LTC6430-20
50MHz TO 350MHz Differential ADC Driver, IF/RF Amplifier

DESCRIPTION

Demonstration circuit 2076A-A features the LTC®6430-20 differential ADC Driver/IF Amplifier. The LTC6430-20 has a power gain of 20.8dB and is part of the LTC6430-YY amplifier series.

The DC2076A-A Demo Board supports the LTC6430-YY amplifier family. The DC2076A-A demo board is optimized for the frequency range from 50MHz to 350MHz and utilizes a minimum of passive external components to configure the amplifier for this application. The native LTC6430-20 has 100Ω differential input and output impedances, so the demo circuit uses 2:1 balun transformers to convert the differential I/O impedances to 50Ω single-ended impedance. Single ended SMA I/O connectors allows simple evaluation with most RF test equipment.

Design files for this circuit board are available at http://www.linear.com/demo/DC2076A-A

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, V_{CC} = 5V

SYMBOL	PARAMETER	CONDITIONS	VALUE/UNITS
Power Supply			
V_{CC}	Operating Supply Range	All V_{CC} Pins plus ±OUT	4.75V to 5.25V
I_{CC}	Current Consumption	Total Current	165mA

SIMPLIFIED SCHEMATIC

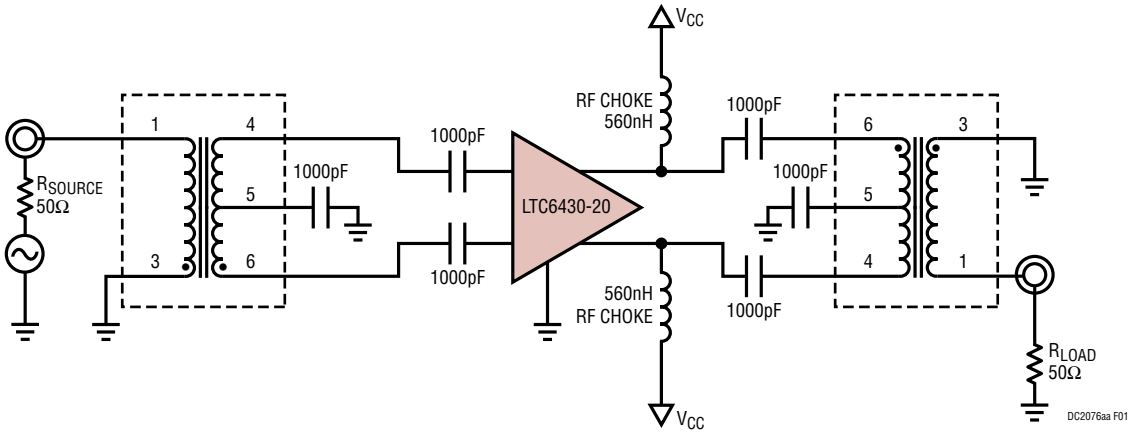


Figure 1. DC2076A-A Simplified Schematic

QUICK START PROCEDURE

Demo Circuit 2076A-A can be set up to evaluate the performance of the LTC6430-20. Refer to Figure 2 for proper equipment connections and follow the procedure below:

Two-Tone Measurement:

Connect all test equipment as suggested in Figure 2.

1. The power labels of "VCC 4.75V-5.25V" and GND directly correspond to the power supply. Typical current consumption of the LTC6430-20 is about 165 mA.
2. Apply two independent signals f1 and f2 from signal generator 1 and signal generator 2 at 240MHz and 241MHz, while setting the amplitude to –17dBm/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 J2, after correcting for external cable losses and attenuations.
4. Change the spectrum analyzer's center frequency and observe the two IM3 tones at 1MHz below and above the input frequencies. The frequencies of IM3_LOW and IM3_HIGH are 239MHz and 242MHz, respectively. The measurement levels should be approximately –96dBc; +50 dBm is typical OIP3 performance for the DC2076A-A demo board at 240MHz.

   The OIP3 calculation is:

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

   Where:

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

   Δ IMD3 = P_{OUT} – P_{IM3}; P_{IM3} is the higher Third-Order intermodulation product.

Single-Tone Measurement:

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

QUICK START PROCEDURE

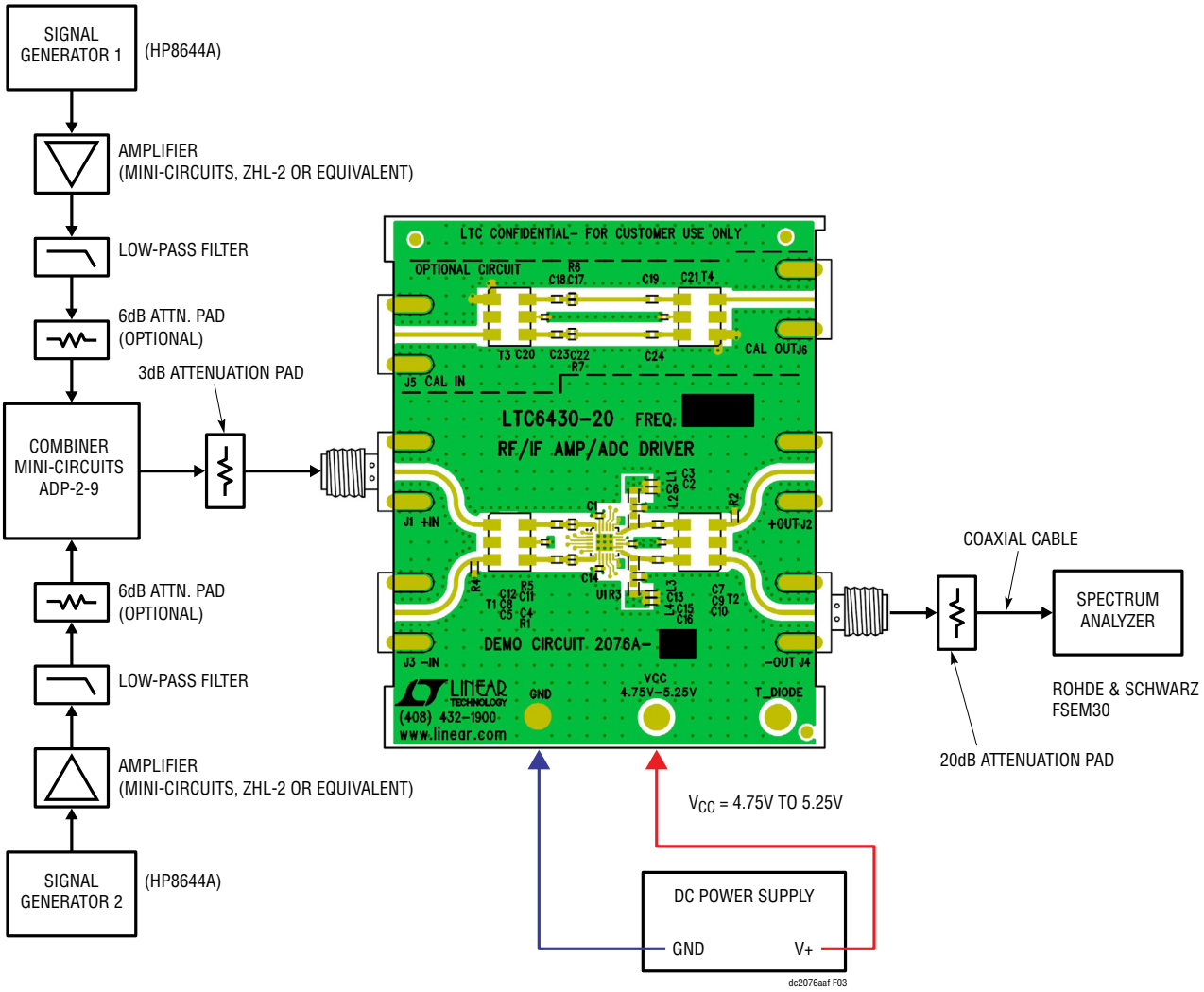


Figure 2. Proper Equipment Setup for IP3 Measurement

OPERATION

Demo Circuit 2076A-A is a high linearity, fixed gain amplifier. It is designed for ease of use. The LTC6430-20 is internally matched to 100Ω differential source and load impedances from 20MHz to 1400MHz. Due to the unpopularity of 100Ω differential test equipment, transformers have been added to convert these impedances to single-ended 50Ω. The frequency range of the circuit is limited by the balun transformers. Hence, this demo board works best over the frequency range from 50MHz to 350MHz. Figure 3 shows the two port DC2076A-A's S-Parameters.The demo circuit's schematic shows a minimum of required passive support components. At the board's input and output are balun transformers. Each of these, T1 and T2, transformers has a 1:2 impedance transformation ratio. The input and output DC blocking capacitors (C5, C7, C10 and C12) are required because this device is internally DC-biased for optimal operation. The frequency appropriate RF chokes (L2 and L3) and the de-coupling capacitors (C2, C3, C15 and C16) provide the proper DC bias to the RF ±OUT nodes. A single 5V supply is required for the V_{CC} pins on the device.

L1, L4, C6 and C13 are optional parts. They are for additional matching components when further optimization to a lower or wider frequency range applications is required.

A pair of stability networks have been added. They consist of a 62 pF capacitor (C4 and C11) and 348Ω resistor (R1 and R5) in parallel at the LTC6430-20 input network to ensure low frequency stability.

The T_DIODE Pin (Turret E1) can be forward biased to ground with 1mA of current. The measured voltage will be an indicator of the chip junction temperature (TJ).

There is an optional circuit at the upper section of the demo board. This extra circuit can be used to calibrate for the insertion loss of the demo board's input and output components.

Please note that a number of DNC pins are connected on the demo board. These connections are not necessary for normal operation, however, failure to float these pins may impair the operation of the device.

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

OPERATION

Table 1. DC2076A-A Board I/O Descriptions

FREQUENCY (MHZ)	POWER GAIN |S21|	OUTPUT THIRD- ORDER INTERCEPT POINT (1) OIP3	OUTPUT THIRD-ORDER INTERMODULATION (1) OIM3	SECOND HARMONIC DISTORTION (2) HD2	THIRD HARMONIC DISTORTION (2) HD3	OUTPUT 1DB COMPRESSION POINT P1DB	NOISE FIGURE (4) NF
50	17.8	48.6	–93.2	–82.8	–95.1	23.4	4.5
100	19.2	48.5	–92.9	–82.3	–96.1	23.4	3.4
140	19.4	49.2	–94.4	–82.6	–96.5	23.1	3.2
200	19.2	49.6	–95.2	–81.3	–90.8 (3)	22.9	3.2
240	18.9	49.9	–95.7	–81.2 (3)	–84.9 (3)	23.2	3.3
300	18.4	51.5	–98.9	–77.6 (3)	–81.4 (3)	22.8	3.7
350	17.6	51.0	–97.9	–80.2 (3)	–83.6 (3)	22.9	3.9
Units	**dB**	**dBm**	**dBc**	**dBc**	**dBc**	**dBm**	**dB**

Notes: All figures are Referenced to J1 (Input Port) and J4 (Output Port).

1. Two-tone Test Conditions: Output Power level = +2dBm/Tone, Tone Spacing = 1MHz
2. Single-Tone Test Conditions: Output Power level = +6dBm.
3. Outside of Input and Output Transformers Working Frequency Range
4. Small Signal Noise Figure

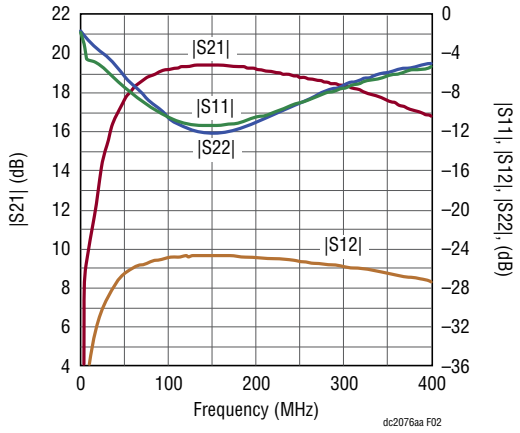


Figure 3. Demo Board S-Parameters

Table 2. DC2076A-A 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.
E1 (T_DIODE)	The measured voltage will be an indicator of the chip junction temperature.
E2 (V_{CC})	Positive Supply Voltage Source.
E3 (GND)	Supply Ground.

ADDITIONAL INFORMATION

As with any RF device, minimizing ground inductance is critical. Care should be taken during the board layout when using these exposed pad packages. A maximum of small-diameter vias should be placed underneath the exposed ground pad. This will ensure a good RF ground and low thermal impedance. Maximizing the copper ground plane will also improve heat spreading and lower the inductance to ground. It is a good idea to cover the via holes with solder mask on the back side of the PCB to prevent solder from wicking away from the critical PCB to the exposed pad interface.

The DC2076A-A is a wide bandwidth demo board, but it is not intended for operation down to DC. The lower frequency cutoff is limited by on-chip matching elements.

Table 3 shows the LTC643X-YY amplifier series and its associated demo boards. Each demo board lists the typical working frequency range and the input and output impedance of the amplifiers.

Table 3. The LTC643X-YY Amplifier Family and Corresponding Application Demo Boards.

Demo Board Number	Frequency Range (MHz)	Notes/ Applications	Board's In/Out Impedance	Amplifier	Amplifier's Impedance
DC1774A-A	50 to 350	Low Frequency	50Ω	LTC6430-15	Differential 100Ω
DC1774A-B	400 to 1000	Mid Frequency	50Ω	LTC6430-15	Differential 100Ω
DC1774A-C	100 to 1200	Wide Frequency	50Ω	LTC6431-15	Single-ended 50Ω
DC2032A	50 to 1000	Cable Infrastructure	75Ω	LTC6430-15	Differential 100Ω
DC2077A	100 to 1200	Wide Frequency	50Ω	LTC6431-20	Single-ended 50Ω
DC2153A	700 to 1700	High Frequency	50Ω	LTC6430-15	Differential 100Ω
DC2090A	50 to 1200	Power Doubler	50Ω	Dual LTC6430-15	Differential 50Ω
DC2076A-A	**50 to 350**	**Low Frequency**	**50Ω**	**LTC6430-20**	**Differential 100Ω**
DC2076A-B	300 to 1000	Mid Frequency	50Ω	LTC6430-20	Differential 100Ω

ADDITIONAL INFORMATION

Setup Signal Sources and Spectrum Analyzer

The LTC6430-20 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 LTC6430-20 requires certain precautions to be observed in the test setup as well as the testing procedure.

Setup Signal Sources

Figure 2 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:

a. High performance signal generators 1 and 2 (HP8644A) are used. These suggested generators have low harmonic distortion and very low phase noise.

b. High linearity amplifiers are used to improve the reverse isolation. This prevents cross talk between the two signal generators and provides higher output power.

c. 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 –50dBc or better.

d. The signal combiner from Mini-Circuits (ADP-2-9) combines the two isolated input signals. This combiner has a typical isolation of 27dB. For improved VSWR and isolation, the H-9 signal combiner from MA/COM is an alternative which features >40dB isolation and a wider frequency range. Passive devices (e.g. combiners) with magnetic elements can contribute nonlinearity to the signal chain and should be used cautiously.

e. 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.

Setup the Spectrum Analyzer

a. 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.

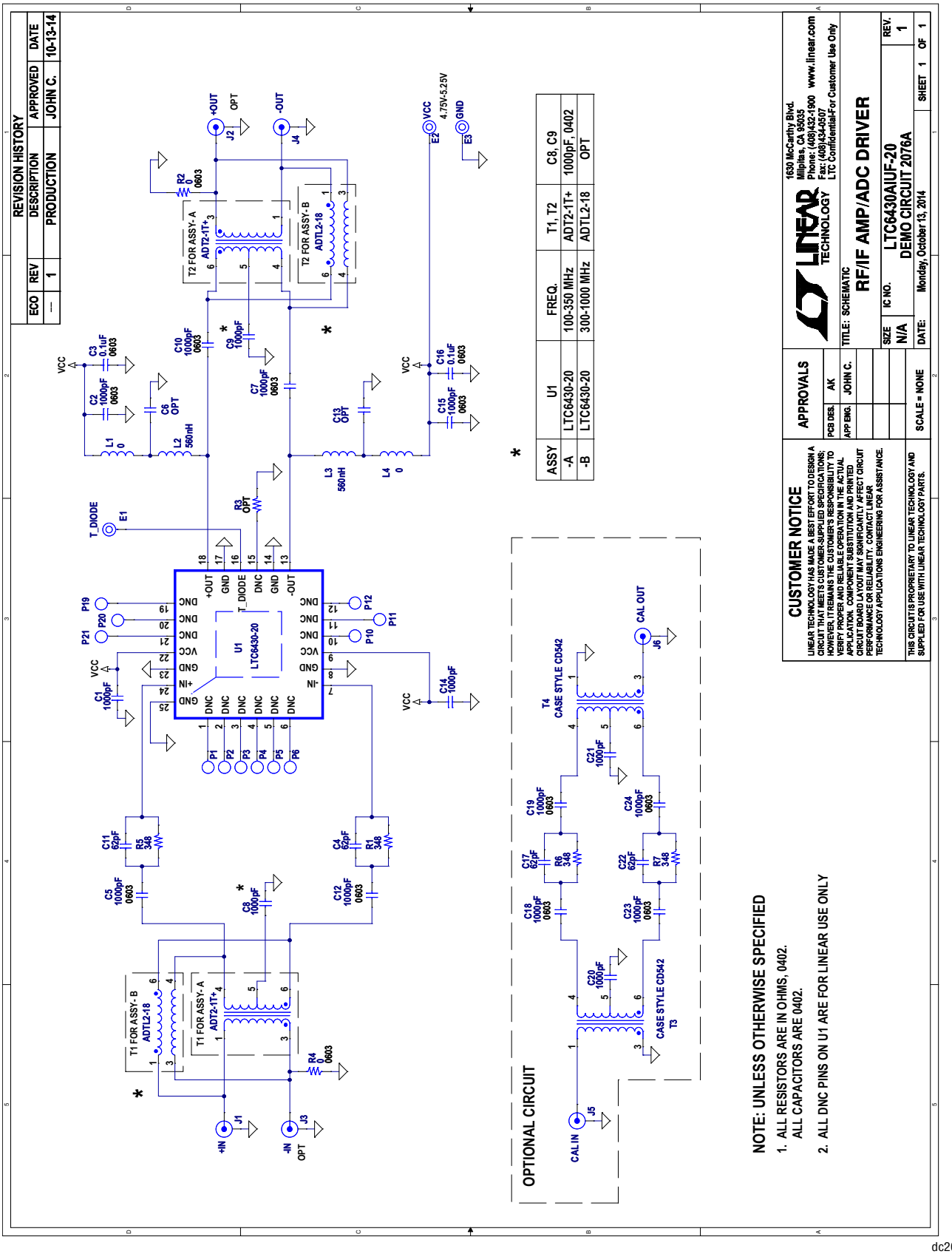
b. Optimize the dynamic range of the spectrum analyzer by adjusting the input attenuation. First increase the spectrum analyzer’s input attenuation (normally in steps of 5dB or 10dB). If the IM product levels decrease when the input attenuation is increased, then the input power level is too high for 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.

c. 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 50dBm OIP3, the measured intermodulation products will be –96dBc below an –17dBm/tone input level and the test system must have intermodulation products approximately –102dBc or better. For best results, the IM products and noise floor should measure at least –106dBc before connecting the DUT.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC2076A-1 Required Circuit Components				
1	2	C1, C14	CAP., X7R, 1000pF, 50V, 5%, 0402	AVX, 04025C102JAT2A
2	6	C2, C5, C7, C10, C12, C15	CAP., X7R, 1000pF, 50V, 5%, 0603	AVX, 06035C102JAT2A
3	2	C3, C16	CAP., X5R, 0.1µF, 10V, 10%, 0603	AVX, 0603ZD104KAT2A
4	2	C4, C11	CAP., NPO, 62pF, 25V, 5%, 0402	AVX, 04023A620JAT2A
5	0	C6, C13	CAP., OPT, ≈0603	OPT
6	0	C17, C22 OPT	CAP., NPO, 62pF, 25V, 5%, 0402	
7	0	C18, C19, C23, C24 OPT	CAP., X7R, 1000pF, 50V, 5%, 0603	
8	0	C20, C21 OPT	CAP., X7R, 1000pF, 50V, 5%, 0402	
9	3	E1-E3	TESTPOINT, TURRET, .093"	MILL-MAX, 2501-2-00-80-00-00-07-0
10	2	J1, J4	CONN., SMA 50Ω EDGE-LAUNCH	E.F.JOHNSON, 142-0701-851
11	0	J2, J3, J5, J6 OPT	CONN., SMA 50Ω EDGE-LAUNCH	
12	2	L1, L4	RES., CHIP, 0Ω, 0603	VISHAY, CRCW06030000Z0ED
13	2	L2, L3	INDUCTOR, CHIP, 560nH, 5%, 0603LS-1608	COILCRAFT, 0603LS-561XJLB
14	2	R1, R5	RES., CHIP, 348 , 1%, 0402	VISHAY, CRCW0402348RFKED
15	0	R6, R7 OPT	RES., CHIP, 348 , 1%, 0402	
16	2	R2, R4	RES., CHIP, 0Ω, 0603	VISHAY, CRCW06030000Z0ED
17	0	R3	RES., CHIP, OPT, 0402	
18	0	T3, T4, OPT	RF TRANSFORMER, CASE STYLE CD542	MINI-CIRCUITS, ADTL2-18+
19	1	U1	Balanced Amplifier LTC6430AIUF-20, QFN24UF-4X4	Linear Tech., LTC6430AIUF-20
DC2076A1-A Required Circuit Components				
1	1	DC2076A	GENERAL BOM	
2	2	C8, C9	CAP., X7R, 1000pF, 50V, 5%, 0402	AVX, 04025C102JAT2A
3	2	T1, T2	RF TRANSFORMER, CASE STYLE CD542	MINI-CIRCUITS, ADT2-1T+

SCHEMATIC DIAGRAM



dc2076aaf

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