CX42054

1700 – 2200 MHz High Dynamic Range, Diversity Receiver Front End

Conexant's CX42054 is an integrated, high-dynamic range, low-noise receiver down converter for two-channel diversity systems. It includes a Low Noise Amplifier (LNA) followed by a double-balanced active mixer. The CX42054 has dual Local Oscillator (LO) inputs, 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 CX42054. The 24-pin Plastic Quad Flat Pack (PQFP) device package and pinout are shown in Figure 2.

Distinguishing Features

- High 3rd Order Input Intercept Point (IIP3) mixer and LNA
- Wideband RF input frequency range (1700 to 2200 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
- –20 °C to +85 °C operating range
- Supports frequency hopping applications

Applications

- PCS/DCS/UMTS communications
- Mobile radio systems
- WLL
- WLAN
- Industrial, Scientific, Medical (ISM) band Applications

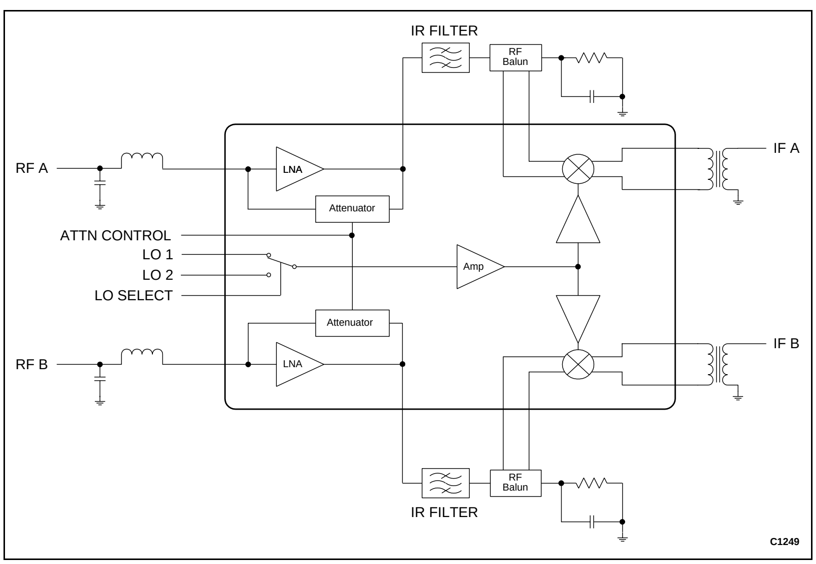

Figure 1. CX42054 Functional Block Diagram

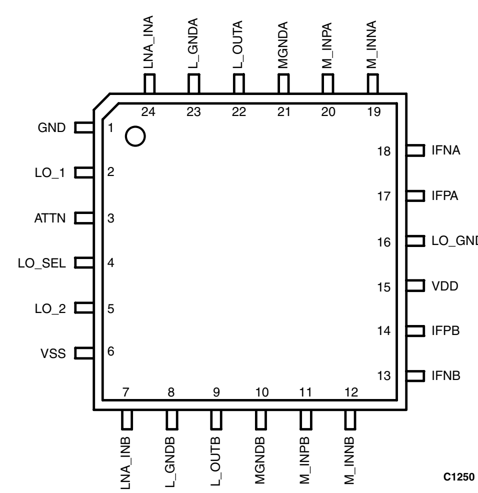

Figure 2. CX42054 Pinout – 24-Pin PQFP Package

Technical Description

The CX42054 consists of two identical channels, A and B, that were specifically designed for 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, that are selected using a common CMOS-compatible control signal. With this ability, the device can be used in applications where frequency hopping is required.

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

Electrical and Mechanical Specifications

The signal pin assignments and functions are described in Table 1. The absolute maximum ratings of the CX42054 are provided in Table 2. The recommended operating conditions are specified in Table 3 and electrical specifications are provided in Table 4. Table 5 provides additional electrical specifications for cascaded channel performance.

Typical performance characteristics of the CX42054 are illustrated in Figures 3 through 9.

Table 1. CX42054 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

Table 2. CX42054 Absolute Maximum Ratings

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 temperature	T_{OPR}	–20		+85	°C
Storage temperature	T_{STG}	–40		+125	°C
Note: No damage to device if only one parameter is applied at a time with other parameters at nominal conditions.					

Table 3. CX42054 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 temperature	T_{OPR}	0		+50	°C

Table 4. CX42054 Electrical Characteristics
(+25° C, Voltage Supply = ±5 V, LO = 0 dBm, RF Frequency = 1900 MHz, IF Frequency = 135 MHz, Mixer Bias = 55 mA)

Parameter	Test Condition	Min	Typical	Max	Units
Low Noise Amplifier					
Gain		11.0	13.5		dB
Noise Figure (NF)			2.6	3.5	dB
Input IP3		+13	+16		dBm
–1 dB compression point		+2.0	+5.0		dBm
RF					
RF input frequency		1700		2200	MHz
RF input (Note 1)	RF = 1700 MHz to 2000 MHz		1.5:1	2.0:1	VSWR
	RF = 1900 MHz		1.5:1	2.0:1	VSWR
RF output (Note 1)	RF = 1700 MHz to 2000 MHz		1.5:1	2.0:1	VSWR
Mixer (Note 2)					
Conversion gain	RF = 1800 to 2000 MHz, LO = 1750 MHz	–3.0	–1.5		dB
	RF = 1700 to 1900 MHz, LO = 1950 MHz	–3.0	–2.0		dB
	RF = 1900 MHz, LO = 1765 MHz	–3.0	–1.0		dB
	RF = 1900 MHz, LO = 2035 MHz	–3.0	–1.5		dB
Single Side Band NF	RF = 1800 MHz to 2000 MHz, LO = 1750 MHz		13	14	dB
	RF = 1700 MHz to 1900 MHz, LO = 1950 MHz		13	15	dB
Input IP3	RF = 1900 MHz, LO= 1765 MHz (mixer bias = 80 mA)	+18	+24		dBm
	RF = 1900 MHz, LO = 1765 MHz	+15	+21		dBm
	RF = 1900 MHz, LO = 2035 MHz	+15	+21		dBm
RF to IF leakage	RF = 1900 MHz, LO = 1765 MHz		–35		dBm
	RF = 1900 MHz, LO = 2035 MHz		–35		dBm
LO to IF leakage	LO = 1765 MHz		–45		dBm
	LO = 2035 MHz		–40		dBm
–1dB compression point (mixer bias = 80 mA)		+11	+17		dBm
–1 dB compression point		+9	+15		dBm
½ IF product suppression			–70	–65	dBc
Local Oscillator					
LO input frequency		1700		2200	MHz
LO input (Note 1)			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)	IF = 50 MHz to 200 MHz IF = 135 MHz		1.5:1 1.5:1	2.0:1 2.0:1	VSWR VSWR

Note 1: In a 50 Ω system obtained with external matching components on input/output ports. See Figure 10 and Table 6 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 = 1900 MHz, IF Frequency = 135 MHz)

Parameter	Test Condition	Min	Typical	Max	Units
RF input (Note 1)			1.5:1		VSWR
NF (Note 2)			4.6	7.0	dB
Gain (Note 3)		7	11		dB
Input IP3 (Note 4)	mixer bias = 80 mA mixer bias = 55 mA	+4 +3	+10 +9		dBm dBm
1 dB compression point (Note 5)	mixer bias = 80 mA mixer bias = 55 mA	–1 –2	+5 +4		dBm dBm
1/2 IF product suppression			–65	–55	dBc
Channel A to B isolation		35	40		dB
LO leakage at RF input			–35	–30	dBm
LO1 to LO2 isolation		30	35		dB
Supply current @ +5.0 V, both channels Supply current @ –5.0 V, both channels			340 10	360 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 Table 6 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: $P_{1dB,system} = (P_{1dB,Mixer} - (G_{LNA} - Loss_{IRfilter}))\ or\ (P_{1dB,LNA}),\ whichever\ \ is\ less$

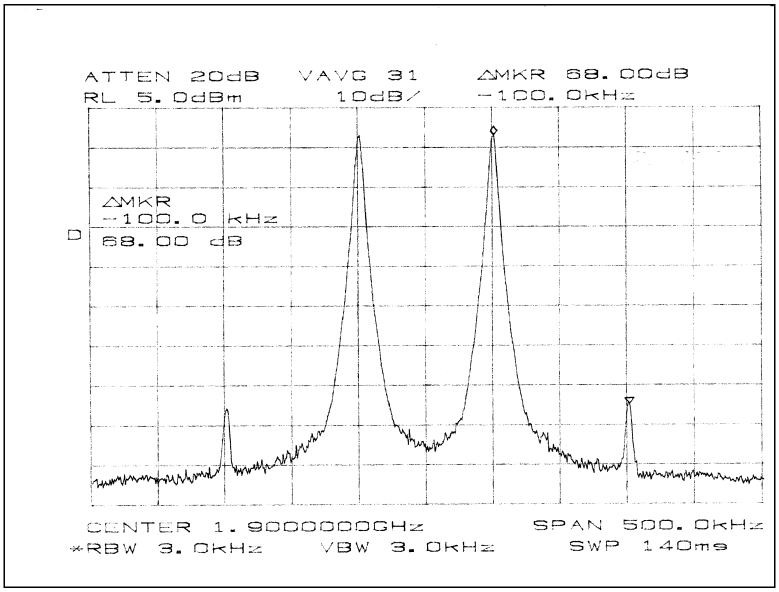

Figure 3. LNA
(IIP3 = +19 dBm, Input Power = –15 dBm)

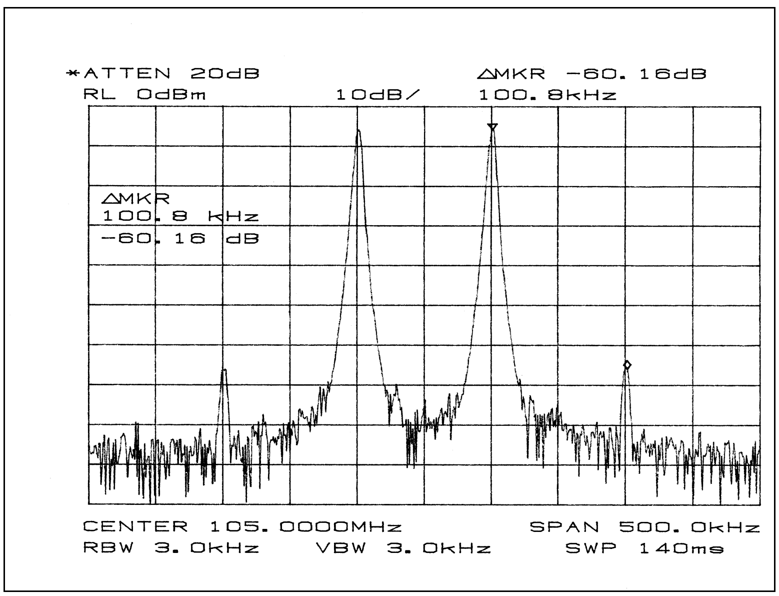

Figure 4. Mixer With High Side LO
(IIP3 = +20 dBm, Input Power = –10 dBm)

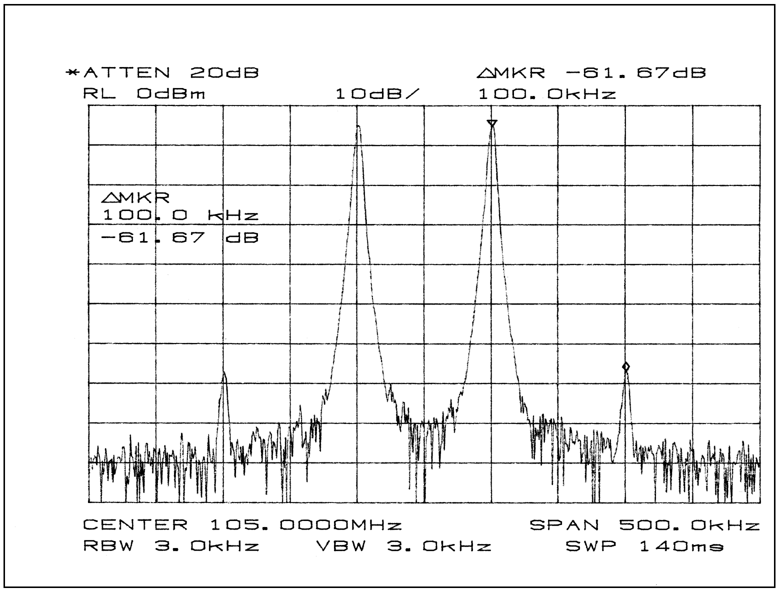

Figure 5. Mixer With Low Side LO
(IIP3 = +20 dBm, Input Power = –10 dBm)

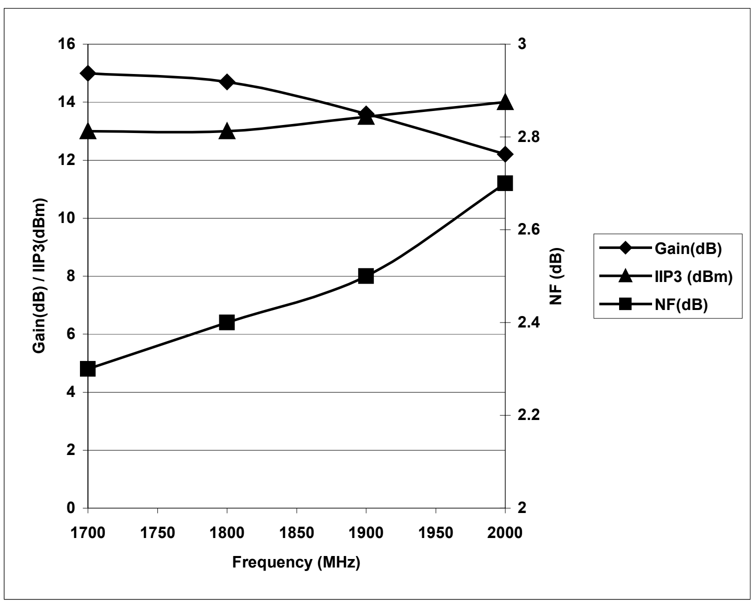

Figure 6. LNA Gain, NF, and IIP3 vs Frequency
(Values Obtained With a 1900 MHz Input Match)

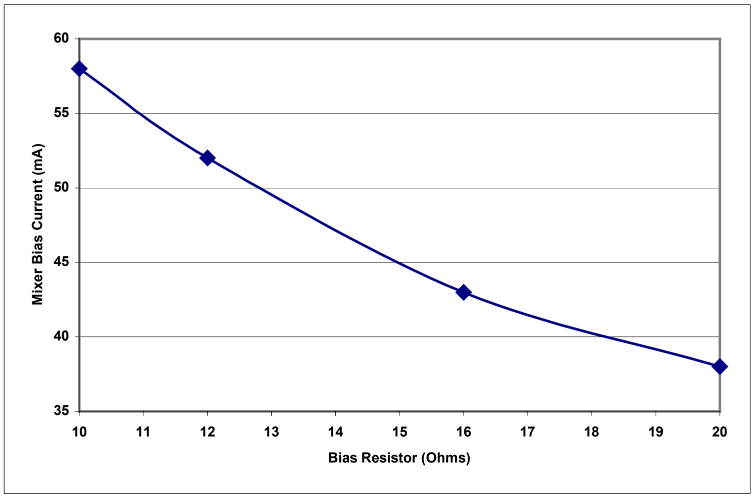

Figure 7. Mixer Bias Current vs. Bias Resistor (RA2, RB2)

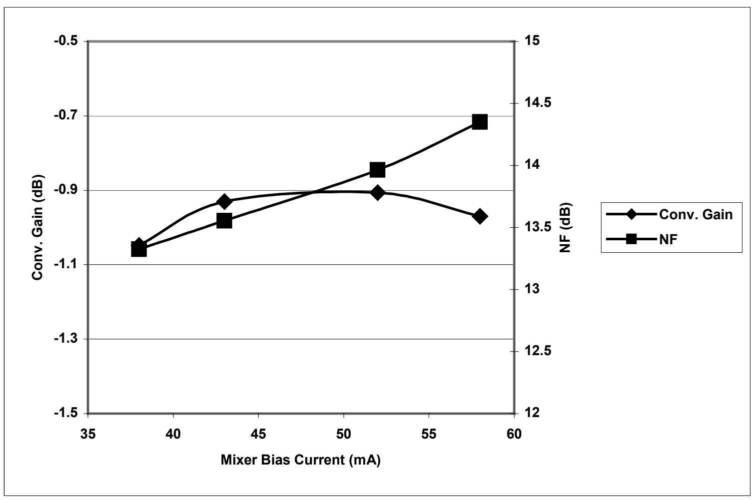

Figure 8. Mixer Conversion Gain vs. Bias Current

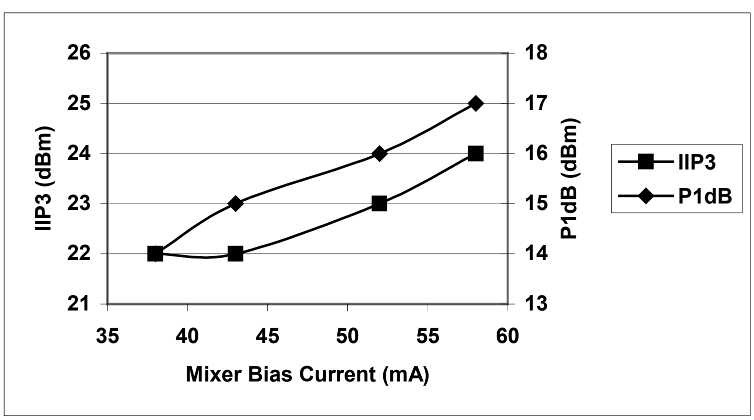

Figure 9. Mixer IIP3 and 1 dB Compression Point vs. Bias Current

Evaluation Board Description

The CX42054 Evaluation Board is used to test the CX42054 mixer and LNA performance. The CX42054 Evaluation Board schematic diagram is shown in Figure 10. Table 6 contains I/O matching network components used in the schematic. The schematic shows the basic design of the Evaluation Board for the RF range of 1800 to 2000 MHz. The IF matching circuitry has been optimized for 100 to 200 MHz. 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 CX42054 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 CX42054 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 $\leq V_{IN} \leq$ 3.0 VDD @ 120 μA

LNA Testing Procedure

Use the following procedure to set up the CX42054 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 7.
2. Connect the CX42054 Evaluation Board to ±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 CX42054 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 7.
2. Connect the CX42054 Evaluation Board to ±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.

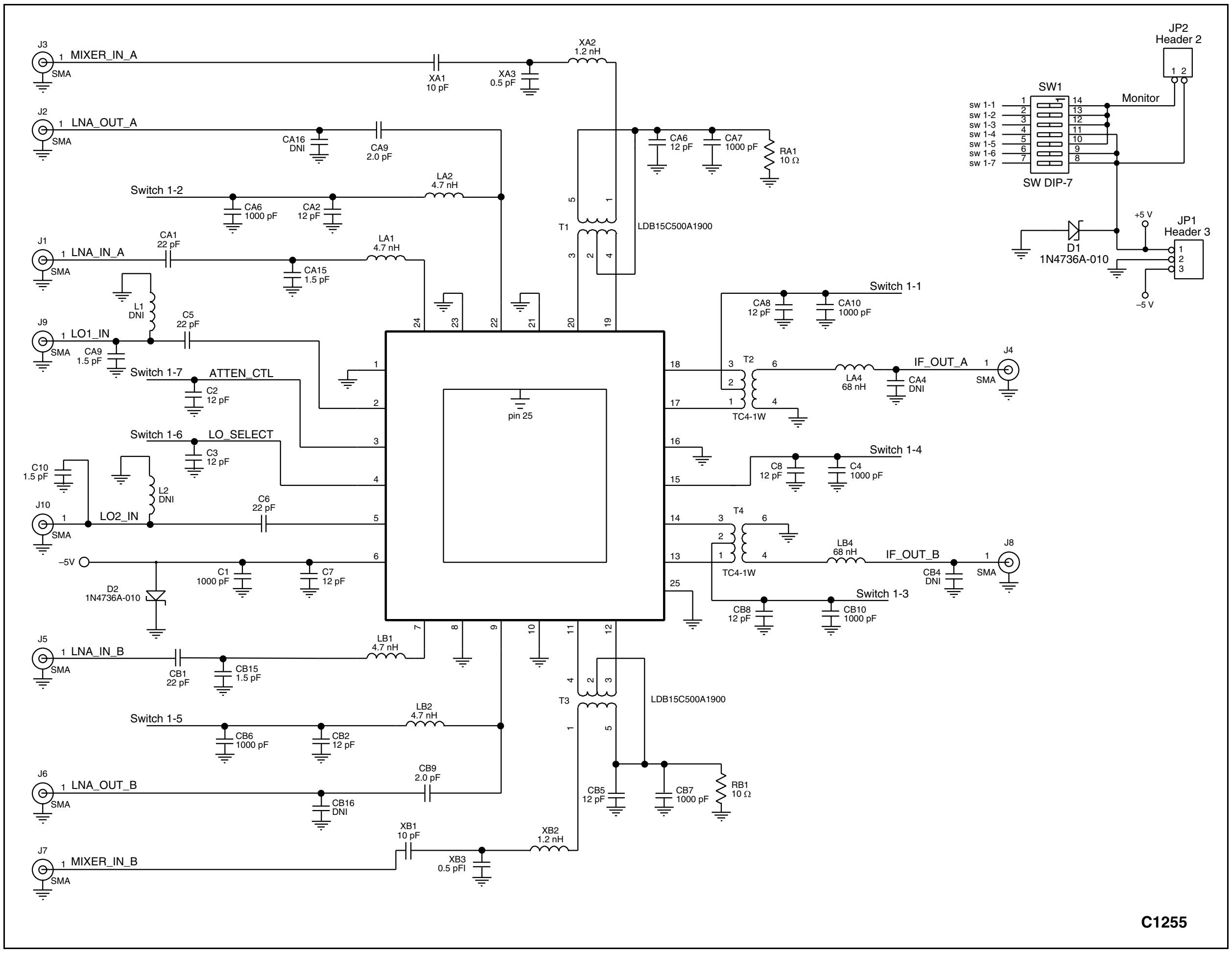

Figure 10. CX42054 Application Schematic

Table 6. Input/Output Matching Network Components for Application Schematic

RF Frequency	CA1, CB1	CA15, CB15	LA1, LB1	T1, T2	XA1, XB1	XA2, XB2	XA3, XB3
1700-1900 MHz	22 pF	1.5 pF	4.7 nH	LDB15C500A1747	22 pF	3.3 nH	1.0 pF
1800-2000 MHz*	22 pF	1.5 pF	4.7 nH	LDB15C500A1900	10 pF	1.2 nH	0.5 pF
2000-2200 MHz	22 pF	1.5 pF	4.7 nH	LDB15C500A2100	0 Ω	2.7 pF	DNI
IF Frequency	**LA4, LB4**	**CA4, CB4**					
50-100 MHz	68 nH	DNI					
100-200 MHz	68 nH	DNI					

Note 1: Standard Evaluation Kit TW10-D212 is optimized for the 1800 to 2000 MHz frequency range. The schematic diagram shown in Figure 10 applies to Evaluation Kit TW10-D212.

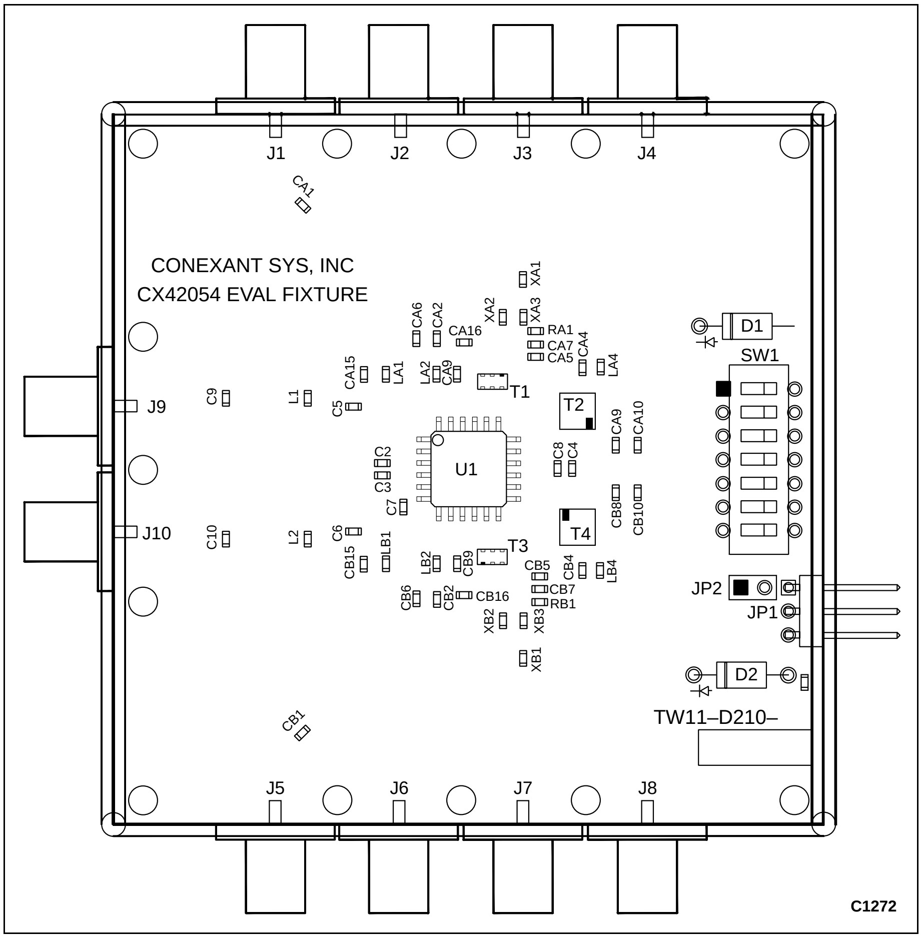

Figure 11. CX42054 Evaluation Board Layout

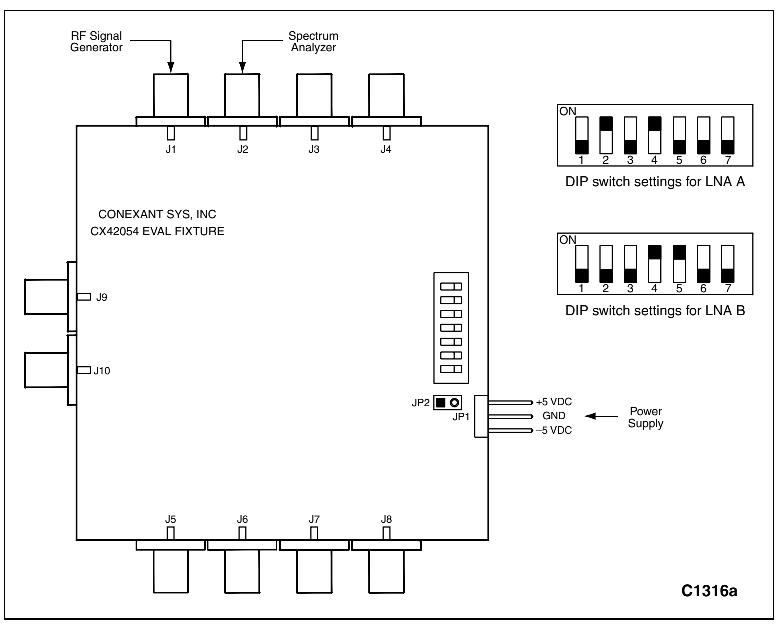

Figure 12. CX42054 Evaluation Board LNA Testing Configuration

Table 7. CX42054 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

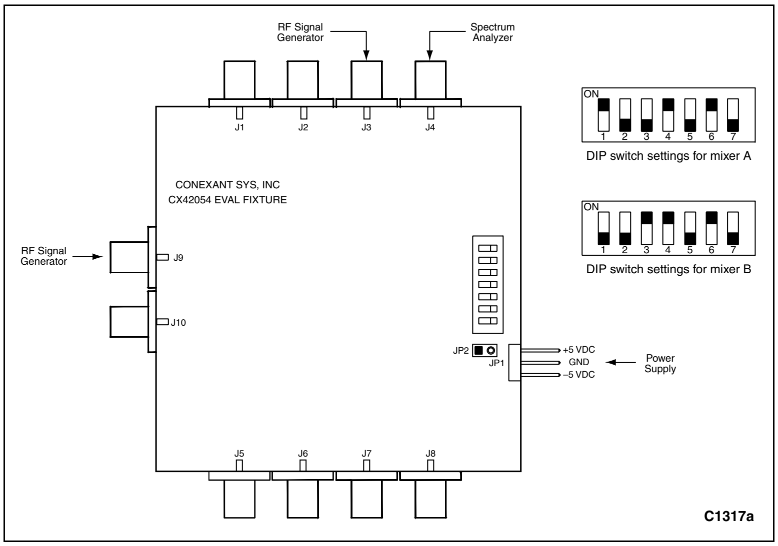

Figure 13. CX42054 Evaluation Board Mixer Testing Configuration

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 CX42054 Evaluation Board can be permanently damaged.*

Package Dimensions

Figure 14 shows the package dimensions for the 24-pin CX42054 PQFP and Figure 15 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.

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. For additional details on both attachment techniques, precautions, and recommended handling procedures, refer to the Conexant document *Solder Reflow Application Note*, document number 101536.

Production quantities of this product are shipped in a standard tape and reel format. For packaging details, refer to the Conexant document *Tape and Reel Information Application Note*, document number 101568.

Electro-Static Discharge (ESD) Sensitivity

The CX42054 is a static-sensitive electronic device. Do not operate or store near strong electrostatic fields. Take proper ESD precautions.

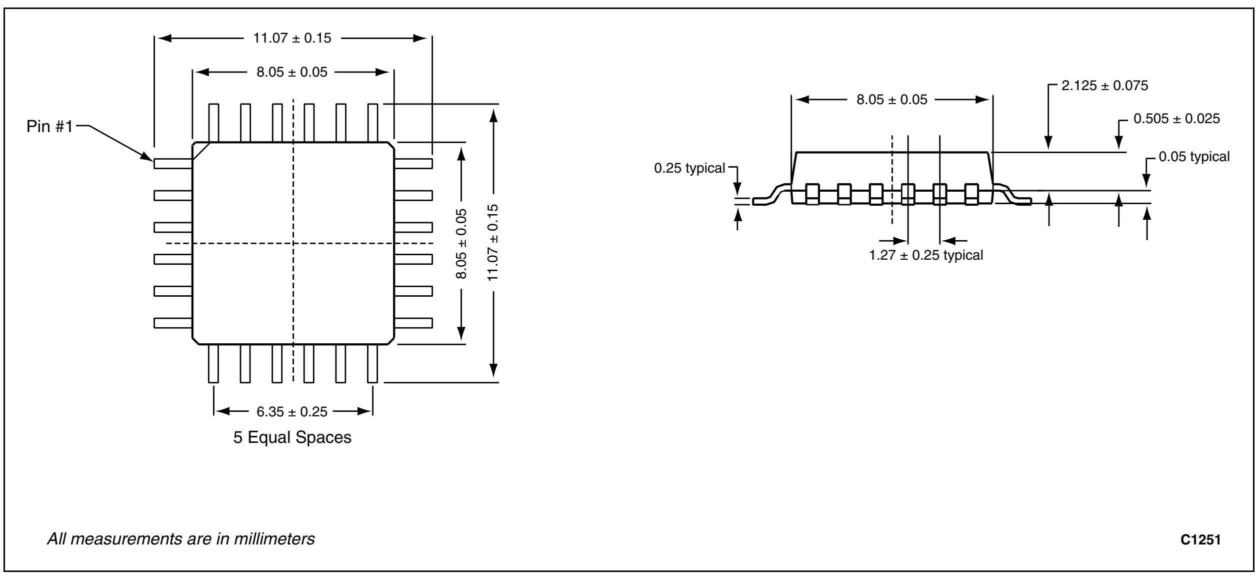

Figure 14. CX42054 24-Pin PQFP Package Dimension Drawing

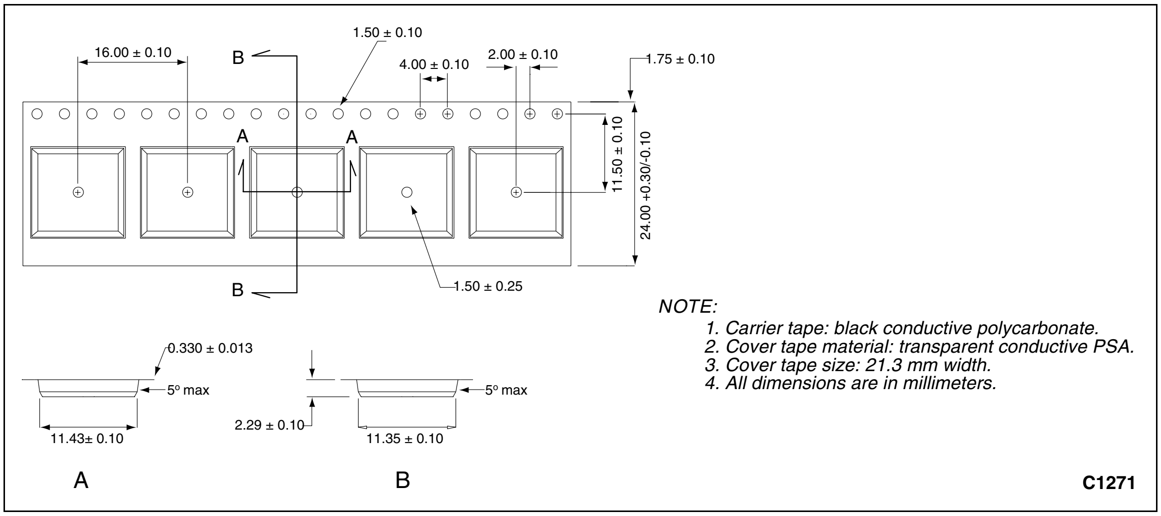

Figure 15 CX42054 24-Pin PQFP Tape and Reel Dimensions

Ordering Information

Model Name	Ordering Part Number	Evaluation Kit Part Number
CX42054 1700-2200 MHz Receiver Front End/Downconverter	CX42054-11	TW10-D212

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