VCO Rider Board with Loop Filter

DESCRIPTION

Demonstration circuit 2664A is a VCO Rider Board with Loop Filter that supports the popular 0.5" × 0.5" VCO package footprint.

The DC2664A expedites evaluation of Phase-Locked Loop (PLL) devices requiring an external Voltage Controlled Oscillator (VCO). Without the DC2664A, each VCO and PLL combination requires a unique loop filter design, resulting in several PLL demo board modifications to evaluate each VCO. These board modifications are time consuming and often result in damage to either the PLL or the VCO.

The DC2664A integrates the VCO and loop filter allowing these unique designs to reside on multiple DC2664As. The DC2664A RFOUT and VTUNE SMA connections allow the user to quickly evaluate a PLL with multiple VCOs without risk of damage from multiple board modifications.

VCOs are notoriously sensitive to power supply noise and spurs. The DC2664A resolves the concern of locating a low noise and low spurious lab supply by powering the VCO with an onboard ultralow noise and ultrahigh PSRR LDO, the LT®3042. A second LT3042 LDO is available on the DC2664A to power an active loop filter. Both LDOs are powered from a single supply, simplifying the number of lab supplies required to evaluate a VCO and PLL combination.

The DC2664A was designed to mate directly with the LTC®6955 (DC2611A) and LTC6952 (DC2609A) demo boards. Examples are provided on the following pages.

Design files for this circuit board are available.

All registered trademarks and trademarks are the property of their respective owners.

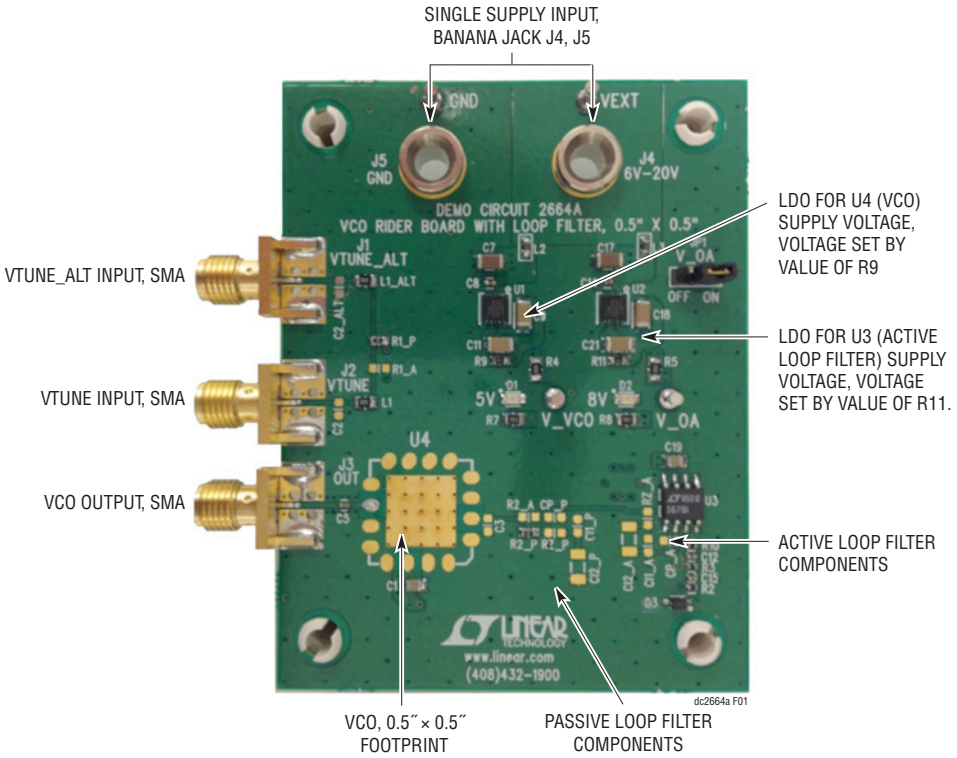


Figure 1. DC2664A Connections

Downloaded from Arrow.com.

QUICK START PROCEDURE

DC2664A Configuration

1. Select and install desired VCO (U4).
2. Set U1 output voltage (V_VCO) equal to the VCO's (U4) data sheet recommended supply voltage. This is accomplished by calculating the R9 value:

$$R9 = \frac{V\_VCO}{100\mu A} \quad (1)$$

   Install R9 if different than factory default value.

   DC2664A arrives from the factory with R9 = 49.9kΩ (V_VCO = 5V). The LT3042 (U1) limits the V_VCO max supply voltage to 15V.
3. Design and install loop filter. Analog Devices provides a loop filter design tool for all Analog Devices' PLLs. Download the appropriate loop filter design tool from the PLL product web page.
4. If an active loop filter is required, set U2's output voltage (V_OA) equal to the VCO's (U4) data sheet max VTUNE voltage. This is accomplished by calculating the R11 value:

$$R11 = \frac{V\_OA}{100\mu A} \quad (2)$$

   Install R11 if different than factory default value.

   DC2664A arrives from the factory with R11 = 80.6kΩ (V_OA = 8V). The LT3042 (U2) limits the V_OA max supply voltage to 15V. For V_OA > 15, uninstall R5 and supply V_OA voltage directly to E4 turret.
5. Connect J4 to a supply voltage and J5 to GND.

$$V_{J4} > Max\ (V\_VCO, V\_OA) + 1V \quad (3)$$

   V_{J4} should not exceed 20V. The two green power supply LEDs (D1, D2) should illuminate after Step 5.
6. Connect J1 or J2 to PLL's Charge Pump (CP) output.
7. Connect J3 to PLL's VCO input.

Downloaded from Arrow.com.

QUICK START PROCEDURE

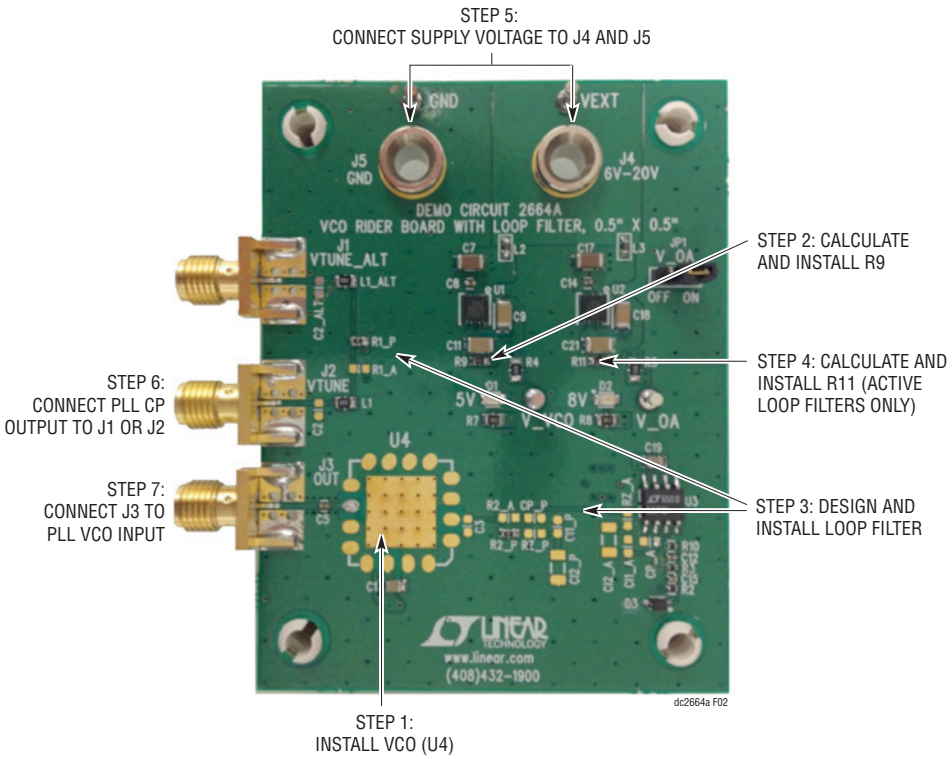


Figure 2. DC2664A Configuration

Downloaded from Arrow.com.

EXAMPLE 1: LTC6952 (DC2664A, DC2609A)

Example 1 demonstrates the direct connect capability of the DC2664A and the DC2609A (LTC6952). The VCO and all loop filter components may reside on the DC2664A. However, to minimize the LTC6952 PFD spurs, it is recommended to leave the C2 loop filter capacitor on the DC2609A demo board. Table 1 provides the recommended DC2609A modifications made to produce Figure 3.

Table 1. DC2609A Board Modifications

UNINSTALL	INSTALL	CONNECTIONS
C81, R51	C14 = 0.1µF R1 = 0Ω C2 = See loop filter design tool	DC2609A J31 connects to DC2664A J1 DC2609A J28 connects to DC2664A J3

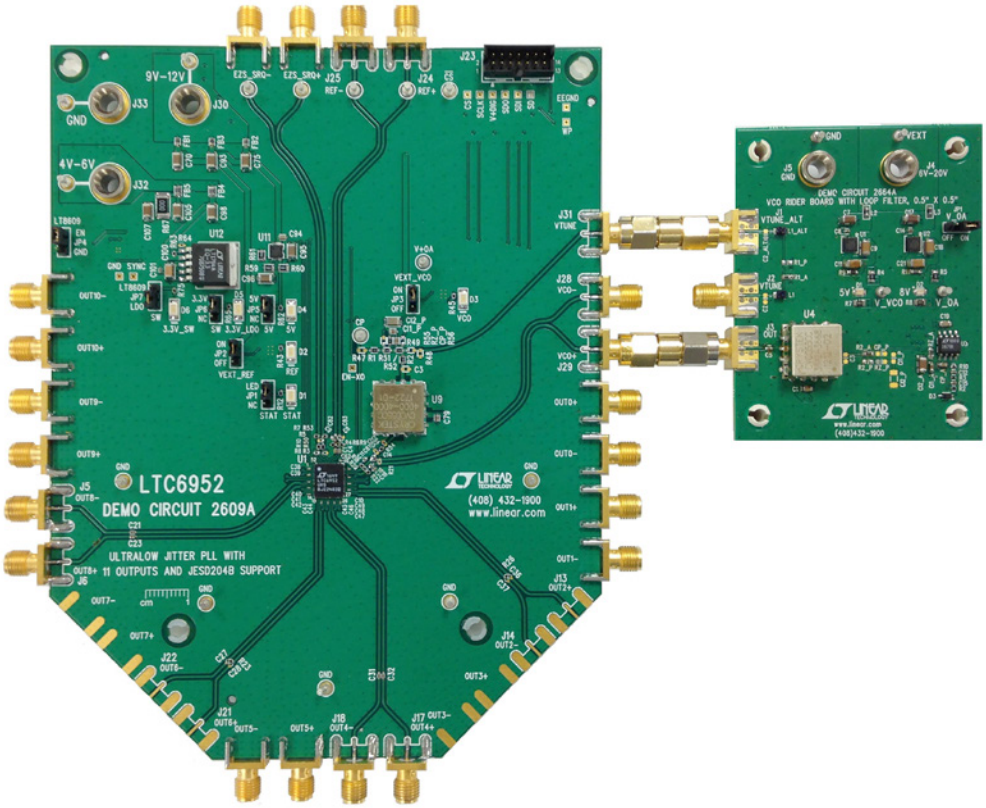


Figure 3. DC2664A and DC2609A Direct Connect

Downloaded from Arrow.com.

EXAMPLE 2: LTC6952 AND LTC6955 (DC2664A, DC2609A, DC2611A)

Example 2 demonstrates the direct connect capability of the DC2664A, the DC2611A (LTC6955), and the DC2609A (LTC6952). The VCO and all loop filter components can reside on the DC2664A. However, to minimize the LTC6952 PFD spurs, it is recommended to leave the C2 loop filter capacitor on the DC2609A demo board. The DC2611A calibration path is used to pass the DC VTUNE voltage from the DC2609A to the DC2664A. To allow the VTUNE voltage to reach the DC2664A, replace the DC2611A's AC-coupling capacitors with 0Ω resistors. Table 2 and Table 3 provide the recommended DC2609A and DC2611A modifications made to produce Figure 3.

Table 2. DC2609A Board Modifications

UNINSTALL	INSTALL	CONNECTIONS
C81, R18, R22, R51	C14 = C16 = 0.1µF R20 = 160Ω, R1 = 0Ω C2 = See loop filter design tool	DC2609A J31 connects to DC211A J23 DC2609A J28 connects to DC2611A J1 DC2609A J29 connects to DC2611A J2

Table 3. DC2611A Board Modifications

UNINSTALL (*)	INSTALL (*)	CONNECTIONS
	C56 = C57 = 0Ω	DC2611A J24 connects to DC2664A J2 DC2611A J25 connects to DC2664A J3

(*) Refer to DC2611A demo manual for correct input termination network for specific frequencies.

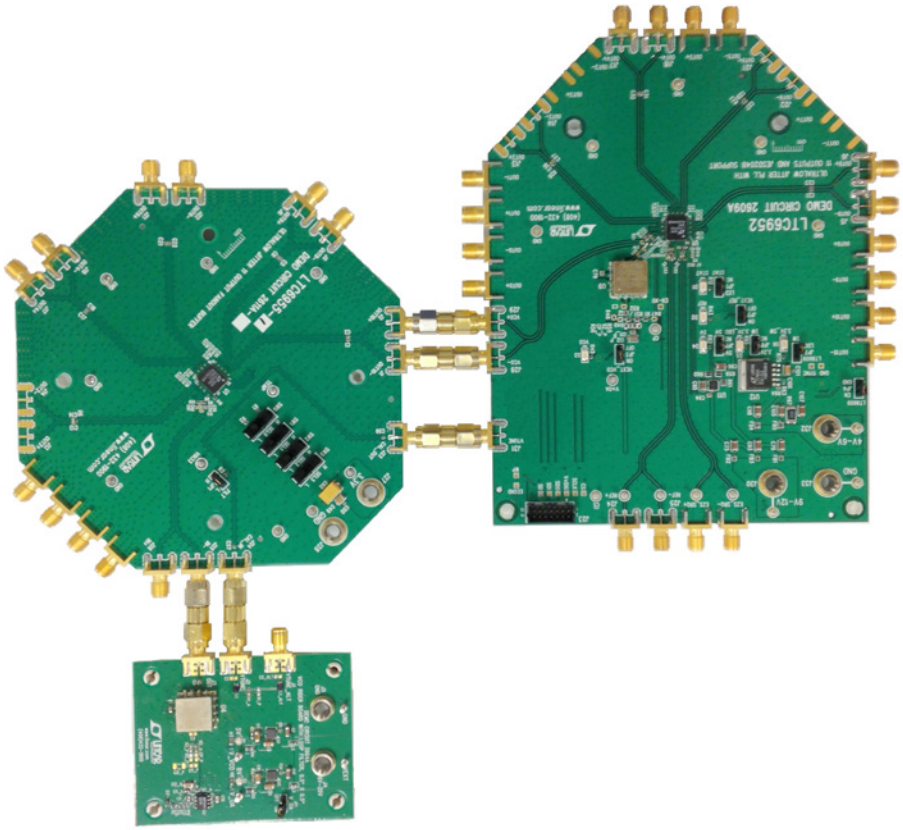


Figure 4. DC2664A, DC2609A and DC2611A Direct Connect

Downloaded from Arrow.com.

TYPICAL DC2664A REQUIREMENTS AND CHARACTERISTICS

Table 4.

PARAMETER	INPUT/OUTPUT	PHYSICAL LOCATION	DETAILS
6V to 20V Power Supply	Input	J4 Banana Jack	Powers the onboard VCO and onboard active loop filter. To determine input voltage, refer to Equation 3.
GND	Output	J5 Banana Jack	Pair with J4
V_VCO	Output/Input	E3 Turret	Output (Default): Connected to LT3042 (U1) output and VCO (U4) supply pin. Max 15V. Input: For VCOs requiring >15V supplies, uninstall R4 and connect an external supply directly to E3.
V_OA	Output/Input	E4 Turret	Output (Default): Connected to LT3042 (U2) output and active loop filter's amplifier (U3) supply pin. Max 15V. Input: For VCO VTUNE pins requiring >15V, uninstall R5 and connect an external supply directly to E4.
V_OA	Input	JP1 Header	Option to power on/off V_OA LDO (U2)
VTUNE_ALT	Input	J1 SMA Connector	Connect PLL Charge Pump output to either VTUNE or VTUNE_ALT.
VTUNE	Input	J2 SMA Connector	VTUNE_ALT is designed to direct connect to the DC2609A's (LTC6952 demo board) VTUNE SMA. Refer to Example 1. VTUNE is designed to direct connect to the DC2611A's (LTC6955 demo board) CAL_IN SMA. Refer to Example 2.
OUT	Output	J3 SMA Connector	VCO's RF output

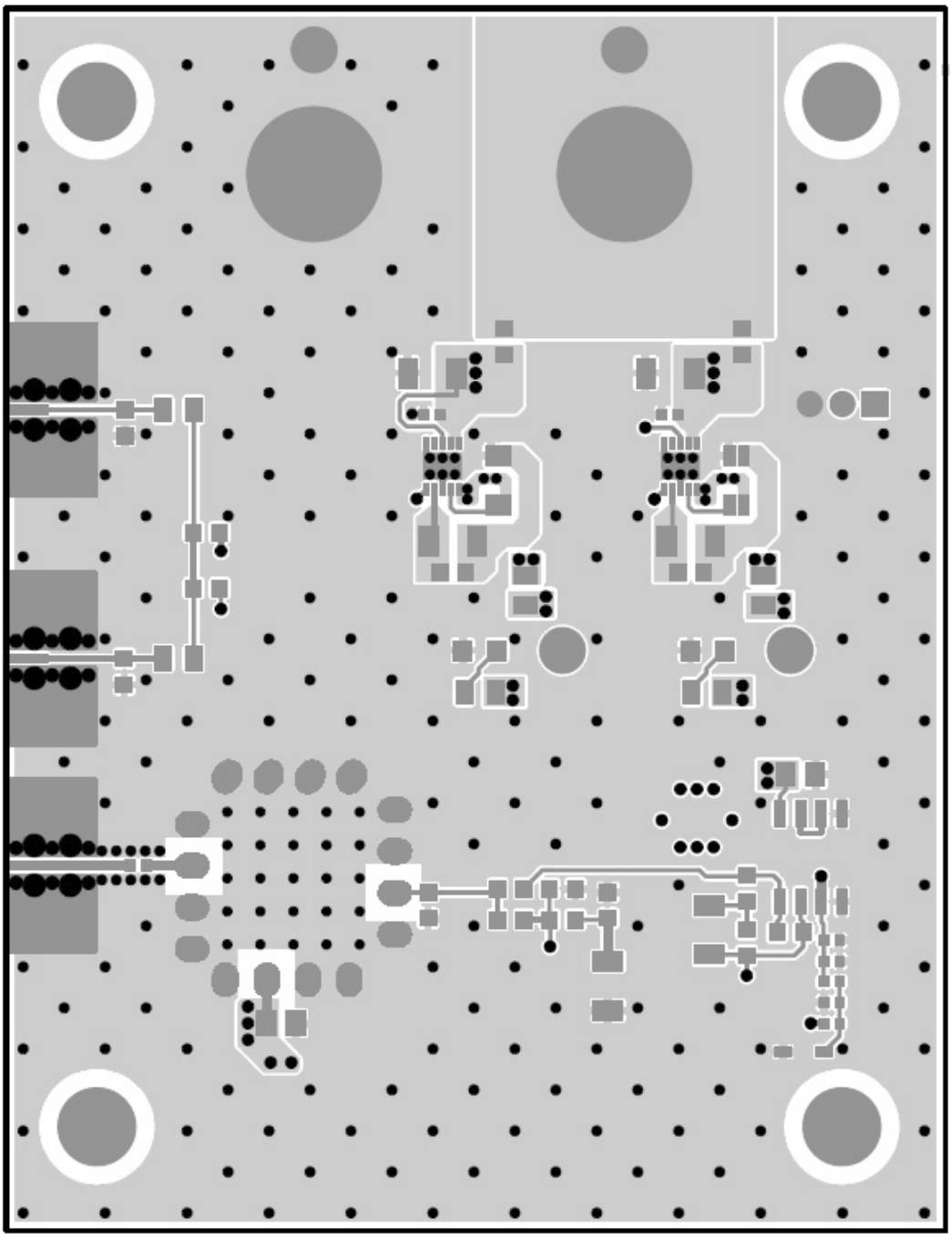
ASSEMBLY OPTIONS

Table 5. DC2664A Options

ASSEMBLY VERSION
DC2664A

Downloaded from Arrow.com.

LAYOUT TOP LAYER



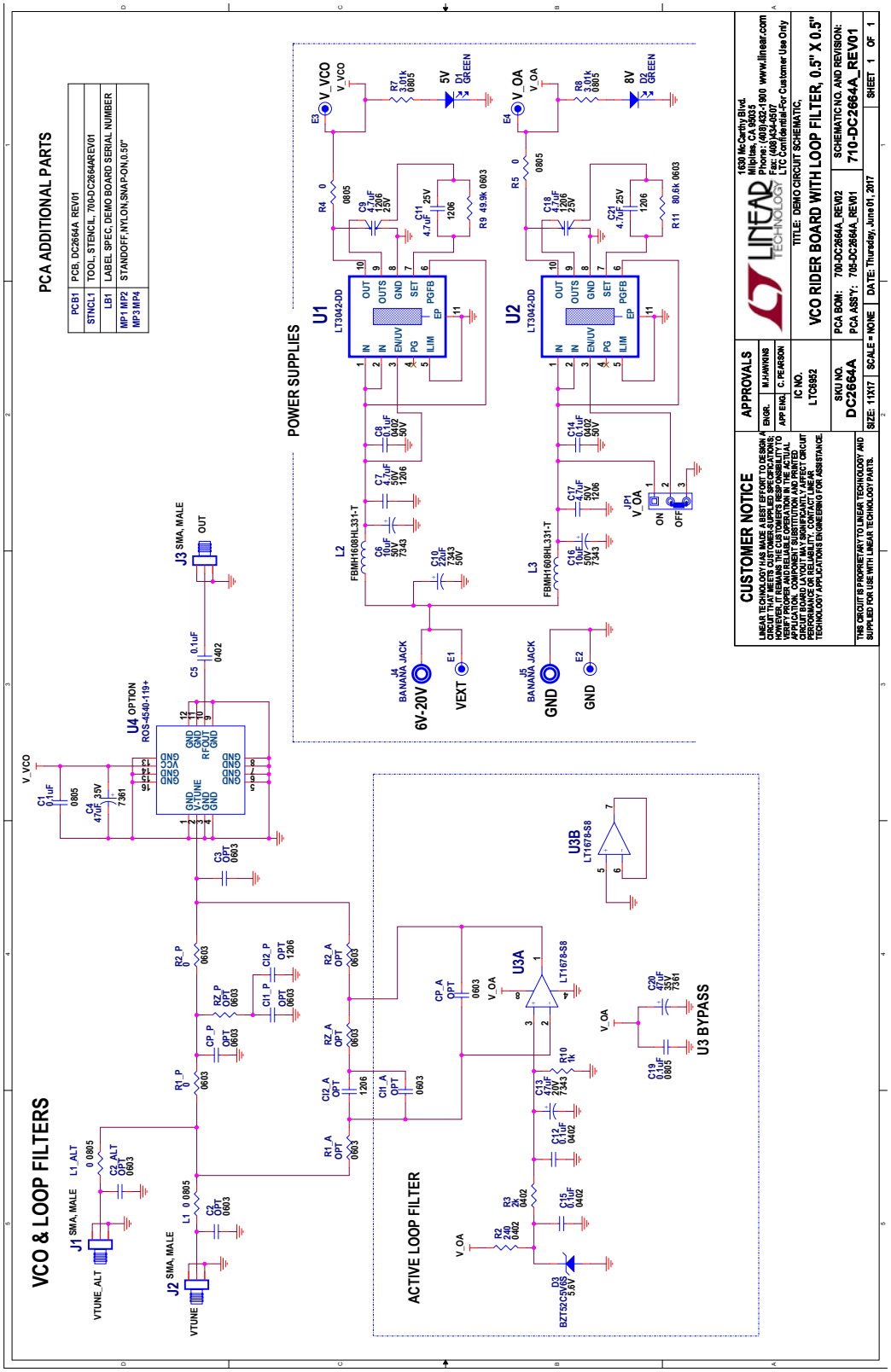
Downloaded from Arrow.com.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER	MANUFACTURER/PART NUMBER
1	2	C1, C19	CAP., 0.1µF, X7R, 50V, 10%, 0805	AVX	08055C104KAT2A
2	0	C2, C2_ALT, C3, CI1_A, CI1_P, CP_A, CP_P	CAP., OPTION, 0603		
3	2	C4, C20	CAP., 47µF, TANT, 35V, 10%, 7361	AVX	TAJV476K035RNJ
4	3	C5, C12, C15	CAP., 0.1µF, X7R, 10V, 10%, 0402	MURATA	GRM155R71A104KA01D
5	2	C6, C16	CAP., 10µF, TANT, 50V, 20%, 7343	AVX	TPSE106M050R0500
6	2	C7, C17	CAP., 4.7µF, X7R, 50V, 10%, 1206	AVX	12065C475KAT2A
7	2	C8, C14	CAP., 0.1µF, X7R, 50V, 10%, 0402	MURATA	GRM155R71H104KE14D
8	4	C9, C11, C18, C21	CAP., 4.7µF, X7R, 25V, 5%, 1206	KEMET	C1206C475J3RACTU
9	1	C10	CAP., 22µF, TANT, 50V, 20%, 7343	KEMET	T521X226M050ATE075
10	1	C13	CAP., 47µF, TANT, 20V, 20%, 7343	AVX	TAJD476M020RNJ
11	0	CI2_A, CI2_P	CAP., OPTION, 1206		
12	2	D1, D2	LED, GREEN, DIFFUSED, 0805	BROADCOM LIMITED	HSMG-C170
13	1	D3	DIODE, ZENER, 5.6V, 200mW, SOD-323, AEC-Q101	DIODES, INC.	BZT52C5V6S-7-F
14	4	E1-E4	TEST POINT, TURRET, 0.064", MTG. HOLE	MILL-MAX	2308-2-00-80-00-00-07-0
15	3	J1-J3	CONN., SMA, JACK, RCPT, END LAUNCH, STR, 50Ω	CINCH/ BEL	142-0701-851
16	2	J4, J5	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE	KEYSTONE	575-4
17	1	JP1	CONN., HDR., MALE, 1mm × 3.2mm, THT, STR	SULLINS CONNECTOR SOLUTIONS	NRPN031PAEN-RC
18	4	L1, L1_ALT, R4, R5	RES., 0Ω, 1/8W, 0805	VISHAY	CRCW08050000Z0EA
19	2	L2, L3	IND.,330Ω @ 100MHz, FERRITE BEAD, 25%, 0.8A, 0.21Ω, 0603	TAIYO YUDEN	FBMH1608HL331-T
20	4	MP1-MP4	STANDOFF, NYLON, SNAP-ON, 0.50"	KEYSTONE	8833
21	1	PCB1	PCB, DC2664A REV01	MAO BANG	600-DC2664A
22	0	R1_A, R2_A, RZ_A,RZ_P	RES., OPTION, 0603		
23	2	R1_P, R2_P	RES., 0Ω, 1/10W, 0603	PANASONIC	ERJ3GEY0R00V
24	1	R2	RES., 240Ω, 1%, 1/16W, 0402	VISHAY	CRCW0402240RFKED
25	1	R3	RES., 2k,1%, 1/16W, 0402	VISHAY	CRCW04022K00FKED
26	2	R7, R8	RES., 3.01k, 1%, 1/8W, 0805	VISHAY	CRCW08053K01FKEA
27	1	R9	RES., 49.9k, 1%, 1/10W, 0603	VISHAY	CRCW060349K9FKEA
28	1	R10	RES., 1k, 1%, 1/16W, 0402	VISHAY	CRCW04021K00FKED
29	1	R11	RES., 80.6k, 1%, 1/10W, 0603	NIC	NRC06F8062TRF
30	2	U1, U2	IC, PSRR RF LINEAR REGULATOR, DFN-10 (DD)	ANALOG DEVICES	LT3042EDD#PBF
31	1	U3	IC, DUAL/QUAD LOW NOISE OP AMPS, SO-8	ANALOG DEVICES	LT1678IS8#PBF
32	0	U4	IC, VCO, 4340MHz to 4540MHz, OPTION	MINI-CIRCUITS	ROS-4540-119+
33	1	XJP1	CONN., SHUNT, FEMALE, 2 POS, 2mm	SAMTEC	2SN-BK-G

Downloaded from Arrow.com.

SCHEMATIC DIAGRAM



Information furnished by Analog Devices is believed to be accurate and reliable. However, no responsibility is assumed by Analog Devices for its use, nor for any infringements of patents or other rights of third parties that may result from its use. Specifications subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Analog Devices.

Downloaded from Arrow.com.

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NONINFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS ($100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.

© ANALOG DEVICES, INC. 2019

Downloaded from Arrow.com.