# 3GHz to 20GHz Microwave Mixer with Wideband DC to 6GHz IF

## FEATURES

- **Integrated LO Buffer: 0dBm LO Drive**
- **50Ω Wideband Matched RF and LO Ports**
- **Wide IF Bandwidth: DC to 6GHz**
- **Upconversion or Downconversion**
- **High IIP3:**
  - **+22.5dBm at 10GHz**
  - **+18.3dBm at 17GHz**
- **+14.6dBm Input P1dB at 10GHz**
- **8dB Conversion Loss at 10GHz**
- 3.3V/132mA Supply
- Fast Turn ON/OFF for TDD Operation
- 3mm × 2mm, 12-Lead QFN Package

## APPLICATIONS

- 5G Broadband Wireless Access
- Microwave Transceivers
- Wireless Backhaul
- Point-to-Point Microwave
- Phased-Array Antennas
- C, X and Ku Band RADAR
- Test Equipment
- Satellite Modems



## DESCRIPTION

The LTC®5552 is a high performance, microwave double balanced passive mixer that can be used for frequency upconversion or downconversion. The device is similar to the LTC5553, but with a broadband, differential DC to 6GHz IF port. The LTC5552 is recommended for applications where the IF frequency range extends below 500MHz. For applications where the IF frequency is always above 500MHz, the LTC5553 is recommended, since it includes an integrated IF balun.

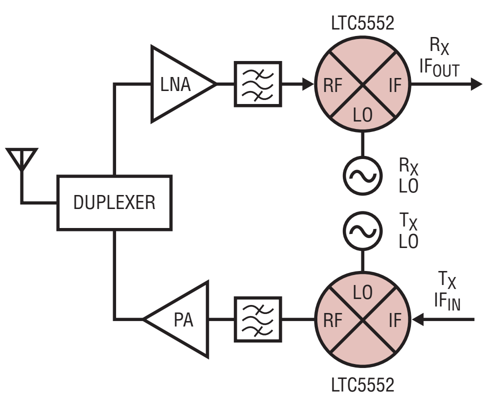
The mixer and integrated RF balun are optimized to cover the 3GHz to 20GHz RF frequency range. The integrated LO amplifier is optimized for the 1GHz to 20GHz frequency range, requiring only 0dBm drive.

The part delivers high IIP3 and P1dB, low LO leakage and high integration in a small package.

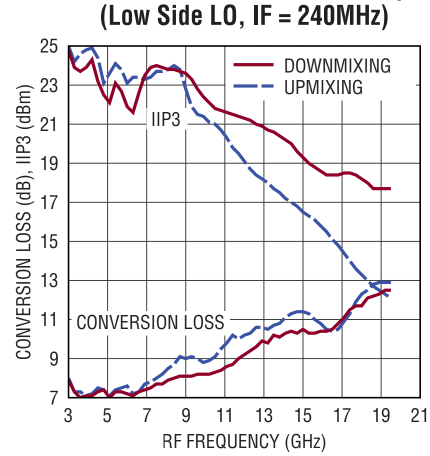
### Electrostatic Sensitive Device

Observe Handling Precautions
ESD Sensitivity:
HBM = Class 0 on Pin 11
Class 1C All Other Pins
CDM = 500V All Pins

## TYPICAL APPLICATION




**Conversion Loss and IIP3 vs RF Frequency (Low Side LO, IF = 240MHz)**

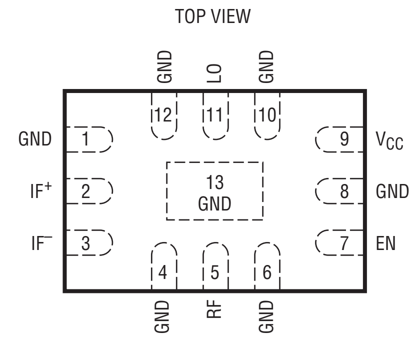


## ABSOLUTE MAXIMUM RATINGS

**(Note 1)**

Supply Voltage ($V_{CC}$) ....................................4V
Enable Input Voltage (EN) ................–0.3V to $V_{CC}$ + 0.3V
LO Input Power (1GHz to 20GHz)..................+10dBm
RF Power (3GHz to 20GHz)...............................+20dBm
RF DC Voltage .............................................±0.1V
$IF^+/IF^-$ Power (LF to 6GHz) ...............................+20dBm
$IF^+/IF^-$ DC Voltage.................................................±0.3V
Operating Temperature Range ($T_C$)........–40°C to 105°C
Storage Temperature Range ..................–65°C to 150°C
Junction Temperature ($T_J$) .................................... 150°C

## PIN CONFIGURATION




UDB PACKAGE
12-LEAD (3mm × 2mm) PLASTIC QFN

$T_{JMAX}$ = 150°C, $\theta_{JC}$ = 25°C/W
EXPOSED PAD (PIN 13) IS GND, MUST BE SOLDERED TO PCB

## ORDER INFORMATION

http://www.linear.com/product/LTC5552#orderinfo

**Lead Free Finish**

| TAPE AND REEL (MINI) | TAPE AND REEL | PART MARKING | PACKAGE DESCRIPTION | CASE TEMPERATURE RANGE |
|---|---|---|---|---|
| LTC5552IUDB#TRMPBF | LTC5552IUDB#TRPBF | LHCK | 12-Lead (3mm × 2mm) Plastic QFN | –40°C to 105°C |

TRM = 500 pieces.

Consult LTC Marketing for parts specified with wider operating temperature ranges.

For more information on lead free part marking, go to: http://www.linear.com/leadfree/

For more information on tape and reel specifications, go to: http://www.linear.com/tapeandreel/. Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.

## DC ELECTRICAL CHARACTERISTICS

**The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_C$ = 25°C. $V_{CC}$ = 3.3V, EN = High, unless otherwise noted. Test circuit shown in Figure 1. (Note 2)**

| PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **Power Supply Requirements** | | | | | | |
| Supply Voltage ($V_{CC}$) | | ● | 3.0 | 3.3 | 3.6 | V |
| Supply Current | EN = High | | | 132 | 150 | mA |
| Shutdown Current | EN = Low | | | | 100 | µA |
| **Enable (EN) Logic Input** | | | | | | |
| Input High Voltage (On) | | ● | 1.2 | | | V |
| Input Low Voltage (Off) | | ● | | | 0.3 | V |
| Input Current | –0.3V to $V_{CC}$ + 0.3V | | –30 | | 100 | µA |
| Chip Turn-On Time | | | | 0.2 | | µs |
| Chip Turn-Off Time | | | | 0.1 | | µs |

## AC ELECTRICAL CHARACTERISTICS

**The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_C$ = 25°C. $V_{CC}$ = 3.3V, EN = High, $P_{LO}$ = 0dBm, $P_{RF}$ = –6dBm (–6dBm/tone for two-tone IIP3 tests), unless otherwise noted. Test circuit shown in Figure 1. (Notes 2, 3)**

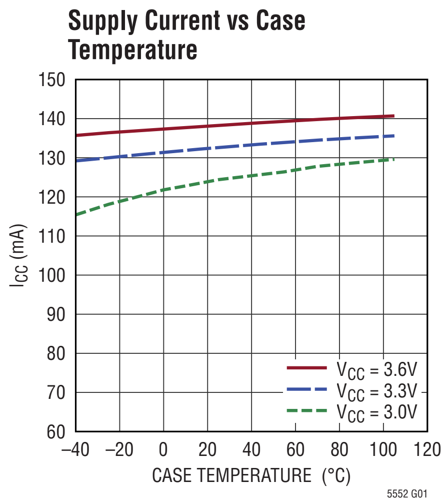
| PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| LO Frequency Range | | ● | | 1 to 20 | | GHz |
| RF Frequency Range | | ● | | 3 to 20 | | GHz |
| IF Frequency Range | | ● | | DC to 6000 | | MHz |
| RF Return Loss | $Z_0$ = 50Ω, 3GHz to 17GHz | | | >9 | | dB |
| LO Input Return Loss | $Z_0$ = 50Ω, 1GHz to 20GHz | | | >10 | | dB |
| LO Input Power | | | –6 | 0 | 6 | dBm |
| **Downmixer Application, IF = 240MHz, Low Side LO** | | | | | | |
| Conversion Loss | RF Input = 4GHz<br>RF Input = 10GHz<br>RF Input = 14GHz<br>RF Input = 17GHz | | | 6.9<br>8.0<br>10.0<br>10.8 | | dB<br>dB<br>dB<br>dB |
| Conversion Loss vs Temperature | $T_C$ = –40°C to 105°C, RF Input = 10GHz | ● | | 0.007 | | dB/°C |
| 2-Tone Input 3rd Order Intercept ($\Delta f_{RF}$ = 2MHz) | RF Input = 4GHz<br>RF Input = 10GHz<br>RF Input = 14GHz<br>RF Input = 17GHz | | | 23.8<br>22.5<br>20.1<br>18.3 | | dBm<br>dBm<br>dBm<br>dBm |
| SSB Noise Figure | RF Input = 10GHz<br>RF Input = 15.7GHz | | | 9.8<br>11.7 | | dB<br>dB |
| LO to RF Input Leakage | $f_{LO}$ = 1GHz to 20GHz | | | <–24 | | dBm |
| LO to IF Leakage | $f_{LO}$ = 1GHz to 20GHz | | | <–19 | | dBm |
| RF to LO Isolation | $f_{RF}$ = 3GHz to 20GHz | | | >53 | | dB |
| RF Input to IF Output Isolation | $f_{RF}$ = 3GHz to 20GHz | | | >34 | | dB |
| Input 1dB Compression | RF Input = 10GHz | | | 14.6 | | dBm |
| **Upmixer Application, IF = 240MHz, Low Side LO** | | | | | | |
| Conversion Loss | RF Output = 4GHz<br>RF Output = 10GHz<br>RF Output = 14GHz<br>RF Output = 17GHz | | | 7.0<br>8.6<br>10.8<br>10.6 | | dB<br>dB<br>dB<br>dB |
| Conversion Loss vs Temperature | $T_C$ = –40°C to 105°C, RF Output = 5.8GHz | | | 0.007 | | dB/°C |
| 2-Tone Input 3rd Order Intercept ($\Delta f_{IF}$ = 2MHz) | RF Output = 4GHz<br>RF Output = 10GHz<br>RF Output = 14GHz<br>RF Output = 17GHz | | | 24.6<br>21.1<br>17.2<br>14.4 | | dBm<br>dBm<br>dBm<br>dBm |
| SSB Noise Figure | RF Output = 10GHz<br>RF Output = 15.7GHz | | | 9.9<br>11.5 | | dB<br>dB |
| LO to RF Output Leakage | $f_{LO}$ = 1GHz to 20GHz | | | <–24 | | dBm |
| LO to IF Input Leakage | $f_{LO}$ = 1GHz to 20GHz | | | <–19 | | dBm |
| IF to LO Isolation | $f_{IF}$ = 500MHz to 9GHz | | | >60 | | dB |
| IF Input to RF Output Isolation | $f_{IF}$ = 500MHz to 9GHz | | | >33 | | dB |
| Input 1dB Compression | RF Output = 10GHz | | | 14.5 | | dBm |

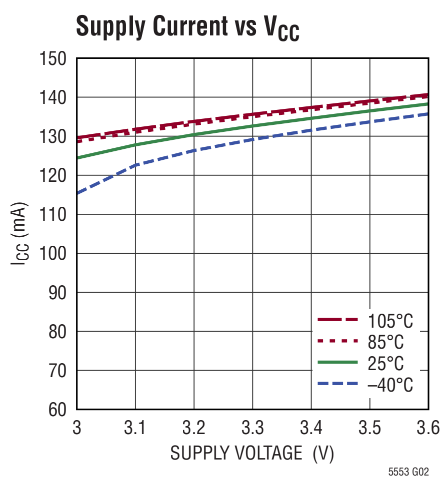
**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** The LTC5552 is guaranteed functional over the –40°C to 105°C case temperature range ($\theta_{JC}$ = 25°C/W).

**Note 3:** SSB noise figure measurements performed with a small-signal noise source, bandpass filter and 2dB matching pad on input, with bandpass filters on LO, and output.

## TYPICAL PERFORMANCE CHARACTERISTICS EN = high, test circuit shown in Figure 1.

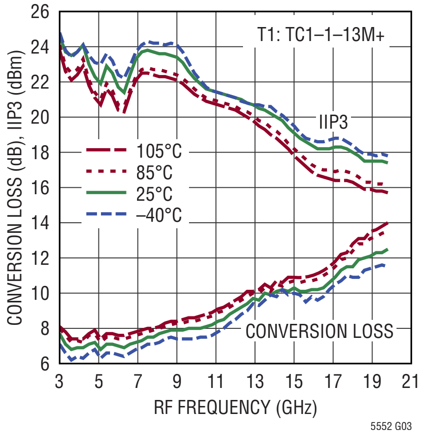


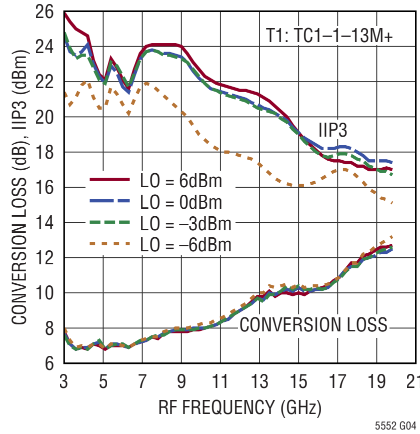
## TYPICAL PERFORMANCE CHARACTERISTICS

**3GHz to 20GHz downmixer application.** **$V_{CC}$ = 3.3V, EN = high, $T_C$ = 25°C, $P_{LO}$ = 0dBm, $P_{IF}$ = –6dBm (–6dBm/tone for two-tone IIP3 tests, Δf = 2MHz), IF = 240MHz, unless otherwise noted. Test circuit shown in Figure 1.**

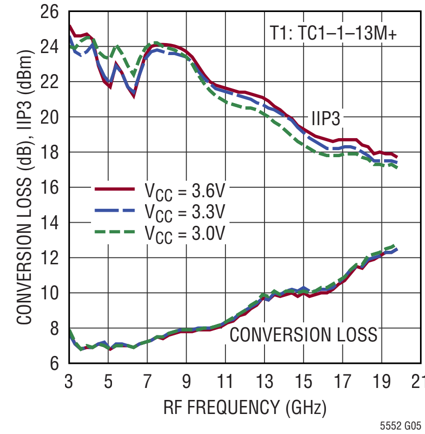
**Conversion Loss and IIP3 vs Case Temperature (Low Side LO)**



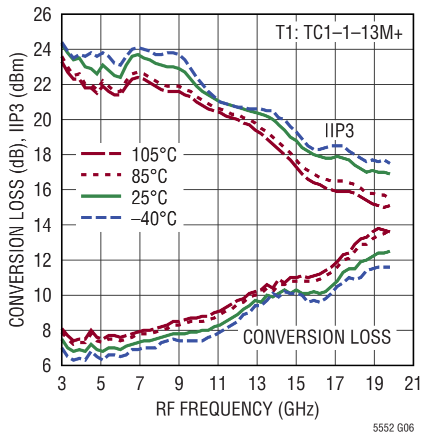

**Conversion Loss and IIP3 vs LO Power (Low Side LO)**



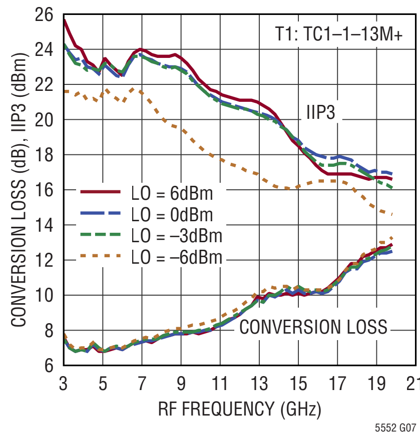

**Conversion Loss and IIP3 vs Supply Voltage (Low Side LO)**



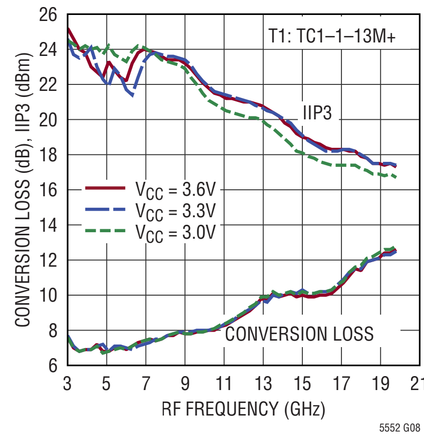

**Conversion Loss and IIP3 vs Case Temperature (High Side LO)**



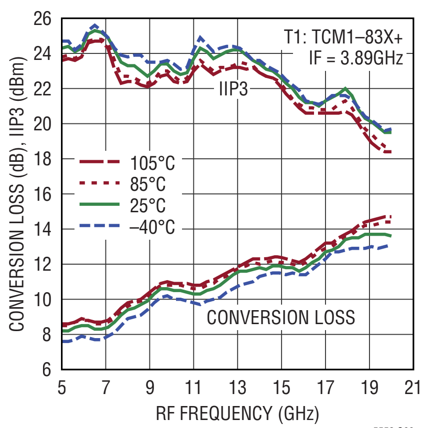

**Conversion Loss and IIP3 vs LO Power (High Side LO)**



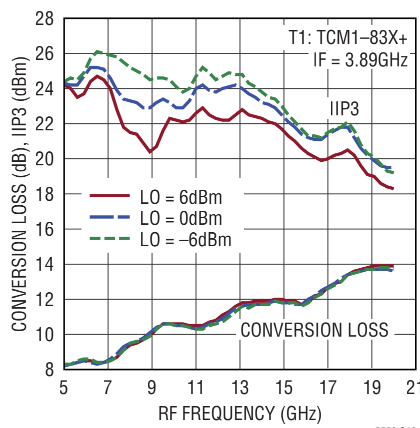

**Conversion Loss and IIP3 vs Supply Voltage (High Side LO)**



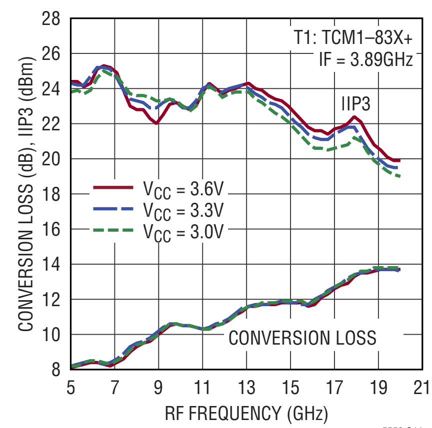

**Conversion Loss and IIP3 vs Case Temperature (Low Side LO)**




**Conversion Loss and IIP3 vs LO Power (Low Side LO)**




**Conversion Loss and IIP3 vs Supply Voltage (Low Side LO)**



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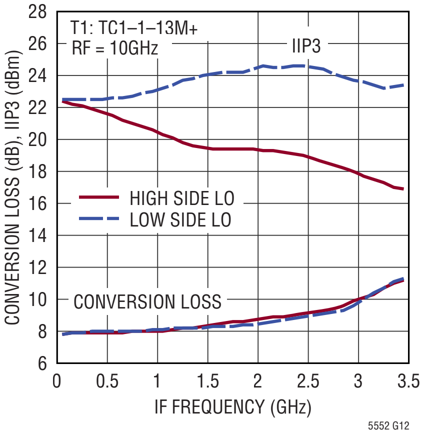
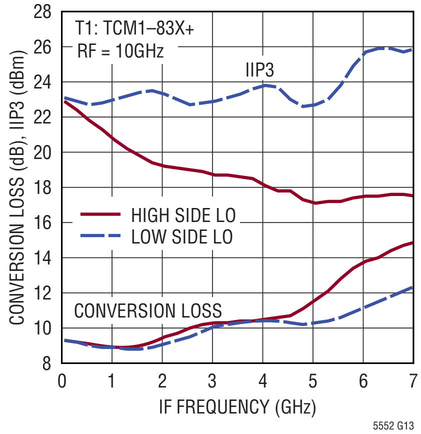
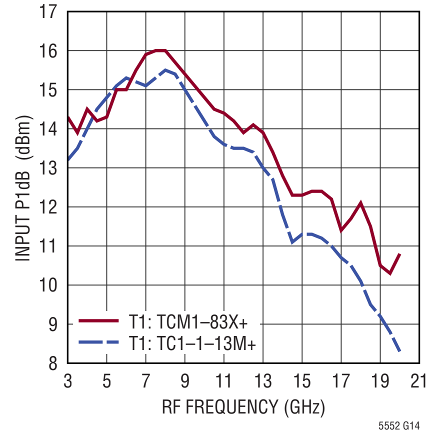
**Conversion Loss and IIP3 vs IF Frequency (RF = 10GHz)**



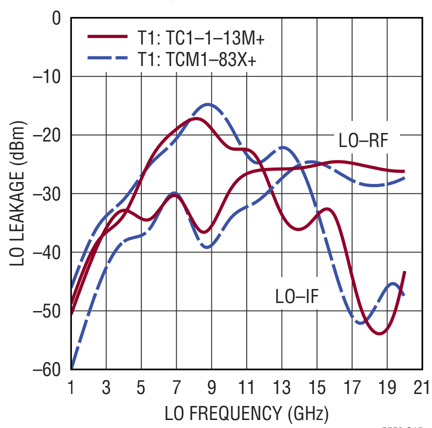

**Conversion Loss and IIP3 vs IF Frequency (RF = 10GHz)**



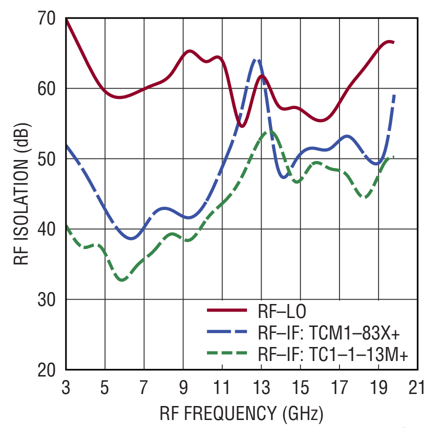

**Input P1dB vs RF Frequency**



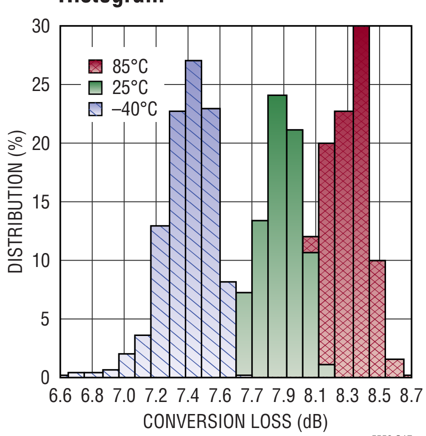

**LO Leakage**



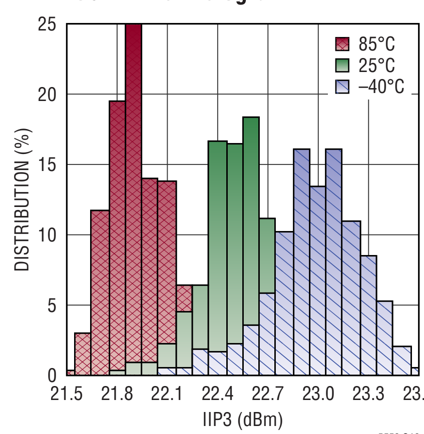

**RF Isolation**




**10GHz Conversion Loss Histogram**




**10GHz IIP3 Histogram**

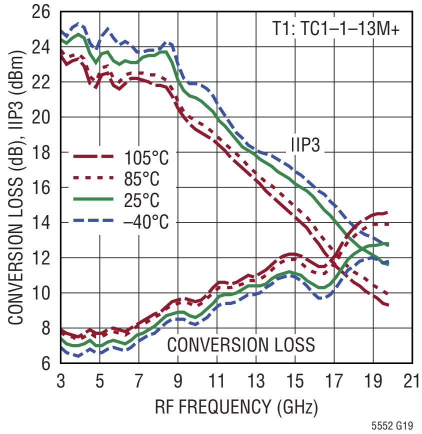


# TYPICAL PERFORMANCE CHARACTERISTICS

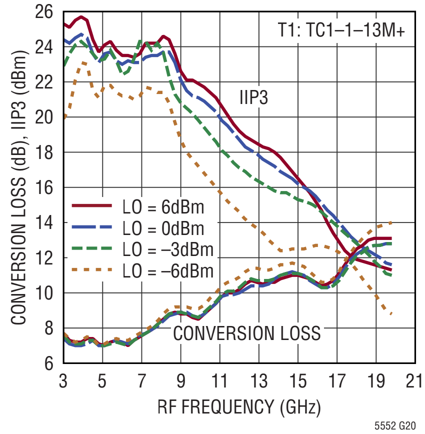
**3GHz to 20GHz upmixer application.**

**$V_{CC}$ = 3.3V, EN = high, $T_C$ = 25°C, $P_{LO}$ = 0dBm, $P_{RF}$ = –6dBm (–6dBm/tone for two-tone IIP3 tests, Δf = 2MHz), IF = 240MHz, unless otherwise noted. Test circuit shown in Figure 1.**

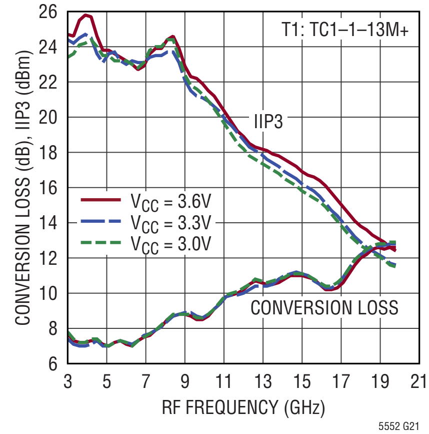
### Conversion Loss and IIP3 vs Case Temperature (Low Side LO)



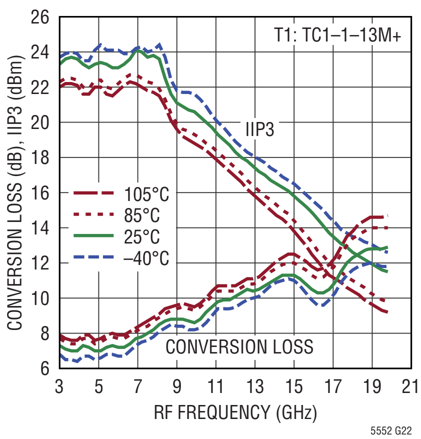

### Conversion Loss and IIP3 vs LO Power (Low Side LO)



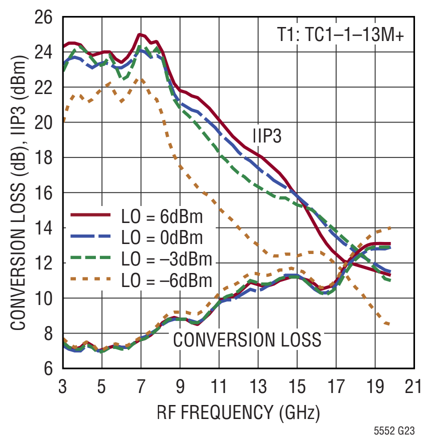

### Conversion Loss and IIP3 vs Supply Voltage (Low Side LO)



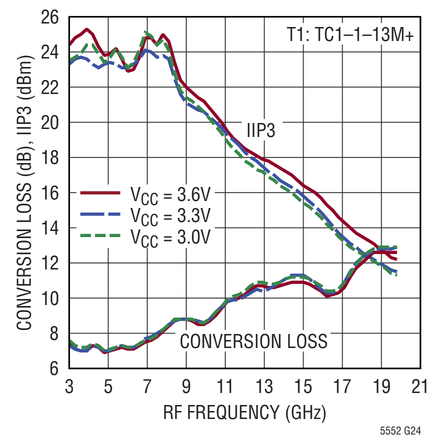

### Conversion Loss and IIP3 vs Case Temperature (High Side LO)



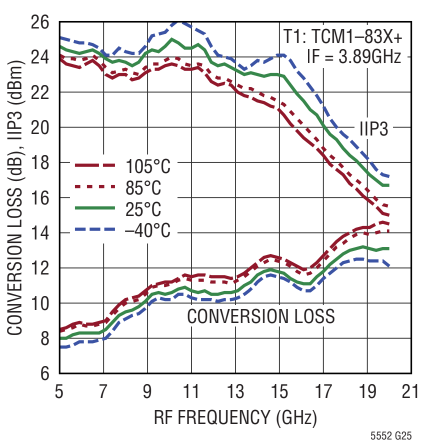

### Conversion Loss and IIP3 vs LO Power (High Side LO)



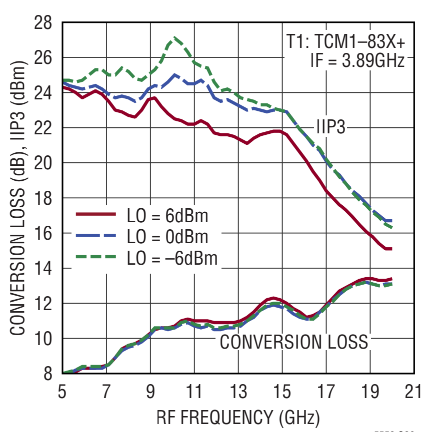

### Conversion Loss and IIP3 vs Supply Voltage (High Side LO)



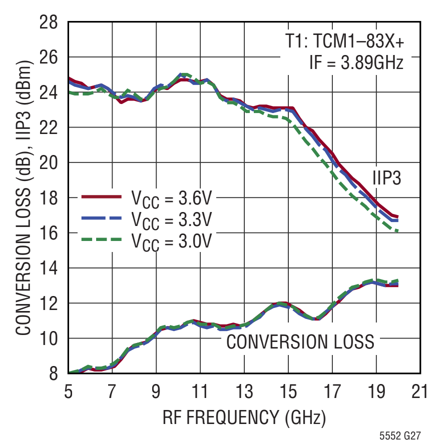

### Conversion Loss and IIP3 vs Case Temperature (Low Side LO)




### Conversion Loss and IIP3 vs LO Power (Low Side LO)




### Conversion Loss and IIP3 vs Supply Voltage (Low Side LO)



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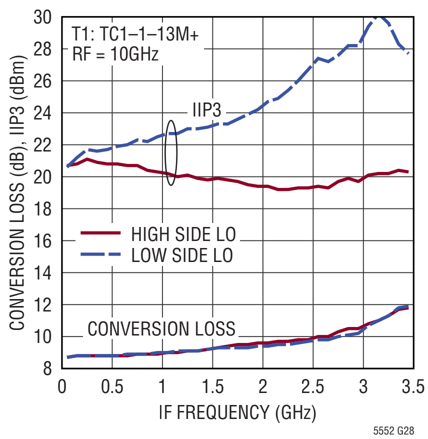
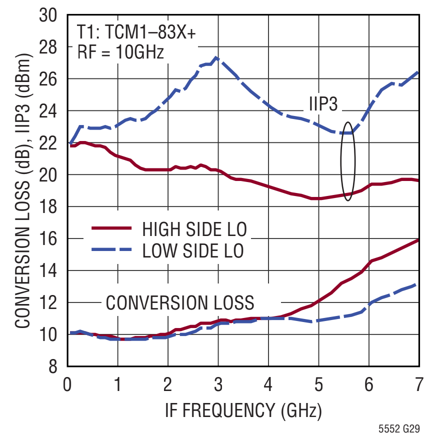
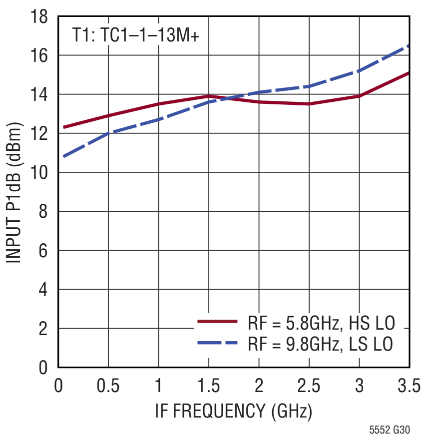
**Conversion Loss and IIP3 vs IF Frequency (RF = 10GHz)**



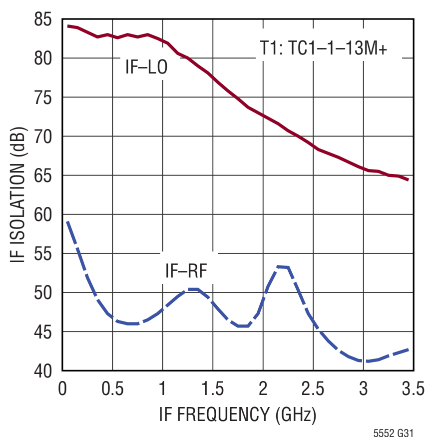

**Conversion Loss and IIP3 vs IF Frequency (RF = 10GHz)**



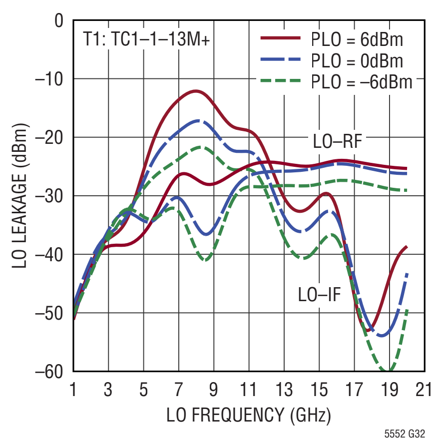

**Input P1dB vs IF Frequency**



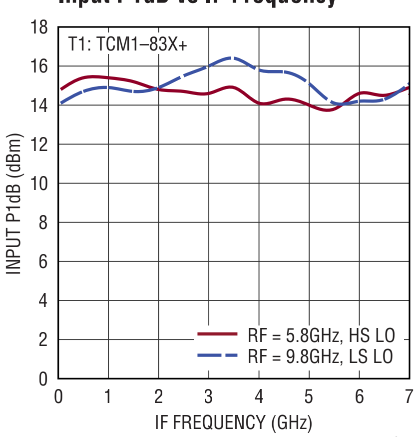

**IF Isolation**




**LO Leakage**




**Input P1dB vs IF Frequency**

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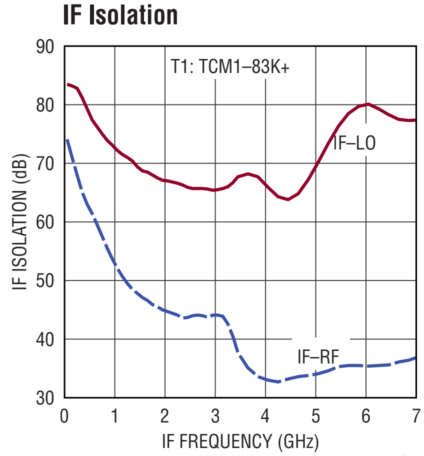


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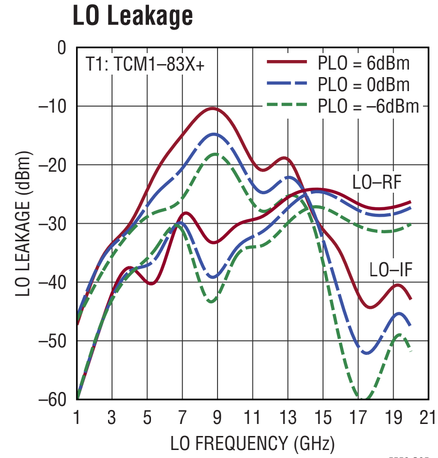


## PIN FUNCTIONS

**GND (Pins 1, 3, 4, 6, 8, 10, 12, Exposed Pad Pin 13):** Ground. These pins must be soldered to the RF ground on the circuit board. The exposed pad metal of the package provides both electrical contact to ground and good thermal contact to the printed circuit board.

**$IF^+$, $IF^-$ (Pins 2, 3):** Differential Terminals for the IF. These pins may be used for a differential IF or connected to an external balun if a single-ended IF port is needed. The IF port can be used from DC up to 6GHz depending on the external balun bandwidth. DC voltages at $IF^+$ and $IF^-$ are 0V.

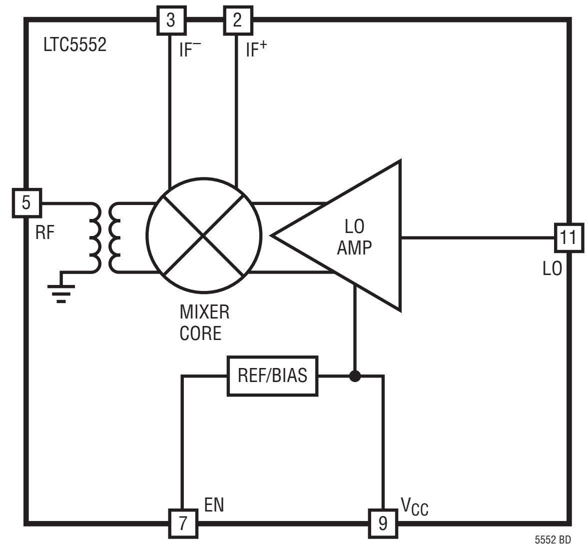
**RF (Pin 5):** Single-Ended Terminal for the RF Port. This pin is internally connected to the primary side of the RF transformer, which has low DC resistance to ground. A series DC blocking capacitor must be used to avoid damage to the integrated transformer if DC voltage is present. The RF port is impedance matched from 3GHz to 20GHz as long as the LO is driven with a 0 ±6dBm source between 1GHz and 20GHz.

**EN (Pin 7):** Enable Pin. When the voltage applied to this pin is greater than 1.2V, the mixer is enabled. When the voltage is less than 0.3V, the mixer is disabled. Typical input current is less than 30µA. This pin has an internal 376kΩ pull-down resistor.

**$V_{CC}$ (Pin 9):** Power Supply Pin. This pin must be externally connected to a regulated 3.3V supply, with a bypass capacitor located close to the pin. Typical current consumption is 132mA when the part is enabled.

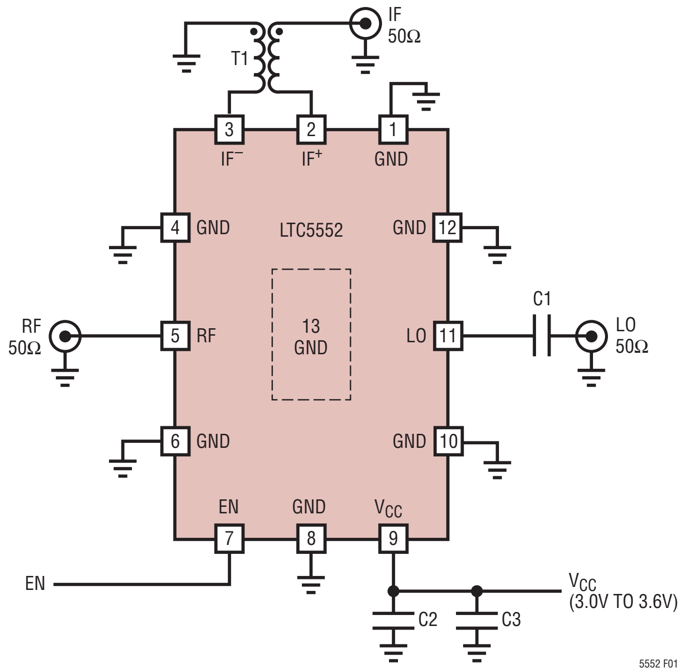
**LO (Pin 11):** Input for the Local Oscillator (LO). A series DC blocking capacitor must be used. Typical DC voltage at this pin is 1.6V.

## BLOCK DIAGRAM




GND PINS ARE NOT SHOWN.

# TEST CIRCUIT




| REF DES | VALUE | SIZE | VENDOR | COMMENT |
|---|---|---|---|---|
| C1 | 18pF | 0402 | AVX | 0402ZK180GBS |
| C2 | 18pF | 0402 | Murata | GJM1555C1H180FB01 |
| C3 | 1µF | 0603 | Murata | GRM188R71A105KA61 |
| T1 | TC1-1-13M+* | | Mini Circuits | IF = 4.5MHz to 3GHz |
| | TCM1-83X+ | | Mini Circuits | IF = 10MHz to 6GHz |

* Standard Evaluation Board Configuration

**Figure 1. Standard Test Circuit Schematic**

## APPLICATIONS INFORMATION

### Introduction

The LTC5552 consists of a high linearity double-balanced mixer core, LO buffer amplifier and bias/enable circuits. See the Block Diagram section for a description of each pin function. The RF and LO are single-ended 50Ω ports. The IF is differential. An external balun is needed if a single-ended IF signal is desired. The LTC5552 can be used as a frequency downconverter where the RF is used as an input and IF is used as an output. It can also be used as a frequency upconverter where the IF is used as an input and RF is used as an output. Low side or high side LO injection can be used. The evaluation circuit and the evaluation board layout are shown in Figure 1 and Figure 2, respectively.

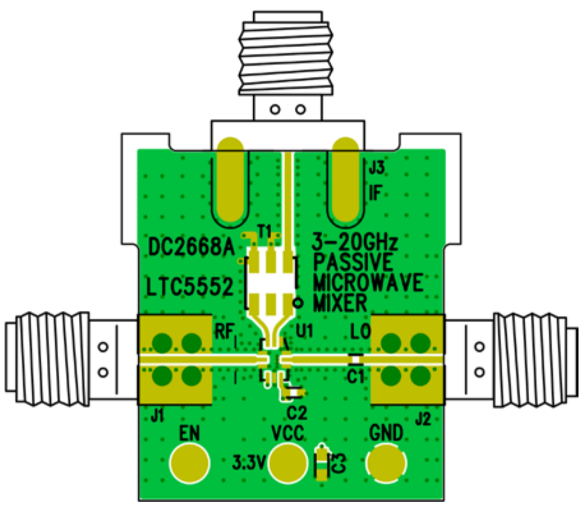



Figure 2. Evaluation Board Layout

### RF Port

The mixer's RF port, shown in Figure 3, is connected to the primary winding of an integrated transformer. The primary side of the RF transformer is DC–grounded internally and the DC resistance of the primary side is approximately 2.5Ω. A DC blocking capacitor is needed if the RF source has DC voltage present. The secondary winding of the RF transformer is internally connected to the mixer core.

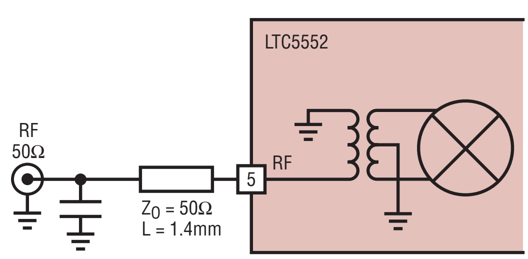



Figure 3. Simplified RF Port Interface Schematic

The RF port is internally broadband matched from 3GHz to 20GHz. A 0.15pF shunt capacitor located 1.4mm away from the RF pin can be used to improve the RF port matching between 13GHz to 15GHz. LO power between –6dBm and 6dBm is required for good RF impedance matching. The measured RF input return loss is shown in Figure 4 for IF frequencies of 900MHz, 2GHz and 4GHz with low side LO.

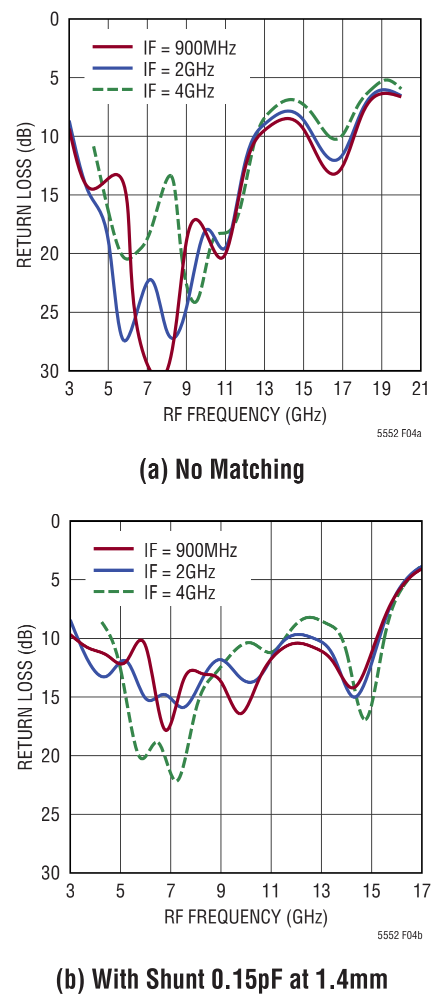



Figure 4. RF Port Return Loss

# APPLICATIONS INFORMATION

The RF input impedance and input reflection coefficient versus RF frequency is listed in Table 1. The reference plane for this data is Pin 5 of the IC, with no external matching, and the LO is driven at 12GHz.

**Table 1. RF Port Impedance and S11 (at Pin 5, No External Matching, LO Input Driven at 12GHz)**

| FREQUENCY (GHz) | RF INPUT IMPEDANCE | S11 | |
|---|---|---|---|
| | | MAG | ANGLE |
| 3 | 50.1 + j33.8 | 0.32 | 71.3 |
| 4 | 63.3 + j37.1 | 0.33 | 52.1 |
| 5 | 96.2 + j14.7 | 0.33 | 11.9 |
| 6 | 75.4 + j16.6 | 0.24 | –25.6 |
| 7 | 54.9 + j18.5 | 0.18 | –65.2 |
| 8 | 37.5 – j8.2 | 0.17 | –141.2 |
| 9 | 39.7 – j3.0 | 0.12 | 161.7 |
| 10 | 44.7 – j4.1 | 0.07 | –140.7 |
| 11 | 45.2 – j10.4 | 0.12 | –108.4 |
| 12 | 38.9 – j16.5 | 0.22 | –113.4 |
| 13 | 32.5 – j22.1 | 0.33 | –113.3 |
| 14 | 28.1 – j24.3 | 0.40 | –114.7 |
| 15 | 30.1 – j22.2 | 0.36 | –116.4 |
| 16 | 27.6 – j13.1 | 0.33 | –140.0 |
| 17 | 24.8 + j3.1 | 0.34 | 170.5 |
| 18 | 19.8 + j18.9 | 0.47 | 141.8 |
| 19 | 17.0 + j19.6 | 0.55 | 132.9 |
| 20 | 21.3 + j19.6 | 0.47 | 130.2 |

## LO Input

The mixer's LO input, shown in Figure 5, consists of a single-ended to differential conversion and high speed limiting differential amplifier. The LO amplifier is optimized for the 1GHz to 20GHz LO frequency range. LO frequencies above or below this frequency range may be used with degraded performance.

The DC voltage at the LO input is about 1.6V. A DC blocking capacitor (C1) is required.

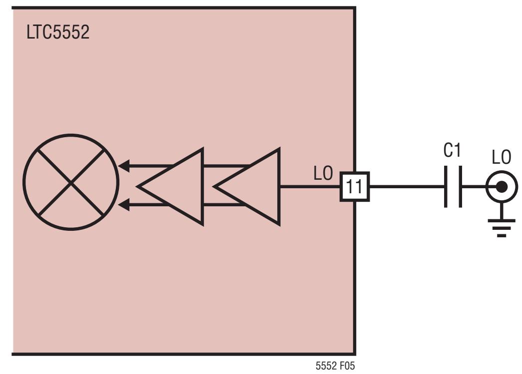



**Figure 5. Simplified LO Input Schematic**

The LO is 50Ω matched from 1GHz to 20GHz. External matching components may be needed for extended LO operating frequency range. To ensure the best LO impedance matching over the very wide bandwidth, no ESD protection devices are used at the LO input. As a result, the LO is the most sensitive pin to ESD stress for the mixer. The measured LO input return loss is shown in Figure 6. The nominal LO input level is 0dBm, although the limiting amplifiers will deliver excellent performance over a ±6dBm input power range.

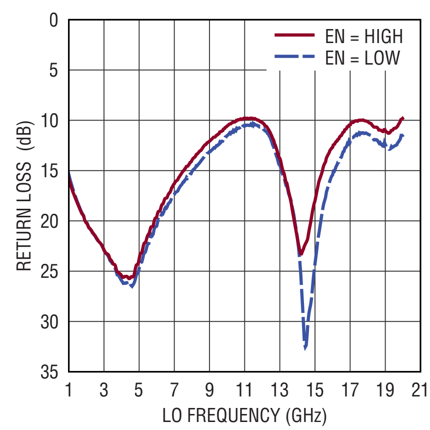



**Figure 6. LO Input Return Loss**

The LO input impedance and input reflection coefficient versus frequency, is shown in Table 2.

## APPLICATIONS INFORMATION

**Table 2. LO Input Impedance vs Frequency (at Pin 11, No External Matching with C1 = 18pF Connected)**

| FREQUENCY (GHz) | INPUT IMPEDANCE | S11 | |
|---|---|---|---|
| | | MAG | ANGLE |
| 1 | 56.3 – j18.0 | 0.18 | –61.0 |
| 2 | 54.1 – j12.3 | 0.12 | –64.7 |
| 3 | 55.1 – j9.7 | 0.10 | –56.8 |
| 4 | 57.9 – j6.1 | 0.09 | –34.4 |
| 5 | 56.1 – j3.5 | 0.07 | –28.0 |
| 6 | 50.4 – j3.0 | 0.03 | –80.6 |
| 7 | 43.4 – j5.7 | 0.09 | –135.4 |
| 8 | 39.3 – j10.7 | 0.17 | –128.2 |
| 9 | 37.1 – j15.8 | 0.23 | –119.0 |
| 10 | 34.8 – j20.2 | 0.29 | –113.6 |
| 11 | 34.4 – j22.1 | 0.31 | –110.6 |
| 12 | 36.8 – j21.3 | 0.28 | –108.0 |
| 13 | 39.8 – j16.2 | 0.21 | –111.9 |
| 14 | 38.1 – j7.4 | 0.16 | –143.5 |
| 15 | 32.9 – j2.7 | 0.21 | –169.3 |
| 16 | 23.9 – j7.1 | 0.36 | –159.4 |
| 17 | 20.1 – j11.4 | 0.45 | –150.0 |
| 18 | 21.6 – j15.4 | 0.44 | –139.4 |
| 19 | 26.9 – j14.8 | 0.35 | –136.5 |
| 20 | 28.4 – j7.4 | 0.29 | –155.9 |

### IF Port

The mixer's IF port is differential as shown in Figure 7. ESD protection diodes are connected to both of these ports. The single-ended impedance of each of the $IF^+$ and $IF^-$ terminals is approximately 25Ω in parallel with 0.25pF. An external 1:1 balun is required for a 50Ω single-ended IF. Using a TC1-1-13M+ balun, for example, the IF port is broadband matched from 4.5MHz to 3GHz, when the LO

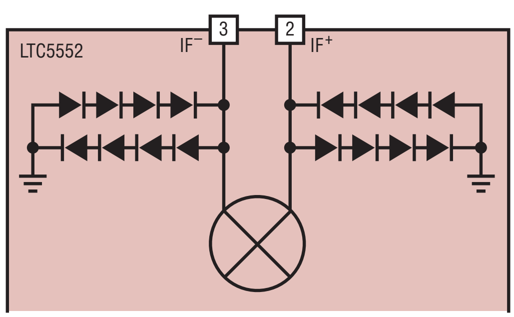



**Figure 7. Simplified IF Port Schematic**

is applied. For higher frequency IF operation, up to 6GHz, the TCM1-83X+ balun is recommended.

The measured IF port return loss is shown in Figure 8.

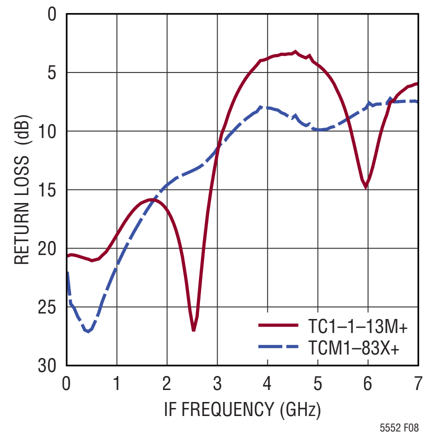



**Figure 8. IF Port Return Loss**

### Enable Interface

Figure 9 shows a simplified schematic of the EN pin interface. To enable the chip, the EN voltage must be higher than 1.2V. The voltage at the EN pin should never exceed $V_{CC}$ by more than 0.3V. If this should occur, the supply current could be sourced through the ESD diode, potentially damaging the IC. If the EN pin is left floating, its voltage will be pulled low by the internal pull-down resistor and the chip will be disabled.

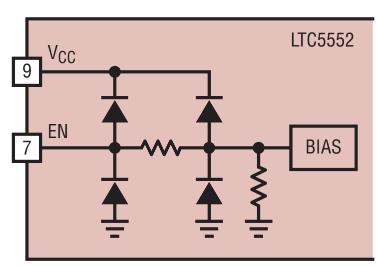



**Figure 9. Simplified Enable Input Circuit**

## APPLICATIONS INFORMATION

### 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.

### Spurious Output Levels

Mixer spurious output levels versus harmonics of the RF and LO are tabulated in Table 3 and Table 4. The spur levels were measured on a standard evaluation board using the test circuit shown in Figure 1. The spur frequencies can be calculated using the following equation:

Frequency Downconversion: $f_{SPUR} = (M \bullet f_{RF}) \pm (N \bullet f_{LO})$

Frequency Upconversion: $f_{SPUR} = (M \bullet f_{IF}) \pm (N \bullet f_{LO})$

**Table 3. IF Output Spur Levels (dBc) – Downmixer Diff Frequency**

**RF = 5250MHz, $P_{RF}$ = –6dBm, $P_{LO}$ = 0dBm, IF = 251MHz, Low Side LO, $V_{CC}$ = 3.3V, EN = High, $T_C$ = 25°C**

| | | N | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 |
| M | **0** | | –26 | –74 | –73 | * | * |
| | **1** | –13 | 0 | –57 | –70 | –74 | * |
| | **2** | –8 | –38 | –73 | –69 | < –75 | –74 |
| | **3** | –34 | –17 | –60 | –59 | < –75 | < –75 |
| | **4** | * | –61 | –71 | –74 | < –75 | < –75 |
| | **5** | * | * | * | –65 | < –75 | < –75 |

* Out of the test equipment range.

**Table 4. RF Output Spur Levels (dBc) – Upmixer Sum Frequency**

**RF = 5399MHz, $P_{RF}$ = –6dBm, $P_{LO}$ = 0dBm, IF = 400MHz, Low Side LO, $V_{CC}$ = 3.3V, EN = High, $T_C$ = 25°C**

| | | N | | | | |
|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **4** |
| M | **0** | | –25 | –19 | –26 | –20 |
| | **1** | –41 | 0 | –38 | –14 | * |
| | **2** | –65 | –63 | –62 | –62 | * |
| | **3** | < –75 | –66 | –70 | –65 | * |
| | **4** | < –75 | < –75 | < –75 | –73 | * |
| | **5** | < –75 | < –75 | < –75 | –73 | * |
| | **6** | < –75 | < –75 | < –75 | –74 | * |
| | **7** | < –75 | < –75 | < –75 | –74 | * |

* Out of the test equipment range.

## APPLICATIONS INFORMATION

### Evaluation Board Insertion Loss

The LTC5552 performance in the data sheet is measured using the evaluation board shown in Figure 2. The insertion loss of the board traces and SMA connectors are not de-embedded. These insertion losses are shown in Figure 10, and the actual performance of the LTC5552 can be estimated using this data. Figure 11 compares the de-embedded performance to the performance measured at the SMA connectors.

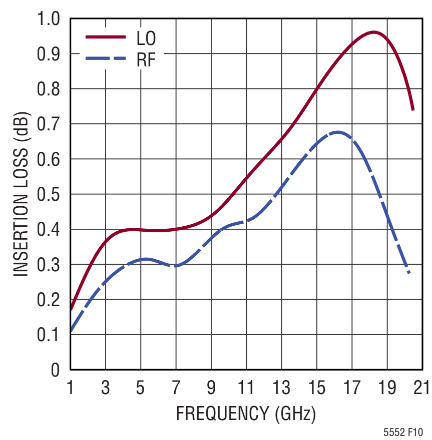



**Figure 10. Insertion Loss of the RF and LO ports**

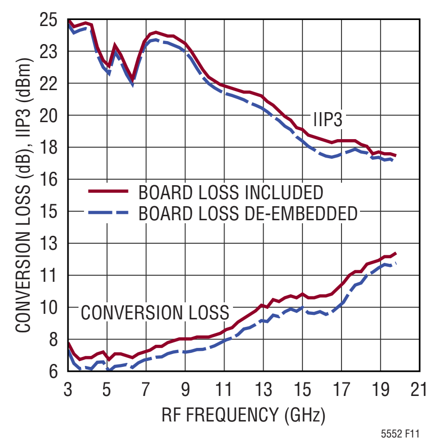
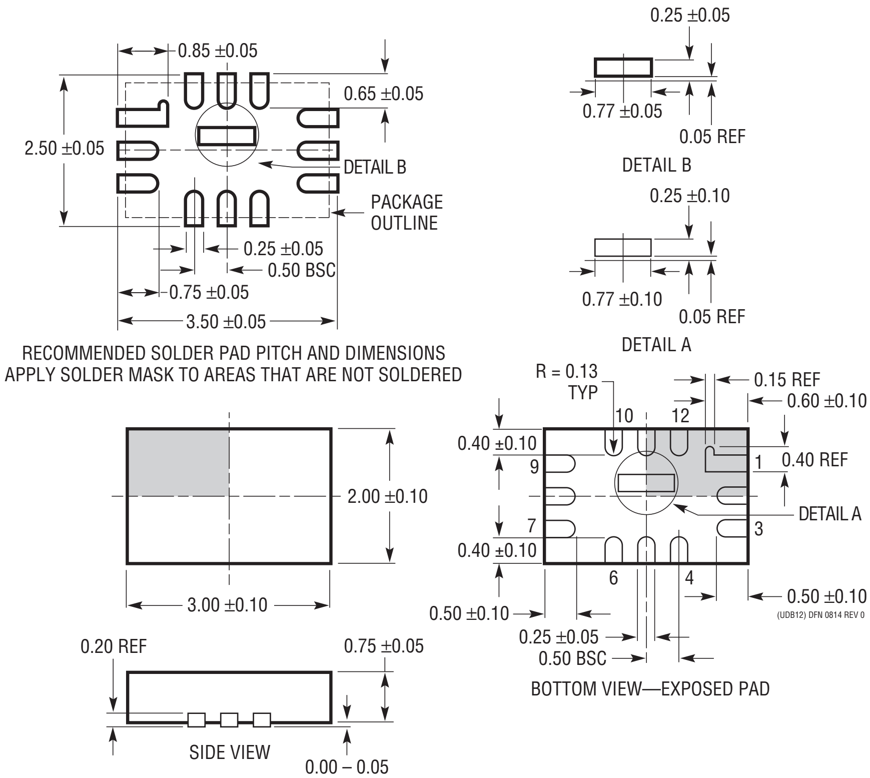



**Figure 11. Comparison of the LTC5552 Performance Before and After De-Embedding the Insertion Loss of the Evaluation Board and SMA Connectors. Downconversion Application with Low Side LO, IF = 240MHz, $V_{CC}$ = 3.3V, EN = High, $T_C$ = 25°C**

# PACKAGE DESCRIPTION

**Please refer to http://www.linear.com/product/LTC5552#packaging for the most recent package drawings.**

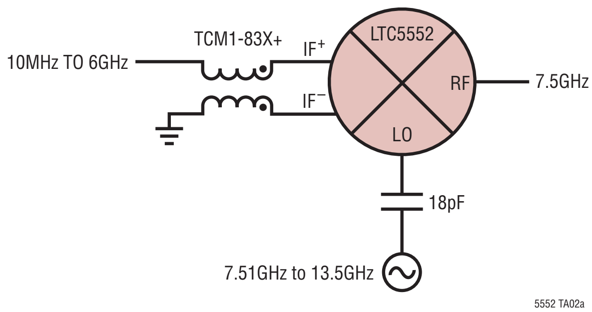
**UDB Package**
**Variation A**
**12-Lead Plastic QFN (3mm × 2mm)**
(Reference LTC DWG # 05-08-1985 Rev Ø)



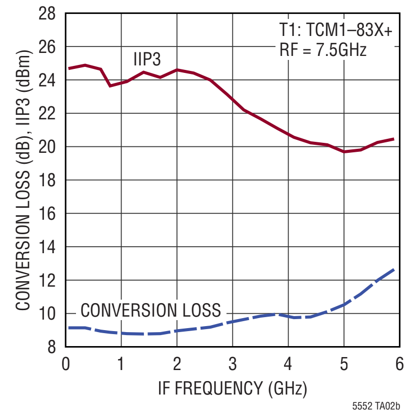

NOTE:
1. DRAWING IS NOT A JEDEC PACKAGE OUTLINE
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

# TYPICAL APPLICATION

**Wideband Upconversion to 7.5GHz**




**Conversion Loss and IIP3 vs Input Frequency (High Side LO)**




# RELATED PARTS

| PART NUMBER | DESCRIPTION | COMMENTS |
|---|---|---|
| **Mixers, Modulators and Demodulators** | | |
| LTC5553 | 3GHz to 20GHz Microwave Mixer | 9dB Conversion Loss, 24dBm IIP3, 500MHz to 9GHz Single-Ended IF with Integrated Balun |
| LTC5548 | 2GHz to 14GHz Microwave Mixer with Wideband DC-6GHz IF | 7.1dB Conversion Loss, 24dBm IIP3, 3.3V/120mA Supply |
| LTC5549 | 2GHz to 14GHz Microwave Mixer | 8dB Conversion Loss, 24dBm IIP3, 500MHz to 6GHz Single-Ended IF with Integrated Balun |
| LTC5544 | 4GHz to 6GHz Downconverting Mixer | 7.5dB Gain, >25dBm IIP3 and 10dB NF, 3.3V/200mA Supply |
| LTC5576 | 3GHz to 8GHz High Linearity Active Upconverting Mixer | 25dBm OIP3, –0.6dB Gain, 14.1dB NF, –154dBm/Hz Output Noise Floor, –28dBm LO Leakage at 8GHz |
| LTC5551 | 300MHz to 3.5GHz Ultrahigh Dynamic Range Downconverting Mixer | +36dBm IIP3; 2.4dB Gain, <10dB NF, 0dBm LO Drive, +18dBm P1dB, 670mW Power Consumption |
| LTC5567 | 400MHz to 4GHz, Active Downconverting Mixer | 1.9dB Gain, 26.9dBm IIP3 and 11.8dB NF at 1950MHz, 3.3V/89mA Supply |
| LTC5577 | 300MHz to 6GHz High Signal Level Active Downconverting Mixer | 50Ω Matched Input from 1.3GHz to 4.3GHz, 30dBm IIP3, 0dB Gain, >40dB LO-RF Isolation, 0dBm LO Drive |
| LTC5510 | 1MHz to 6GHz Wideband High Linearity Active Mixer | 50Ω Matched Input from 30MHz to 6GHz, 27dBm OIP3, 1.5dB Gain, Upconversion or Downconversion |
| LTC5586 | 300MHz to 6GHz Ultra-Wideband Direct I/Q Demodulator with IF Amplifier | I/Q Bandwidth DC to 1GHz, +30dBm IIP3, 80dBm OIP2, Image Rejection >60dB, DC Offset Cancellation |
| LTC5588-1 | 6GHz I/Q Modulator | 200MHz to 6GHz Direct Conversion, 31dBm OIP3 Adjustable to 34dBm, –160dBm/Hz Output Noise Floor, Excellent ACPR |
| **Amplifiers** | | |
| LTC6430-20 | High Linearity Differential IF Amp | 20MHz to 2GHz Bandwidth, 20.8dB Gain, 51dBm OIP3, 2.9dB NF at 240MHz |
| LTC6432-15 | High Linearity Differential IF Amp | 100kHz to 1.4GHz Bandwidth, 15.9dB Gain, 50.3dBm OIP3, 3.2dB NF at 150MHz |
| **RF Power Detectors** | | |
| LTC5564 | 15GHz Ultra Fast 7ns Response Time RF Detector with Comparator | 600MHz to 15GHz, –24dB to 16dBm Input Power Range, 9ns Comparator Response Time, 125°C Version |
| LTC5582 | 40MHz to 10GHz RMS Detector | ±0.5dB Accuracy Over Temperature, ±0.2dB Linearity Error, 57dB Dynamic Range |
| LTC5596 | 100MHz to 40GHz RMS Power Detector | 35dB Dynamic Range (–37dBm to –2dBm), ±1dB Flatness from 200MHz to 30GHz |
| **RF PLL/Synthesizer with VCO** | | |
| LTC6948 | Ultralow Noise, Low Spurious Frac-N PLL with Integrated VCO | 373MHz to 6.39GHz, –157dBc/Hz WB Phase Noise Floor, –274dBc/Hz Normalized In-Band 1/f Noise |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