

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 1048A

## 1.5GHz TO 2.7GHz DIRECT CONVERSION I/Q RECEIVER

LT5575

### DESCRIPTION


Demonstration circuit 1048A is a 1.5GHz to 2.7GHz Direct Conversion I/Q Receiver featuring the LT5575.

The LT<sup>®</sup>5575 is an 800MHz to 2.7GHz direct conversion quadrature demodulator optimized for high linearity receiver applications. It is suitable for communications receivers where an RF signal is directly converted into I and Q baseband signals with bandwidth up to 490MHz. The LT5575 incorporates balanced I and Q mixers, LO buffer amplifiers and a precision, high frequency quadrature phase shifter. The integrated on-chip broadband transformers provide 50Ω single-ended interfaces at

the RF and LO inputs. Only a few external capacitors are needed for its application in an RF receiver system.

Demonstration circuit 1048A is designed for evaluating the LT5575 in the frequency range between 1.5GHz and 2.7GHz. It can be optimized for input frequencies below 1.5GHz by installing external shunt capacitors at RF input and LO input ports. Refer to the LT5575 data sheet for details.

**Design files for this circuit board are available. Call the LTC factory.**

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**Table 1. Typical Performance Summary (T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5V, EN = High, f<sub>RF</sub> = 1900MHz (Δf = 200kHz for 2-tone IIP2 and IIP3 tests), P<sub>RF</sub> = -10dBm (-10dBm/tone for 2-tone IIP2 and IIP3 tests), f<sub>LO</sub> = 1901MHz, P<sub>LO</sub> = 0dBm, unless otherwise noted.)**

PARAMETER	CONDITIONS	VALUE
Supply Voltage		4.5V to 5.25V
Supply Current		132mA
Maximum Shutdown Current	EN = Low	100μA
Output DC Offset Voltage	I <sub>OUT</sub> <sup>+</sup> - I <sub>OUT</sub> <sup>-</sup>  ,   Q <sub>OUT</sub> <sup>+</sup> - Q <sub>OUT</sub> <sup>-</sup>	< 9mV
RF/LO Input Frequency Range	No External Matching (High Band) With External Matching (Low Band, Mid Band)	1.5GHz to 2.7GHz 0.8GHz to 1.5GHz
Baseband Frequency Range		DC to 490MHz
Baseband I/Q Output Impedance	Single-Ended	65Ω // 5pF
RF/LO Input Return Loss	Z <sub>0</sub> = 50Ω, 1.5GHz to 2.7GHz, Internally Matched	> 10dB
LO Input Power		-13dBm to 5dBm
Conversion Gain	Voltage Gain, R <sub>LOAD</sub> = 1kΩ	4.2dB
Noise Figure	Double-Side Band	12.7dB
Input 3 <sup>rd</sup> -Order Intercept	2 RF tones, -10dBm/Tone, Δf = 200kHz	22.6dBm
Input 2 <sup>nd</sup> -Order Intercept	2 RF tones, -10dBm/Tone, Δf = 200kHz	60dBm
Input 1dB Compression		11.2dBm
I/Q Gain Mismatch		0.01dB
I/Q Phase Mismatch		0.4°
LO to RF leakage		-64.6dBm
RF to LO Isolation		57.1dB

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### APPLICATION NOTE

#### ABSOLUTE MAXIMUM INPUT RATING

Power Supply Voltage .....	5.5V
Enable Voltage .....	-0.3V to $V_{CC} + 0.3V$
RF Input Power .....	20dBm
LO Input Power .....	10dBm
RF Input DC Voltage .....	$\pm 0.1V$
LO Input DC Voltage .....	$\pm 0.1V$

#### FREQUENCY RANGE

Demonstration circuit 1048A is designed for evaluating the LT5575 in the frequency range between 1.5GHz and 2.7GHz. In this frequency range, both of the LT5575's RF and LO ports are internally matched to  $50\Omega$ . Below 1.5GHz, a shunt capacitor to ground placed close to the RF and LO pins of the IC can be used to provide impedance matching to maintain best performance. Matching capacitor values for different frequency bands are listed in Table 2.

**Table 2. RF and LO match and Baseband Output Filtering**

Frequency Range	RF Match	LO Match	Baseband
	C10	C12	C1-C4
Low Band: 800 to 1000MHz	4.7pF	3.9pF	10pF
Mid Band: 1000MHz to 1500MHz	2pF	2pF	2.2pF
High Band: 1500MHz to 2700MHz	None	None	None

#### OUTPUT FILTERING

Proper filtering of unwanted high frequency mixing products at the I and Q outputs is important to maintain superior linearity. The most convenient method is to terminate each output with a shunt capacitor to ground. The capacitor value should be optimized depending upon the operating frequency. However, the capacitors may reduce baseband output bandwidth. Filtering capacitor values for different frequency bands are listed in Table 2.

#### TEST EQUIPMENT AND SETUP

Refer to Figure 1 for proper measurement equipment setup.

Use high performance signal generators with low harmonic output for 2-tone measurements. Otherwise, low-pass filters at the signal generator outputs should be used to suppress higher-order harmonics.

High quality combiners that provide broadband  $50\Omega$  termination on all ports and have good port-to-port isolation should be used. Attenuators on the outputs of the signal generators are recommended to further improve source isolation, to prevent the sources from modulating each other and generating inter-modulation products.

Spectrum analyzers can produce significant internal distortion products if they are overdriven. Generally, spectrum analyzers are designed to operate at their best with about -30dBm to -40dBm at their input. Sufficient spectrum analyzer input attenuation should be used to avoid saturating the instrument.

Before performing measurements on the DUT, the system performance should be evaluated to ensure that: 1) a clean input signal is obtained and 2) the spectrum analyzer internal distortion is minimized.

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### QUICK START PROCEDURE

Demonstration circuit 1048A is easy to set up to evaluate the performance of the LT5575. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

**NOTE:**

- a. Care should be taken to never exceed absolute maximum input rating.
  - b. DC power should never be applied to the EN pin before it is applied to the Vcc pin.
1. Connect all test equipment as shown in Figure 1.
  2. Apply 5V DC supply power, and verify that the current consumption is approximately 132mA.
  3. Apply RF and LO input signals to perform AC measurements.
  4. Set the LO signal generator (#1) to provide a 1901MHz, 0dBm, CW signal to the demo board LO input port.
  5. Set the RF signal generators (#2 and #3) to provide two -10dBm CW signals to the demo board RF input port—one at 1899.9MHz, and the other at 1900.1MHz.

6. Set the Spectrum Analyzer's start frequency to 100kHz and stop frequency to 1400kHz. Sufficient spectrum analyzer input attenuation should be used to avoid saturating the instrument.

7. Measure input 2<sup>nd</sup> and 3<sup>rd</sup> order intercepts:

- a.  $IIP2 = P1 - P2 + Pin$

- b.  $IIP3 = (P1 - P3) / 2 + Pin$

Where P1 is the lowest power level of the two fundamental output tones at either 900kHz or 1100kHz, P2 is the 2<sup>nd</sup> order product at 200kHz, P3 is the largest 3<sup>rd</sup> order product at either 700kHz or 1300kHz, and Pin is the input power (in this case, -10dBm). All units are in dBm.

8. Voltage conversion gain can also be measured. But be ware that the gain is reduced by combiner loss plus 7.23dB, because the load impedance to each output pin is 50 $\Omega$  in this setup. Please refer to the LT5575 datasheet for more detailed explanation.
9. Measure LO to RF leakage, RF to LO isolation, and Input 1dB compression.
10. Double-Side band Noise Figure can be measured directly on a noise figure meter. Refer to noise figure meter manual for instructions.

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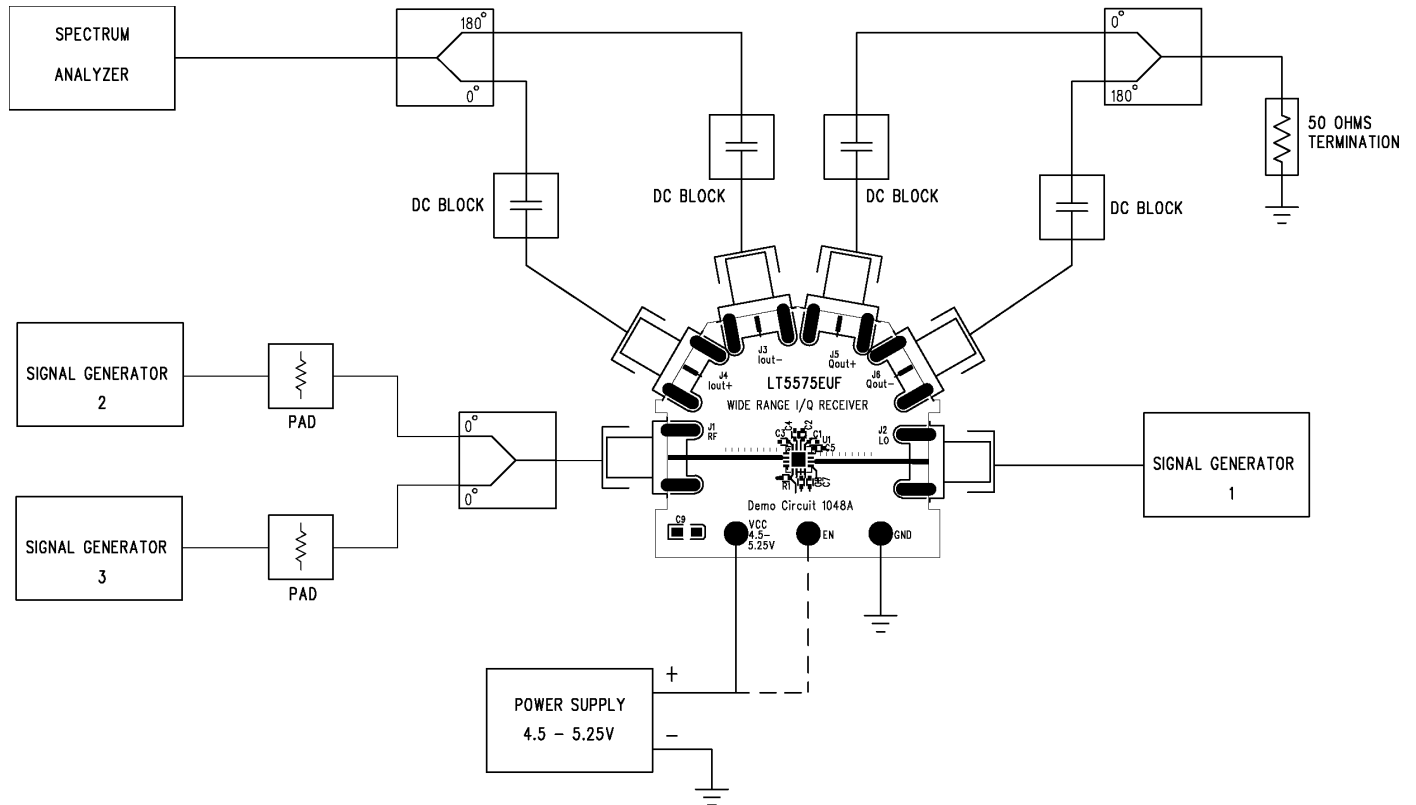
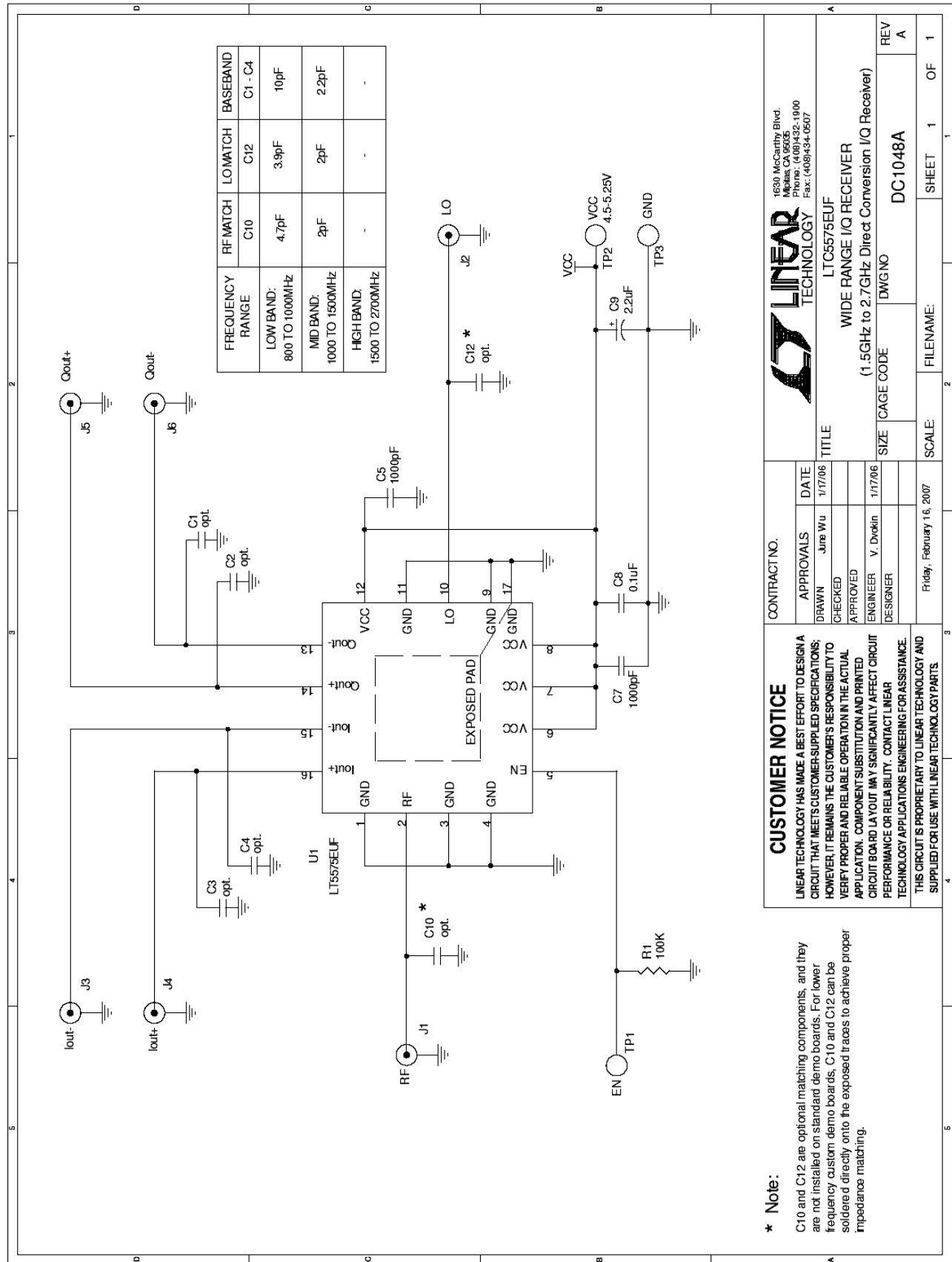


Figure 1. Proper Measurement Equipment Setup

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**\* Note:**

C10 and C12 are optional matching components, and they are not installed on standard demo boards. For lower frequency custom demo boards, C10 and C12 can be soldered directly onto the exposed traces to achieve proper impedance matching.

**CUSTOMER NOTICE**

LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE. THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

**CONTRACT NO.**

APPROVALS	DATE
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CHECKED:	
APPROVED:	
ENGINEER: V. Dvorkin	1/17/06
DESIGNER:	

**TITLE**

LT5575EUF  
WIDE RANGE I/Q RECEIVER  
(1.5GHz to 2.7GHz Direct Conversion I/Q Receiver)

**SCALE:**

Friday, February 16, 2007

**FILENAME:**

DC1048A

**SIZE**

CAGE CODE

**REV**

REV A

**SHEET**

1 OF 1

**LINEAR TECHNOLOGY**

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