TRF2432EVM

This user's guide provides an overview of the TRF2432 evaluation module (EVM) and the software environment to get you started using the TRF2432EVM. It also provides a general description of the features and functions to be considered while using this module.

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1 Overview

1.1 Purpose

The TRF2432EVM provides a platform for evaluating the TRF2432 dual-band, tri-mode 802.16 IQ/IF transceiver with dual VCO synthesizers under various signals, reference, and supply conditions. Use this document with the EVM schematic diagram supplied. Using the TRF2432EVM, you can rapidly evaluate the TRF2432 with a minimum of manual setup. The CD-ROM provides all the software needed to test the device.

1.2 EVM Basic Functions

The reference input can be provided using the onboard crystal Y1 or brought in externally using SMA connector J2. The receiver in-phase and quadrature outputs can be monitored through SMA connectors J17 and J19. The transmitter in-phase and quadrature inputs are brought in through SMA connectors J12, J13, J14, and J15.

The TRF2432EVM allows the user to program the TRF2432 internal registers via the supplied computer parallel port cable and serial interface software. The interface allows write access to all registers that define the operation modes of the TRF2432.

1.3 System Requirements

Use the following equipment when evaluating the TRF2432EVM:

- ±5-V power supply, 500 mA, +3.3-V power supply, 500 mA
- Personal computer (PC) running Windows™ 98, 2000, or XP
- Signal generator: Agilent ESG series (with baseband I/Q modulation option for modulated testing) or equivalent
- Spectrum analyzer: Agilent PSA series (with phase noise option) or equivalent.
- Vector signal analyzer: Agilent 89600 series for 802.16x modulated EVM testing or equivalent.

1.4 Power Requirements

The demonstration board requires 5 V, –5 V, and 3.3 V for proper operation. Connect +5 V at P1, –5 V at P2, +3.3 V at P4, and all returns at P3.

Voltage Limits

Exceeding the maximum input voltages can damage EVM components. Undervoltage can cause improper operation of some or all of the EVM components.

1.5 Software Installation

This section explains how to install the software and gives a quick overview of the main parts tool menus. The software requires a PC running Windows 98, 2000, or XP.

All necessary software to operate the serial interface is provided on the enclosed CD-ROM. The version 1.0 of the TRF2432 software allows full control and programmability of all the different functions and modes of the TRF2432. The software is GUI-based and employs an intuitive graphical environment. Insert the CD-ROM into the computer to be used to operate the serial interface.

TI broadband wireless access (BWA) LabVIEW™ GUI Installation Instructions:

1. On the provided CD, double-click on **setup.exe**. This installs the LabVIEW run-time engine as well as the TI_BWA GUI (located in the Windows Programs menu).The installer prompts you to select the directory in which you wish to install the program. The installer automatically installs the TI_BWA GUI software, the National Instruments LabVIEW run-time engine, and the LabWindows run-time engine in one seamless installation. The software was created using LabVIEW, but it *does* not require LabVIEW to be installed on the PC. This is why the run-time engines are installed.
2. If the PC being used has never been configured to write data over the parallel printer port, then this step is necessary; otherwise, the GUI is ready and this step can be skipped. Unzip AccessHW.zip to a Temp directory. After extracting the files, run **setup.exe**. This installs the required .dll files to allow LabVIEW to access the parallel port.

1.6 Hardware Configuration

The TRF2432EVM can be configured in a variety of ways to accommodate a specific mode of operation. Before starting evaluation, the user should decide on the configuration and make the appropriate connections or changes. The demonstration board comes with the following factory-set configuration

Jumper J4 is installed between 1-2.

To prepare the TRF2432EVM for evaluation, connect the following:

- +5 V to connector P1 and the return to P3.
- –5 V to connector P2 and the return to P3.
- +3.3 V to connector P4 and the return to P3.
- Connect the provided parallel port cable from the LPT1 port of a PC to the DB25 connector J1 on the

TRF2432EVM.

2 TRF2432EVM Operational Procedure

2.1 Starting the Serial Interface Program

Power up the EVM. In the Windows Programs menu, find the TI_BWA entry and click on it. At this point, the LabVIEW code loads and automatically runs. The following screen appears as shown in Figure 1.

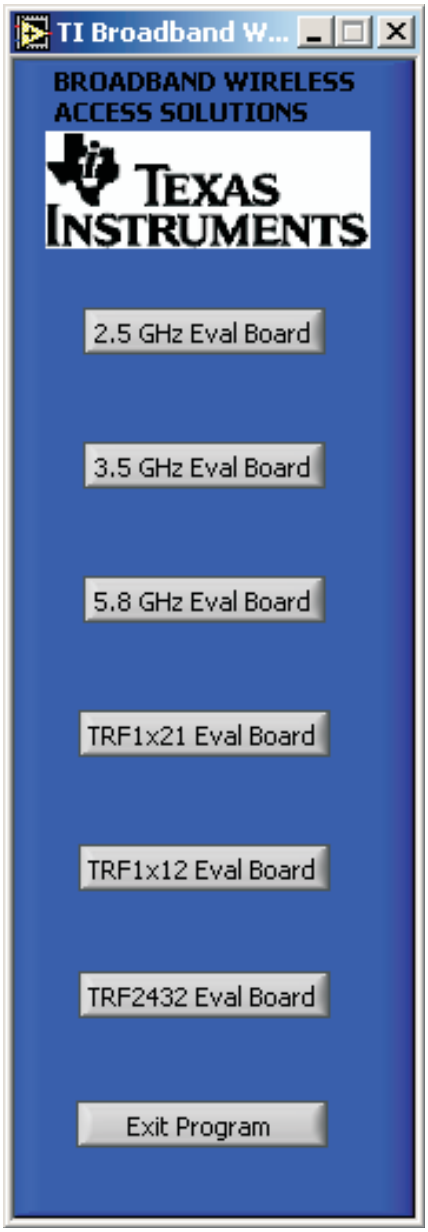


Figure 1. TI_BWA GUI Main Menu

Click on *TRF2432 Eval Board*. The TRF2432 GUI window appears as shown in Figure 2.

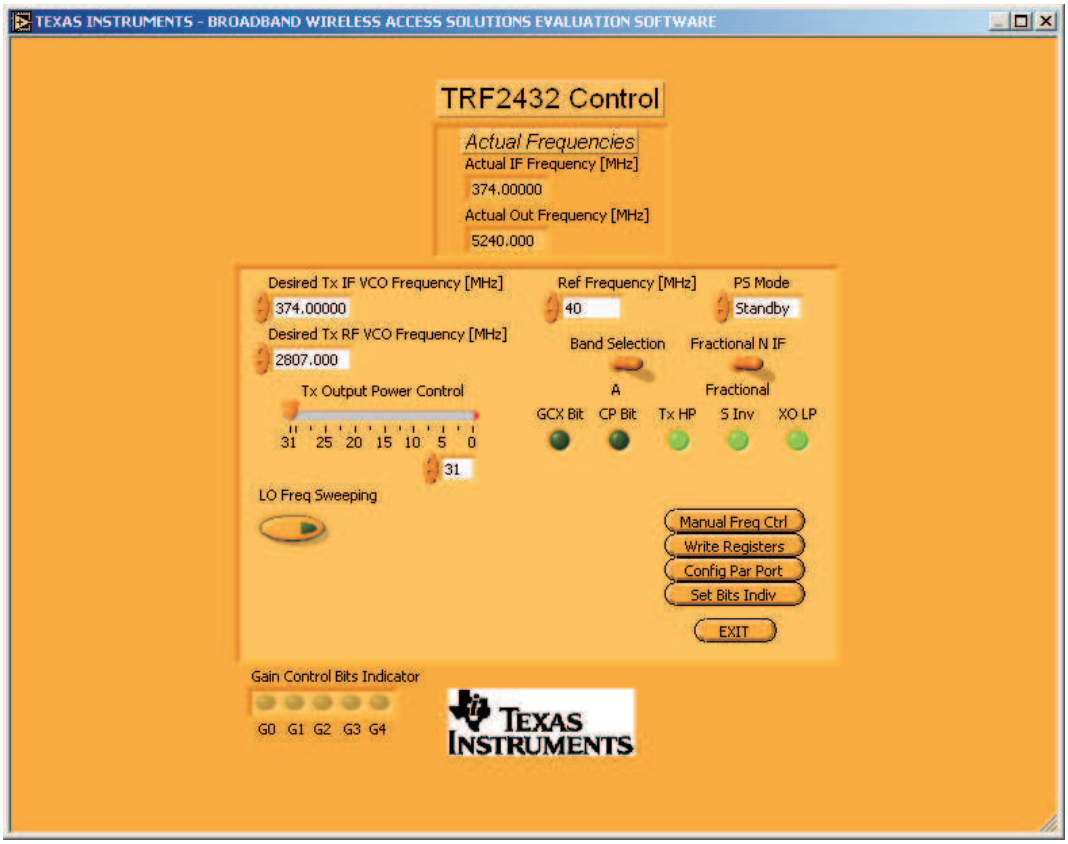


Figure 2. TRF2432 Serial Interface GUI

2.1.1 Programming the TRF2432

Programming control of the TRF2432 is via J1 on the reference board. An interface cable is provided with the board to transition from J1 on the reference board to a standard DB25-style connector. Connect this cable to the PC parallel port via a standard 1:1 wired DB25 cable.

The pin assignments for the reference board are shown in Table 1.

Table 1. Pin Assignments for the Reference Board

Data Bit	Signal Name	PC DB25 Pin	Ref Board J1 Pin
0	CLK	2	1
1	DATA	3	2
2	LE	4	3
—	GROUND	18	4

All controls needed to program the TRF2432 are available on the main screen. See the TRF2432 data sheet (SLWS177) for explanation of controls. The actual output frequency is shown for convenience only and is the calculated RF frequency that would be generated if the TRF2432 were being used with the companion TRF2436 chip.

2.1.2 Parallel Port Configuration

The parallel port address and pin assignments can be modified by clicking on the **Configure Part Port** button. The default parallel port address is 378, and the pin assignments are set to match Table 1. In most cases, leave the configuration at the default settings.

2.1.3 Manual Register Control

Manual bit-by-bit control of all programming registers is available by clicking on the ***Set Bits Individually*** button. The register/bit assignments are in the same order as Table 16 of the data sheet.

After modifying bit settings, press the ***SEND*** button next to a register to write the new values to the TRF2432. Any changes made to the bit settings on this panel are reflected on the main panel when the manual panel is closed. Be aware that manually modifying bit settings can potentially send invalid control values.

2.1.4 Manual Frequency Control

The ***Manual Freq Control*** panel allows input of IF/RF register values and any reference frequency. It calculates the resulting IF VCO and RF VCO frequencies. Pressing the ***SEND*** button writes the new register values to the TRF2432. This panel is intended for use in cases where an external reference frequency other than 40 MHz or 44 MHz is used. Be aware that manually modifying bit settings can potentially send invalid control values.

2.2 TX Operation

1. Connect equipment to reference board as shown in Figure 3.

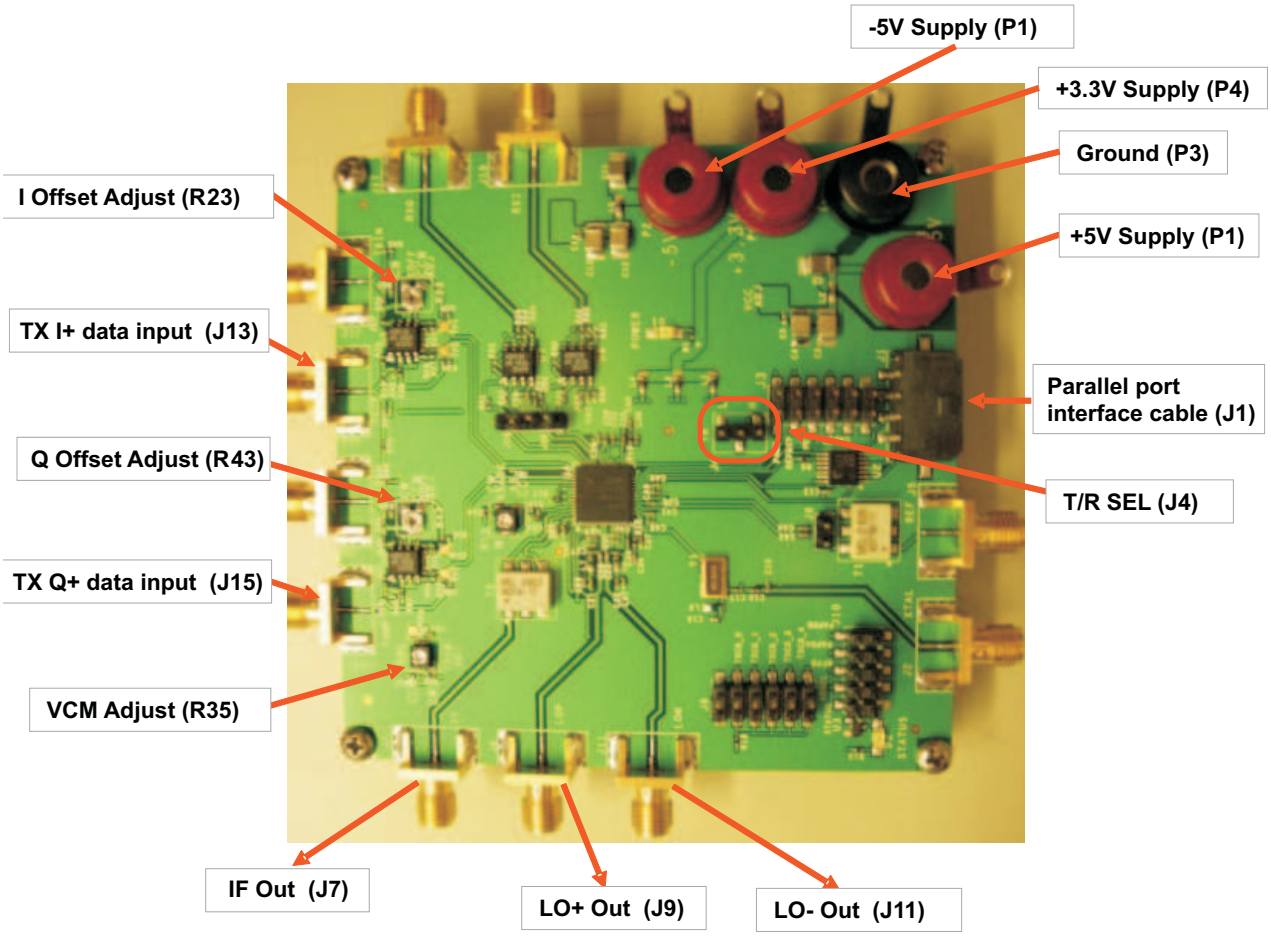


Figure 3. Connections for TX Operation With Differential Drivers

2. Connect LO+ and LO– ports to test equipment, or terminate them in 50-Ω loads.
3. Set common-mode voltage of the I/Q source to 0 V.
4. Set T/R select to TX by connecting the center pin of J4 to the*H* pin (J4-2 to J4-1).
5. Turn on power supplies.

6. Connect a DVM from TP1 to GND, and adjust the common-mode voltage to ~1.5 Vdc using R35.
7. Program DUT to desired operating frequencies, and set to ACTIVE mode.
8. Adjust I offset and Q offset using R23/R43 to null carrier (for single-tone IQ input) or minimize I/Q offset error (for modulated IQ input).
9. Observe IF output or LO outputs on spectrum analyzer.

2.3 TX Operation Without Differential Amplifiers

The reference board is provided with differential amplifiers that generate differential I, I/, Q, and Q/ signals from single-ended I and Q inputs.

If an external differential drive is to be provided, the differential amplifiers on the board can be bypassed by adding/removing the following 0-Ω resistors:

Remove R26, R31, R24, R27, R40, R48, R41, and R45.

Install R20, R34, R36, and R50.

This removes the differential amplifiers from the circuit and connects the external I/Q drive source directly to the TRF2432 inputs.

When using an external differential drive, a common-mode voltage of ~1.5 V must be provided by the external source. In addition, any I or Q offset adjustment must be provided by the external source.

2.4 RX Operation

1. Connect equipment to reference board as shown in Figure 4.

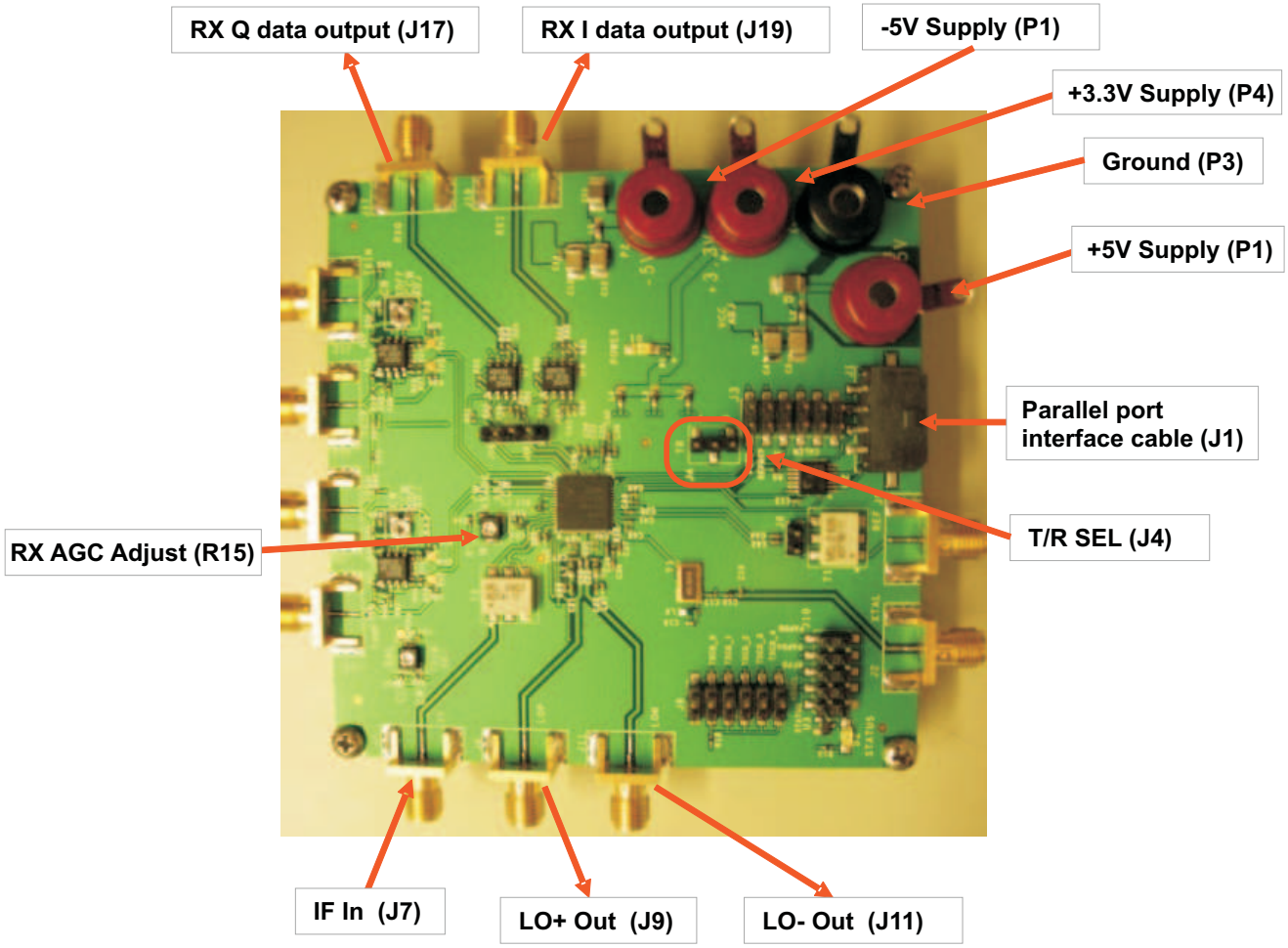


Figure 4. Connections for RX Operation

2. LO+ and LO– ports should either be connected to test equipment or terminated in 50-Ω loads.
3. Set T/R select to RX by connecting the center pin of J4 to the *L* pin (J4-2 to J4-3).
4. Turn on power supplies.
5. Connect a DVM from R16 to GND, and adjust RX AGC voltage to desired level (1- 2 Vdc typical using R15).
6. Program DUT to desired operating frequencies, and set to ACTIVE mode.
7. Monitor RX I/Q outputs by connecting to appropriate test equipment.

2.5 Reference Frequency Crystal Operation

A 40-MHz reference crystal is included on the reference board (Y1). The board can use an external crystal as follows:

1. Remove C17.
2. Install C18 if a DC block is required. Otherwise, install a 0-Ω resistor in the C18 location.
3. Install an appropriate termination resistor in the C19 location (if required).
4. Connect a single-ended reference frequency source to the board via J2 SMA connector.

2.6 Additional Information for TX With Modified Schematic

The common mode at the baseband inputs of the TRF2432 is set by the potentiometer R35. For carrier suppression adjustment, VCM_ADJ_I and VCM_ADJ_Q should be brought out via wires. They need to be connected to dc power supplies with nominal value equal to the common mode at IP, IN and QP, QN signals. The VCM_ADJ_I and VCM_ADJ_Q signals then can be fine tuned to minimize the carrier feed through at the TRF2432 IF output.

3 Physical Description

This section describes the physical characteristics and PCB layout of the EVM, lists the components used on the module, and provides the schematic drawing.

3.1 PCB Layout

The EVM is constructed on a 4-layer, 3.5-inch x 3.6-inch, 0.042-inch thick PCB using Polycad 370 Turbo/HR material. Figure 5 through Figure 8 show the PCB layout for the EVM.

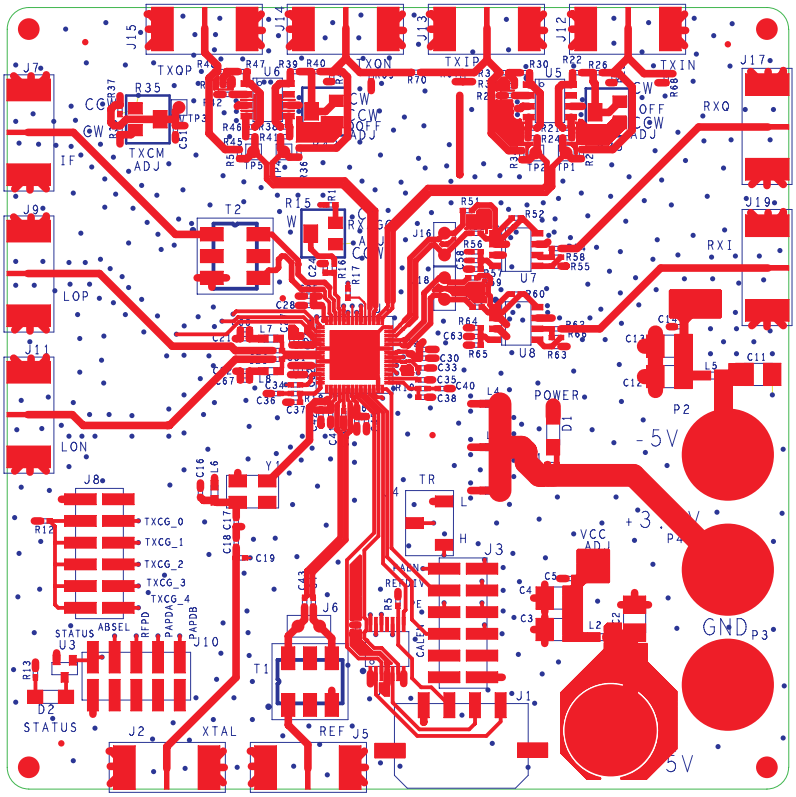


Figure 5. Top Layer 1

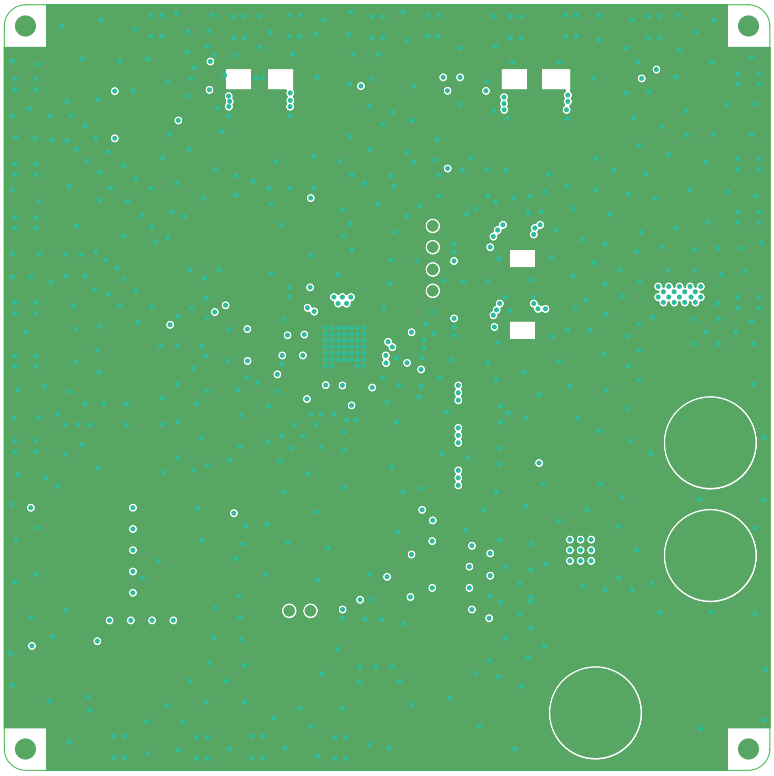


Figure 6. Ground Plane Layer 2

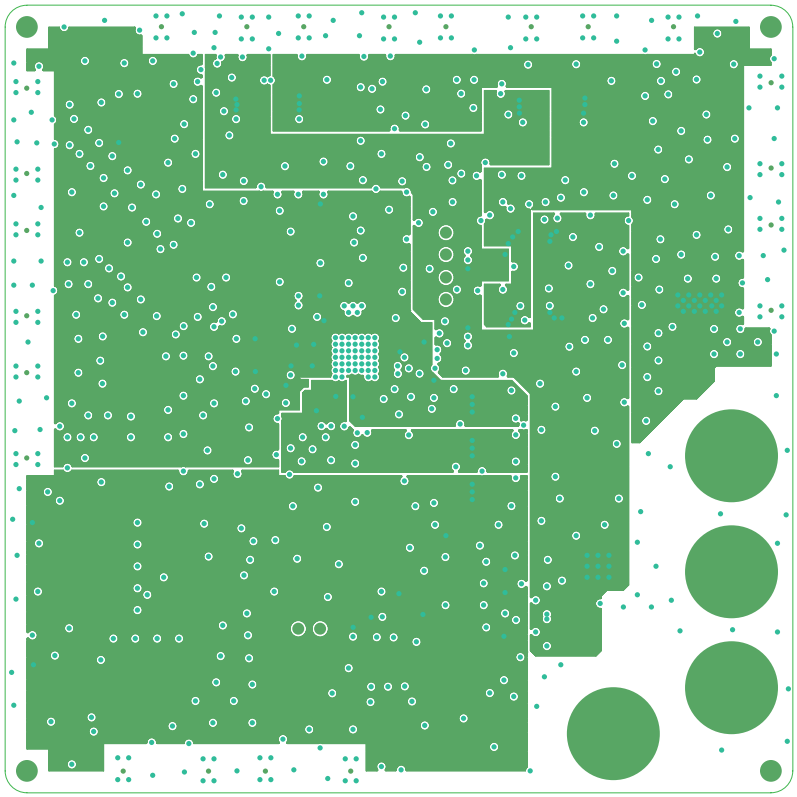


Figure 7. Power Plane Layer 3

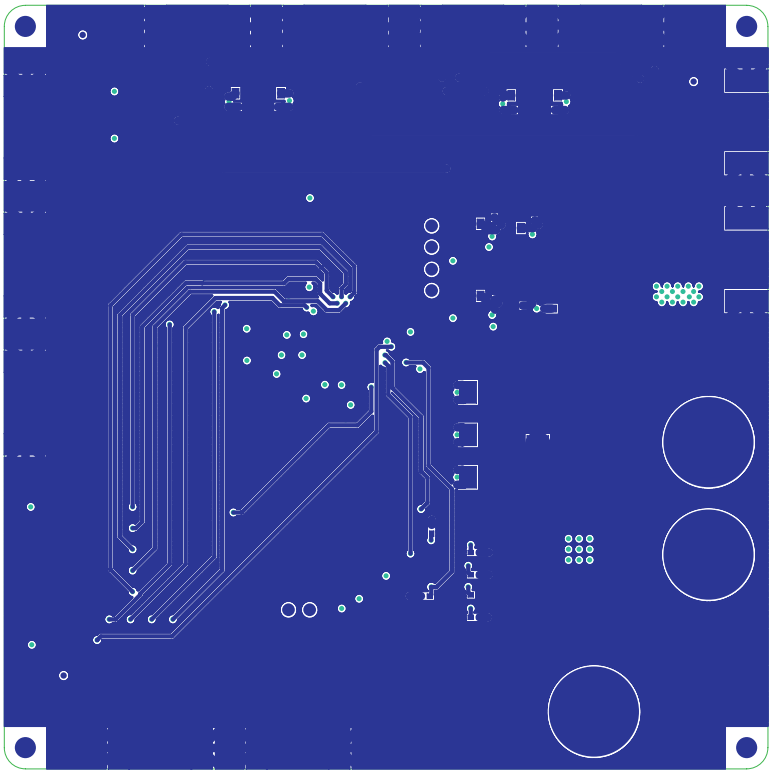


Figure 8. Bottom Layer 4

3.2 Parts List

Table 4-1 lists the parts used in constructing the EVM.

Table 2. TRF2432EVM PARTS LIST

TRF2432 Parts List				
Qty	**Reference**	**Value**	**MFR and Part Number**	**NOTE**
6	C1, C4, C8, C9, C10, C13	1µF	Panasonic ECJ-0EB0J105M	
2	C2, C11	47µF	Panasonic ECJ-4YB0J476M	
2	C3, C12	10µF	Panasonic ECJ-4YB1A106K	
15	C5, C14, C15, C21, C25, C27, C29, C31, C41, C43, C44, C45, C58, C63, C67	100nF	Panasonic ECJ-0EB1A104K	
11	C39, C40, C48, C50, C51, C53, C55, C57, C60, C62, C65	10nF	Panasonic ECJ-0EB1E103K	
1	C16	36pF	Murata GRM1555C1H360JZ01D	
1	C17	330pF	Panasonic ECJ-0EB1H331K	
2	C18, C19	330pF	Panasonic ECJ-0EB1H331K	DNI
2	C20, C23	5.6pF	Panasonic ECD-G0E5R6C	
10	C22, C24, C26, C28, C30, C32, C33, C42, C46, C66	100pF	Panasonic ECJ-0EB1E101K	
3	C34, C35, C37	1000pF	Panasonic ECJ-0EB1E102K	
1	C36	22n	Panasonic ECJ-0EB1C223K	
1	C38	680pF	Panasonic ECJ-0EB1H681K	
8	C47, C49, C52, C54, C56, C59, C61, C64	1µF	Panasonic ECJ-1VB1A105K	

Table 2. TRF2432EVM PARTS LIST (continued)

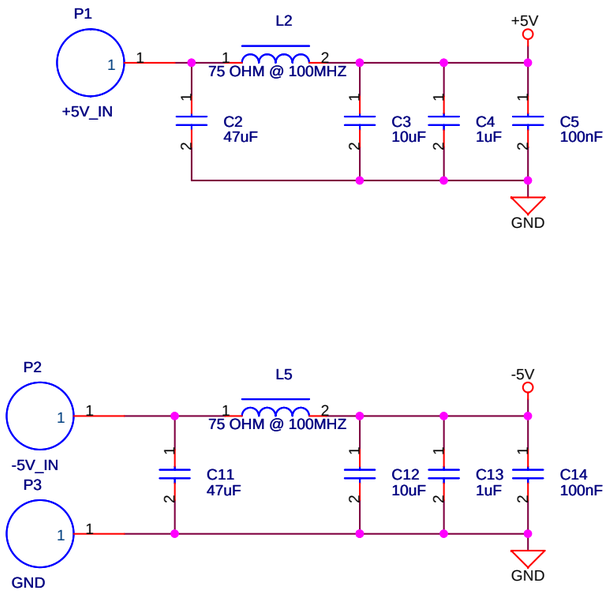
TRF2432 Parts List				
Qty	**Reference**	**Value**	**MFR and Part Number**	**NOTE**
2	D1, D2	GREEN	Lite-On LTST-C150KGKT	
1	J1	HEADER 4/SM	Molex 43650-0412	
11	J2, J5, J7, J9, J11, J12, J13, J14, J15, J17, J19	XTAL_IN	Johnson Comp 142-0701-841	
2	J3, J8	HEADER 6x2/SM	Molex 015-91-0060	
1	J4	HEADER 3	Berg 54201-S08-3	
3	J6, J16, J18	HDR2 Header 2 pos, 0.100 ctr		
1	J10	NU HEADER 5x2/SM	Molex 015-91-0050	DNI
5	L1, L2, L3, L4, L5	75 Ω at 100MHz	Murata BLM18BA750SN1D	
1	L6	270nH	Murata LQW18ANR27J00D	
2	L7, L8	1.8nH	Coilcraft 0603CS-1N8XJLU	
3	P1, P2, P4	+5V_IN	Allied ST-351A	
1	P3	GND	Allied ST-351B	
2	R1, R13	1.5K	Panasonic ERJ-2RKF1501X	
8	R5–R12	10K	Panasonic ERJ-2RKF1002X	
1	R14	1.33kΩ	Panasonic ERJ-2RKF1331X	
1	R15	2K POT	Bourns 3214W-1-202E	
1	R16	100	Panasonic ERJ-S02F1000X	
1	R17	1.54kΩ	Panasonic ERJ-2RKF1541X	
1	R18	130	Panasonic ERJ-2RKF1300X	
1	R19	210	Panasonic ERJ-2RKF2100X	
18	R20, R26, R31, R32, R34, R36, R40, R48, R49, R50, R51, R53, R56, R58, R59, R61, R65, R66	NU 0 Ω	Panasonic ERJ-2GE0R00X	DNI
8	R21, R22, R29, R30, R38, R39, R46, R47	1K	Panasonic ERJ-2GEJ102X	
2	R23, R43	100 POT	Bourns 3214W-1-101E	
6	R24, R27, R33, R37, R41, R45	100	Panasonic ERJ-2RKF1000X	
8	R25, R44, R54, R62, R67, R68, R69, R70	NU 49.9	Panasonic ERJ-2RKF49R9X	DNI
3	R28, R42, R55	499	Panasonic ERJ-2RKF4990X	
1	R63	NU 499	Panasonic ERJ-2RKF4991X	DNI
1	R35	5K POT	Bourns 3214W-1-502E	
2	R52, R60	NU 4.02K	Panasonic ERJ-2RKF4021X	DNI
2	R57, R64	NU 2.49K	Panasonic ERJ-2RKF2491X	DNI
1	T1	ADT16-1T	Mini Circuits ADT16-1T	
1	T2	ADT4-1T	Mini Circuits ADT4-1T	
5	TP1-TP5	T POINT	NO PART	DNI
1	U2	TC74LCX125FT	Toshiba TC74LCX125FT	
1	U3	IRLML2402	International Rectifier IRLML2402	
1	U4	TRF2432	TI TRF2432	
2	U5, U6	AD8132	AD8132AR	
2	U7, U8	AD8130	AD8130AR	
1	Y1	40MHz	World Technology 98M400-ST	
4	MP3	NU STAND OFF		DNI
4	MP2	NU SCREW		DNI
4		Nylon Standoff	Keystone 1902CK	

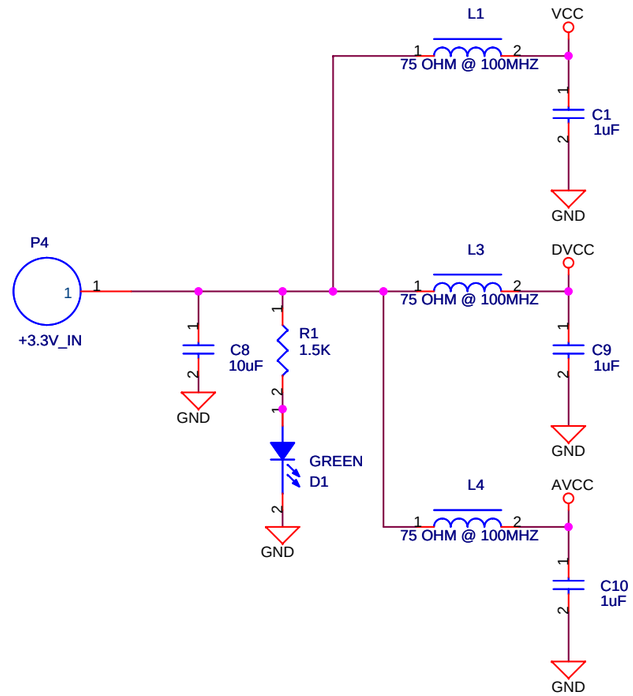
Table 2. TRF2432EVM PARTS LIST (continued)

TRF2432 Parts List				
Qty	**Reference**	**Value**	**MFR and Part Number**	**NOTE**
4		SCREW, 4-40 × 3/8"		

3.3 Schematic Drawing

The schematic drawing follows this page.





TEXAS INSTRUMENTS

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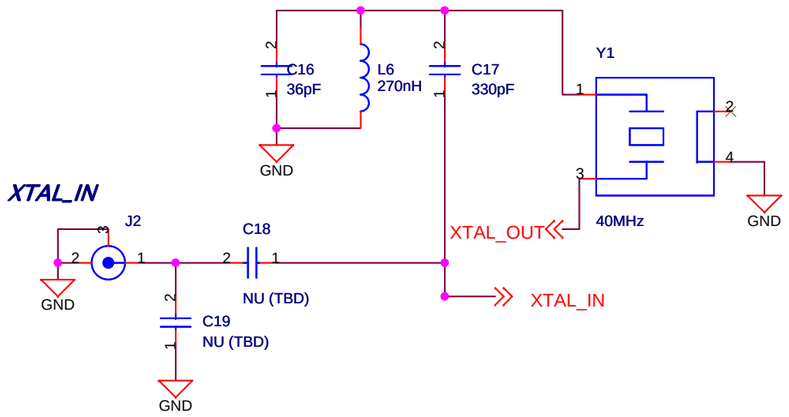
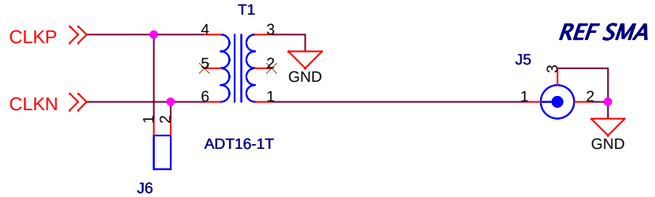
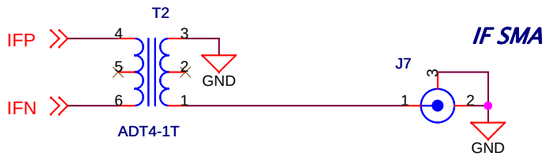
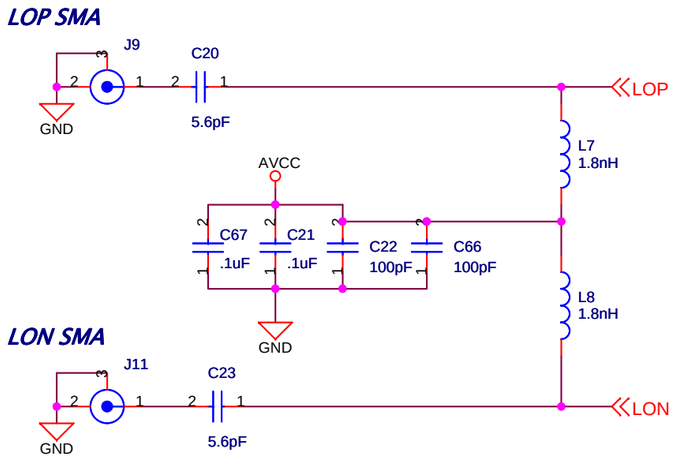
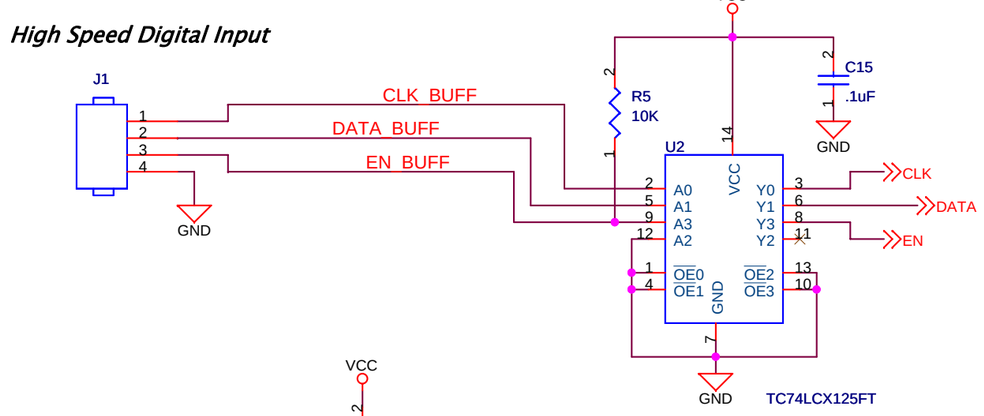
	Date: Thursday, August 10, 2006	Sheet 1 of 5

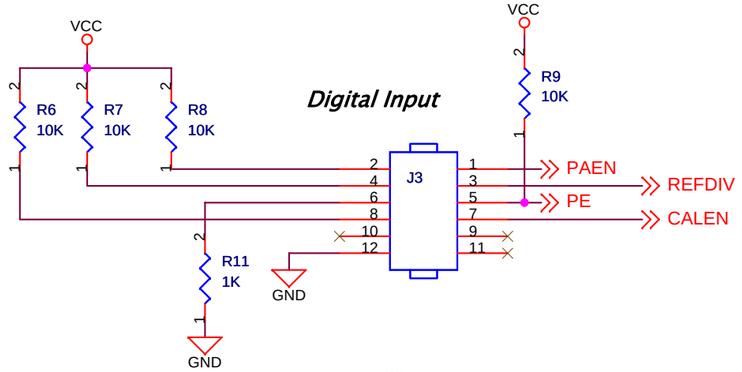


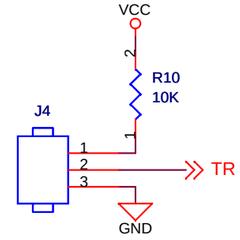


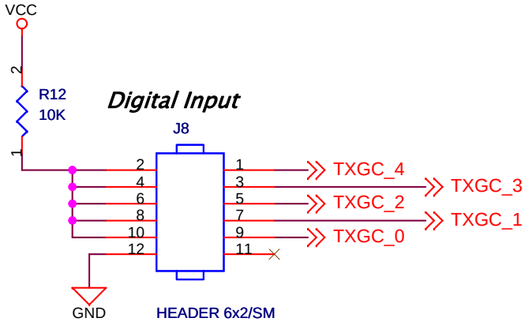


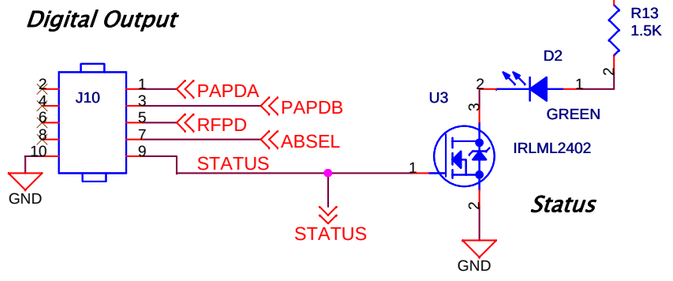












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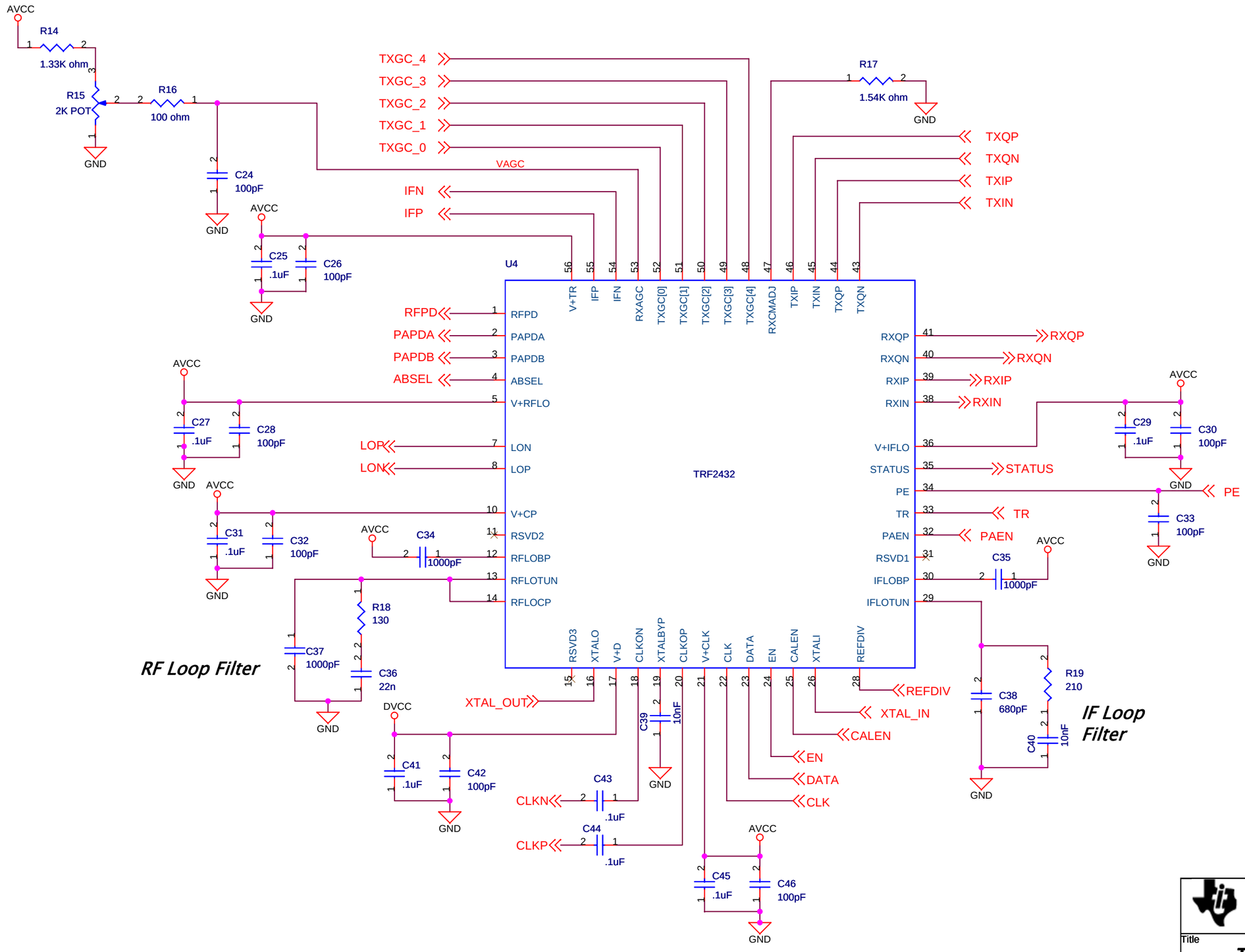

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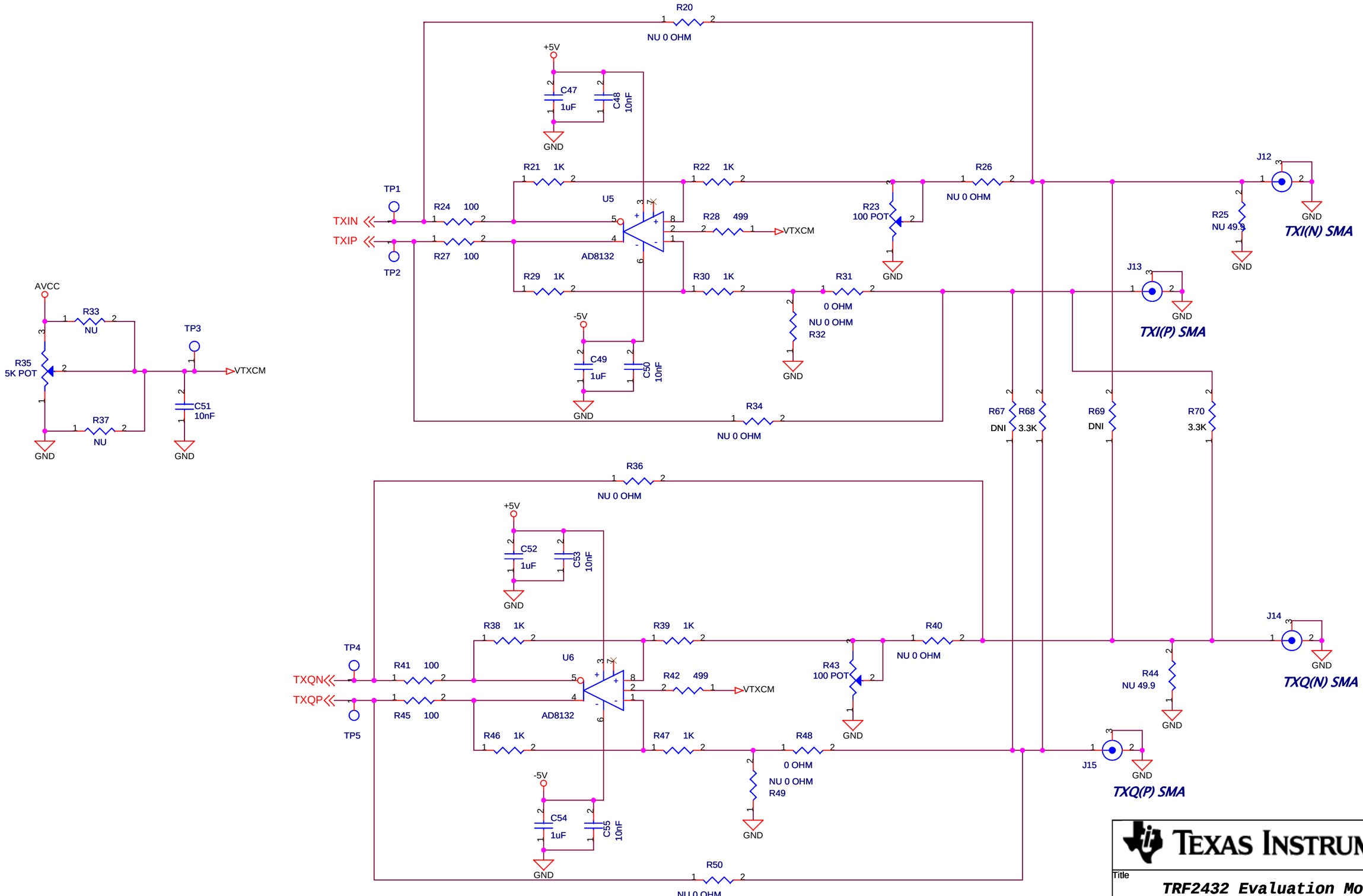

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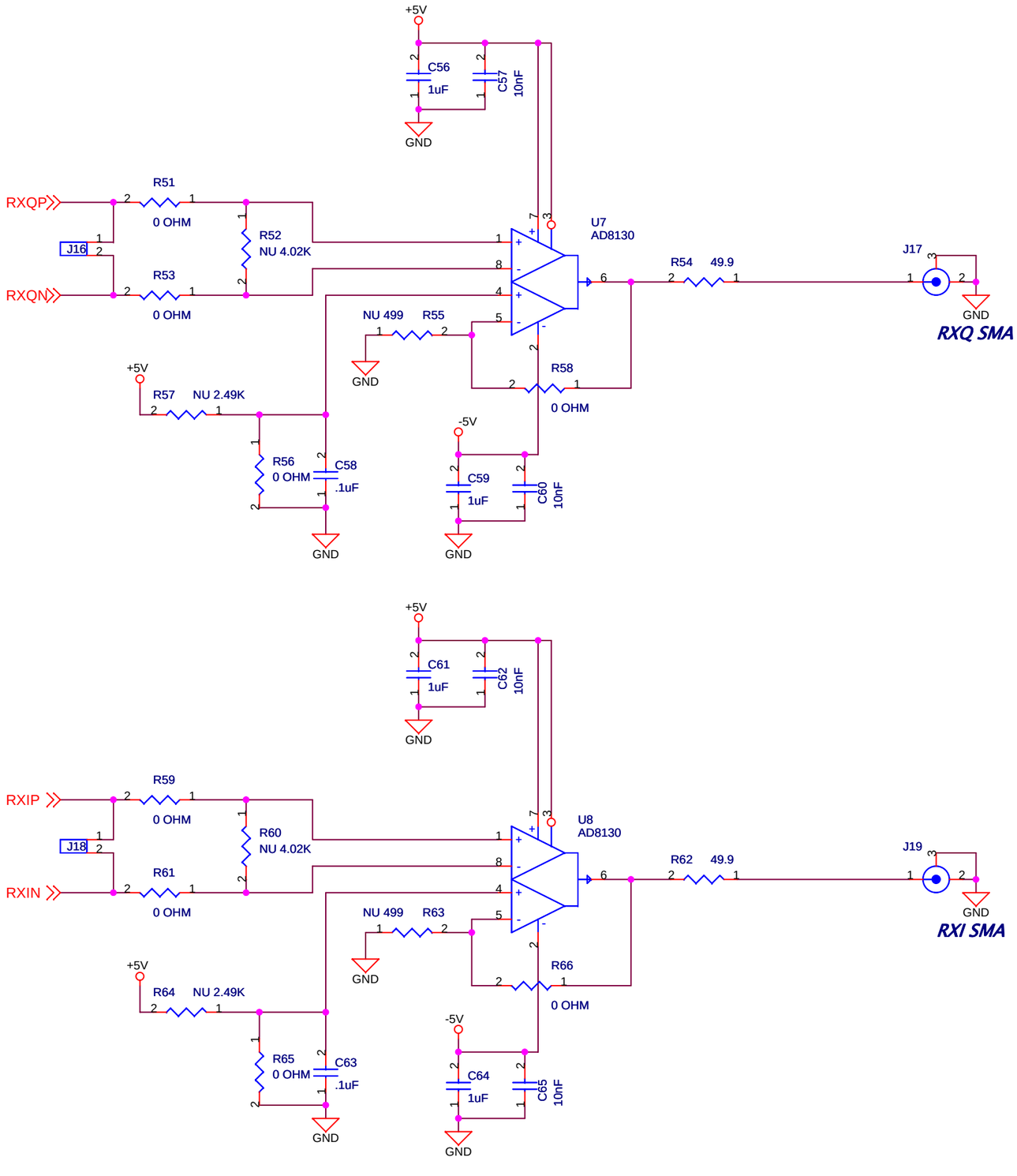

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EVALUATION BOARD/KIT IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of -5 V to +5 V and the output voltage range of -5 V to +5 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 60°C. The EVM is designed to operate properly with certain components above 60°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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