrical Test	Note 2	100%	100%	100%
Burn-In[1]	1038, Note 3	100%	100%	100%
Electrical Test	Note2	100%	100%	100%
Burn-In[2]	Note 3	100%	100%	100%
Electrical Test	Note 2, 4	100%	100%	100%
Fine Leak	1071	100%	N/A	N/A
Gross Leak	1071	100%	N/A	N/A
X-Ray	2076	100%	N/A	N/A
External Visual	2071	100%	N/A	N/A

1. The actual test methods and conditions will vary depending upon component type and packaging.
2. Electrical tests performed are selected for each device type and usually consist of some or all of the following; V_B, I_R, C_T, V_F, R_S.
3. Burn-in methods and conditions vary with components type, packing and ratings. An example of typical burn-in conditions is given in Table 2.
4. The recommended PDA across burn-in, for all levels, is 10%.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0337

Table 2. Recommended Burn-In Conditions

Component Type: Varactor, PIN
– Burn-in[1] HTRB Ta = 125 °C V_R = 80% rated V_B T = 48 hours
– Burn-in[2] HTFB Ta = 125 °C I_F = 10 mA T = 96 hours; Tx; TxV T = 240 hours; S

1. The actual test methods and conditions will vary depending upon component type and packaging.

Component Type: Schottky
– Burn-in[1] HTFB Ta = 125 °C I_F = 5 mA T = 48 hours
– Burn-in[2] HTFB Ta = 125 °C I_F = 5 mA T = 96 hours; Tx; TxV T = 240 hours; S

2. Electrical tests performed are selected for each device type and usually consist of some or all of the following; V_B, I_R, C_T, V_F, R_S.

Table 3. Semiconductor Diode Group B Inspection

Subgroup	Test Inspection	MIL-STD-750 Method	Level Requirements	
			S	Tx and TxV
1	Physical dimensions	2066	Sample	N/A
2	Solderability	2066	Sample	Sample
	Resistance to solvents	1022	Sample	Sample
3	Temperature cycle	1051	Sample	Sample
	Thermal shock	1056	Sample	Sample
	Fine leak	1071	Sample	Sample
	Gross leak	1071	Sample	Sample
	Electrical test	Note 1	Sample	Sample
	Decap internal visual	2075	Sample	Sample
	SEM	2077	Optional	Optional
	Bond strength	2037	Sample	Sample
	Die shear	2017	Sample	Sample
4	Operation life	1037	Sample	N/A
		1027 (t = 340 hrs)	N/A	Sample
	Electrical test	Note 1	Sample	Sample
5	Thermal resistance	3101	Sample	Sample
6	High temperature storage	1032 (t =340 hrs)	N/A	Sample
	electrical test	Note 1	N/A	Sample

1. Electrical tests performed are selected for each device type and usually consist of some or all of the following; V_B, I_R, C_T, V_F, R_S.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0338

Table 4. Semiconductor Group C Inspection

Subgroup	Test Inspection	MIL-STD-750 Method	Level Requirements	
			S	Tx and TxV
1	Physical dimensions	2066	N/A	Sample
2	Thermal shock	1056	Sample	Sample
	Terminal strength	2036	Sample	Sample
	Fine leak	1071	Sample	Sample
	Gross leak	1071	Sample	Sample
	Moisture resistance	1021	Sample	Sample
	Electrical test	Note 1	Sample	Sample
3	Shock	2016	Sample	Sample
	Vibration variable frequency	2056	Sample	Sample
	Acceleration	2006	Sample	Sample
	Electrical test	Note 1	Sample	Sample
4	Salt atmosphere	1041	Sample	Sample
5	Operation life	1026 (t = 1000 hrs)	Sample	Sample
	Electrical test	Note 1	Sample	Sample

1. Electrical tests performed are selected for each device type and usually consist of some or all of the following; V_B, I_R, C_T, V_F, R_S.

Table 5. Semiconductor Diodes Group B and C Sample Sizes

Subgroup	Small Lot Sample[1]	Small Lot Sample TxV and Tx[1]	Sampling Plan LTPD	Sampling Plan TxV and Tx LTPD
B1	8	N/A	10	N/A
B2	6	4	15	15
B3	6	6[2]	10	10[2]
B4	8	12	10	5
B5	8	6	10	15
B6	N/A	12	N/A	7
C1	N/A	6	15	15
C2	6	6	10	10
C3	6	6	10	10
C4	6	6	15	15
C5	12	12	10	10

1. Small lot sample size is applicable for inspection lots containing less than 500 units.
2. Decap Visual will be performed on one device for TxV and Tx levels.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0339

Table 6. Screening Sequence for Chips and Beam Leads

Subgroup	Test Inspection	MIL-STD-833 Method	Level Requirements	
			S	B
	Temperature storage Temperature cycle Electrical test Visual inspection	1008 1010 Note 2 2010	100% 100% 100%	100% 100% 100%
Sample Evaluation Tests				
1	Internal visual	2010	Q/Acc 10/0	Q/Acc 10/0
2	Stabilization bake Temperature cycle Constant acceleration Electrical test Burn-in[1] Electrical test Burn-in[2] Electrical test	1008 1010 2001 Note 2 1015 (t = 240 hrs) Note 3 Note 2 1005 (t = 1000 Hrs) Note 3 Note 2	10/1 10/1 10/1 10/1 10/1 10/1 10/1 10/1 10/1 10/1	N/A N/A N/A N/A N/A N/A N/A N/A N/A 10/1
3	Wire bond evaluation	2011	10/0	10/0
4	SEM	2018	Sample	N/A

1. The actual test methods and conditions will vary depending upon component type and packaging.
2. Electrical tests performed are selected for each device type and usually consist of some or all of the following; V_B, I_R, C_T, V_F, R_S.
3. Burn-in methods and conditions vary with components type, packing and ratings. An example of typical burn-in conditions are given in Table 2.

Table 7. GaAs MMICs Sequences[1]

Test Inspection	MIL-STD-833		Requirements	
	Method	Condition	Class S	Class B
Pre-seal burn-in	1030		Optional	Optional
Nondestructive bond pull	2023		100%	N/A
Internal visual	2017		100%	100%
Stabilization bake	1008	C	100%	100%
Temperature cycling or thermal shock	1010 1011	C A, min.	100% NA	100% 100%
Mechanical shock or constant acceleration	2002 2001	B A (Y1 only)	100% 100%	100% 100%
PIND (Particle Impact Noise Detection)	2020	A or B	100%	N/A
Electrical			100%	Optional
Burn-in	1015	125 °C	100%	100%
Final electrical test	Per applicable device application		100%	100%
Seal 1. Fine 2. Gross	1014		100%	100%
Radiographic	2012		100%	N/A
External visual	2009		100%	100%

1. For hermetic package parts.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0340

Table 8. MMIC Group B Inspection

Subgroup	Test Inspection	MIL-STD-833 Method	Level Requirements		Sample Size Qty/Acc.
			S	B	
1	Physical dimensions	2016	Sample	Sample	2/0
2	PIND test	2020	Sample	N/A	15/0
3	Resistance to solvents	2015	Sample	Sample	4/0
4	Internal visual and mechanical	2014	Sample	Sample	1/0
5	Bond strength	2011	Sample	Sample	2/0
6	Die shear strengths	2019	Sample	Sample	2/0
7	Solderability	2003	Sample	Sample	1/0
8	Electrical test Electrostatic Discharge Sensitivity Electrical Test	3015	Sample	Sample	3/0

Table 9. MMIC Group C Inspection

Subgroup	Test Inspection	MIL-STD-833 Method	Level Requirements		Sample Size Qty/Acc.
			S	B	
1	External visual	2009	Sample	Sample	5/0
	Temperature cycle	1010	Sample	Sample	
	Constant acceleration	2001	Sample	Sample	
	Fine leak	1014	Sample	Sample	
	Gross leak	1014	Sample	Sample	
	X-ray	2012	Sample	N/A	
	Visual examination		Sample	Sample	
	Electrical test		Sample	Sample	
2	Steady state life	1005 (t = 100 hrs)	Sample	Sample	5/0
	electrical test			Sample	
3	Internal wafer vapor contents	1018	Sample	Sample	3/0

Reliability—MTTF Data

Accelerated life testing was performed on MESFETs fabricated by the MSAG® process to determine the median time to failure of the DC–6 control device product line. The devices used in the test were small signal MESFETs with a gate periphery of 300 µm. The conditions were a DC bias of 3 V_{DS} and 100% of I_{DSS}. The failure criteria was a 20% decrease in the value of I_{DSS}. This decrease in I_{DSS} is a result of an increase in channel resistance and represents approximately 0.1 dB increase in insertion loss.

Temperature step stress testing was necessary for the determination of MTTF due to the high reliability of the GaAs devices. The channel temperatures and median lifetimes for the units on test were:

Temperature (°C)	Median Lifetime (Hours)
400	60
370	270
350	1000

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0341

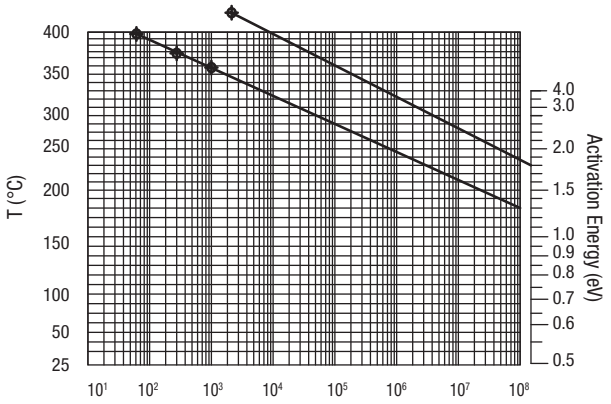
The failure mechanism is a physiochemical process that, as an activation energy follows the Arrhenius equation which relates reaction rate to temperature.

$$R = R_0 e^{-EA/KT}$$

where: R_0, K are constants
EA = Activation Energy in Election Volts
T = Absolute Temperature ° Kelvin

A graphical solution using specially prepared graph paper allows the easy determination of EA and also convenient display of median time to failure at normal operating temperature.

This data shows that for 150 °C operating temperature, the median time to failure is 10^9 hours for the DC–6 GHz family of control devices. These results are the best reported for microwave GaAs devices.

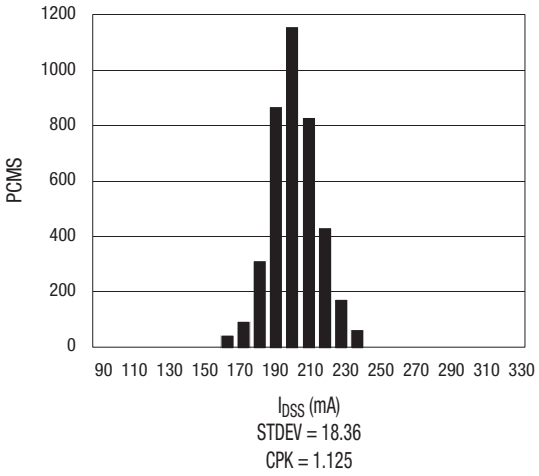


Median Time To Failure

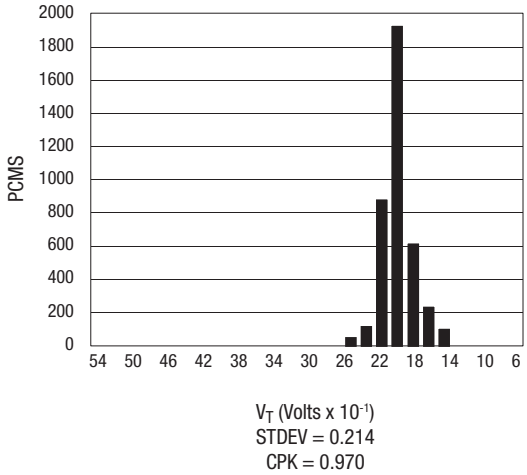
Median Time to Failure is the time required for 1/2 of units to fail. Mean Time to Failure is found by measuring the individual lifetime of a population of devices and calculating the average lifetime. For this discussion, Median Time To Failure approximates the Mean Time To Failure. Mathematically the MTTF is represented as the reciprocal of the failure rate (λ) for the useful life of the devices. The MTBF (Mean Time between Failures) can be expressed as 1.443 times the MTTF.

GaAs MMIC Product Uniformity

The quality and consistency of Skyworks GaAs MMIC DC–6 GHz chips fabricated using the ITT MSAG process is maintained throughout implementation of Statistical Process Control methods. Wafer fabrication, assembly and test all maintain records which will enable us to ultimately produce performance control to the six sigma level. Several examples of the excellent performance distribution with respect to the MMIC chips themselves are displayed below where the number of PCMS is plotted vs I_{DSS}, pinch off voltage, gate to drain breakdown voltage, and 40 Ω thin film resistor values. The data represents approximately 125 wafers (250,000 devices). Skyworks has a standard 3 V process and a standard 5 V process. The data below is from the 3 V process.

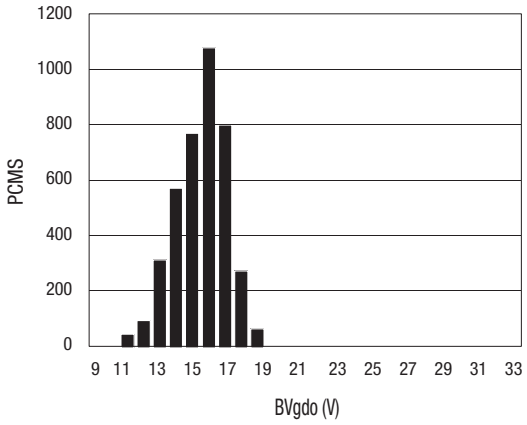


FET I_{DSS}

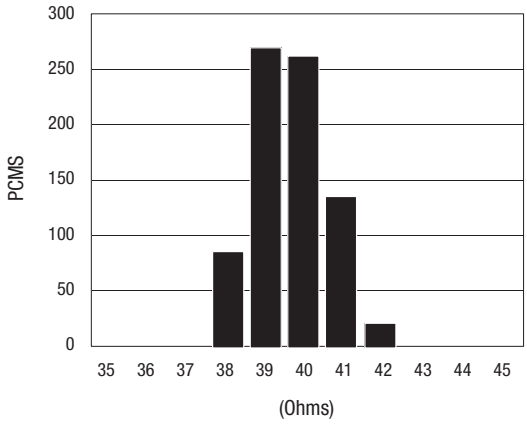


FET V_T

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0342

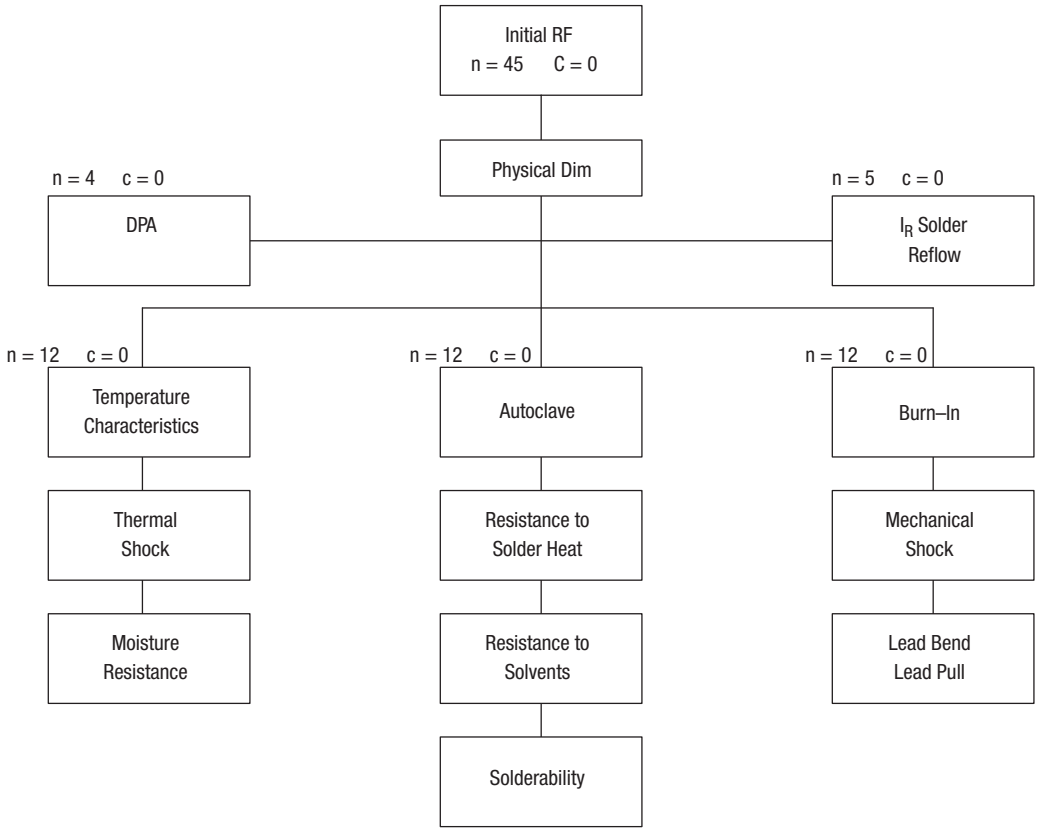


FET BVgdo



40 Ohm Thin Film Resistor

Qualification for SOIC/SOT Packages



Flow Chart of Qualification Procedure of Plastic SOIC or SOT Packages

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0343

APPLICATION NOTE

Waffle Pack Chip Carrier Handling/Opening Procedure



Proper ESD handling practice should be adhered to at all times when handling a Skyworks product.



Step 1

Remove carrier clip. Do not allow separation between the waffle pack and cover.



Step 2

Place lidded waffle pack onto a flat ESD surface. Avoid separation between the waffle pack and cover.



Step 3

Gently tap cover using the handle of a set of tweezers. This will remove any devices that are clinging to the inside paper.



Step 4

Lift cover.



Step 5

Remove the two layers of paper. They should be slid off the waffle pack with light pressure.



Step 6

Remove die from carrier. The use of a vacuum tool is strongly suggested. Tweezers should not be used to remove die.

Caution: *Devices should be handled only at an ESD-approved workstation.*

Waffle pack chip carriers are made of ChipSentry® black conductive polycarbonate from fluoroware.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0344

ESD Awareness

Skyworks deploys state-of-the-art ESD controls from wafer fabrication through to assembly, test, and pack. In order to maintain device integrity, Skyworks has outlined critical ESD guidelines that should be followed as a minimum. Skyworks adheres to the requirements outlined in MIL-HDBK-263, MIL-STD-1686 and ESD Association 2.0 Handbook.

Closing



Step 1

When closing the package the two layers of paper should be aligned properly with the waffle pack.



Step 2

The cut corner in the upper left should match up on the waffle pack and cover. The clip can be put back on when the cover is properly set on waffle pack.



Step 3

Slide carrier clip on. Avoid separation between the waffle pack and cover.

Device Handling

Remove ESD-sensitive devices from protective containers at approved ESD work stations only.

ESD wrist straps are required when handling devices outside their ESD protective packaging.

All personnel shall be properly grounded (footstraps/wrist straps) prior to opening static shielding bags.

ESD-sensitive devices should always be handled by the part body. Avoid touching the leads. When hand tools are required to accomplish an operation, use only tools that are dissipative, conductive, or treated with topical antistat.

ESD Workstation

Your ESD safe work area should follow the requirements outlined in MIL-HDBK-263 and ESD Association Handbook 2.0. The following requirements are strongly recommended:

Personnel

The use of constant wrist strap monitors is highly recommended. This monitor guarantees that the connection to ground is continuously made. An alarm will sound when that connection is broken.

Clothing

An ESD-protective garment (smock, etc.) shall be used at the workstation. While a person may be grounded using a wrist strap or foot strap, that does not ensure that certain clothing fabrics can dissipate a charge to ground. The use of a conductive smock is required.

Floors

Conductive or dissipative ESD flooring should be utilized whenever possible. This flooring shall be checked for ESD properties on a regular basis.

Work Surfaces

Your ESD work surface should be covered with soft dissipative material. This surface shall be tied to earth ground and shall be configured in a common point ground. In addition, the work surface shall be free of any static generating material, such as nonessential plastics, or cellophane tape.

Equipment

All equipment used to process ESD-sensitive devices shall be checked for the generation of static charging. Whether soldering irons, wave solder machines, device insertion machines or test equipment, the generation of static electricity is of concern.

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0345

APPLICATION NOTE

APN1001: Circuit Models for Plastic Packaged Microwave Diodes

Abstract

This paper reports on the measurement and establishment of circuit models for SOT-23 and SOD-323 packaged diodes. Results indicate that the 1.5 nH estimate for the SOT-23 is a useful result, as is 1.2 nH for SOD-323 single packaged diodes. It was also determined that the effective inductance of the SOT-23 may be reduced to approximately 0.4 nH by adding a second bond wire and modifying the microstrip line. Other lead configurations, including parallel bond wires and common cathode configurations, were also studied.

Introduction

Discrete, low-cost, surface mount semiconductor diodes are attractive choices for UHF and microwave applications where package parasitic may have a significant impact on performance. The most common package styles are the SOT-23 and the SOD-323 (Figure 1) which were neither designed nor intended for RF service. A primary limitation to their high-frequency performance, particularly in PIN diode shunt connected switches, is parasitic package inductance, which limits high-frequency isolation. The model information available from vendors of these devices has been generally limited to estimates of inductance, typically 1.5 nH, for single junction SOT-23 diodes. Establishing a better model will enable circuit designers to better predict performance and possibly give the manufacturer alternative designs to reduce package parasitic effects.

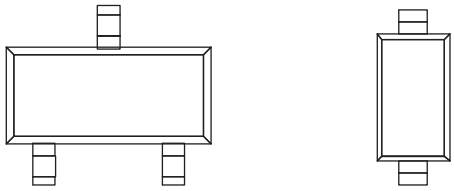


Figure 1. Diode Package Styles

Package Modeling

Network Analysis

To create a high-frequency device model S-parameter, measurements were taken over a wide frequency band so that resonance and other high order effects would be included in the measurements. This procedure utilizes an HP 8510C vector network analyzer. The package under test was inserted into an Inter-Continental Microwave test fixture as a series connected element. This fixture uses a Thru-Reflect-Line calibration procedure to produce accurate calibration and assures a reference plane at the device under test.

Using this methodology, a circuit model was generated for each of the devices as shown in Figures 2 and 3. These models produce very good correlation between the measured and simulated performance as shown in Figure 4.

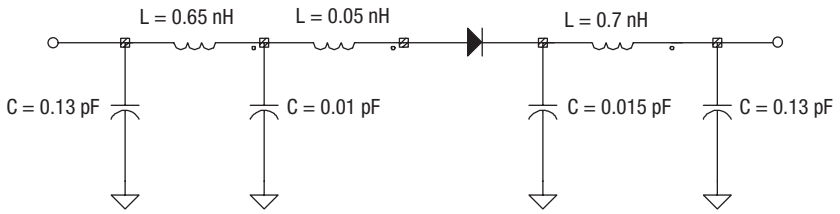


Figure 2. SOT-23 Circuit Model

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0346

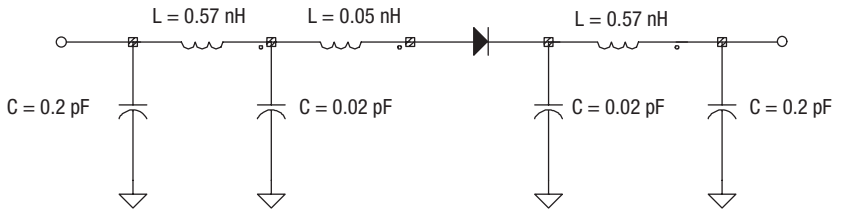


Figure 3. SOD-323 Circuit Model

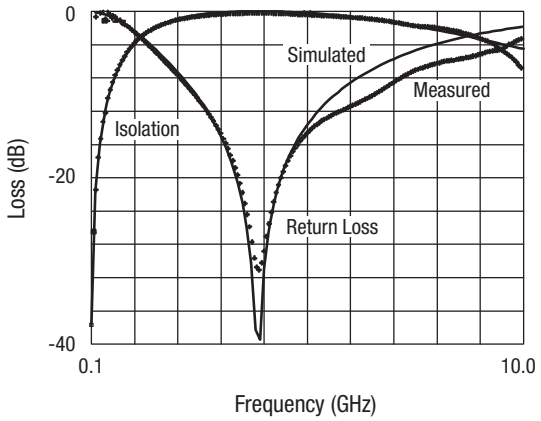


Figure 4. Measurement vs. Model Simulation of a SOT-23 Package

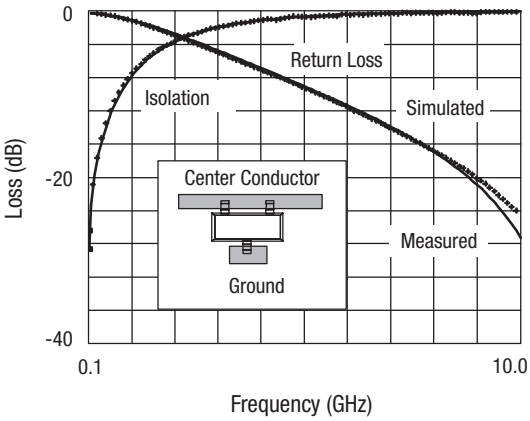


Figure 5. SOT-23 Validation: Simulation vs. Measurement

Impedance Measurements

The HP 4291A Impedance Analyzer, an instrument based on measuring the vector V/I with coverage from 1 MHz–1.8 GHz, was also utilized to characterize inductance of the packages under consideration. Measurements were taken on a group of PIN diodes that were forward biased to low values of forward resistance. The inductance values derived from these measurements are shown in Table 1 and compare well with the values derived from network analysis. The advantage of the direct impedance measurement is the capability of a quick measurement without the necessity of hard bonding the device to a substrate.

Validation of Simulated Model

Validation of the model was performed by placing the diode into a test circuit that simulates a shunt connected switch. The test circuit was constructed using a Duriod microstrip board and the device was placed as shown in Figure 5. This provided a different operating environment because not only was the diode connected differently, but the microstrip insulator had a different dielectric constant.

The measured performance of this circuit was imported into the circuit simulator and compared to a simulation using the circuit model. Figure 6 shows good validation of the network analyzer generated model.

Alternative SOT-23 Designs for Lower Inductance

To reduce the total inductance of the SOT-23 package, alternative wire bonding schemes were studied. Figure 6 shows four bonding wire designs considered in this study. The measured inductance of these bonding schemes are shown on Table 1.

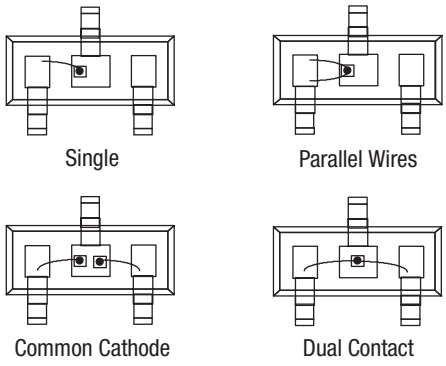


Figure 6. SOT-23 Configurations

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0347

The single wire SOT-23 diode with 1.5 nH inductance will perform with 10.1 dB isolation at 900 MHz as a shunt connected switch. The inductance is reduced to 1.2 nH if a parallel bond wire is attached to the diode contact. This will increase the isolation to 11.6 dB. A further reduction of inductance may be obtained by adding a second diode chip in a common cathode configuration. This reduces the inductance to 0.84 nH resulting in an increase in isolation to 14.6 dB.

Since two junctions are employed, in the common cathode alternative, the capacitance is doubled under reverse bias. The consequence may be an adverse effect on insertion loss. The inductance of the dual bond wire design is similar to the common cathode design resulting in similar performance. But, if the package is inserted in the microstrip circuit with a gap in the transmission line as shown in Figure 7, then the effective inductance is reduced to below 0.4 nH and the isolation is increased to 20 dB at 900 MHz. Figure 7 shows a plot of the measured isolation of the dual bond wire package versus frequency to 4 GHz. A plot of an inductance of 1.5 nH is shown as a reference.

Table 1 shows a summary of the effective package inductance values for the SOD-323 and SOT-23 packaged diodes with alternative wiring configurations using the measurement techniques described.

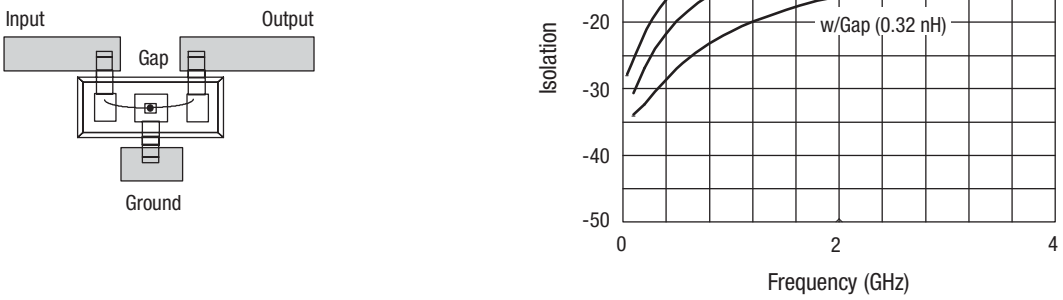


Figure 7. SOT-23 Dual Bond Wire With and Without a Gap

Package	Configuration	S-Parameter Model (nH @ 1 GHz)	S-Parameter Validation (nH @ 1 GHz)	HP 4291A Inductance (nH)
SOT-23	Single junction	1.45	1.5	1.5/1.7
SOT-23	Dual no gap	1.2	0.9	
SOT-23	Dual gap	0.5	0.4	
SOT-23	Parallel bonds			1.2
SOT-23	Common cathode			0.84
SOT-323	Single junction	1.1	1.19	1.2

Table 1. Summary of Package Inductance Values

EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0348

Conclusion

As a result of this effort, accurate and concise microwave models are now available for commonly used, low-cost, surface mount, SOT-23 and SOD-323 packaged diodes. The measurement methodology utilized de-imbedding techniques valid at frequencies through 10 GHz. This material will assist design engineers to design and predict circuit performance using these popular devices.

In addition, it was demonstrated that the inductance of the SOT-23 may be significantly reduced by modifying both the internal package wiring and the microstrip transmission line. This further improves the frequency response of the package.

Reference

R.W. Waugh and D. Gustedt, “Low Cost Surface Mount Power Limiters,” Proceedings RF EXPO WEST, March 1992, pp. 19-40.

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0349

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0350

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0351

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0352

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0353

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0354

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EX-1042
Kangxi Communication Technologies (Shanghai) Co., Ltd. v. Skyworks Solutions, Inc.
0355

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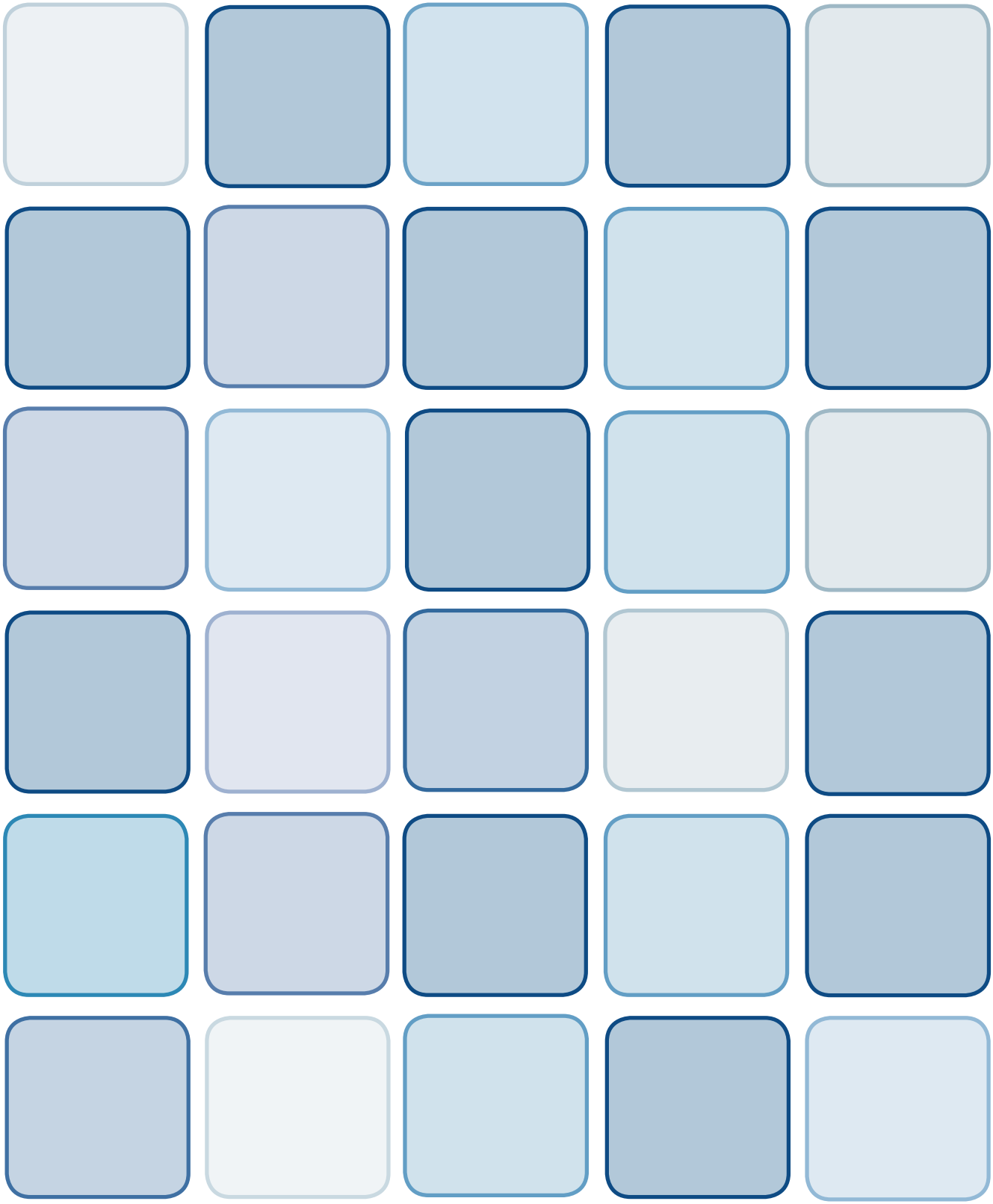
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