DATA SHEET

SKY42053: 700 – 1000 MHz High Dynamic Range, Diversity Receiver Front End

Applications

- Cellular and GSM communications
- Mobile radio systems
- Paging
- Industrial, Scientific, Medical (ISM) band

Features

- High IIP3 mixer and LNA
- Wideband RF input frequency range (700 to 1000 MHz)
- Single or two-channel applications
- Use with LNA-mixer cascaded or mixer-only
- Bias selectable LNA/mixer functions
- Integrated solid state attenuator
- CMOS-compatible control interfaces
- ±5 V supply operation
- Operating range of –40 °C to +85 °C
- Supports frequency hopping applications
- PQFP (24-pin, 11 x 11 mm) package

Description

Skyworks SKY42053 is an integrated, high-dynamic range, low-noise receiver down converter for two-channel diversity systems. The device is fabricated using Skyworks highly reliable GaAs Metal Semiconductor Field-Effect Transistor (MESFET) technology.

The SKY42053 includes a Low Noise Amplifier (LNA), followed by a double-balanced active mixer. Dual Local Oscillator (LO) inputs are selected using an external switch interface. The internal attenuator is integrated with the LNA. The attenuator function is also controlled using an externally controlled CMOS-compatible interface.

Figure 1 shows a functional block diagram for the SKY42053. The 24-pin, 11 x 11 mm Plastic Quad Flat Pack (PQFP) device package and pinout are shown in Figure 2. Signal pin assignments and functional pin descriptions are provided in Table 1.

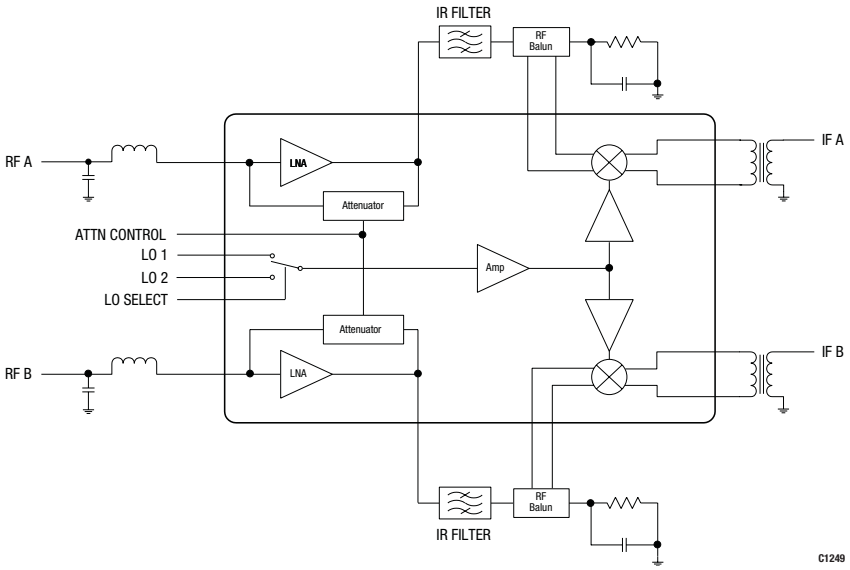


Figure 1. SKY42053 Functional Block Diagram

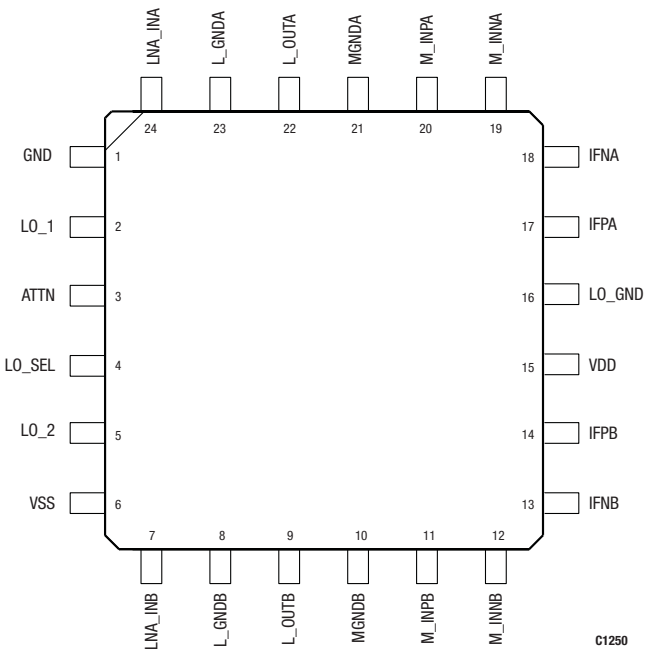


Figure 2. SKY42053 Pinout – 24-Pin PQFP Package (Top View)

Table 1. SKY42053 Signal Descriptions

Pin #	Name	Description	Pin #	Name	Description
1	GND	Ground	13	IFNB	Channel B negative differential mixer IF output
2	LO_1	Local oscillator 1 input for channels A and B	14	IFPB	Channel B positive differential mixer IF output
3	ATTN	Channels A and B attenuator control	15	VDD	Positive supply voltage
4	LO_SEL	LO_1/LO_2 select control	16	LO_GND	Local oscillator ground
5	LO_2	Local oscillator 2 input for channels A and B	17	IFPA	Channel A positive differential mixer IF output
6	VSS	Negative supply voltage	18	IFNA	Channel A negative differential mixer IF output
7	LNA_INB	Channel B LNA input	19	M_INNA	Channel A negative differential mixer input
8	L_GNDB	Channel B LNA ground	20	M_INPA	Channel A positive differential mixer input
9	L_OUTB	Channel B LNA output	21	MGNDA	Channel A mixer ground
10	MGNDB	Channel B mixer ground	22	L_OUTA	Channel A LNA output
11	M_INPB	Channel B positive differential mixer input	23	L_GNDA	Channel A LNA ground
12	M_INNB	Channel B negative differential mixer input	24	LNA_INA	Channel A LNA input

Technical Description

The SKY42053 consists of two identical channels (A and B), specifically designed for the purpose of diversity in base station applications.

Each channel consists of a single-ended LNA and a double-balanced differential mixer. The LNAs share a common CMOS-compatible attenuator control switch, which bypasses the LNA, providing 20 dB of attenuation.

Each channel shares two independent LO signals (LO1 and LO2) selected using a common CMOS-compatible control signal. With this ability, the SKY42053 can be used in frequency hopping applications.

The LNAs and mixers are independently biased. This allows design flexibility with power management functions in base station receivers.

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.

If the part is attached in a reflow oven, the temperature ramp rate should not exceed 10 °C per second. Maximum temperature should not exceed 225 °C and the time spent at a temperature that exceeds 210 °C should be limited to less than 10 seconds. If the part is manually attached, precaution should be taken to ensure that the part is not subjected to a temperature that exceeds 300 °C for more than 10 seconds.

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.

Electrical and Mechanical Specifications

The absolute maximum ratings of the SKY42053 are provided in Table 2 and the recommended operating conditions provided in Table 3. Electrical characteristics of the SKY42053 are provided in Table 4. Table 5 provides additional electrical specifications for full channel performance.

Typical performance characteristics of the SKY42053 are illustrated in Figures 3 through 9. Figure 14 provides the package dimensions for the 24-pin PQFP, and Figure 15 provides the tape and reel dimensions.

Electrostatic Discharge (ESD) Sensitivity

The SKY42053 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

Table 2. SKY42053 Absolute Maximum Ratings
(T_A = +25 °C, unless otherwise noted)

Parameter	Symbol	Min	Typical	Max	Units
Positive DC power supply	VDD			+5.5	V
Negative DC power supply	VSS			–6.0	V
Power dissipation	P_D			2.25	W
Input power	P_{IN}			+15	dBm
Thermal resistance	R_{TH}		+25		°C/W
Operating case temperature	T_{OPR}	–40		+85	°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 values.

Table 3. SKY42053 Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Units
Positive DC supply voltage	VDD	+4.75	+5.0	+5.25	V
Negative DC supply voltage	VSS	–4.75	–5.0	–5.25	V
Operating case temperature	T_{OPR}	–40		+85	°C

Table 4. SKY42053 Electrical Characteristics
(+25 °C, Voltage Supply = ±5 V, LO = 0 dBm, RF Frequency = 900 MHz, LO Frequency = 829 MHz, IF Frequency = 71 MHz, Mixer Bias = 55 mA, unless otherwise noted)

Parameter	Test Condition	Min	Typical	Max	Units
Low Noise Amplifier					
Gain		12.8	14.3		dB
Noise Figure			1.7	2.5	dB
Input IP3		13.5	16.0		dBm
–1 dB compression point		4.5	6.0		dBm
RF					
RF input frequency		700		1000	MHz
RF input (Note 1)			1.5:1	2.0:1	VSWR
RF output (Note 1)			1.5:1	2.0:1	VSWR
Mixer (Note 2)					
Conversion gain		1.0	2.2		dB
Single side band Noise Figure			9.5	12.5	dB
Input IP3		+23	+25		dBm
RF to IF leakage			–50 –50		dBm dBm
LO to IF leakage			–45 –50		dBm dBm
–1dB compression point 1/2 IF product suppression		+14	+17 –75	 –70	dBm dBc
Local Oscillator					
LO input frequency		700		1000	MHz
LO input (Note 1)	50 Ω		1.5:1	2.0:1	VSWR
LO level input		–5	0	+5	dBm
Intermediate Frequency					
IF output frequency		50		250	MHz
IF output (Note 1)			1.5:1	2.0:1	VSWR

Note 1: In a 50 Ω system obtained with external matching components on input/output ports. See Figure 10, and Tables 6 and 7 for matching network configuration and element values.
Note 2: Include RF balun and IF transformer losses.

Table 5. Full Channel Performance
(+25 °C, Voltage Supply = ±5 V, LO = 0 dBm, RF Frequency = 900 MHz, LO Frequency = 829 MHz, IF Frequency = 71 MHz, Mixer Bias = 55 mA, Image Reject Filter Loss = 1.0 dB, unless otherwise noted)

Parameter	Test Condition	Min	Typical	Max	Units
RF input (Note 1)			1.5:1	2.0:1	VSWR
Noise Figure (Note 2)			2.7	4.7	dB
Gain (Note 3)		12.8	15.5		dB
Input IP3 (Note 4)		7.5	10.3		dBm
1 dB compression point (Note 5)		–0.3	+3.7		dBm
1/2 IF product suppression			–70	–60	dBc
Channel A to B isolation		35	40		dB
LO leakage at RF input			–40	–35	dBm
LO1 to LO2 isolation		35	40		dB
Supply current @ +5.0 V, both channels Supply current @ –5.0 V, both channels			340 10	400 15	mA mA

Note 1: In a 50 Ω system obtained with external matching network on LNA and mixer input ports. See Figure 10, and Tables 6 and 7 for network elements and frequency ranges.

Note 2: Calculated using the following equation:

$$NF_{Cascaded} = 10 \times Log\left(10^{\left(\frac{NF_{LNA}}{10}\right)} + \left(\frac{10^{\left(\frac{NF_{Mixer} + Loss_{IRfilter}}{10}\right)} - 1}{10^{\left(\frac{G_{LNA}}{10}\right)}}\right)\right)$$

Note 3: Calculated using the following equation:

$$ConversionGain_{Cascaded} = G_{LNA} - Loss_{IRfilter} + G_{Mixer}$$

Note 4: Calculated using the following equation:

$$IIP3 = 10 \times Log\left(\left[\frac{1}{10^{\left(\frac{IIP3_{Mixer} - \left(G_{LNA} - Loss_{IRfilter}\right)}{10}\right)}} + \frac{1}{10^{\left(\frac{IIP3_{LNA}}{10}\right)}}\right]^{-1}\right)$$

Note 5: Calculated using the following equation:

$$P_{1dB,system} = (P_{1dB,Mixer} - (G_{LNA} - Loss_{IRfilter})) \text{ or } (P_{1dB,LNA}), \text{ whichever is less}$$

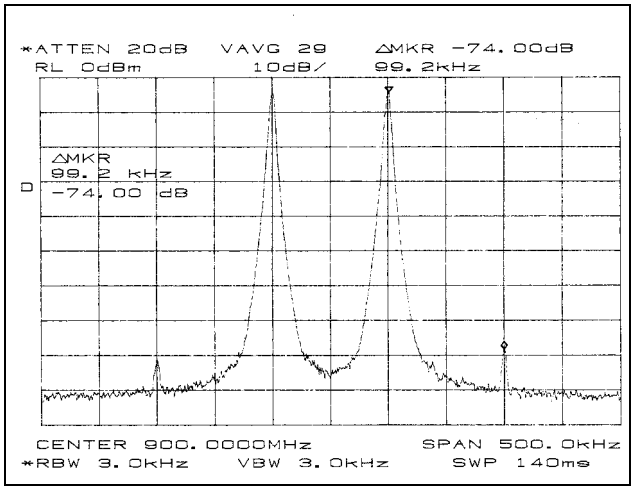


Figure 3. LNA
(IIP3 = +17 dBm, Input Power = –20 dBm)

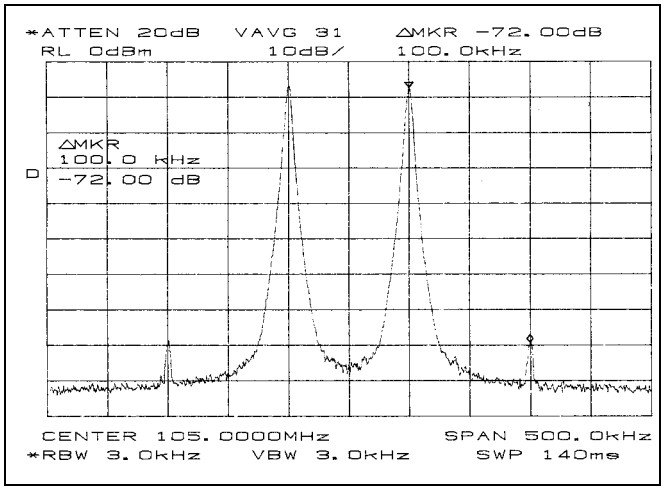


Figure 4. Mixer With High Side LO
(IIP3 = +26 dBm, Input Power = –10 dBm)

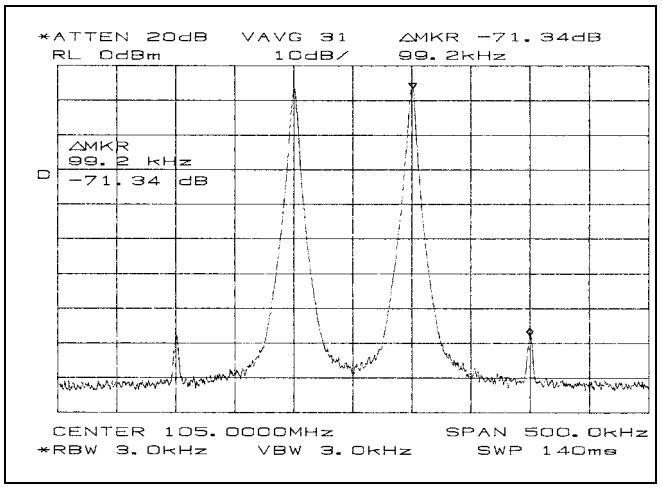


Figure 5. Mixer With Low Side LO
(IIP3 = +25 dBm, Input Power = –10 dBm)

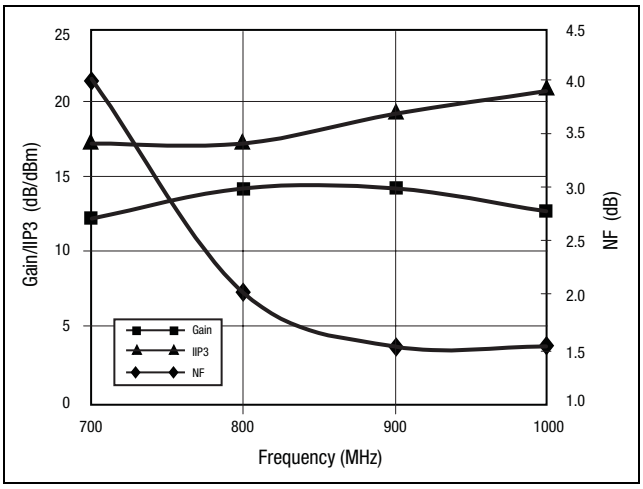


Figure 6. LNA Gain, NF, and IIP3 vs Frequency
(Values Obtained With a 900 MHz Input Match)

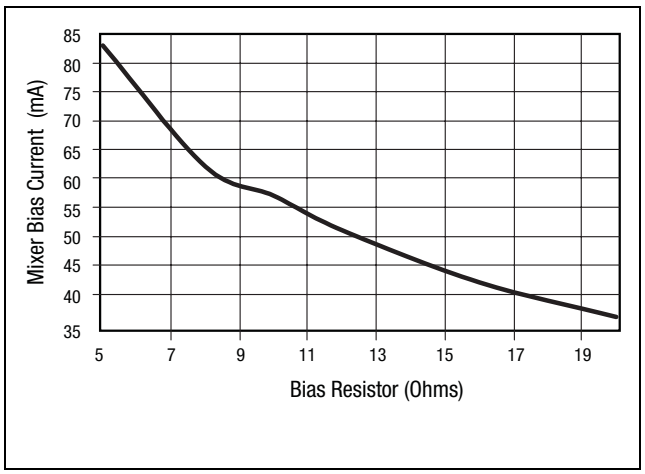


Figure 7. Mixer Bias Current vs Bias Resistor (RA1, RB1)

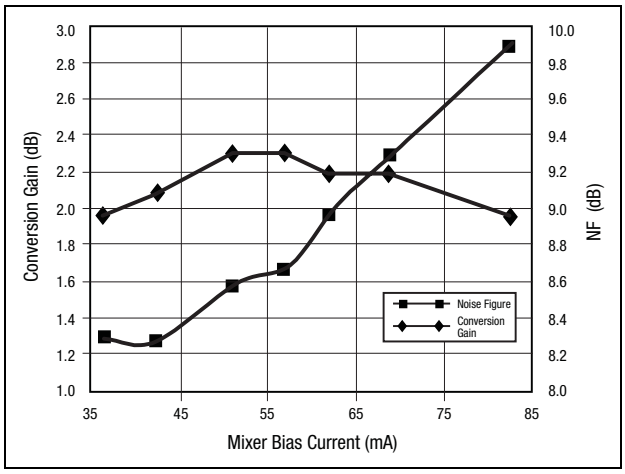


Figure 8. Mixer Conversion Gain and Noise Figure vs Bias Current

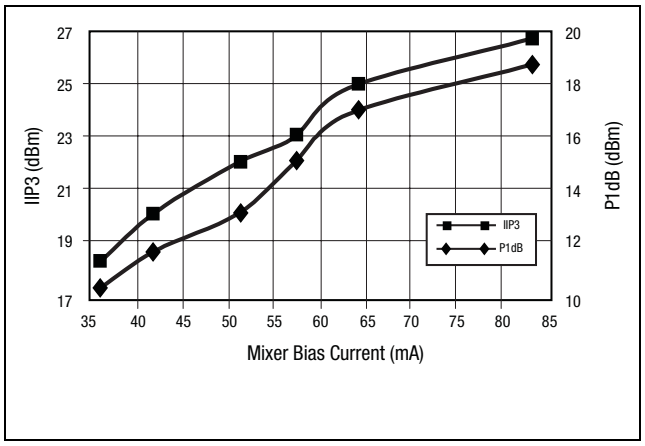


Figure 9. Mixer IIP3 and –1 dB Compression Point

Evaluation Board Description

The SKY42053 Evaluation Board is used to test the performance of the SKY42053 mixer and LNA. An Evaluation Board schematic diagram is shown in Figure 10. The schematic shows the basic design of the Evaluation Board for the RF range of 800 to 1000 MHz. The IF matching circuitry has been optimized for 60 to 130 MHz. Tables 6 and 7 contain I/O matching network components used in the schematic for RF and IF frequencies, respectively. Figure 11 displays the Evaluation Board layout.

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 downset paddle of the PQFP provides necessary electrical grounding and is the main thermal conduit for heat dissipation. Any printed circuit board using the SKY42053 must have sufficient solder mask clearance beneath the IC (i.e., approximately 110 percent of the downset paddle). This provides adequate solder coverage for the downset paddle and minimizes excessive lead standoff. Multiple vias to the grounding layer beneath the device are required for maximum thermal relief.
3. The inclusion of external bypass capacitors on the VSS and VDD voltage inputs of the LNAs and mixers is recommended. The application schematic in Figure 10 shows these capacitors (1000 pF and 12 pF) in shunt with each control switch, as well as the VSS supply. The 1000 pF capacitor serves as a low frequency bypass, while the 12 pF capacitor prevents any RF signals from coupling on to the DC supply voltages. It is recommended that the bypass capacitors be placed as close as possible to the SKY42053 for best results.
4. The LNA receives its bias voltage via the LNA output pin. The use of a blocking capacitor (RF short) on the LNA input/output and mixer input is required.
5. Ceramic or wire-wound balanced transformers (baluns) may be used to provide the differential input to the active mixer. The secondary center tap of these baluns provides the DC return path for the mixer bias current. Balun selection criterion should include DC current handling capability, differential phase/amplitude balance, insertion loss, and temperature performance.
6. The application of an image-reject filter between the LNA and mixer is recommended.
7. For proper switching of the control interface circuits, the following conditions must be met:

   Off: 0 VDC $\leq V_{IN} \leq$ 0.5 VDC @ 30 μA

   On: 3.0 VDC $\leq V_{IN} \leq$ VDD @ 120 μA
8. Resistors RA1 and RB1 are required but should not be less than 10 Ω.

LNA Testing Procedure

Use the following procedure to set up the SKY42053 Evaluation Board for LNA testing. Refer to Figure 12 for guidance:

1. Set all the DIP switches to off. For information on the switch settings, refer to Table 8.
2. Connect the SKY42053 Evaluation Board to $\pm$5 VDC power supplies using insulated supply cables. VDD should be set to +5.0 V and VSS to –5.0 V. If available, enable the current limiting function of the power supplies as follows:

   + 5 VDC supply current limit = 200 mA

   –5 VDC supply current limit = 50 mA

   Connect red and yellow banana plugs to VDD, a purple plug to VSS, and a black plug to ground. Connect a three-slot plug to the side (JP1) and a two-slot plug to the top (JP2).
3. Connect a signal generator to the LNA A input port (J1). Set the generator to the desired RF frequency at a power level of –20 dBm, but do not enable.
4. Connect a spectrum analyzer to the output port of LNA A (J2).
5. Enable the power supply by turning switches #2 and #4 on.
6. Enable the RF signal and take measurements.
7. Repeat steps 3 through 6 for LNA B, but use switches #4 and #5 to enable the power supply.

Mixer Testing Procedure

Use the following procedure to set up the SKY42053 Evaluation Board for mixer testing. Refer to Figure 13 for guidance:

1. Set all the DIP switches to off. For information on the switch settings, refer to Table 8.
2. Connect the SKY42053 Evaluation Board to $\pm$5 VDC power supplies using insulated supply cables. VDD should be set to +5.0 V and VSS to –5.0 V. If available, enable the current limiting function of the power supplies as follows:

   + 5 VDC supply current limit = 200 mA

   –5 VDC supply current limit = 50 mA

   Connect red and yellow banana plugs to VDD, a purple plug to VSS, and a black plug to ground. Connect a three-slot plug to the side (JP1) and a two-slot plug to the top (JP2).
3. Connect a signal generator to the LO1 input port (J9). Set the generator to the desired LO frequency at a power level of 0 dBm, but do not enable.
4. Connect a signal generator to the Mixer A input port (J3). Set the generator to the desired RF frequency at a power level of 0 dBm, but do not enable.
5. Connect a spectrum analyzer to the output port of Mixer A (J4).
6. Enable the power supply by turning switches #1 and #4 on.

7. Enable LO1 by turning switch #6 on.
8. Enable the LO signal, then enable the RF signal and take measurements.
9. Repeat steps 4 through 8 for mixer B, but use switches #3 and #4 to enable the power supply. If LO2 is desired, turn switch #6 off and connect the LO signal generator to the LO2 input port (J10).

***CAUTION**: If any of the input signals exceed the rated maximum values, the SKY42053 Evaluation Board can be permanently damaged.*

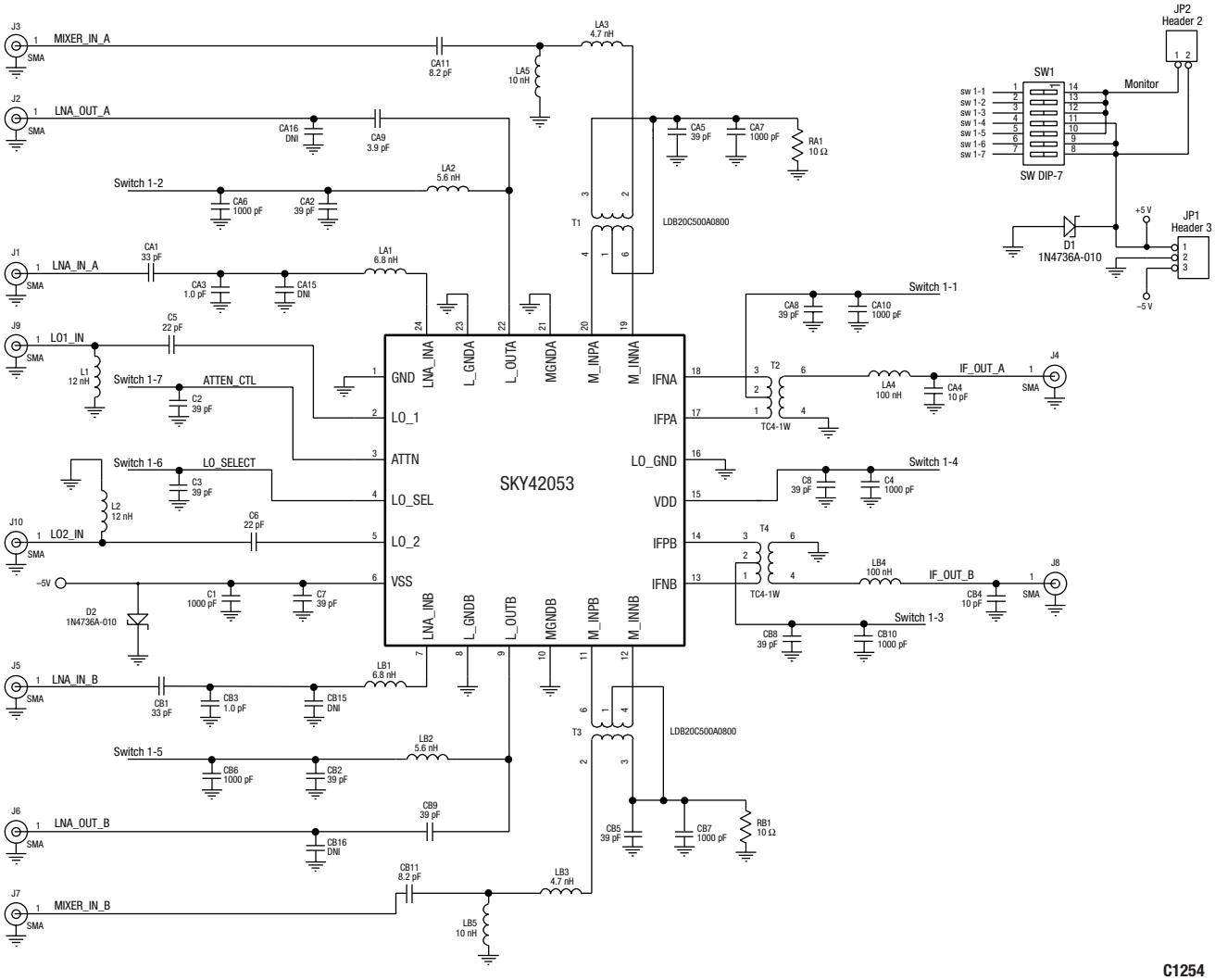


Figure 10. SKY42053 Application Schematic

Table 6. Input/Output Matching Network Components (RF Frequency)

RF Frequency	LA1, LB1	CA3, CB3	CA9, CB9	CA16, CB16	T1, T2	CA11, CB11	LA5, LB5	LA3, LB3
800-1000 MHz	6.8 nH	1.0 pF	3.9 pF	DNI	LDB20C500A800	4.7 pF	15 nH	33 nH
700-800 MHz (Note 1)	6.8 nH	1.0 pF	3.9 pF	DNI	LDB20C500A800	8.2 pF	10 nH	4.7 nH

Note 1: Standard Evaluation Kit TW11-D222 is optimized for the 850 to 1000 MHz frequency range. The schematic diagram shown in Figure 10 applies to Evaluation Kit TW11-D222.

Table 7. Input/Output Matching Network Components (IF Frequency)

IF Frequency	LA4, LB4	CA4, CB4
40-80 MHz	150 nH	10 pF
70-200 MHz (Note 1)	100 nH	10 pF

Note 1: For the stated values, CA4 and CB4 need to be moved to the side of LA4 and LB4 closest to the SKY42053.

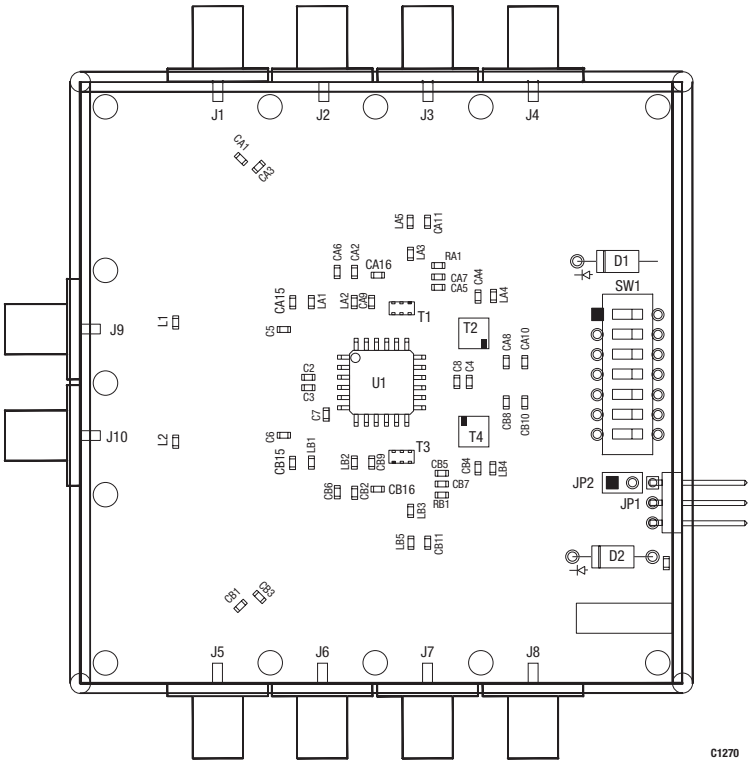


Figure 11. SKY42053 Evaluation Board Layout

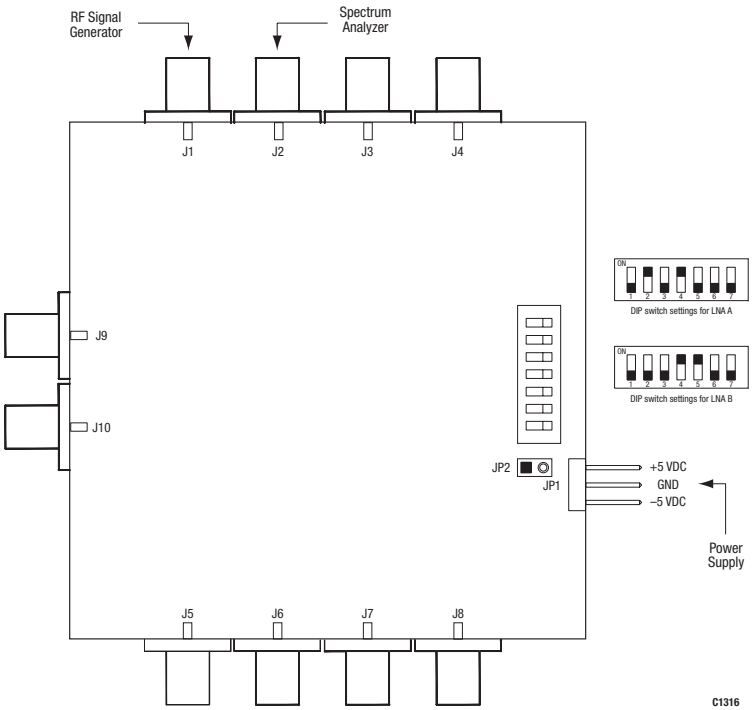


Figure 12. SKY42053 Evaluation Board LNA Testing Configuration

Table 8. SKY42053 Switch Pack Description

Switch	Name	Description
#1	V_{MIX_A}	ON enables mixer A
#2	V_{LNA_A}	ON enables LNA A
#3	V_{MIX_B}	ON enables mixer B
#4	VDD	ON enables VDD
#5	V_{LNA_B}	ON enables LNA B
#6	$V_{LOSELECT}$	ON selects LO1, OFF selects LO2
#7	$V_{ATTENUATOR}$	ON enables attenuation

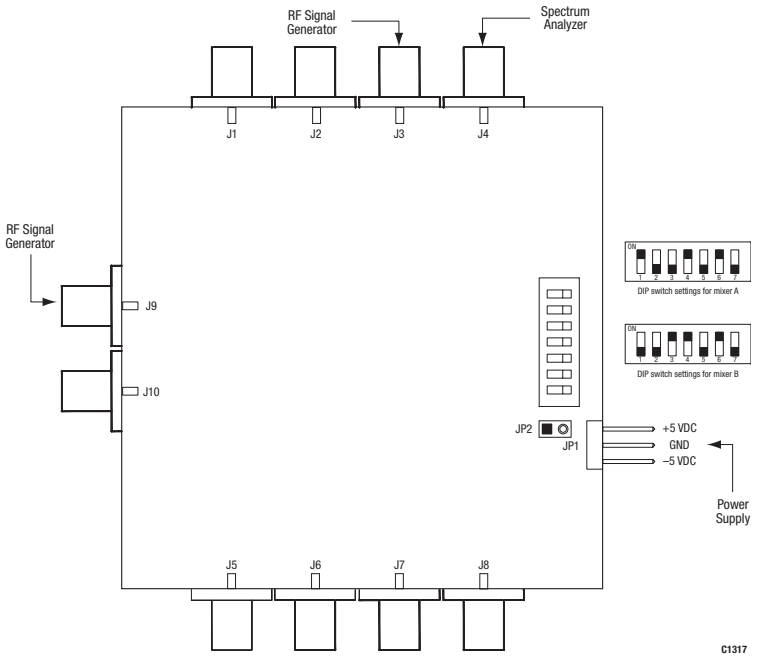


Figure 13. SKY42053 Evaluation Board Mixer Testing Configuration

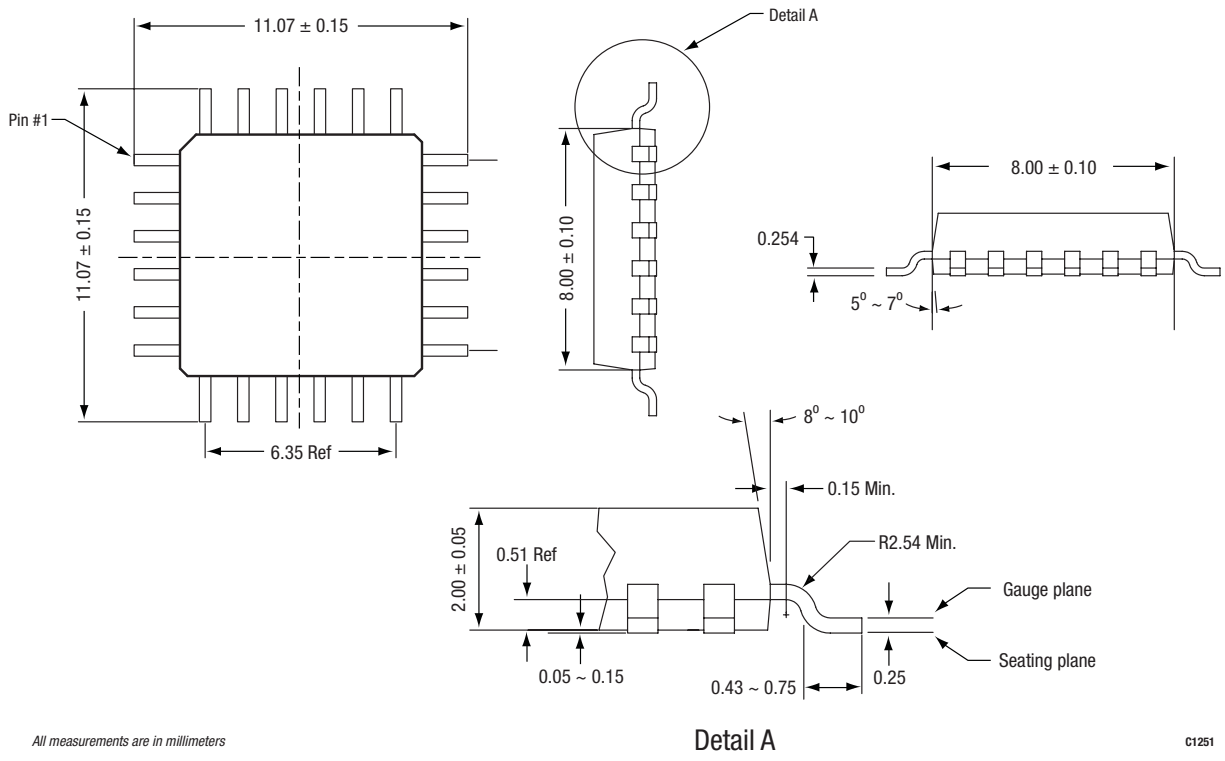
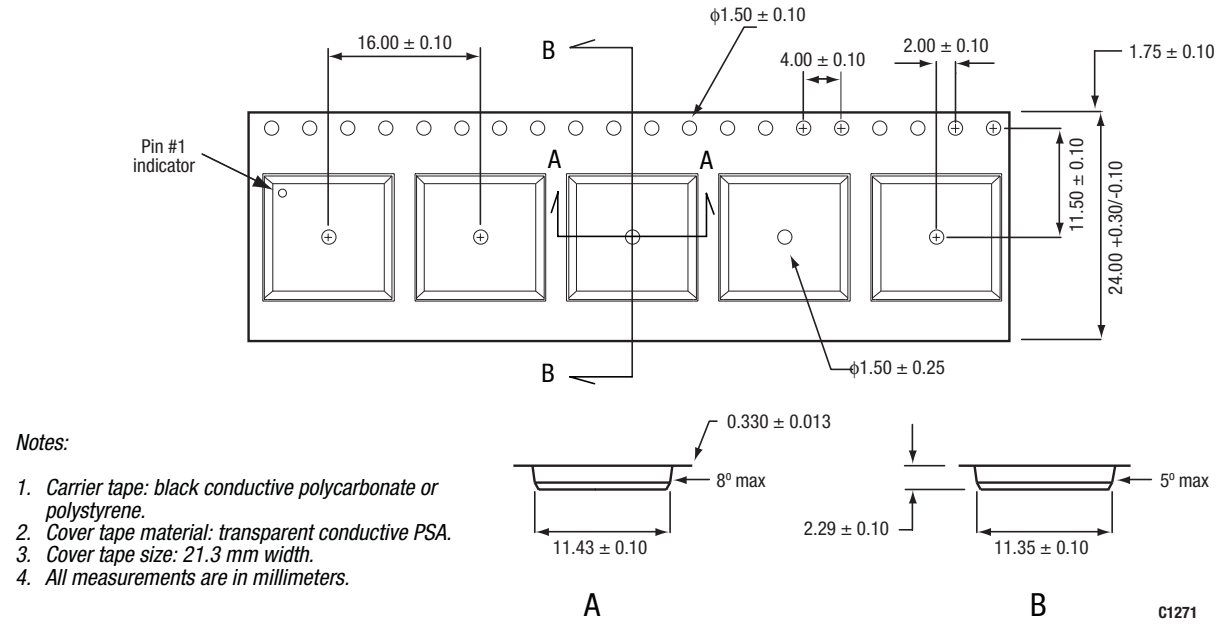


Figure 14. SKY42053 24-Pin PQFP Package Dimensions



Notes:

1. *Carrier tape: black conductive polycarbonate or polystyrene.*
2. *Cover tape material: transparent conductive PSA.*
3. *Cover tape size: 21.3 mm width.*
4. *All measurements are in millimeters.*

Figure 15. SKY42053 24-Pin PQFP Tape and Reel Dimensions

Ordering Information

Model Name	Manufacturing Part Number	Evaluation Kit Part Number
SKY42053 Diversity Receiver Front End	SKY42053-11	TW11-D222