LTC5564
15GHz RF Power Detector with Comparator

DESCRIPTION

The demonstration circuit 1646A features the LTC®5564, an UltraFast™ RF peak detector with a built in gain-selectable high speed operational amplifier and comparator.

The 1646A demo circuit includes a simple impedance matching network that provides better than 10dB return loss for working frequencies ranging from 5.2GHz to 6.2GHz and from 14.7GHz to 16.5GHz. The input matching circuit can be easily changed for other working frequency plans. The Demo Circuit Modification page provides the design information required for modifying with this demo circuit 1646A.

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

PERFORMANCE SUMMARY (T_A = 25°C), $V_{CC} = V_{CCRF} = V_{CCA} = V_{CCP}$ = 5V

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage		3		5.5	V
Supply Current			44		mA
Amplifier Characteristics					
V_{OUT} Output Offset	Supply Voltage = 5V, No RFIN Gain1 Gain2 Gain4 Gain8		 290 295 315 360		 mV mV mV mV
	Supply Voltage = 3.3V, No RFIN Gain1 Gain2 Gain4 Gain8		 280 280 290 315		 mV mV mV mV
Demodulation Bandwidth	Gain1, V_{OUT} = 500mV Gain2, V_{OUT} = 500mV Gain4, V_{OUT} = 500mV Gain8, V_{OUT} = 500mV		75 52 35 15		MHz MHz MHz MHz
V_{OUT} Output Voltage Swing	Supply Voltage = 3V to 5V	0.3		V_{CCA} – 1.6	V
Comparator Characteristics					
V_{COMP} Low	Supply Voltage = 5V		0.2		V
V_{COMP} High	Supply Voltage = 5V		4.8		V
Comparator Response Time	10dBm RFIN Step to V_{COMP} 50%		9		ns
Comparator Hysteresis			10		mV
RF Characteristics					
RFIN Frequency Range		0.6		15	GHz
RFIN AC Input Resistance	Frequency = 1000MHz, Power Level = 0dBm		135		Ω
RFIN Input Shunt Capacitance	Frequency = 1000MHz, Power Level = 0dBm		0.77		pF
RFIN Input Power Range		–24		16	dBm
Digital I/O					
	LOW = 0.8V (Max), HIGH = V_{CCA} – 0.8V (Min)				
LEN	Comparator Enable Comparator Disable	 V_{CCA} –0.8		0.8	V V

QUICK START PROCEDURE

Operation

The demonstration circuit 1646A is preconfigured to work for applications at frequencies of 5.8GHz and 15GHz. It has better than 15dB return loss at these targeted frequencies. The input dynamic range at 5.8GHz is 40dB (from –24dBm to 16dBm) and slightly lower sensitivity at 15GHz.

Comparator

The high speed comparator compares the external reference voltage on the V_{REF} pin to the internal signal voltage V_P from the peak detector and produces the output logic signal V_{COMP}. V_P is the internal comparator positive input as shown in Figure 1 Simplified Block Diagram.

The demo board has a typical 10mV hysteresis for its comparator and its response time can be as fast as 9ns (10dBm input power step to V_{COMP} 50%) through out its supporting frequencies.

The, 1646A demo board's, LEN test point provides latch enable/disable functionality of the comparator. The comparator is always enabling with the pulling down 10k resistor (R8) to ground. Connecting The LEN test point to V_{CC} will place the comparator in the disable mode.

The R1 and R2 footprints are optional for configuring DC voltage of the V_{REF} test point. The C1 is the ground coupling capacitor of the, R1 and R2, voltage divider.

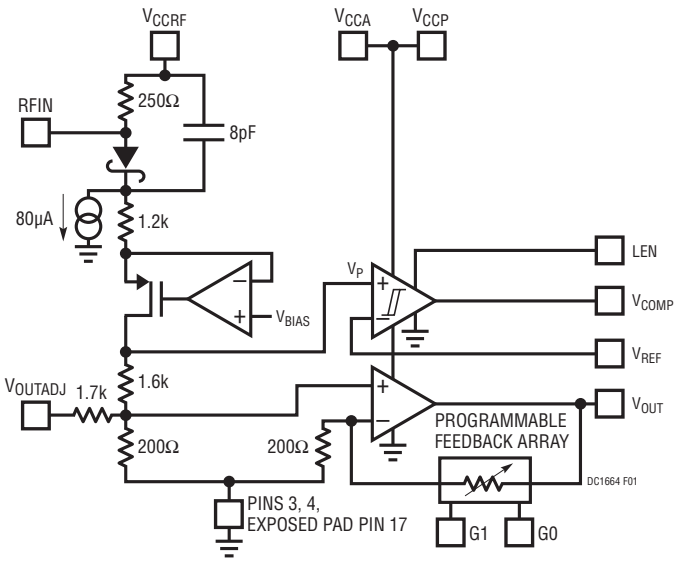


Figure 1. Simplified Block Diagram

The VCC_COMP (E11) test point is an alternative output of V_{COMP} (J2 SMA connector). Install a 0Ω resistor or a jumper to R3 will have the comparator Output at VCC-COMP test point.

Loading Bypass Capacitors

The LTC5564 has been designed to directly drive a capacitive load of 10pF at V_{OUT}. When driving a capacitive load greater than 10pF a series resistance should be added between V_{OUT} and the load to maintain good stability. This resistance should be placed as close to V_{OUT} as possible.

The demo board 1646A is loaded with R series = R6 = 0Ω. Refer to Table 2 for typical series resistor (R6) values for various capacitive loads.

Table 2. Typical Series Resistor (R6) Values for V_{OUT} Capacitive Loading

C_{LOAD}	R SERIES(R6)
Up to 10pF	0Ω
11pF to 20pF	40Ω
21pF to 100pF	68Ω
Greater Than 100pF	100Ω

Amplifier

The high speed amplifier offers four gain settings and is capable of driving a 1.7mA load with an output swing range of approximately 295mV to V_{CC} – 1.6V.

The standard demonstration circuit 1646A has a unity gain. Therefore, the pins G0 and G1 (or the test point Gain0 and Gain1) are pulling down for the logical Low with R10 = R11 = 10k resistors. The pins can be connected to V_{CC} forming the logical High for others gains setting. Refer to Table 3 for gain setting operation.

The V_{OUTADJ} pin provides output DC offset adjustment to satisfy various interface requirements. Setting V_{OUT} to 500mV also provides the maximum demodulation bandwidth in each gain mode.

The R9, R12 and C13 footprints are provided on the demo board to configure the V_{OUTADJ} DC voltage. The R9 and R12 are forming voltage divider topology and the C13 is the ground coupling capacitor. Refer to the LTC5564

QUICK START PROCEDURE

data sheet for Typical Performance Characteristics curve or Table 3 for the typical V_{OUTADJ} voltage for the desired V_{OUT} DC output offset in each gain setting.

The VCC_OUT (E12) test point is an alternative output of V_{OUT} (J3 SMA CONNECTOR). Install a 0Ω resistor or a jumper at R5 will have the V_{OUT} at this VCC_OUT test point.

The R7 and C12 footprints are provided for output loading at designed resistance and capacitance.

Demonstration circuit 1646A is easy to setup for evaluating the performance of the LTC5564. Refer to Figure 2 for measurement equipment set-up and follow the procedure below:

A. Measure Detector Output Power (V_{OUT}):

Connect DC power supply's negative (–) lead to demo board GND test point and positive (+) lead (between 3V to 5.5V) to V_{CC} test point.

Connect a DC volt meter to the V_{OUT} port (SMA connector J3) to measure the DC detector output voltage.

Connect signal generator's output to demo board RFIN (SMA connector J1) via coaxial cable. It is common practice to include a 2dB or 3dB attenuation pad to minimize reflections back into the signal generator. (Typical 540mV V_{OUT} with 0dBm input power at 5.8GHz)

B. Measure Comparator Output (V_{COMP}):

Connect DC power supply's negative (–) lead to demo board GND test point and positive (+) lead (between 3V to 5.5V) to V_{CC} test point.

Connect a DC volt meter (or an oscilloscope) to the V_{COMP} port (SMA connector J2) to measure the V_{COMP} switch point voltages.

Set V_{REF} to desired reference voltage. (with 10dBm input power at RFIN, the typical V_{REF} tripped point is 1.23V)

Increase The RF input power level to the point when the V_{COMP} output voltage will go to a high level. (typically V_{CC} – 0.2V)

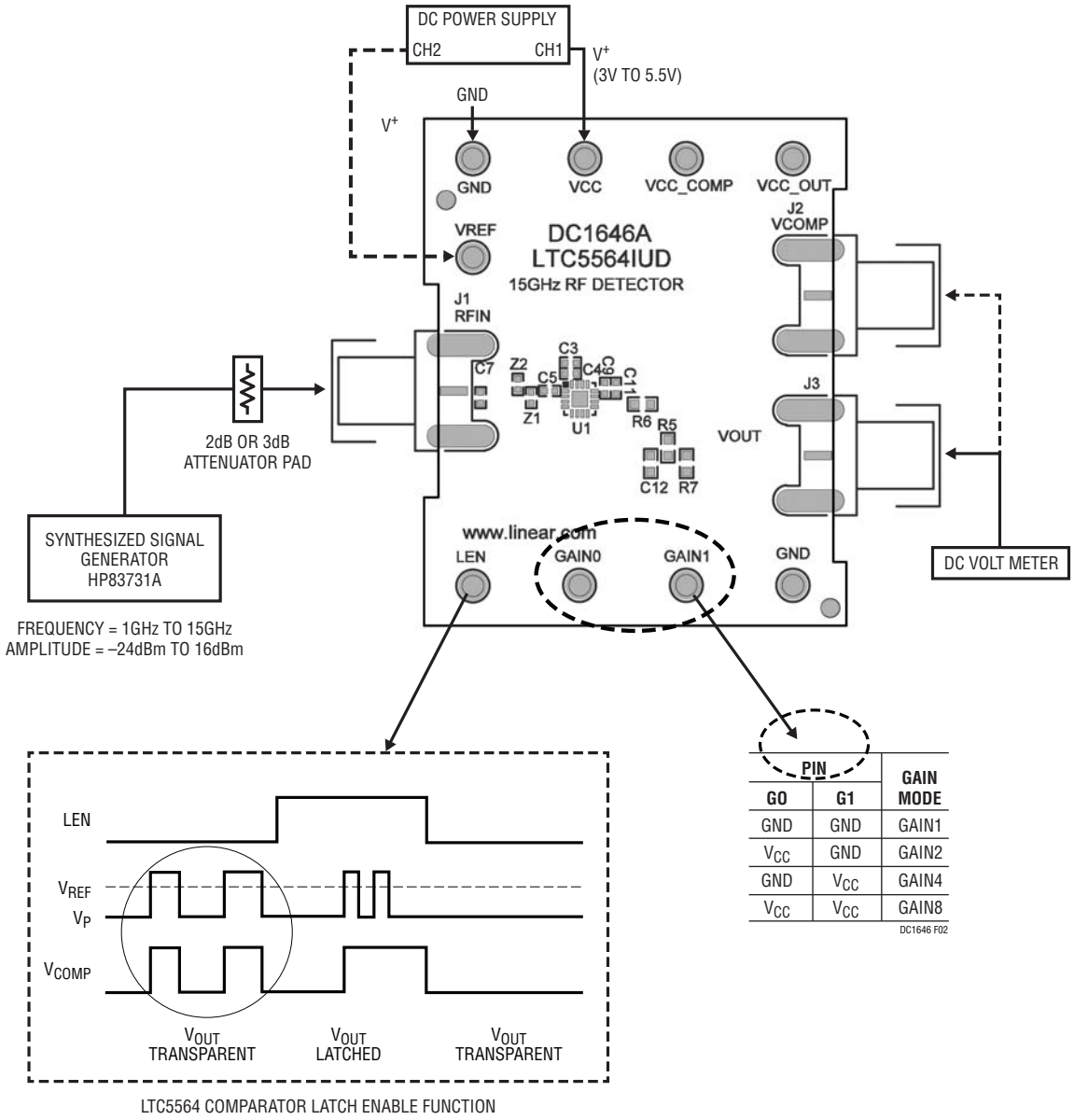
Optional measurements can be done by increasing V_{REF} reference level. During the measurements, when V_{COMP} is HIGH, connect LEN to V_{CC}. Remove the RF input signal and the V_{COMP} will continue to stay high.

Table 3. Gain Mode and Typical V_{OUTADJ} Operation

PIN				
G1	G0	GAIN MODE	DESCRIPTION	REQUIRED V_{OUTADJ} FOR A GIVEN DC OUTPUT OFFSET
GND	GND	GAIN1	Minimum Gain Setting (V_{OUT}/RFIN ≈ 1.5dB)	$V_{OUTADJ} = 0.95 \bullet V_{OUT} – 0.174$
GND	V_{CCA}	GAIN2	V_{OUT}/RFIN Increased 6dB	$V_{OUTADJ} = (V_{OUT} – 0.07)/2.10$
V_{CCA}	GND	GAIN4	V_{OUT}/RFIN Increased 12dB	$V_{OUTADJ} = (V_{OUT} + 0.05)/3.16$
V_{CCA}	V_{CCA}	GAIN8	V_{OUT}/RFIN Increased 18dB	$V_{OUTADJ} = (V_{OUT} + 0.25)/5.26$

Note: Valid range for $V_{OUT} \approx 0.195V \leq V_{OUT} \leq V_{CC} – 1.6$

QUICK START PROCEDURE



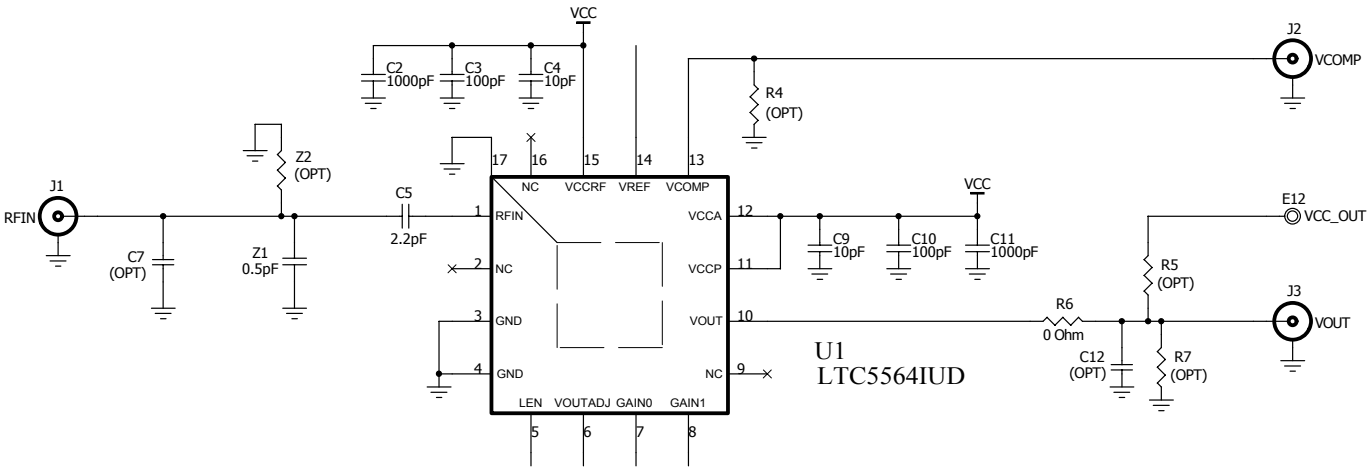
PIN		GAIN MODE
G0	G1	
GND	GND	GAIN1
V_{CC}	GND	GAIN2
GND	V_{CC}	GAIN4
V_{CC}	V_{CC}	GAIN8

DC1646 F02

Figure 2. Proper Measurement Equipment Set-Up

QUICK START PROCEDURE

Modification of RFIN Port for Other Frequency Ranges



Impedance Matching Circuits Components and Values at Selected Frequency Ranges

FREQUENCY RANGE[1]	C5 VALUE/PART#[2]	Z1 VALUE/PART#[2]	Z2 VALUE/PART#[2]
1.6GHz to 3.4GHz	100pF/GJM1555C1H101JZ01	6.8nH/0402CS-6N8XGL	No Placement
7GHz to 8.5GHz	0.5pF/GJM1555C1HR50BB01	0.3pF/GJM1555C1HR30BB01	No Placement
8.6GHz to 10.7GHz	0.2pF/GJM1555C1HR20BB01	0.1pF/GJM1555C1HR10BB01	No Placement
11.7GHz to 12.2GHz	10pF/GJM1555C1H100JB01	No Placement	2.2pF/GJM1555C1H2R2CB01
0.5GHz to 1.9GHz and 5.7GHz to 11.3GHz[3]	20pF/GJM1555C1H200JB01	137Ω/RK73H1ETTP1370F	137Ω/RK73H1ETTP1370F
5.2GHz to 6.2GHz and 14.7GHz to 16.5GHz[4]	2.2pF/GJM1555C1H2R2CB01	0.5pF/GJM1555C1HR50BB01	No Placement

(1) The impedance matching networks at stated frequency ranges have 10dB or better return loss.

(2) Capacitors, inductors and resistors are manufacture by MURATA, COILCRAFT or KOA respectively.

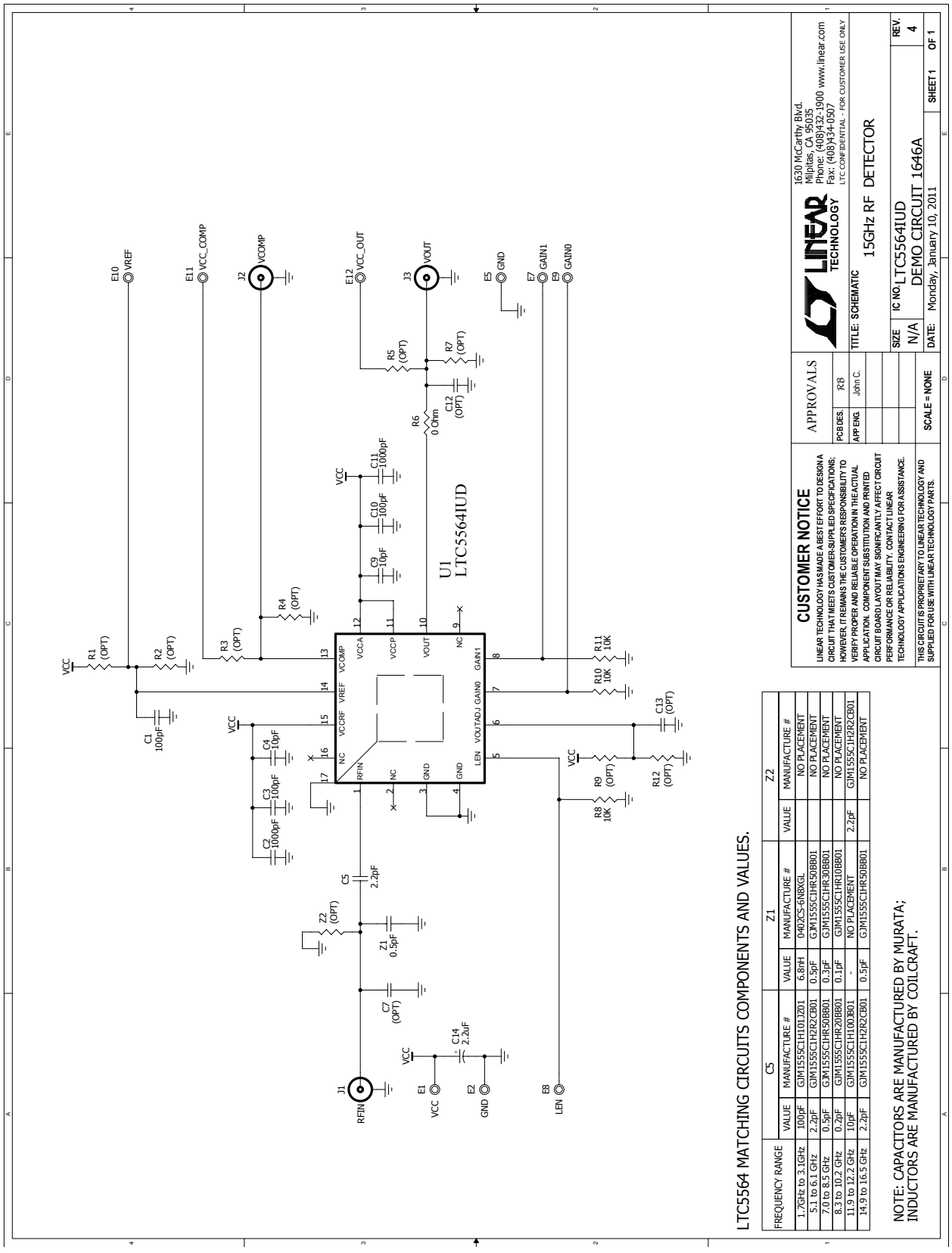
(3) Resistive matching has wider frequency ranges at the expense of degraded sensitivity by 6dB to 8dB.

(4) Default DC1646A demo board frequencies ranges.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	3	C1, C3, C10	CAP, NPO 100pF 25V 10% 0402	AVX 04023A101KAT2A
2	2	C2, C11	CAP, X7R 1000pF 50V 10% 0402	AVX 04025C102KAT2A
3	2	C4, C9	CAP, NPO 10pF 25V 10% 0402	AVX 04023A100KAT2A
4	1	C5	CAP, C0G 2.2pF 50V ±0.25pF 0402	MURATA GJM1555C1H2R2CB01D
5	0	C7, C13 (OPT)	CAP, 0402	
6	0	C12 (OPT)	CAP, 0603	
7	1	C14	CAP, TANT 2.2µF 20V 20% 3216	AVX TPSA225M020R3000
8	9	E1, E2, E5, E7, E8, E9, E10, E11, E12	TURRET, TESTPOINT 0.063”	MILL MAX 2308-2-00-80-00-00-07-0
9	3	J1, J2, J3	CONN, SMA 50Ω	E. F. JOHNSON 142-0701-851
10	0	R1 to R5, R7, R9, R12 (OPT)	RES, 0603	
11	1	R6	RES/JUMPER, CHIP 0Ω 1/16W 1A 0603	VISHAY CRCW06030000Z0EA
12	3	R8, R10, R11	RES, CHIP 10K 0.06W 5% 0603	VISHAY CRCW060310K0JNEA
13	1	U1	I.C., PRECISION RF PWR DET QFN(16)(UD)3mm × 3mm	LINEAR TECHNOLOGY CORP LTC5564IUD
14	1	Z1	CAP, C0G 0.50pF 50V ±0.1pF 0402	MURATA GJM1555C1HR50BB01D
15	0	Z2 (OPT)	RES, 0402	
16	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1646A
17	1		STENCIL	STENCIL 1646A

SCHEMATIC DIAGRAM



LTC5564 MATCHING CIRCUITS COMPONENTS AND VALUES.

FREQUENCY RANGE	C5		Z1			Z2		
	VALUE	MANUFACTURE #	VALUE	MANUFACTURE #	VALUE	MANUFACTURE #		
1.7GHz to 3.1GHz	100pF	GJM1555C1H101JD1	6.8nH	0402CS-6N8XGL		NO PLACEMENT		
5.1 to 6.1 GHz	2.2pF	GJM1555C1H2R2CB01	0.5pF	GJM1555C1HR50BB01		NO PLACEMENT		
7.0 to 8.5 GHz	0.5pF	GJM1555C1HR50BB01	0.3pF	GJM1555C1HR30BB01		NO PLACEMENT		
8.3 to 10.2 GHz	0.2pF	GJM1555C1HR20BB01	0.1pF	GJM1555C1HR10BB01		NO PLACEMENT		
11.9 to 12.2 GHz	10pF	GJM1555C1H100JB01	-	NO PLACEMENT	2.2pF	GJM1555C1H2R2CB01		
14.9 to 16.5 GHz	2.2pF	GJM1555C1H2R2CB01	0.5pF	GJM1555C1HR50BB01		NO PLACEMENT		

NOTE: CAPACITORS ARE MANUFACTURED BY MURATA;
INDUCTORS ARE MANUFACTURED BY COILCRAFT.

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APPROVALS

PCB DES.	RB
APP ENG.	John C.

LINEAR TECHNOLOGY

1630 McCarthy Blvd.
Milpitas, CA 95035
Phone: (408)432-1900 www.linear.com
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TITLE: SCHEMATIC
15GHz RF DETECTOR

SIZE	IC NO.	REV.
N/A	LTC5564IUD DEMO CIRCUIT 1646A	4

SCALE = NONE	DATE: Monday, January 10, 2011	SHEET 1 OF 1

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Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

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