

### DESCRIPTION

Demonstration circuit 831 is an I/Q modulator featuring the LT5518. The LT<sup>®</sup>5518 is a 1.6GHz to 2.4GHz direct I/Q modulator designed for high performance wireless applications, including wireless infrastructure. It may also be configured as an image reject upconverting mixer, by applying 90° phase-shifted signals to the I and Q inputs.

The 5518's high-speed, internally matched LO amplifier drives two double-balanced mixer cores, allowing the use of a low power, single-ended LO source. The 5518 allows direct modulation of an RF signal using differential baseband I and Q signals. It supports GSM, EDGE, CDMA, CDMA2000, W-CDMA, 64-QAM, OFDM and other modulation formats.

The 5518's I/Q baseband inputs consist of voltage-to-current converters that in turn drive double-balanced mixers. The outputs of these mixers are summed and applied to an on-chip RF transformer, which converts

the differential mixer signals to a 50Ω single-ended output. The four balanced I and Q base-band input ports are intended for DC coupling from a source with a common-mode voltage level of about 2.1V. The differential input impedance of the baseband inputs is approximately 2.9KΩ, making them ideally suited for voltage-drive applications.

The 5518's LO path consists of an LO buffer with single-ended input, and precision quadrature generators which produce the LO drive for the mixers.

Demonstration circuit 831 is designed for an RF output frequency range from 1.5GHz to 2.4GHz.

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

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# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 831

## HIGH LINEARITY DIRECT QUADRATURE MODULATOR

Table 1. Typical Performance Summary ( $T_A = 25^\circ\text{C}$ )

PARAMETER	CONDITION ( $f_{33} = 2\text{MHz}$ , $f_{10} = 2000\text{MHz}$ )	VALUE
Supply Voltage		4.5V to 5.25V
Supply Current	$V_{CC} = 5\text{V}$ , EN = High	128mA
Maximum Shutdown Current	$V_{CC} = 5\text{V}$ , EN = Low	50 $\mu\text{A}$
RF Frequency Range		1.5GHz to 2.4GHz
Baseband Frequency Range		DC to 400 MHz
LO Input Return Loss	$Z_0 = 50\Omega$	14dB
RF Output Return Loss	$Z_0 = 50\Omega$	14dB
LO Input Power		-10dBm to +5dBm
LO Frequency Range		1.5GHz to 2.4GHz
Conversion Gain	$P_{RF} = -10\text{dBm}$ , $P_{LO} = 0\text{dBm}$ , defined as $20 \cdot \log(V_{\text{out}, 50\text{ ohms}} / V_{\text{in, differential I or Q}})$	-4dB
Output 3 <sup>rd</sup> Order Intercept	2-Tone, $P_{RF} = -10\text{dBm/Tone}$ , $\Delta f = 100\text{KHz}$ , $P_{LO} = 0\text{dBm}$	+22.8dBm
Output 2 <sup>nd</sup> Order Intercept	2-Tone, $P_{RF} = -10\text{dBm/Tone}$ , $\Delta f = 100\text{KHz}$ , $P_{LO} = 0\text{dBm}$	+49dBm
Output 1dB Compression	$P_{LO} = 0\text{dBm}$	+8.2dBm
LO leakage	$P_{LO} = 0\text{dBm}$	-45dBm
Sidetone leakage	$P_{LO} = 0\text{dBm}$	38dBc

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### APPLICATION NOTE

#### RF FREQUENCY RANGE

No tuning is required for operation over the RF frequency range of 1.5GHz to 2.4 GHz.

#### BASEBAND FREQUENCY RANGE

The baseband frequency range extends from DC to 400 MHz (3dB bandwidth).

#### LO TO RF LEAKAGE

The LT<sup>®</sup>5518 offers excellent LO to RF leakage performance, typically -45 dBm at 2.14 GHz.

The LO leakage may be further reduced by the introduction of small DC offsets at each of the baseband inputs, typically less than 10mV.

#### SIDETONE TO RF LEAKAGE

The LT<sup>®</sup>5518 also offers very good sidetone suppression at the RF port.

The sidetone suppression may be further enhanced by the introduction of small phase and amplitude offsets at each of the baseband inputs.

### 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. High quality combiners that provide broadband 50 ohm 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 modulat-

ing each other and generating intermodulation 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.

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 831

## HIGH LINEARITY DIRECT QUADRATURE MODULATOR

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### QUICK START PROCEDURE

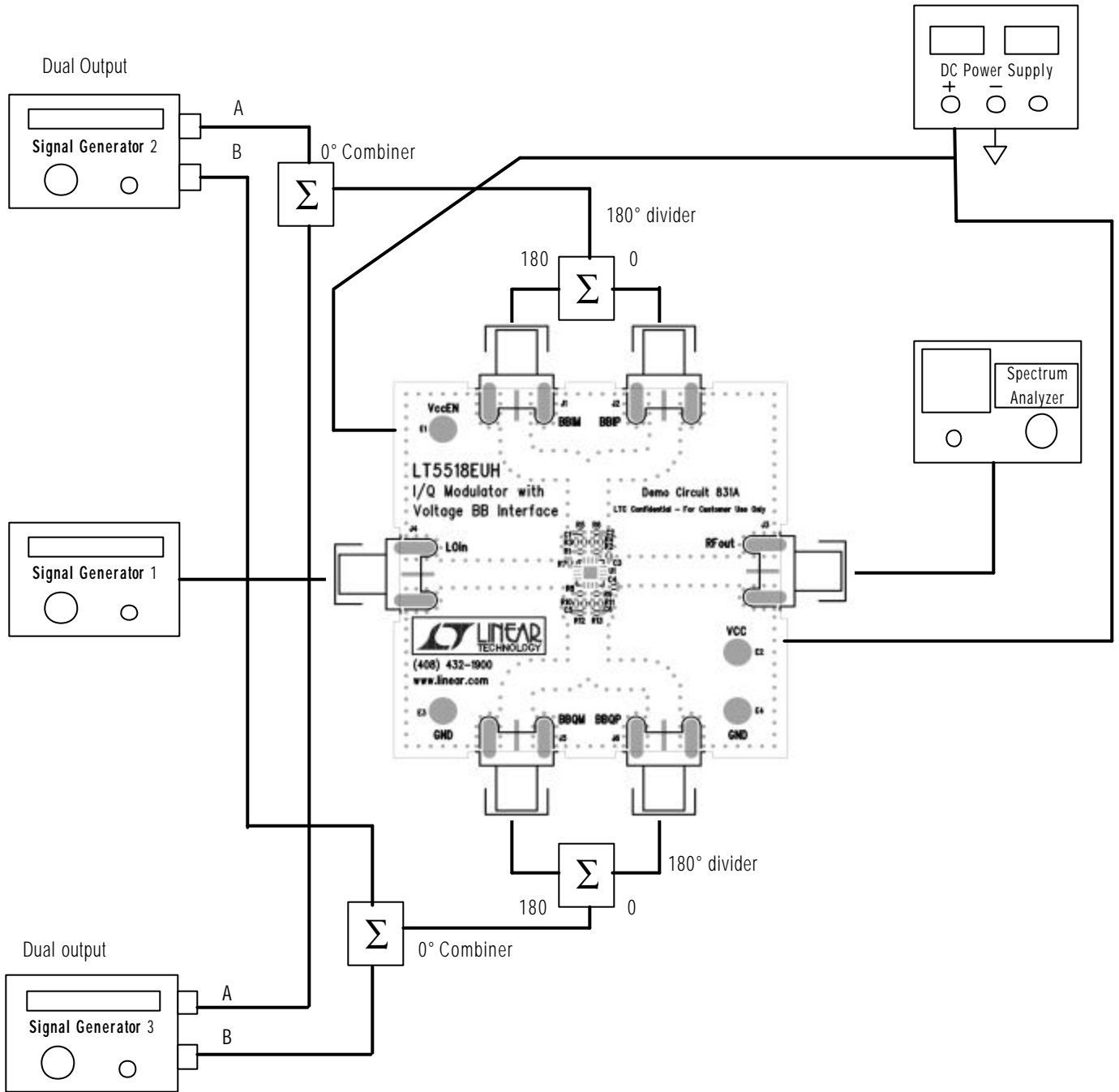
Demonstration circuit 831 is easy to set up to evaluate the performance of the LT5518. Refer to Figure 1 for proper measurement equipment setup.

Follow the procedure below:

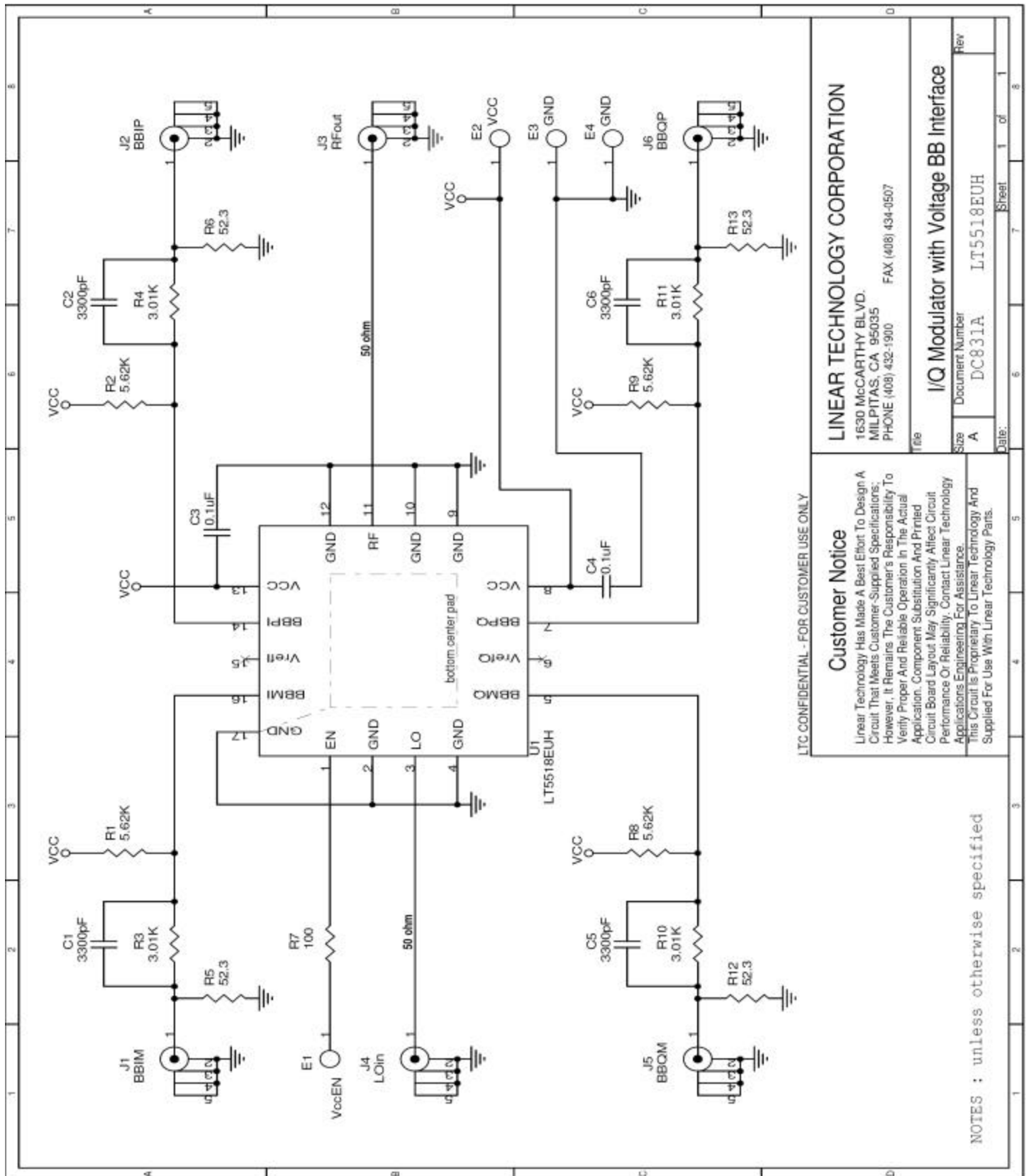
1. Connect all test equipment as shown in Figure 1.
2. Set the DC power supply's current limit to 150mA, and adjust output voltage to 5V.
3. Connect Vcc to the 5V DC supply, and then connect VCCEN to 5V; the modulator is enabled (on).
4. Set Signal Generator #1 to provide a 2000MHz, 0dBm, CW signal to the demo board LO input port.
5. Set the Signal Generators #2 and #3 to provide two -10dBm CW signals to the combiner ports - one at 2MHz, and the other at 2.1MHz. For both generators, output B should lead output A by 90°. These 2 signals must be in quadrature to drive the demo board properly.
6. To measure 3<sup>rd</sup> order distortion and conversion gain, set the Spectrum Analyzer start and stop frequencies to 2001.8MHz and 2002.3MHz, respectively. Sufficient spectrum analyzer input attenuation should be used to avoid distortion in the instrument.
7. The 3<sup>rd</sup> order intercept point is equal to  $(P_1 - P_3) / 2 + P_1$ , where  $P_1$  is the average power level of the two fundamental output tones at 2002MHz and 2002.1MHz;  $P_3$  is the average power level of the two 3<sup>rd</sup> order products at 2001.9MHz and 2002.2MHz. All units are in dBm.
8. To measure 2<sup>nd</sup> order distortion, set the Spectrum Analyzer start and stop frequencies to 2204MHz and 2206MHz, respectively. Sufficient spectrum analyzer input attenuation should be used to avoid distortion in the instrument.
9. The 2<sup>nd</sup> order intercept point is equal to  $P_1 - P_2 + P_1$ , where  $P_1$  is the power level of the fundamental output tone at 2002MHz,  $P_2$  is the 2<sup>nd</sup> order product at 2204.1MHz. All units are in dBm.

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 831 HIGH LINEARITY DIRECT QUADRATURE MODULATOR

Figure 1. Proper Measurement Equipment Setup



# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 831 HIGH LINEARITY DIRECT QUADRATURE MODULATOR



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## 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.

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File I/Q Modulator with Voltage BB Interface

Size	Document Number	Rev
A	DC831A	LT5518EUH

Date: \_\_\_\_\_ Sheet 1 of 1

NOTES : unless otherwise specified