

# LTC5592

## Dual 1.6GHz to 2.7GHz High Dynamic Range Downconverting Mixer

### DESCRIPTION

Demonstration circuit 1710A-C is a dual 1.6GHz to 2.7GHz high dynamic range downconverting mixer featuring the LTC®5592. The LTC5592 is part of a family of dual-channel high dynamic range, high gain downconverting mixers covering the 600MHz to 4.5GHz frequency range. **The demo circuit 1710A-C and the LTC5592 are optimized for 1.6GHz to 2.7GHz RF applications. The LO frequency must fall within the 1.7GHz to 2.5GHz range for optimum performance.** A typical application is a LTE or WiMAX receiver with a 2.3GHz to 2.7GHz RF input and low side LO.

The LTC5592 is designed for 3.3V operation, however the IF amplifiers can be powered by 5V for the highest P1dB. A low current mode is provided for power savings, and each of the mixer channels has independent shutdown control.

The LTC5592's high conversion gain and high dynamic range enable the use of lossy IF filters in high-selective receiver designs, while minimizing the total solution cost, board space and system-level variation.

#### High Dynamic Range Dual Downconverting Mixer Family

| DEMO #           | IC PART #      | RF RANGE                | LO RANGE                |
|------------------|----------------|-------------------------|-------------------------|
| DC1710A-A        | LTC5590        | 600MHz to 1.7GHz        | 700MHz to 1.5GHz        |
| DC1710A-B        | LTC5591        | 1.3GHz to 2.3GHz        | 1.4GHz to 2.1GHz        |
| <b>DC1710A-C</b> | <b>LTC5592</b> | <b>1.6GHz to 2.7GHz</b> | <b>1.7GHz to 2.5GHz</b> |
| DC1710A-D        | LTC5593        | 2.3GHz to 4.5GHz        | 2.1GHz to 4.2GHz        |

**Design files for this circuit board are available at <http://www.linear.com/demo>**

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### PERFORMANCE SUMMARY

$T_C = 25^\circ\text{C}$ ,  $V_{CC} = V_{CCIF} = 3.3\text{V}$ ,  $ENA = ENB = \text{High}$ ,  $I_{SEL} = \text{Low}$ ,  $P_{LO} = 0\text{dBm}$ ,  $P_{RF} = -3\text{dBm}$  ( $\Delta f = 2\text{MHz}$  for two-tone IIP3 tests), unless otherwise noted. (Note 1)

| PARAMETER   | CONDITIONS   | VALUE         | UNITS         |
|---|--|---------------|---------------|
| VCC Supply Voltage Range  |  | 3.1 to 3.5    | V             |
| VCCIF Supply Voltage Range                                      |  | 3.1 to 5.3    | V             |
| Total Supply Current ( $V_{CC} + V_{CCIF}$ ), Normal Power Mode | Both Mixer Channels Enabled                          | 401           | mA            |
| Total Supply Current ( $V_{CC} + V_{CCIF}$ ), Low Power Mode    | Both Mixer Channels Enabled, $I_{SEL} = \text{High}$ | 252           | mA            |
| Total Supply Current During Shutdown                            | $ENA = ENB = \text{Low}$                             | $\leq 500$    | $\mu\text{A}$ |
| ENA, ENB Input High Voltage (Channel Enabled)                   |  | $> 2.5$       | V             |
| ENA, ENB Input Low Voltage (Channel Disabled)                   |  | $< 0.3$       | V             |
| ENA, ENB Input Current  | $-0.3\text{V}$ to $V_{CC} + 0.3\text{V}$             | $-20$ to $30$ | $\mu\text{A}$ |
| ISEL Input High Voltage (Low Power Mode)                        |  | $> 2.5$       | V             |
| ISEL Input Low Voltage (Normal Power Mode)                      |  | $< 0.3$       | V             |
| ISEL Input Current  | $-0.3\text{V}$ to $V_{CC} + 0.3\text{V}$             | $-20$ to $30$ | $\mu\text{A}$ |

# DEMO MANUAL DC1710A-C

## PERFORMANCE SUMMARY $T_C = 25^\circ\text{C}$ , $V_{CC} = V_{CCIF} = 3.3\text{V}$ , $\text{ENA} = \text{ENB} = \text{High}$ , $\text{ISEL} = \text{Low}$ , $P_{LO} = 0\text{dBm}$ , $P_{RF} = -3\text{dBm}$ ( $\Delta f = 2\text{MHz}$ for two-tone IIP3 tests), unless otherwise noted. (Note 1)

| PARAMETER                    | CONDITIONS   | VALUE                        | UNITS      |
|------------------------------|--|------------------------------|------------|
| LO Input Frequency Range     |  | 1700 to 2500                 | MHz        |
| LO Input Return Loss         | $Z_0 = 50\Omega$ , $f_{LO} = 1700\text{MHz}$ to $2500\text{MHz}$ | $>17$                        | dB         |
| LO Input Power Range         | $f_{LO} = 1700\text{MHz}$ to $2500\text{MHz}$                    | $-4$ to $6$                  | dBm        |
| RF Input Frequency Range     | Low Side LO<br>High Side LO                                      | 1900 to 2700<br>1600 to 2300 | MHz<br>MHz |
| RF Input Return Loss         | $Z_0 = 50\Omega$ , $f_{RF} = 1600\text{MHz}$ to $2700\text{MHz}$ | $>13$                        | dB         |
| IF Output Frequency          | Can be re-matched for other frequencies                          | 190                          | MHz        |
| IF Output Return Loss        | $Z_0 = 50\Omega$   | $>12$                        | dB         |
| LO to RF Leakage             | $f_{LO} = 1700\text{MHz}$ to $2500\text{MHz}$                    | $< -34$                      | dBm        |
| LO to IF Leakage             | $f_{LO} = 1700\text{MHz}$ to $2500\text{MHz}$                    | $< -37$                      | dBm        |
| RF to LO Isolation           | $f_{RF} = 1600\text{MHz}$ to $2700\text{MHz}$                    | $>57$                        | dB         |
| RF to IF Isolation           | $f_{RF} = 1600\text{MHz}$ to $2700\text{MHz}$                    | $>37$                        | dB         |
| Channel-to-Channel Isolation | $f_{RF} = 1600\text{MHz}$ to $2700\text{MHz}$                    | $>47$                        | dB         |

### Low Side LO Downmixer Application: $\text{ISEL} = \text{Low}$ , $\text{RF} = 1900\text{MHz}$ to $2700\text{MHz}$ , $\text{IF} = 190\text{MHz}$ , $f_{LO} = f_{RF} - f_{IF}$

|   |   |                      |                   |
|---|---|----------------------|-------------------|
| Conversion Gain   | RF = 1950MHz<br>RF = 2350MHz<br>RF = 2550MHz  | 9.5<br>8.3<br>8.1    | dB<br>dB<br>dB    |
| Input 3rd Order Intercept   | RF = 1950MHz<br>RF = 2350MHz<br>RF = 2550MHz  | 26.3<br>27.3<br>26.3 | dBm<br>dBm<br>dBm |
| SSB Noise Figure  | RF = 1950MHz<br>RF = 2350MHz<br>RF = 2550MHz  | 9.4<br>9.8<br>9.9    | dB<br>dB<br>dB    |
| SSB Noise Figure Under Blocking                                       | $f_{RF} = 2400\text{MHz}$ , $f_{LO} = 2210\text{MHz}$ , $f_{BLOCK} = 2500\text{MHz}$ ,<br>$P_{BLOCK} = 5\text{dBm}$<br>$P_{BLOCK} = 10\text{dBm}$ | 15.3<br>21.2         | dB<br>dB          |
| 2RF – 2LO Output Spurious Product<br>( $f_{RF} = f_{LO} + f_{IF}/2$ ) | $f_{RF} = 2255\text{MHz}$ at $-10\text{dBm}$ , $f_{LO} = 2160\text{MHz}$ ,<br>$f_{IF} = 190\text{MHz}$  | $-68$                | dBc               |
| 3RF – 3LO Output Spurious Product<br>( $f_{RF} = f_{LO} + f_{IF}/3$ ) | $f_{RF} = 2223.33\text{MHz}$ at $-10\text{dBm}$ , $f_{LO} = 2160\text{MHz}$ ,<br>$f_{IF} = 190\text{MHz}$   | $-74$                | dBc               |
| Input 1dB Compression   | $f_{RF} = 2350\text{MHz}$ , $V_{CCIF} = 3.3\text{V}$<br>$f_{RF} = 2350\text{MHz}$ , $V_{CCIF} = 5\text{V}$  | 11<br>14.6           | dBm<br>dBm        |

### Low Power Mode, Low Side LO Downmixer Application: $\text{ISEL} = \text{High}$ , $\text{RF} = 1900\text{MHz}$ to $2700\text{MHz}$ , $\text{IF} = 190\text{MHz}$ , $f_{LO} = f_{RF} - f_{IF}$

|                           |  |              |            |
|---------------------------|--|--------------|------------|
| Conversion Gain           | RF = 2350MHz   | 7.1          | dB         |
| Input 3rd Order Intercept | RF = 2350MHz   | 22.3         | dBm        |
| SSB Noise Figure          | RF = 2350MHz   | 10.2         | dB         |
| Input 1dB Compression     | $f_{RF} = 2350\text{MHz}$ , $V_{CCIF} = 3.3\text{V}$<br>$f_{RF} = 2350\text{MHz}$ , $V_{CCIF} = 5\text{V}$ | 11.3<br>12.6 | dBm<br>dBm |

## PERFORMANCE SUMMARY

$T_C = 25^\circ\text{C}$ ,  $V_{CC} = V_{CCIF} = 3.3\text{V}$ ,  $EN_A = EN_B = \text{High}$ ,  $I_{SEL} = \text{Low}$ ,  $P_{LO} = 0\text{dBm}$ ,  $P_{RF} = -3\text{dBm}$  ( $\Delta f = 2\text{MHz}$  for two-tone IIP3 tests), unless otherwise noted. (Note 1)

| PARAMETER   | CONDITIONS  | VALUE | UNITS |
|---|---|-------|-------|
| <b>High Side LO Downmixer Application: <math>I_{SEL} = \text{Low}</math>, <math>R_F = 1600\text{MHz}</math> to <math>2300\text{MHz}</math>, <math>I_F = 190\text{MHz}</math>, <math>f_{LO} = f_{RF} + f_{IF}</math></b> |   |       |       |
| Conversion Gain   | $R_F = 1750\text{MHz}$  | 9.1   | dB    |
|   | $R_F = 1950\text{MHz}$  | 8.7   | dB    |
|   | $R_F = 2150\text{MHz}$  | 8.3   | dB    |
| Input 3rd Order Intercept   | $R_F = 1750\text{MHz}$  | 25.3  | dBm   |
|   | $R_F = 1950\text{MHz}$  | 25.4  | dBm   |
|   | $R_F = 2150\text{MHz}$  | 25.1  | dBm   |
| SSB Noise Figure  | $R_F = 1750\text{MHz}$  | 9.2   | dB    |
|   | $R_F = 1950\text{MHz}$  | 9.8   | dB    |
|   | $R_F = 2150\text{MHz}$  | 10.4  | dB    |
| SSB Noise Figure Under Blocking   | $f_{RF} = 1950\text{MHz}$ , $f_{LO} = 2140\text{MHz}$ , $f_{BLOCK} = 1850\text{MHz}$ ,<br>$P_{BLOCK} = 5\text{dBm}$ | 16.5  | dB    |
|   | $P_{BLOCK} = 10\text{dBm}$  | 22.7  | dB    |
| 2LO – 2RF Output Spurious Product<br>( $f_{RF} = f_{LO} - f_{IF}/2$ )   | $f_{RF} = 2045\text{MHz}$ at $-10\text{dBm}$ , $f_{LO} = 2140\text{MHz}$ ,<br>$f_{IF} = 190\text{MHz}$              | -68   | dBc   |
| 3LO – 3RF Output Spurious Product<br>( $f_{RF} = f_{LO} - f_{IF}/3$ )   | $f_{RF} = 2076.67\text{MHz}$ at $-10\text{dBm}$ , $f_{LO} = 2140\text{MHz}$ ,<br>$f_{IF} = 190\text{MHz}$           | -75   | dBc   |
| Input 1dB Compression   | $f_{RF} = 1950\text{MHz}$ , $V_{CCIF} = 3.3\text{V}$  | 10.6  | dBm   |
|   | $f_{RF} = 1950\text{MHz}$ , $V_{CCIF} = 5\text{V}$  | 14    | dBm   |

Note 1: Subject to change without notice. Refer to the latest LTC5592 data sheet for most-up-to-date specifications.

## DETAILED DESCRIPTION

### ABSOLUTE MAXIMUM RATINGS

**NOTE.** Stresses beyond Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

|  |                                 |
|--|---------------------------------|
| Supply Voltage ( $V_{CC}$ ).....             | 4.0V                            |
| IF Supply Voltage ( $V_{CCIF}$ ).....        | 5.5V                            |
| Enable Voltage ( $EN_A$ , $EN_B$ ) .....     | -0.3V to $V_{CC} + 0.3\text{V}$ |
| Bias Adjust Voltage ( $IFBA$ , $IFBB$ )..... | -0.3V to $V_{CC} + 0.3\text{V}$ |
| Power Select Voltage ( $I_{SEL}$ ) .....     | -0.3V to $V_{CC} + 0.3\text{V}$ |
| LO Input Power (1GHz to 3GHz) .....          | 9dBm                            |
| RFA, RFB Input Power (1GHz to 3GHz) .....    | 15dBm                           |
| Operating Temperature Range ( $T_C$ ).....   | -40°C to 105°C                  |

### SUPPLY VOLTAGE RAMPING

Fast ramping of the supply voltage can cause a current glitch in the internal ESD protection circuits. Depending on the supply inductance, this could result in a supply voltage transient that exceeds the maximum rating. A supply voltage ramp time of greater than 1ms is recommended.

**Do not clip powered test leads directly onto the demonstration circuit's  $V_{CC}$  and  $V_{CCIF}$  turrets.** Instead, make all necessary connections with power supplies turned off, then increase to operating voltage.

### ENABLE FUNCTION

The LTC5592's two mixer channels can be independently enabled or disabled. When the Enable voltage ( $EN_A$  or  $EN_B$ ) is logic high ( $>2.5\text{V}$ ), the corresponding mixer channel is enabled. When the Enable voltage is logic low ( $<0.3\text{V}$ ), the mixer channel is disabled. The voltages at the enable pins should never fall below -0.3V or exceed the power supply voltage by more than 0.3V. The Enable pins must be pulled high or low. If left floating, the on/off state of the IC will be indeterminate. A logic table for the Enable control ( $EN_A$ ,  $EN_B$ ) is shown in Table 1.

**Table 1. Enable Control Logic Table**

| ENA, ENB | MIXER CHANNEL STATE |
|----------|---------------------|
| Low      | Disabled            |
| High     | Enabled             |

dc1710acf

## DETAILED DESCRIPTION

### LOW POWER MODE

The LTC5592 features a low power mode, which allows the flexibility to choose a 37% total power saving when lower RF performance is acceptable. When the ISEL voltage is logic low ( $<0.3V$ ), both mixer channels operate at nominal power and best performance. When the ISEL voltage is logic high ( $>2.5V$ ), both mixer channels are in low power mode and operate with reduced performance. The ISEL voltage should never fall below  $-0.3V$  or exceed the power supply voltage by more than  $0.3V$ . The ISEL pin must be pulled low or high. If left floating, the operating state of the IC will be indeterminate. A logic table for ISEL is shown in Table 2.

**Table 2. ISEL Logic Table**

| ISEL | OPERATING MODE                 |
|------|--------------------------------|
| Low  | Normal power, best performance |
| High | Low power, reduced performance |

### RF INPUTS

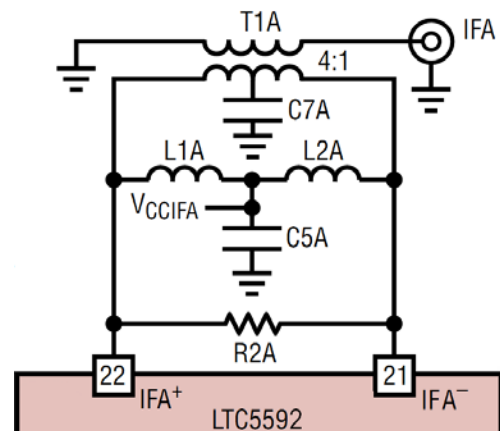
Demonstration circuit 1710A-C's RF inputs of channel A and channel B are identical. For the RF inputs to be matched, the appropriate LO signal must be applied. The RF inputs' impedance is dependent on LO frequency, but the demonstration circuit 1710A-C's RF inputs are well matched to  $50\Omega$  from  $1.6GHz$  to  $2.7GHz$ , with better than  $13dB$  return loss, when a  $1.7GHz$  to  $2.5GHz$  LO signal is applied.

### LO INPUT

The LTC5592's LO amplifier is optimized for the  $1.7GHz$  to  $2.5GHz$  LO frequency range. LO frequencies above and below this frequency range may be used with degraded performance. The LO input is always  $50\Omega$ -matched when  $V_{CC}$  is applied to the chip, even when one or both of the channels is disabled. The nominal LO input level is  $0dBm$ . The LO input power range is between  $-4dBm$  and  $6dBm$ .

### IF OUTPUTS

Demonstration circuit 1710A-C features single-ended,  $50\Omega$ -matched IF outputs for  $190MHz$ . The channel A and the channel B IF outputs are identical, and the impedance matching is realized with a bandpass topology using IF transformers as shown in Figure 1. Only channel A is shown for clarity and simplicity.



**Figure 1. IF Output with Bandpass Matching**

Demonstration circuit 1710A-C can be easily reconfigured for other IF frequencies by simply replacing inductors L1A, L2A, L1B and L2B. Inductor values for several common IF frequencies are presented in Table 3, and return losses are plotted in Figure 2. An external load resistor, R2A, can be used to improve impedance matching if desired.

**Table 3. Inductor Values vs. IF Frequencies**

| IF FREQUENCY (MHz) | L1A, L2A, L1B, L2B (nH) |
|--------------------|-------------------------|
| 140                | 270                     |
| 190                | 150                     |
| 240                | 100                     |
| 300                | 56                      |
| 380                | 33                      |
| 450                | 22                      |

For IF frequencies below  $90MHz$ , the values of the inductors become unreasonably high, and the lowpass topology shown in Figure 3 is preferred. See the LTC5592 data sheet for details.

## DETAILED DESCRIPTION

Demonstration circuit 1710A-C's IF outputs can be easily converted to lowpass matching. Follow the procedures below, and refer to Figure 3 and Figure 4 to modify the channel A IF output. Modifications for Channel B are similar.

- Remove existing L1A, L2A, and C7A.
- Cut the traces leading to the IF transformer close to the pads of L1A and L2A.
- Insert series inductors onto the cut traces.
- Install a 0Ω jumper between the pads of C5A and C7A.
- Install resistor at location R2A.
- Install C9A next to, or on top of, R2A.

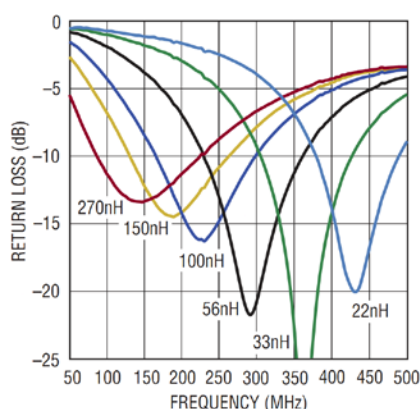


Figure 2. IF Output Return Loss with Bandpass Matching

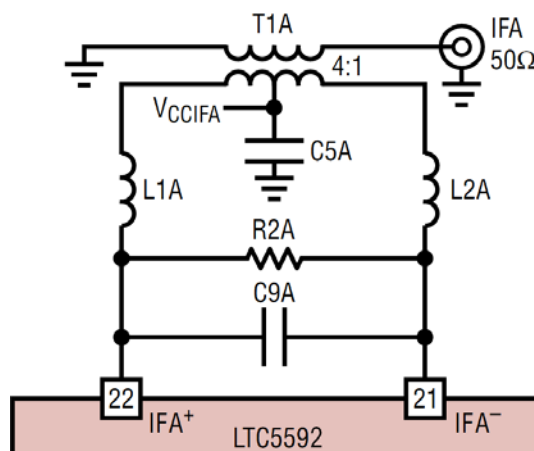


Figure 3. IF Output with Lowpass Matching

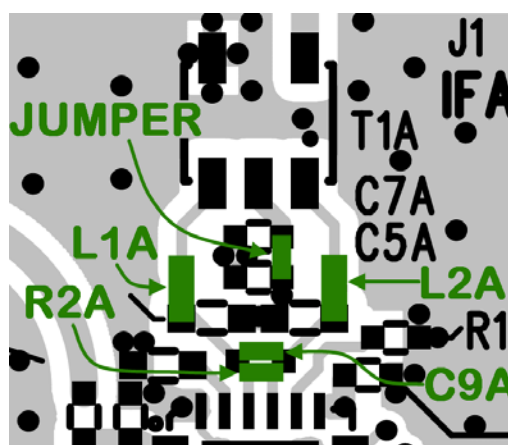


Figure 4. IF Output with Lowpass Matching

## MEASUREMENT EQUIPMENT AND SETUP

The LTC5592 is a dual high dynamic range downconverting mixer IC with very high input 3rd order intercept. Accuracy of its performance measurement is highly dependent on equipment setup and measurement technique. The recommended measurement setups are presented in Figure 5, Figure 6, and Figure 7. The following precautions should be observed:

1. Use high performance signal generators with low harmonic output and low phase noise, such as the Rohde & Schwarz SME06. Filters at the signal generators' outputs may also be used to suppress higher-order harmonics.
2. A high quality RF power combiner that provide broadband 50Ω-termination on all ports and have good port-to-port isolation should be used, such as the MCLI PS2-17.
3. Use high performance amplifiers with high IP3 and high reverse isolation, such as the Mini-Circuits ZHL-1042J, on the outputs of the RF signal generators to improve source isolation to prevent the sources from modulating each other and generating intermodulation products.
4. Use attenuator pads with good VSWR on the demonstration circuit's input and output ports to improve

## MEASUREMENT EQUIPMENT AND SETUP

- source and load match to reduce reflections, which may degrade measurement accuracy.
5. A high dynamic range spectrum analyzer, such as the Rohde & Schwarz FSEM30, should be used for linearity measurement.
  6. Use narrow resolution bandwidth (RBW) and engage video averaging on the spectrum analyzer to lower the displayed average noise level (DANL) in order to improve sensitivity and to increase dynamic range. However, the trade off is increased sweep time.
  7. Spectrum analyzers can produce significant internal distortion products if they are overdriven. Generally, spectrum analyzers are designed to operate at their best with about  $-30\text{dBm}$  at their input filter or preselector. Sufficient spectrum analyzer input attenuation should be used to avoid saturating the instrument, but too much attenuation reduces sensitivity and dynamic range.
  8. Before taking measurements, the system performance should be evaluated to ensure that:
    - a. Clean input signals can be produced. The two-tone signals' OIP3 should be at least  $15\text{dB}$  better than the DUT's IIP3.
    - b. The spectrum analyzer's internal distortion is minimized.
    - c. The spectrum analyzer has enough dynamic range and sensitivity. The measurement system's IIP3 should be at least  $15\text{dB}$  better than the DUT's OIP3.
    - d. The system is accurately calibrated for power and frequency.

### A SPECIAL NOTE ABOUT RF TERMINATION

The LTC5592 consists of high linearity passive double-balanced mixer cores and IF buffer amplifiers. Due to the bidirectional nature of all passive mixers the  $\text{LO} \pm \text{IF}$  mixing products, also referred to as pseudo-image spurs, are always present at the RF input, typically at a level  $12\text{dB}$  below the RF input signal. Mismatched impedances at the pseudo-image spur frequencies, such as when filters are used for SSB NF measurements, can significantly impact the linearity and noise figure measurements. To avoid interference from the pseudo-image spurs, terminate the RF input port with an isolator, diplexer, or attenuator. In the recommended measurement setups presented in Figure 6 and Figure 7, the  $6\text{dB}$  attenuator pad at the demonstration circuit's RF input serves this purpose.

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## QUICK START PROCEDURE

Demonstration circuit 1710A-C is easy to set up to evaluate the performance of the LTC5592. Refer to Figure 5, Figure 6, and Figure 7 for proper equipment connections. The following procedures describe performing measurements on Mixer Channel A. The measurement procedures for Mixer Channel B are identical.

**NOTE.** Care should be taken to never exceed absolute maximum input ratings. Make all connections with RF and DC power off.

### RETURN LOSS MEASUREMENTS

1. Configure the Network Analyzer for return loss measurement, set appropriate frequency range, and set the test signal to  $-3\text{dBm}$ .
2. Calibrate the Network Analyzer.
3. Connect all test equipment as shown in Figure 5 with the signal generator and the DC power supply turned off.
4. Increase the DC power supply voltage to  $3.3\text{V}$ , and verify that the total current consumption is close to the figure listed in the Typical Demonstration Circuit Performance Summary. The supply voltage should be confirmed at the demo board VCC, VCCIF and GND terminals to account for lead ohmic losses.

## QUICK START PROCEDURE

5. With the LO signal applied, and all unused demo board ports terminated in  $50\Omega$ , measure return losses of the RFA input and IFA output ports.
6. Set the test signal to 0dBm, and re-calibrate the Network Analyzer.
7. Terminate all unused demo board ports in  $50\Omega$ . Measure return losses of the LO input port.

## RF PERFORMANCE MEASUREMENTS

1. Connect all test equipment as shown in Figure 6 with the signal generators and the DC power supply turned off.
2. Increase the DC power supply voltage to 3.3V, and verify that the total current consumption is close to the figure listed in the Typical Demonstration Circuit Performance Summary. The supply voltage should be confirmed at the demo board VCC, VCCIF and GND terminals to account for lead ohmic losses.
3. Set the LO source (Signal Generator 1) to provide a 0dBm CW signal at appropriate LO frequency to the demo board LO input port.
4. Set the RF sources (Signal Generators 2 and 3) to provide two -3dBm CW signals, 2MHz apart, at the appropriate RF frequencies to the demo board RFA input port.
5. Measure the resulting IFA output on the Spectrum Analyzer:

- a. The wanted two-tone IF output signals are at:

$$\begin{aligned} f_{IF1} &= f_{RF1} - f_{LO}, \text{ and} \\ f_{IF2} &= f_{RF2} - f_{LO} \text{ for low side LO,} \\ &\text{and} \\ f_{IF1} &= f_{LO} - f_{RF1}, \text{ and} \\ f_{IF2} &= f_{LO} - f_{RF2} \text{ for high side LO} \end{aligned}$$

- b. The 3rd order intermodulation products which are closest to the wanted IF signals are used to calculate the Input 3rd Order Intercept:

$$\begin{aligned} f_{IM3,1} &= f_{RF1} - f_{LO} - \Delta_{IF}, \text{ and} \\ f_{IM3,2} &= f_{RF2} - f_{LO} + \Delta_{IF} \text{ for low side LO,} \\ &\text{and} \end{aligned}$$

$$\begin{aligned} f_{IM3,1} &= f_{LO} - f_{RF1} + \Delta_{IF}, \text{ and} \\ f_{IM3,2} &= f_{LO} - f_{RF2} - \Delta_{IF} \text{ for high side LO} \end{aligned}$$

$$\text{Where } \Delta_{IF} = f_{RF2} - f_{RF1}.$$

6. Calculate Input 3rd Order Intercept:

$$IIP3 = (\Delta_{IM3})/2 + P_{RF}$$

Where  $\Delta_{IM3} = P_{IF} - P_{IM3}$ .  $P_{IF}$  is the lowest IF output signal power at either  $f_{IF1}$  or  $f_{IF2}$ .  $P_{IM3}$  is the highest 3rd order intermodulation product power at either  $f_{IM3,1}$  or  $f_{IM3,2}$ .  $P_{RF}$  is the per tone RF input power.

7. Turn off one of the RF signal generators, and measure Conversion Gain, RF to IF isolation, LO to IF leakage, and Input 1dB compression point.

## NOISE FIGURE MEASUREMENT

1. Configure and calibrate the noise figure meter for mixer measurements.
2. Connect all test equipment as shown in Figure 7 with the signal generator and the DC power supply turned off.
3. Increase the DC power supply voltage to 3.3V, and verify that the total current consumption is close to the figure listed in the Typical Demonstration Circuit Performance Summary. The supply voltage should be confirmed at the demo board VCC, VCCIF and GND terminals to account for lead ohmic losses.
4. Measure the single-sideband noise figure.



## QUICK START PROCEDURE

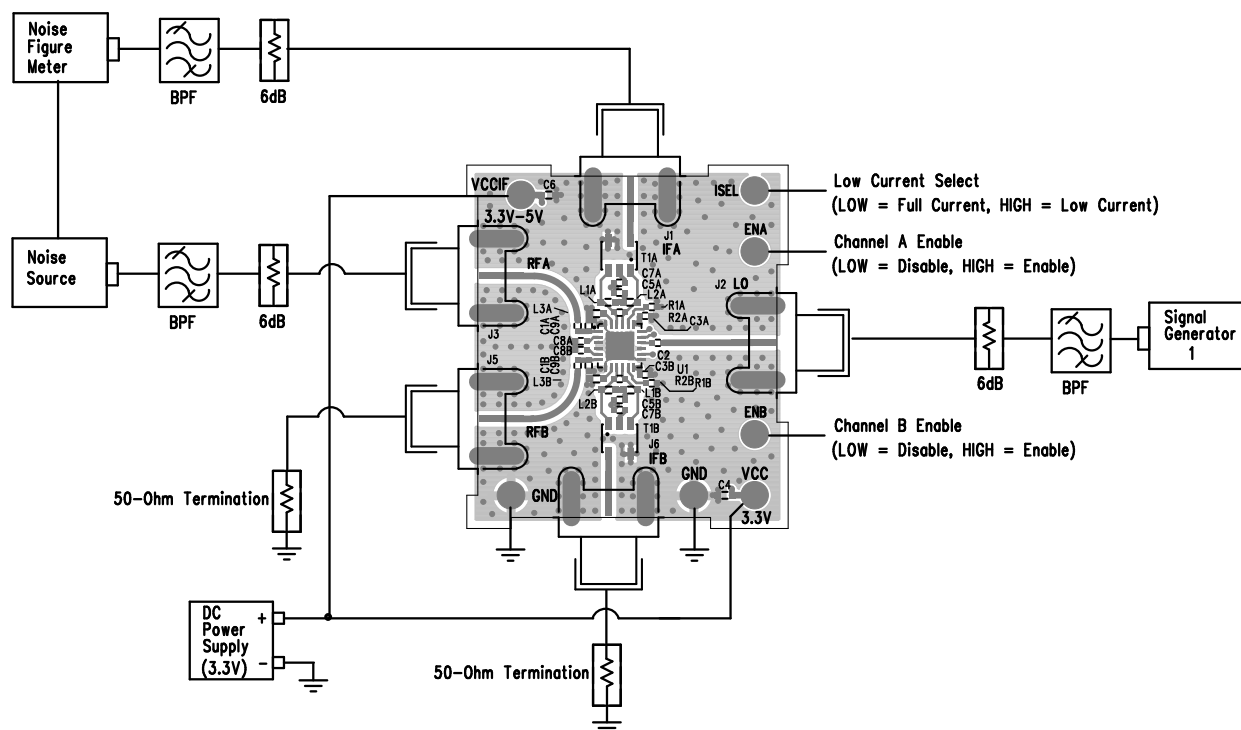
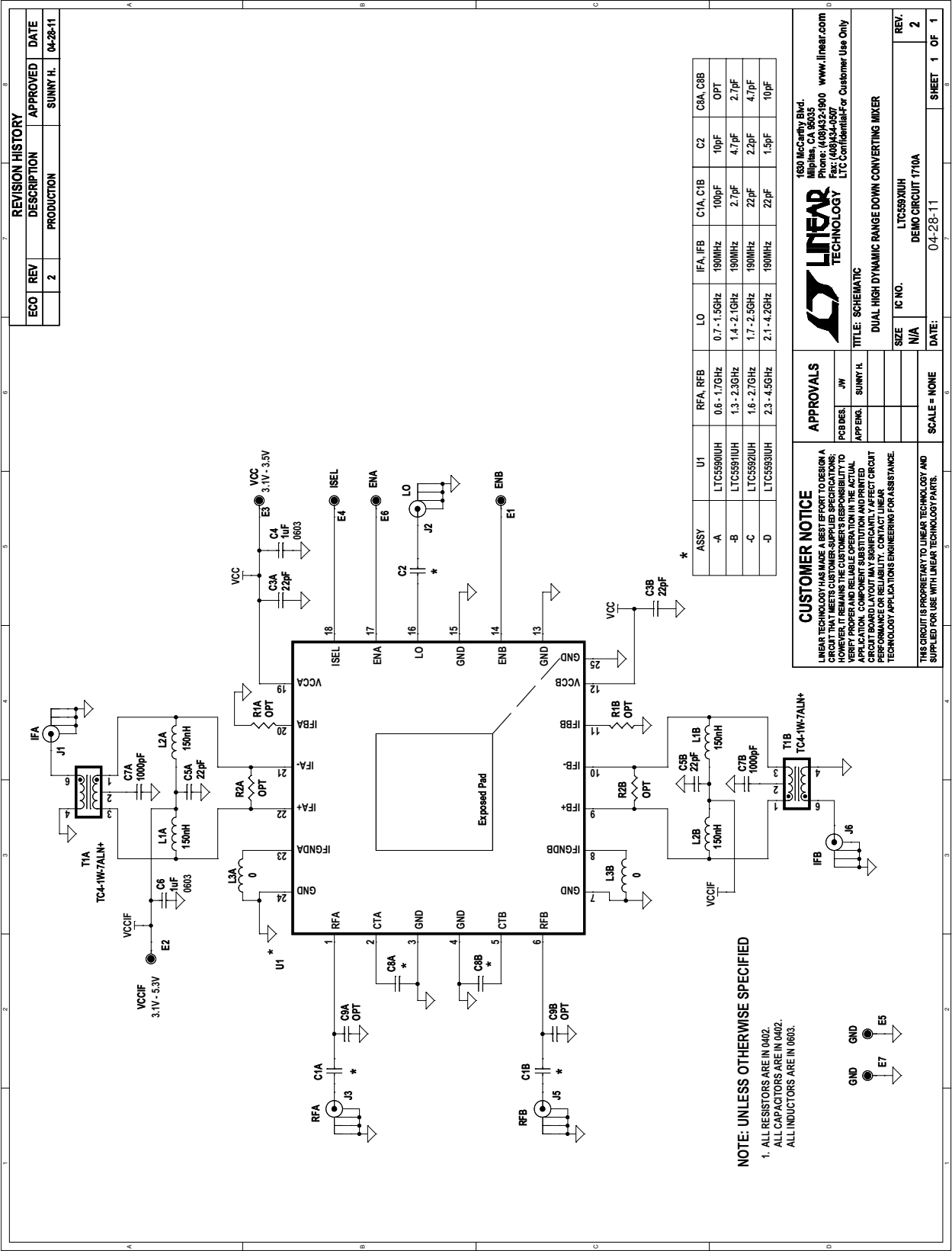


Figure 7. Proper Equipment Setup for Noise Figure Measurement

## PARTS LIST

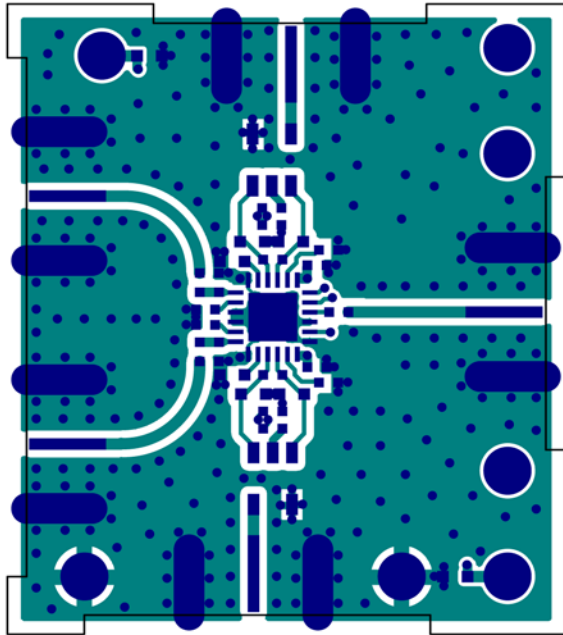
| ITEM | QTY | REFERENCE                    | PART DESCRIPTION                                   | MANUFACTURER/PART NUMBER          |
|------|-----|------------------------------|--|-----------------------------------|
| 1    | 6   | C1A, C1B, C3A, C3B, C5A, C5B | CAP, COG, 22pF, $\pm 1\%$ , 50V, 0402              | AVX, 04025A220FAT                 |
| 2    | 1   | C2                           | CAP, COG, 2.2pF, $\pm 0.1\text{pF}$ , 50V, 0402    | AVX, 04025A2R2BAT                 |
| 3    | 2   | C4, C6                       | CAP, X5R, 1 $\mu\text{F}$ , $\pm 10\%$ , 10V, 0603 | AVX, 0603ZD105KAT                 |
| 4    | 2   | C7A, C7B                     | CAP, X7R, 1000pF, $\pm 5\%$ , 50V, 0402            | AVX, 04025C102JAT                 |
| 5    | 2   | C8A, C8B,                    | CAP, COG, 4.7pF, $\pm 0.1\text{pF}$ , 50V, 0402    | AVX, 04025A4R7BAT                 |
| 6    | 0   | C9A, C9B (OPT)               | CAP, 0402, OPTION                                  |                                   |
| 7    | 7   | E1, E2, E3, E4, E5, E6, E7   | TESTPOINT, TURRET, 0.061"                          | MILL-MAX, 2308-2-00-80-00-00-07-0 |
| 8    | 5   | J1, J2, J3, J5, J6           | CONN., SMA, 50 $\Omega$ , EDGE-LAUNCH              | AMPHENOL CONNEX, 132357           |
| 9    | 4   | L1A, L1B, L2A, L2B           | IND., WIRE-WOUND, 150nH, $\pm 2\%$ , 0603          | COILCRAFT, 0603CS-R15XGLW         |
| 10   | 2   | L3A, L3B                     | RES., CHIP, 0 $\Omega$ , 0603                      | VISHAY, CRCW06030000Z0EA          |
| 11   | 0   | R1A, R1B, R2A, R2B (OPT)     | RES., 0402, OPTION                                 |                                   |
| 12   | 2   | T1A, T1B                     | TRANSFORMER, SMT, RF WIDEBAND, 4:1                 | MINI-CIRCUITS, TC4-1W-7ALN+       |
| 13   | 1   | U1                           | IC., LTC5592IUH, QFN 5X5                           | LINEAR TECHNOLOGY, LTC5592IUH#PBF |

SCHEMATIC DIAGRAM

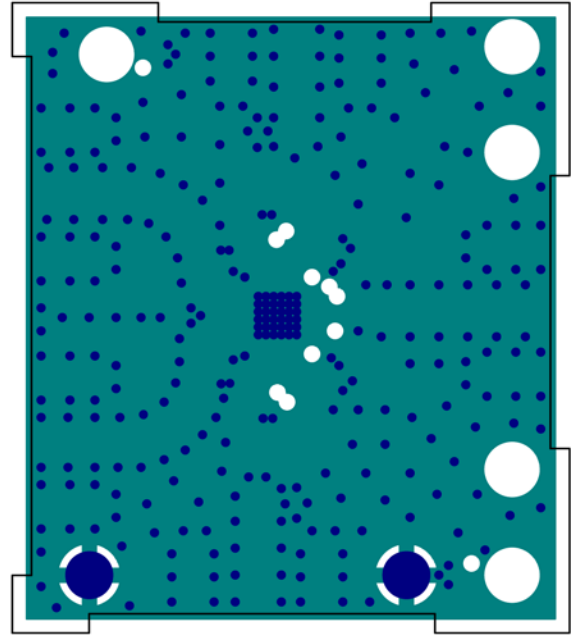


## PCB LAYOUT

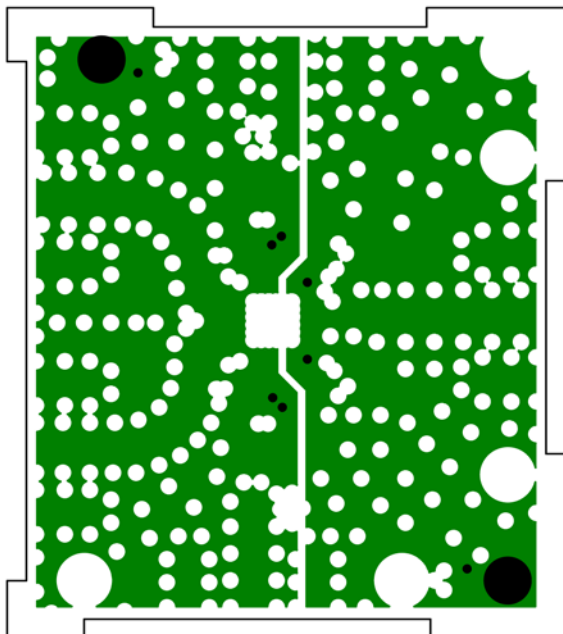
Layer 1. Top Layer



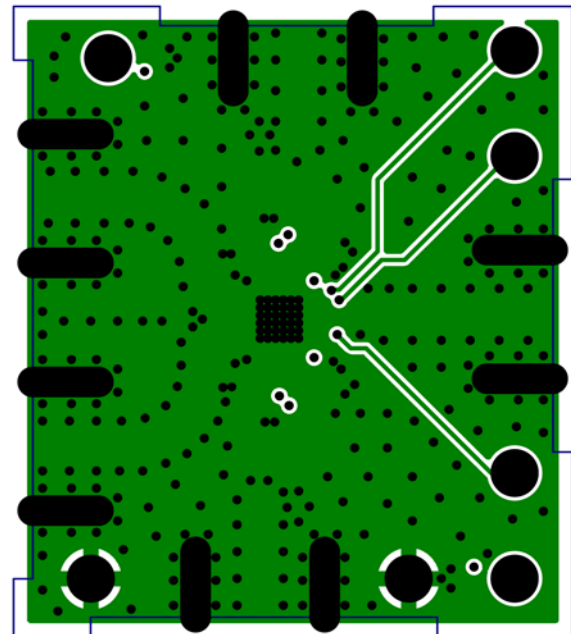
Layer 2. Ground Plane



Layer 3. Power Plane



Layer 4. Bottom Layer



# DEMO MANUAL DC1710A-C

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