

# LTC6432-15

## 100kHz to 1000MHz Differential ADC Driver/IF/RF Amplifier


### DESCRIPTION

Demonstration circuit 2496A features the LTC6432-15 differential ADC Driver/IF Amplifier. The [LTC®6432-15](#) has a fixed power gain of 15.9dB and works from 100kHz to 1400MHz. It is part of the high linearity LTC643X-YY amplifier series.

As a differential amplifier, the LTC6432-15 offers flat gain and impressive linearity from 100kHz to 1GHz using a single output bias network. Since high fidelity differential test equipment is lacking, the DC2496A offers single

ended inputs and outputs so that the LTC6432-15 performance may be evaluated with standard test equipment. The native LTC6432-15 has 100Ω differential source and load impedances, so the demo circuit uses 2:1 transformers to convert the differential input/output impedances to 50Ω single-ended impedance.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC2496A-A>**

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# DEMO MANUAL

## DC2496A-A/DC2496A-B

### OPERATION

Demo Circuit 2496A is a high linearity, fixed gain amplifier. It is designed for ease of use. The LTC6432-15 is internally matched to 100Ω differential source and load impedances from 100kHz to 1400MHz. Due to the unpopularity of 100Ω differential test equipment, transformers have been added to convert these impedances to single-ended 50Ω. Hence, demo boards with various transformers are built for corresponding working frequency ranges. The frequency range of the 2496A evaluation circuit is limited by these input and output transformers. There are provisions for installing various SMT transformers on either the top or bottom side of DC2496A's PCB.

Because LTC6432-15 has a very wide working frequency range, no single transformer can cover its full 13 octave frequency band. The DC2496A PCB is quite versatile. There are footprints for various transformers on the PCB. Two demo board versions cover most commonly used frequencies as shown in Table 1.

**Table 1. Frequency Ranges and Suggested 2:1 Transformers.**

DC NUMBER	FREQUENCY (MHz)	TRANSFORMER'S PART #	MANUFACTURER
2496A-A	0.1 to 20	SYTX2-6T-1+	Mini-Circuits
2496A-B	1 to 250	ADT2-1T+	
--	20 to 400	ADT2-1T-1P+	
--	200 To 950	ADTL2-18+	

Please note that the suggested frequency bands are narrower than small-signal S-Parameters would indicate. At the edges of their useful band, these transformers contribute distortion that degrades the performance of the LTC6432-15.

Figure 1 and Figure 2 show demo board DC2496A-A and DC2496A-B schematics. Each demo circuit's schematic shows the required passive support components. At the board's inputs and outputs are the low frequency transformer, SYTX2-6T-1+ or the mid-frequency transformer, ADT2-2T+. Each of these transformers has a 1:2 impedance transformation ratio. The input and output DC blocking capacitors (C7, C9, C12 and C17) are required because this device is internally DC-biased for optimal

operation. The  $V_{CC}$  pull-up networks (L1, L2, L3, L4, R1, R5, R9 and R13) and the de-coupling capacitors (C2, C3, C4, C5, C19, C20, C21 and C22) provide the proper DC bias to the RF  $\pm$ OUT nodes. A single 5V supply is required for the  $V_{CC}$  pins on the device.

A pair of stability networks have been added. They consist of a 1μF capacitor (C6 and C15) and 348Ω resistor (R4 and R14) in parallel at the LTC6432-15 inputs to ensure low frequency stability.

It is important to note that X8R capacitors are used in the RF signal path. The DC block and feedback caps have been specified as X8R capacitors. High capacitance density (high capacitor values in a small package) typically contribute distortion products due to their poor voltage coefficient. Film and NPO capacitors have low distortion but are unwieldy at 1μF values. As a compromise we have found that X8R capacitors exhibit low distortion at reasonable capacitance densities.

If the user is concerned with thermal heating and the associated reliability, the chip provides a means to determine the chip temperature. The T\_DIODE pin (turret E4) can be forward biased to ground with 1mA of current. The measured voltage will be an indicator of the chip junction temperature ( $T_J$ ).

Please note that eight DNC pins are connected on the demo board. These connections are not utilized for normal operation and should be left open circuit on the final PCB.

Table 2 shows the function of each input and output on the board.

**Table 2. DC2496A board I/O descriptions**

CONNECTOR	FUNCTION
J1 (IN)	Single-ended input. Impedance matched to 50Ω. Drive from a 50Ω network analyzer or signal source.
J4 (OUT)	Single-ended output. Impedance matched to 50Ω. Drives a 50Ω network analyzer or spectrum analyzer.
E4 (T_DIODE)	When forward biased, the measured voltage will be an indicator of the chip junction temperature ( $T_J$ ).
E2 ( $V_{CC}$ )	Positive supply voltage source.
E3 (GND)	Supply ground.

## OPERATION

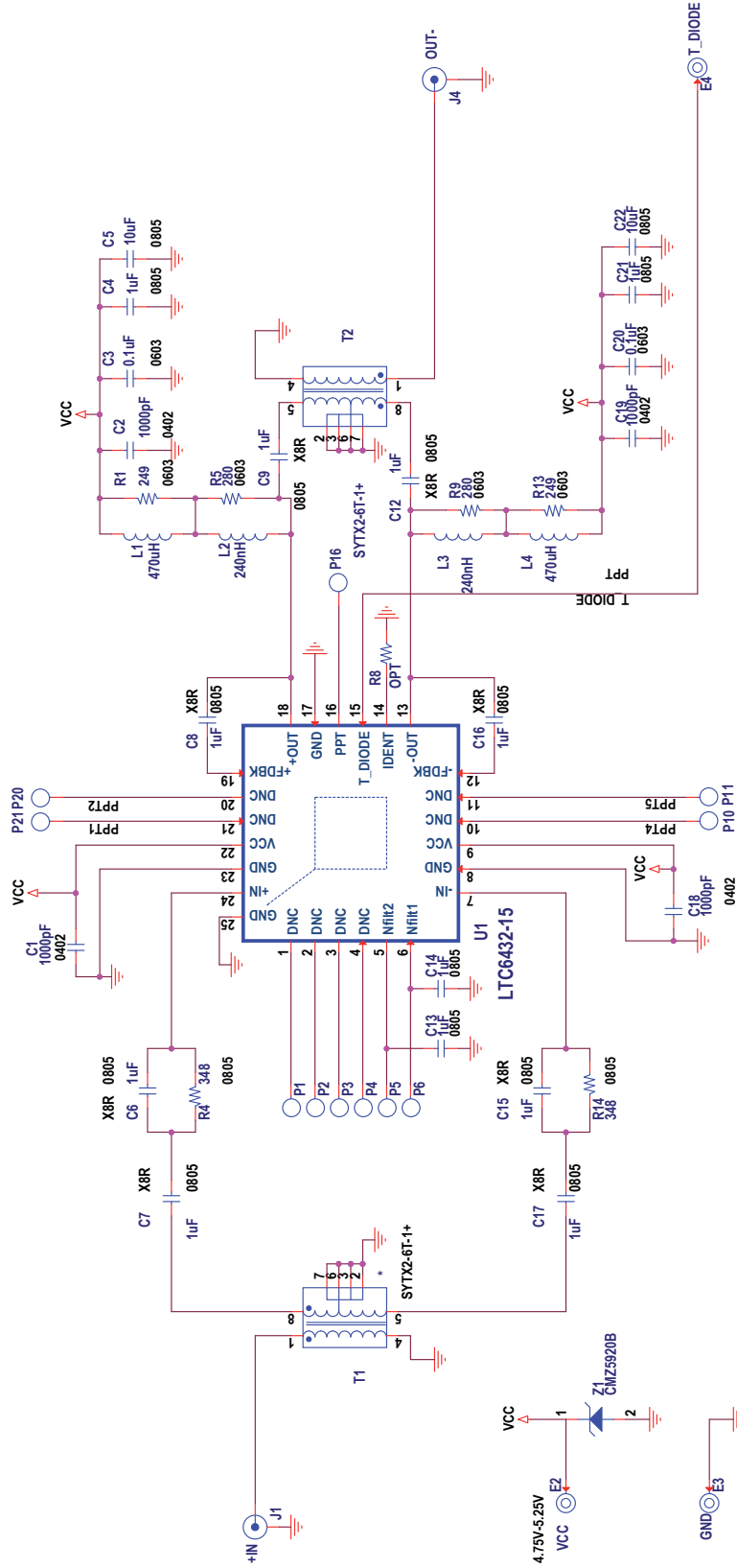


Figure 1. DC2496A-A Simplified Schematic

# DEMO MANUAL

## DC2496A-A/DC2496A-B

### OPERATION

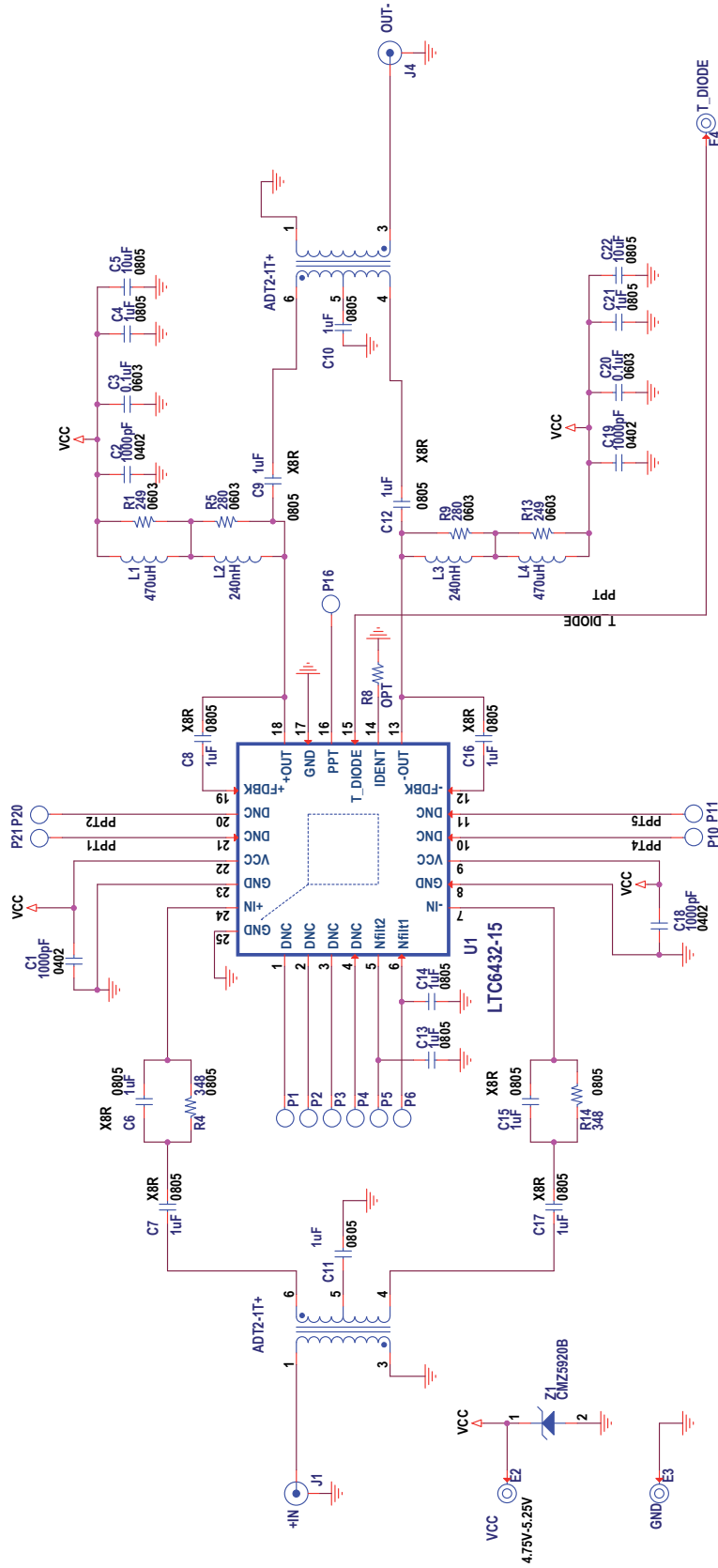
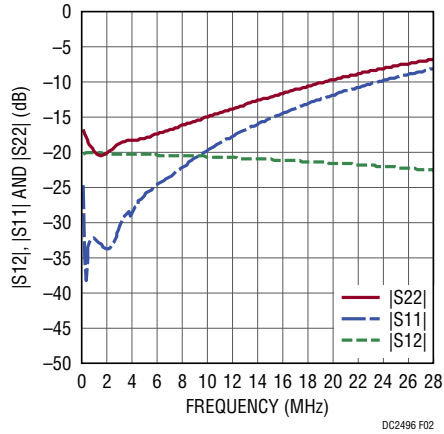


Figure 2. DC2496A-B Simplified Schematic

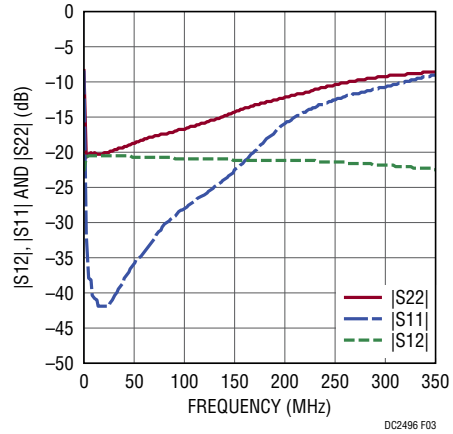
### OPERATION

Figure 3 and Figure 4 show the two port DC2496A-A's and DC2496A-B's S-Parameters performances, and Figure 5

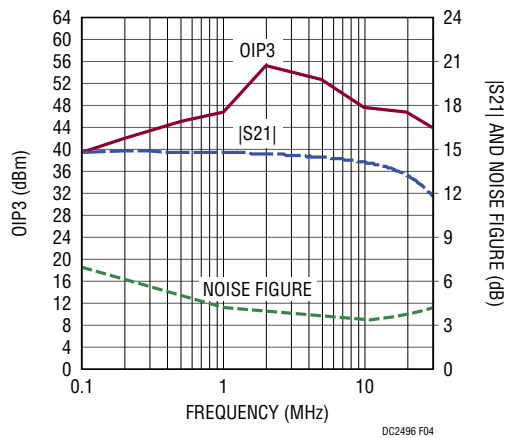
and Figure 6 show demo boards' typical linearity, noise figures and gain performances.



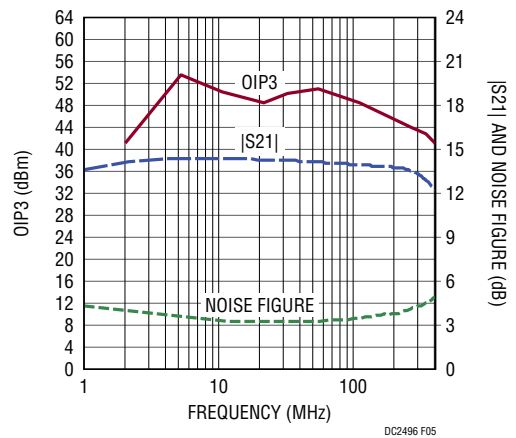
**Figure 3. Demo Board DC2496A-A S-Parameters Performance**



**Figure 4. Demo Board DC2496A-B S-Parameters Performance**



**Figure 5. DC2496A-A OIP3, Gain and Noise Figure Performance**



**Figure 6. DC2496A-B OIP3, Gain and Noise Figure Performance**

## OPERATION

### Setup Signal Sources and Spectrum Analyzer

The LTC6432-15 is an amplifier with high linearity performance. Therefore, the output intermodulation products are very low. Even using high dynamic range test equipment, third-order intercept (IP3) measurements can drive test setups to their limits. Consequently, accurate measurement of IP3 for a low distortion IC such as the LTC6432-15 requires certain precautions to be observed in the test setup as well as the testing procedure.

### Set Up Signal Sources

Figure 7 shows a proposed IP3 test setup. This setup has low phase noise, good reverse isolation, high dynamic range, sufficient harmonic filtering and wideband impedance matching. The setup is outlined below:

- High performance signal generators 1 and 2 (HP8644A) are used. These suggested generators have low harmonic distortion and very low phase noise.
- High linearity amplifiers are used to improve the reverse isolation. This prevents cross talk between the two signal generators and provides higher output power.
- A low pass filter is used to suppress the harmonic content from interfering with the test signal. Note that second order inputs can “mix” with the fundamental frequency to form intermodulation (IM) products of their own. We suggest filtering the harmonics to  $-50\text{dBc}$  or better.
- For improved VSWR, distortion and isolation, the H-6287-10 signal combiner from Werlatone covers the 100kHz to 50MHz band. It features  $>30\text{dB}$  isolation over this band. From 20MHz to 1400MHz, we suggest the H9 signal combiner from MA/COM which features  $>40\text{dB}$  isolation. Passive devices (e.g. combiners) with magnetic elements can contribute nonlinearity to the signal chain and should be used cautiously.

- The attenuator pads on all three ports of the signal combiner will further support isolation of the two input signal sources. They also reduce reflections and promote maximum power transfer with wideband impedance matching.

### Set Up the Spectrum Analyzer

- Adjust the spectrum analyzer for maximum possible resolution of the intermodulation products' amplitude in dBc. A narrower resolution bandwidth will take a longer time to sweep.
- Optimize the dynamic range of the spectrum analyzer by adjusting the input attenuation. First increase the spectrum analyzer's input attenuation (normally in steps of 5 or 10dB). If the IM product levels decrease when the input attenuation is increased, then the input power level is too high for the spectrum analyzer to make a valid measurement. Most likely, the spectrum analyzer's 1st mixer was overloaded and producing its own IM products. If the IM reading holds constant with increased input attenuation, then a sufficient amount of attenuation was present. Adding too much attenuation will bury the intended IM signal in the noise floor. Therefore, select just enough attenuation to achieve a stable and valid measurement.
- In order to achieve this valid measurement result, the test system must have lower total distortion than the DUT's intermodulation. For example, to measure a  $53\text{dBm}$  OIP3, the measured intermodulation products will be  $-102\text{dBc}$  below a  $-13\text{dBm}$ /tone input level and the test system must have intermodulation products approximately  $-108\text{dBc}$  or better. For best results, the IM products and noise floor should measure at least  $-112\text{dBc}$  before connecting the DUT.

### QUICK START PROCEDURE

Demo Circuit 2496A-A can be set up to evaluate the performance of the LTC6432-15. Refer to Figure 7 for proper equipment connections and follow the procedure below:

#### Two-Tone Measurement:

Connect all test equipment as suggested in Figure 7.

1. The power labels of “VCC 4.75V-5.25V” and GND directly correspond to the power supply. Typical current consumption of the LTC6432-15 is about 166mA.
2. Apply two independent signals f1 and f2 from signal generator 1 and signal generator 2 at 5MHz and 5.2MHz, while setting the amplitude to -13dBm/tone at the demo board input (J1).
3. Monitor the output tone level on the spectrum analyzer. Adjust the signal generator levels such that the output power measures +2dBm/tone at the amplifier output J4, after correcting for external cable losses and attenuations.
4. Change the spectrum analyzer’s center frequency and observe the two IM3 tones at 0.2 MHz below and above the input frequencies. The frequencies of IM3\_LOW and

IM3\_HIGH are 4.8MHz and 5.4MHz, respectively. The measurement levels should be approximately -102dBc; +53dBm is typical OIP3 performance for the DC2496A-A demo board at 5 MHz.

The OIP3 calculation is:

$$OIP3 = P_{OUT} + \Delta IMD3/2$$

Where:

$P_{OUT}$  is the lower of the two fundamental output signal products.

$\Delta IMD3 = P_{OUT} - P_{IM3}$ ;  $P_{IM3}$  is the higher of the two third-order intermodulation products.

#### Single-Tone Measurement:

5. Continue with step 4 above, turn off one signal source to measure gain and harmonic distortions.

#### ADDITIONAL DOCUMENTATION

Refer to the demo board link from the LTC6432-15 product page for BOM, PCB, Gerber, Check Plots and full unabridged schematic.

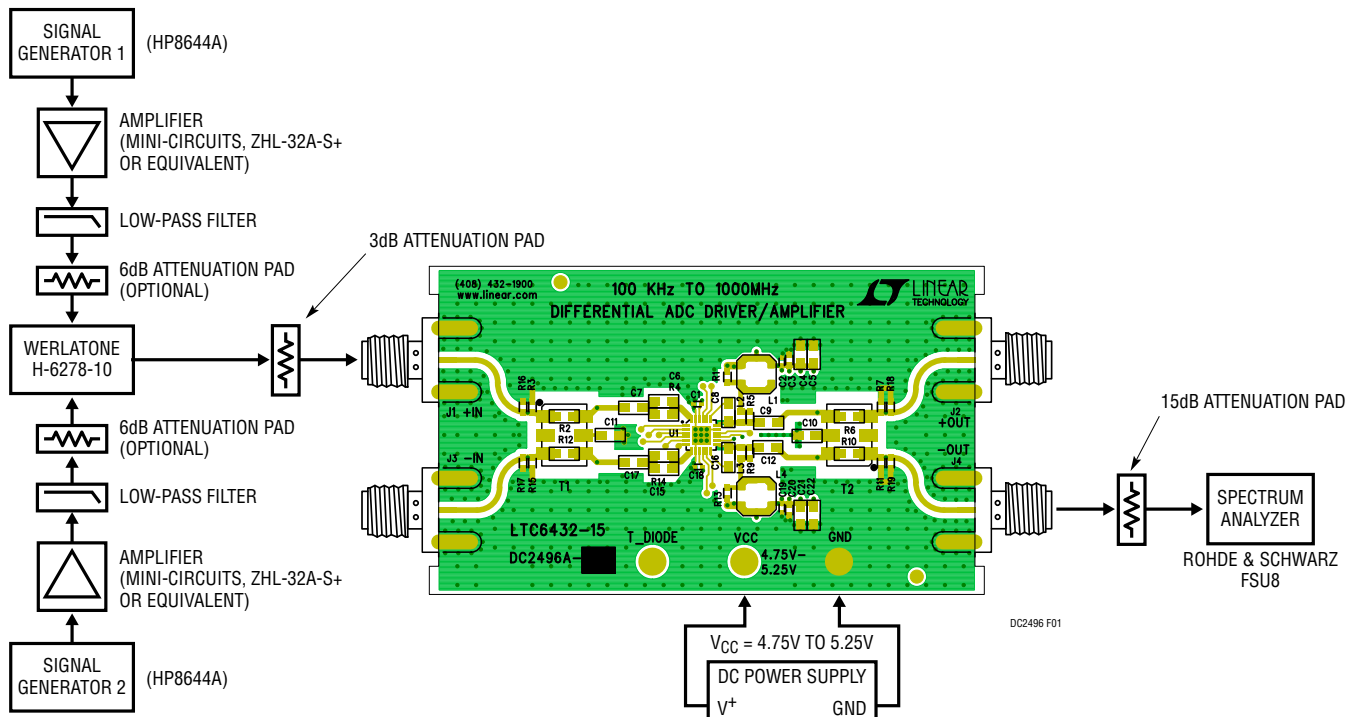


Figure 7. Proper Measurement Equipment Setup

# DEMO MANUAL

## DC2496A-A/DC2496A-B

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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