TRF1x21EVM

Contents

1 Introduction 1
2 EVM Test Configuration 2
3 Software Control 3
4 Basic Test Procedure 4
5 Optional Configurations 6
6 Physical Description 7

List of Figures

1 System Block Diagram 2
2 Test Setup Block Diagram 2
3 WiMAX GUI Front Panel 4
4 TRFx21 GUI Front Panel 4
5 TRF1x21EVM Performance 6
6 Top Layer 1 8
7 Ground Plane Layer 2 9
8 Power Plane Layer 3 10
9 Bottom Layer 4 11

List of Tables

1 TRF1x21EVM Parts List 11

1 Introduction

1.1 Overview

This is the user's guide for the TRF1x21 evaluation module (EVM). The TRF1x21 is a transmit up-converter with integrated digital attenuators, amplifiers, and synthesizers for use in a WiMAX system.

1.2 EVM Configuration Options

The EVM can be configured as a TRF1121 or TRF1221. The configuration of the board is marked by a component placed in either the R1121 or R1221 location. The TRF1121 operates in the 2.3-GHz to 2.7-GHz band and the TRF1221 operates in the 3.3-GHz to 3.8-GHz band.

1.3 System Block Diagram

The basic radio system block diagram in Figure 1 demonstrates where the TRF1x21 fits in the overall transceiver. The dashed box highlights the TRF1x21 device.

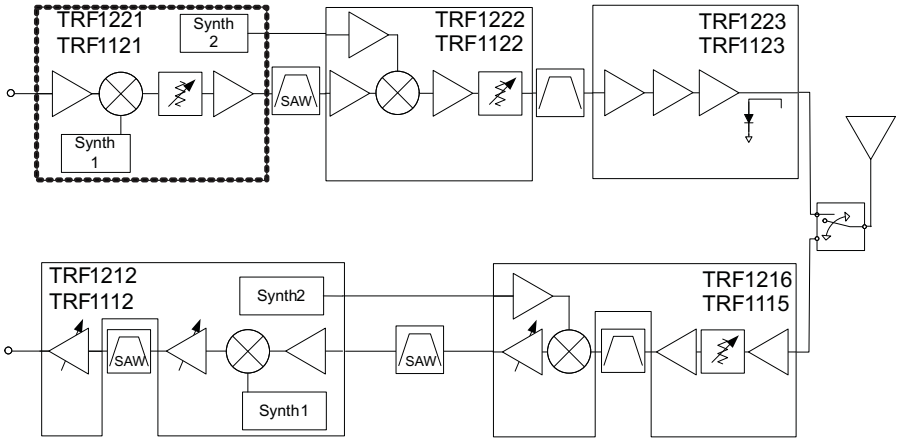


Figure 1. System Block Diagram

2 EVM Test Configuration

2.1 Test Block Diagram

The test setup for general testing of the TRF1x21 is shown in Figure 2.

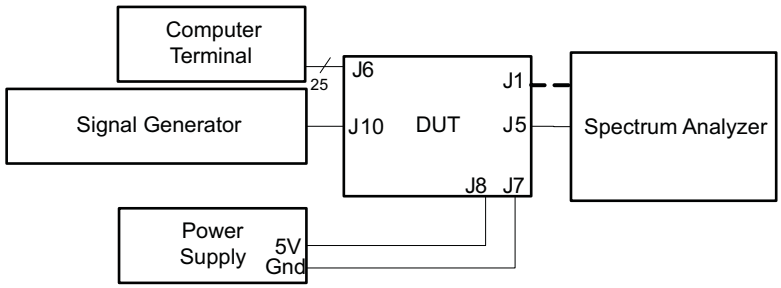


Figure 2. Test Setup Block Diagram

2.2 Test Equipment

The following equipment is required for completing RF Testing:

- Power supply with current readout — Agilent E3631 or Equivalent
- Signal generator for input signal — Agilent E4438C or Equivalent
- Spectrum analyzer — Agilent E4440A or Equivalent
- Computer with parallel port

2.3 Calibration

The input/output RF cables should be good-quality RF cables due to the high-frequency signals.

- Measure the insertion loss of the RF output cable, and use this value to compensate for the output power read from the spectrum analyzer when measuring the RF synthesizer output. The insertion loss value can be stored in the analyzer's Reference Level Offset parameter.
- Verify that the input signal at the end of the cable connected to the board is at the desired set-point value. If not, adjust for the insertion loss by incrementing the amplitude on the signal generator

3 Software Control

3.1 Installation Instructions

- Open folder named WiMAX_GUI_Installer_Verx.x.fdr.
- Run Setup.exe.
- Follow the on-screen instructions.

3.2 Software Launch Instructions

- Start the program by clicking on the TI_WIMAX_GUI program.
- The main screen appears as in Figure 3.
- Select the TFX1x21 radial button.
- The TRF1x21 GUI is launched as seen in Figure 4.

3.3 Software Operation

- Select TX BB Freq for desired input frequency.
- Select appropriate TX IF VCO Freq to set the desired TRX IF Freq. output
- Select the desired TX RF VCO Freq.
- Toggle the *Select Device* switch to match the frequency band of the EVM.
- Select the desired digital attenuator value on the TX Digital Attn slider bar.
- RF LO Freq Sweep: provides an option to automatically sweep the RF LO between prescribed points and with prescribed resolution
- Attn Ctrl: Toggle switch to manually control the digital bits of the attenuator
- Write Registers: loads the parameters from the screen to the device
- Reference Freq: the EVM has an onboard 18-MHz TCXO; hence, there is no need to change this value. If an alternate reference is used, then this parameter can be changed.

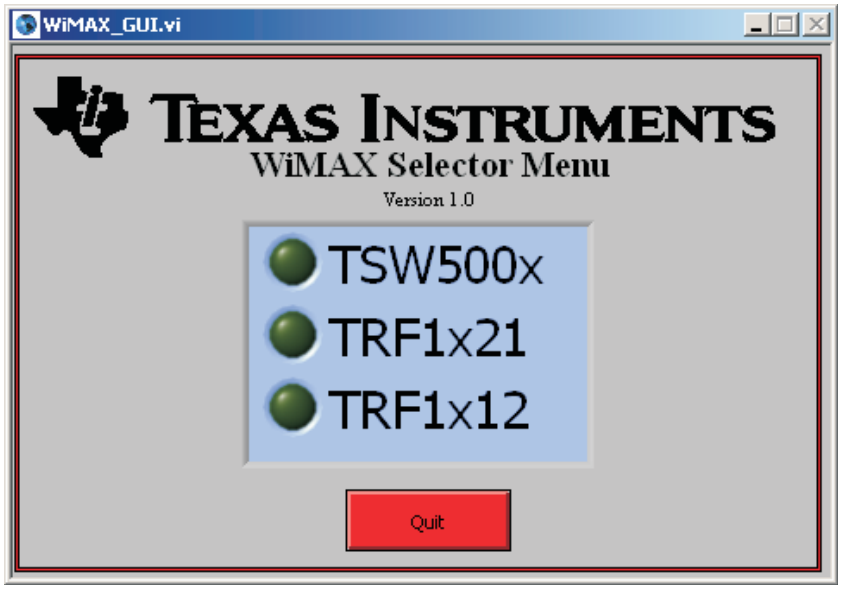


Figure 3. WiMAX GUI Front Panel

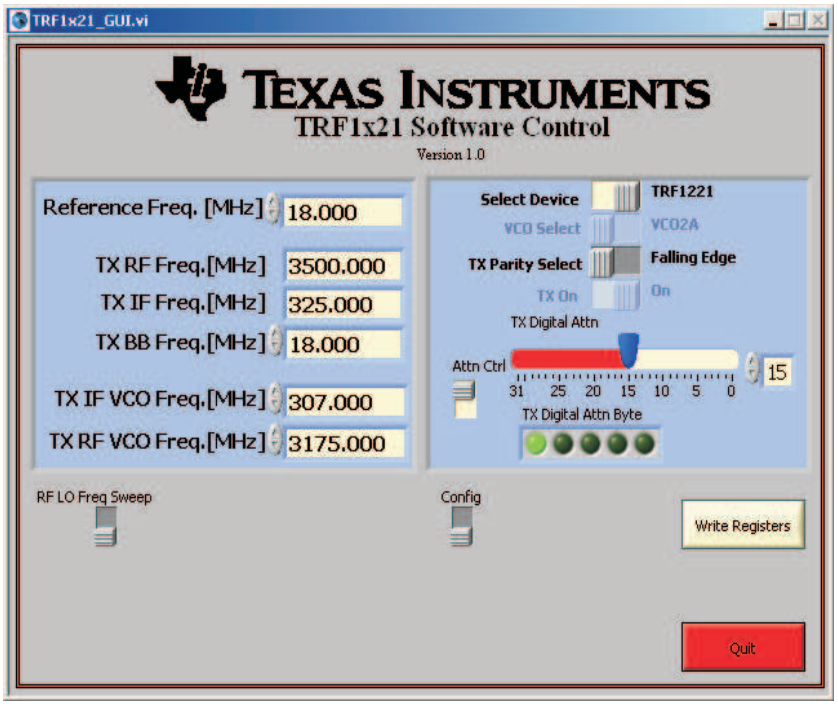


Figure 4. TRFx21 GUI Front Panel

4 Basic Test Procedure

This section outlines the basic test procedure for testing the EVM. This section is divided into three test sections: DC and Programmability, Basic CW RF, and Modulated WiMAX signals. The first section requires only power supply with current readout and computer for programmability. The second section requires basic RF test equipment and basic technical know-how. The third section is for reference and requires specialized equipment; only sections one and two are required to ensure basic functionality.

4.1 Initial Inspection

- Determine which device is placed on the board by inspecting which jumper resistor is installed at the R1121and R1221 location.

4.2 DC/Programmability Test

- Connect +5V to J8; connect ground to J7.
- Engage power supplies.
- Verify current is 200 ±25 mA.
- Launch TI_WiMAX_GUI software.
- Select the TRF1x21 radio button.
- Verify TX BB Freq. is 18 MHz; verify TX IF VCO Freq. is 307 MHz; verify TX RF VCO Freq. is 3175 MHz (TRF1212) or 2075 (TRF1112)
- Press the *Write Registers* button.
- Verify LEDs D1 and D2 illuminate.

4.3 Basic RF Test

- Inject a 18-MHz CW signal in at J10 at –20 dBm.
- Set TX Digital Attn to 15.
- Connect the spectrum analyzer at J5.
- Set the spectrum analyzer center frequency to 325 MHz; set span to 10 MHz; set reference level to 10 dBm.
- Measure signal at 325 MHz, and verify signal at –20 dBm ±2 dB
- Change TX Digital Attn to 0
- Measure signal at 325 MHz and verify signal at –4 dBm ±2 dB
- Move RF output cable to J1.
- Change spectrum analyzer center frequency to 3175 MHz (TRF1221) or 2075 MHz (TRF1121).
- Measure RF synthesizer output signal; verify level is at 2 dBm (TRF1221) or 3 dBm (TRF1121) ±2 dB; ensure that the RF cable loss is compensated for.

4.4 Modulated RF Performance

- Inject a 18-MHz modulated signal in at J10 at -20 dBm.
- Connect the spectrum analyzer at J5, and initiate WiMAX analysis program.
- Set the spectrum analyzer center frequency to 325 MHz.
- Set TX Digital Attn to 0.
- Verify that output signal power is at –5 dBm ±2 dB; ensure that the output cable loss is accounted for.
- Verify that EVM performance is less than –40 dB.

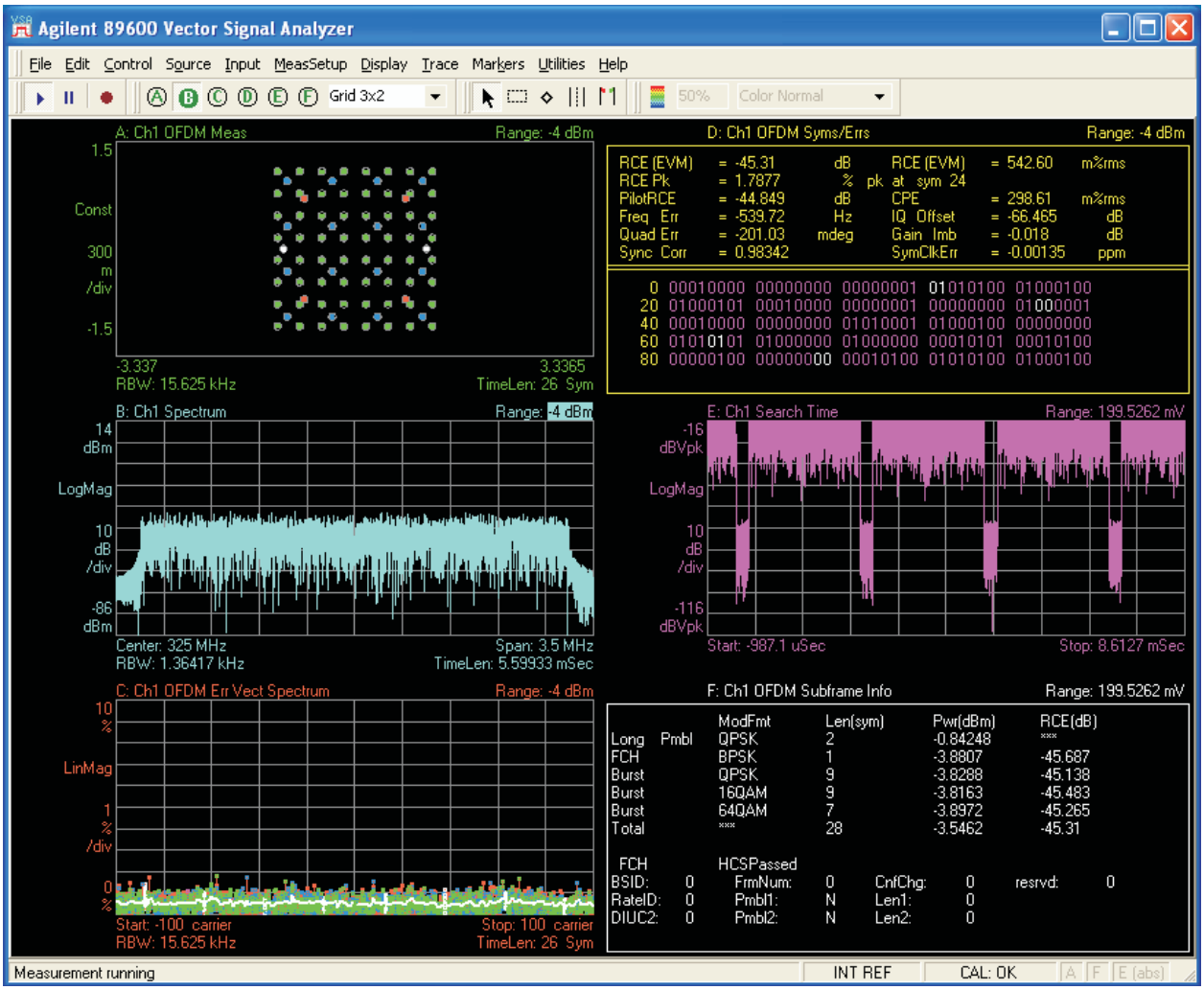


Figure 5. TRF1x21EVM Performance

5 Optional Configurations

5.1 External Reference Oscillator

The EVM is configured with a TCXO to provide the 18-MHz reference frequency. If desired, an external reference can be injected at J3. To employ this option, the following modifications are required.

- Move C4 to R4 location.
- Inject reference frequency at J3.

5.2 Differential Inputs

The normal configuration uses transformers and baluns to convert the differential signals to single-ended in order to facilitate laboratory testing. If desired, any of the inputs can be converted to differential operation which may be desirable when cascading one or more of the chipset's EVMs together.

5.2.1 IF Output

- Remove T2.
- Place R24: 0 Ω resistor (1210).
- Place R18: 0 Ω resistor.
- Differential outputs at J5 and J4

5.2.2 LO Output

- Remove T1.
- Jumper across pads of T1 (input to output on each side) using a 0-Ω 0201 resistor.
- Place 3.6-pF (TRF1221) or 4.7-pF (TRF1121) capacitor at R3.
- Differential inputs at J1 and J2

5.2.3 BB Input

- Remove T3.
- Move R38 to R39 location.
- Insert R36 and R37 (0-Ω 1206 resistors).

5.3 Split DC Supply

The EVM uses one supply to power the device and the reference oscillator circuitry. If desired, these supplies can be separated so that the true current draw of the device can be measured. To employ this option, the following modifications must be done.

- Remove FB10.
- Clip 5-V lead to TP1 (5VAUX).

6 Physical Description

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

6.1 PCB Layout

The EVM is constructed on a 4-layer, 3.25-inch × 3.25-inch, 0.062-inch thick PCB using FR4-170 material. Figure 6 through Figure 9 show the PCB layout for the EVM.

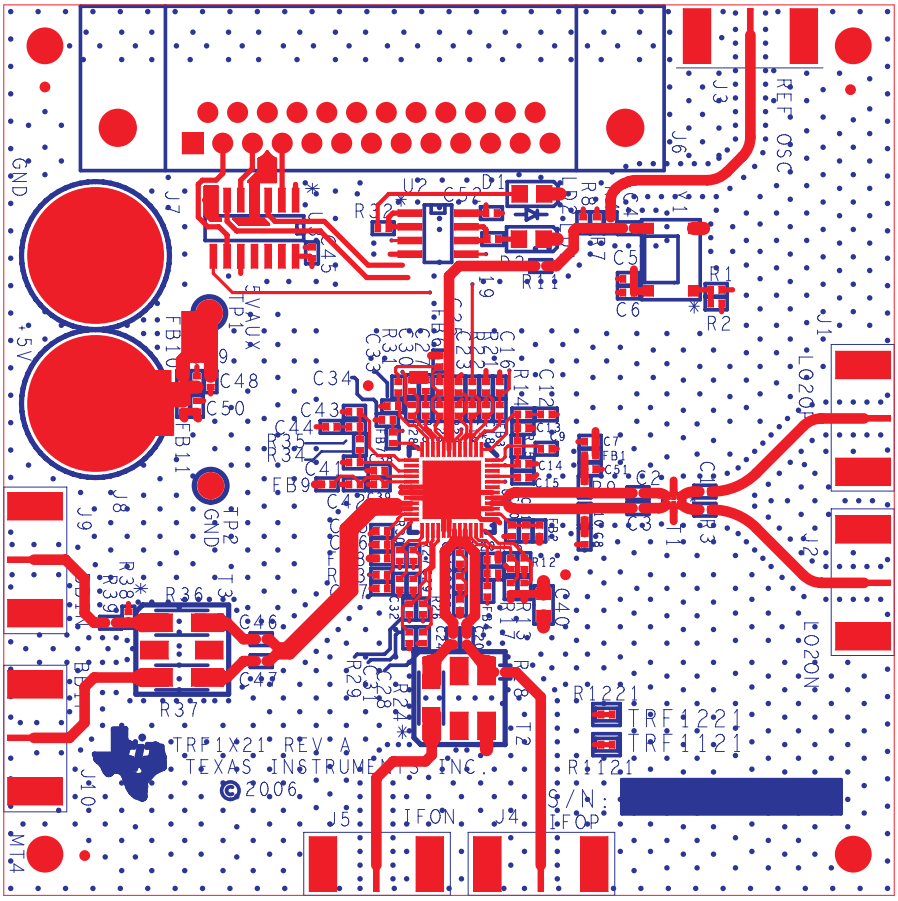


Figure 6. Top Layer 1

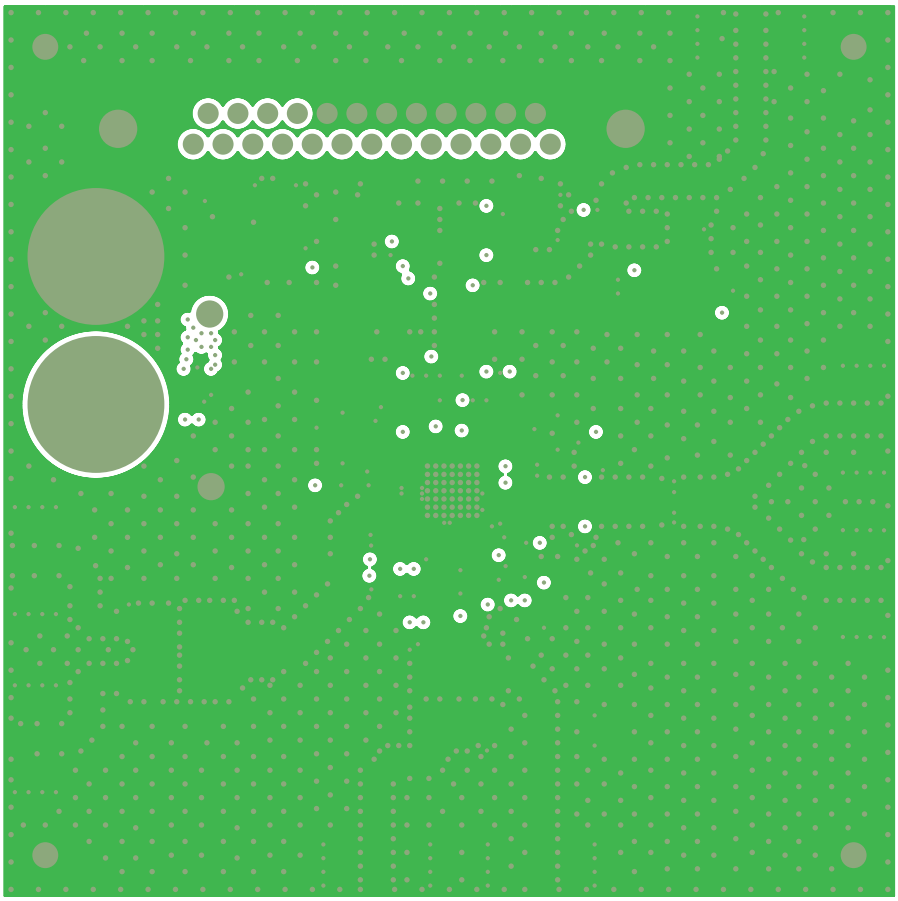


Figure 7. Ground Plane Layer 2

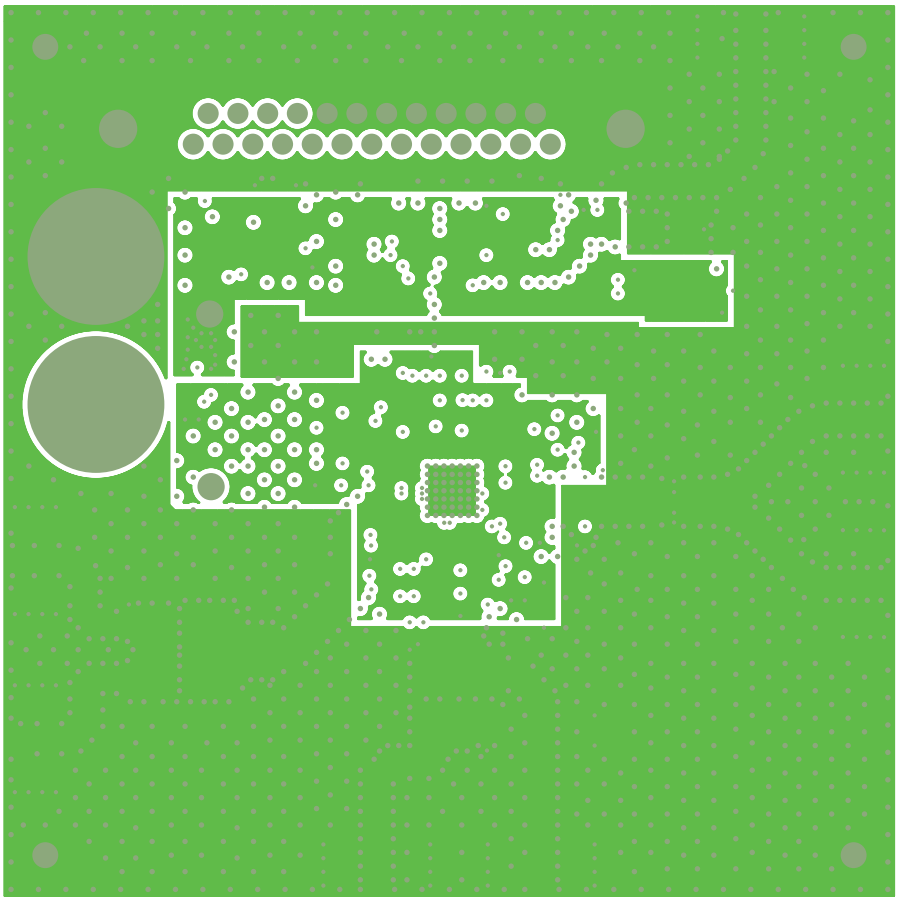


Figure 8. Power Plane Layer 3

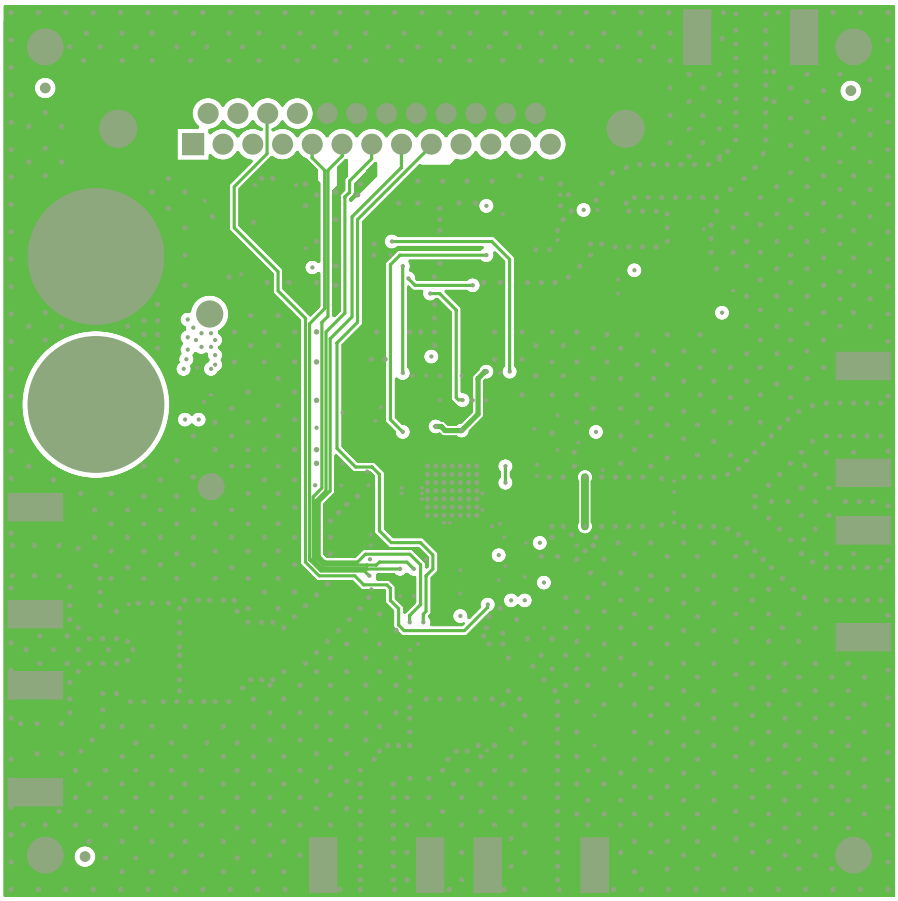


Figure 9. Bottom Layer 4

6.2 Parts List

Table 1 lists the parts used in constructing the EVM.

Table 1. TRF1x21EVM Parts List

Qty	Reference	Value	MFR Name	MFR Part Number	Note
11	C1 C8 C10 C16 C17 C21 C26 C34 C35 C39 C51	4.7pF	Murata	GRM1555C1H4R7CZ01D	TRF1121 EVM
11		3.6pF		GRM1555C1H3R6CZ01D	TRF1221 EVM
2	C2 C3	4.7pF	Murata	GRM1555C1H4R7CZ01D	
3	C4 C45 C52	0.1µF	AVX	0402YD104KAT2A	
1	C5	0.01µF	AVX	0402YC103KAT2A	
4	C6 C48 C49 C50	1µF	Panasonic	ECJ-0EB1A105M	
7	C7 C11 C22 C25 C36 C41 C42	470pF	Murata	GRM1555C1H471JA01D	
3	C9 C15 C38	100nF	Murata	GRM155R61A104KA01D	
1	C12	0.039µF	AVX	0402YD393KAT2A	
1	C13	3900pF	Murata	GRM155R71H392KA01D	
1	C14	390pF	Murata	GRM1555C1H391JA01D	
3	C18 C27 C33	10nF	Murata	GRM155R71C103KA01D	
8	C19 C23 C28–C32 C37	DNI	Murata	DNI	DNI

Table 1. TRF1x21EVM Parts List (continued)

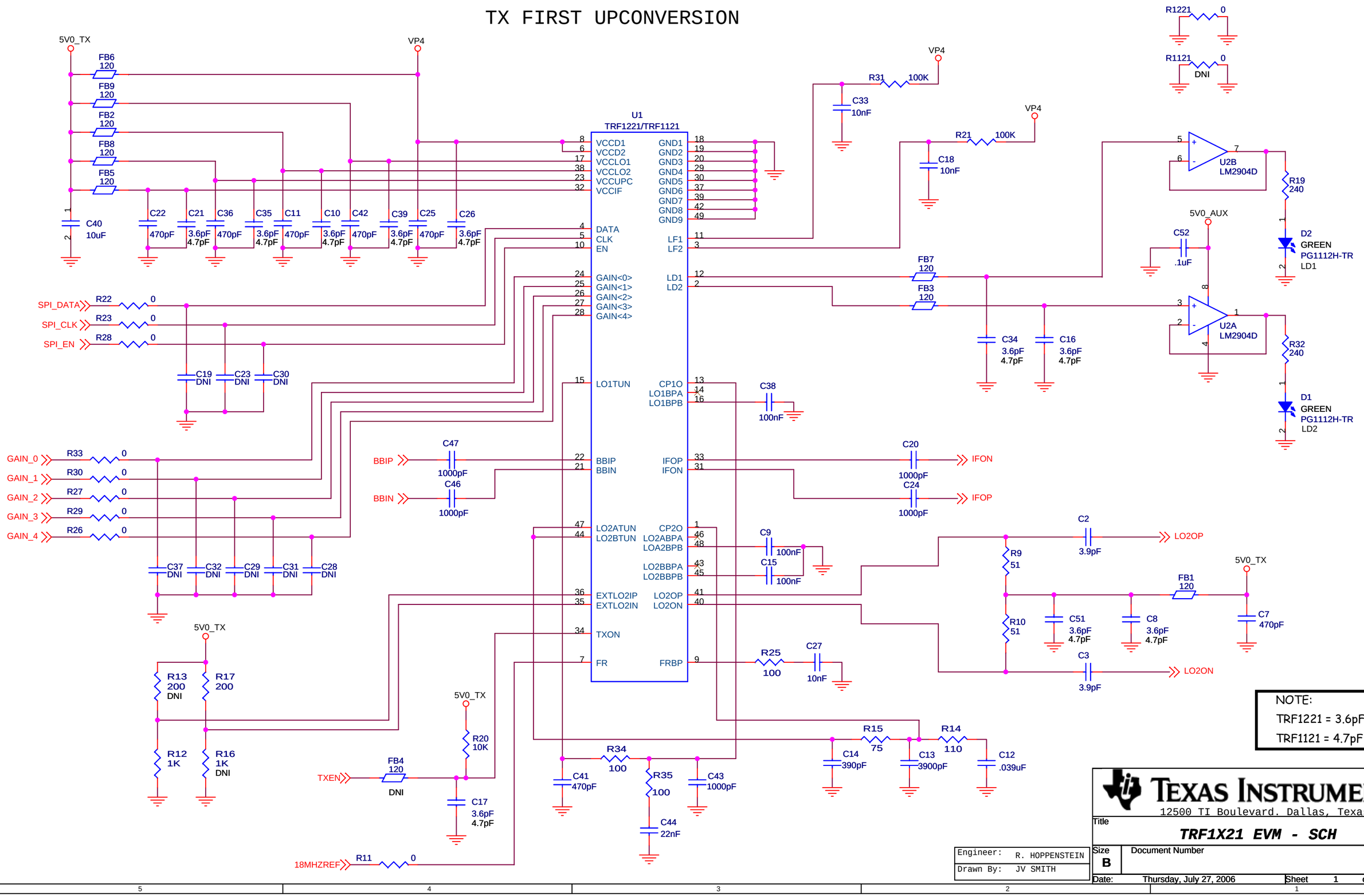
Qty	Reference	Value	MFR Name	MFR Part Number	Note
5	C20 C24 C43 C46 C47	1000pF	Murata	GRM155R71H102KA01D	
1	C40	10µF	Murata	GRM21BF50J106ZE01L	
1	C44	22nF	Murata	GRM155R71E223KA61D	
2	D1 D2		Stanley	PG1112H-TR	
10	FB1– FB3, FB5–FB11	120	Murata	BLM15AG121SNIB	
1	FB4	120	Murata	BLM15AG121SNIB	DNI
7	J1–J5, J9 J10	SMA	Johnson Components	142-0701-851	
1	J6	DB25	AMP	5745536-2	
1	J7	BLK	ALLIED ELECTRONICS	ST-351B	
1	J8	RED	ALLIED ELECTRONICS	ST-351A	
4	MT1–MT4	STANDOFF	KEYSTONE	1902CK	STANDOFF
12	R1 R11 R22 R23 R26–R30 R33 R38 R1121	0	Panasonic	ERJ-2GE0R00X	
1	R2	10K	Panasonic	ERJ-2GEJ103X	DNI
4	R3 R4 R18 R39	0	Panasonic	ERJ-2GE0R00X	DNI
1	R1121	0	Panasonic	ERJ-2GE0R00X	TRF1121 EVM
1	R1221	0	Panasonic	ERJ-2GE0R00X	TRF1221 EVM
2	R9 R10	51	Panasonic	ERJ-2GEJ510X	
1	R12	1K	Panasonic	ERJ-2RKF1001X	
1	R13	200	Panasonic	ERJ-2RKF2000X	DNI
1	R14	110	Panasonic	ERJ-2RKF1100X	
1	R15	75	Panasonic	ERJ-2RKF75R0X	
1	R16	1K	Panasonic	ERJ-2RKF1001X	DNI
1	R17	200	Panasonic	ERJ-2RKF2000X	
2	R19 R32	240	Panasonic	ERJ-2GEJ241X	
3	R7 R8 R20	10K	Panasonic	ERJ-2GEJ103X	
2	R21 R31	100K	Panasonic	ERJ-2GEJ104X	
3	R24 R36 R37	0	Panasonic	ERJ-8GEY0R00V	DNI
3	R25 R34 R35	100	Panasonic	ERJ-2RKF1000X	
1	T1	2326MHz	Anaren	BD2326J50100A00	TRF1121 EVM
1		3150MHz		BD3150J50100A00	TRF1221 EVM
1	T2		Minicircuits	ADT2-1T	
1	T3		Minicircuits	ADT9-1T	
1	TP1	Red	Keystone	5000	
1	TP2	Blk	Keystone	5001	
1	U1		TI	TRF1121	TRF1121 EVM
	U1		TI	TRF1221	TRF1221 EVM
1	U2		TI	LM2904D	
1	U3		TI	SN74HCT125D	
1	Y1	18MHz	Vectron	VTC1-A0CE-18M000	

NOTE: DNI = DO NOT INSTALL

6.3 Schematic Drawing

The schematic drawing appears on the following page.

TX FIRST UPCONVERSION



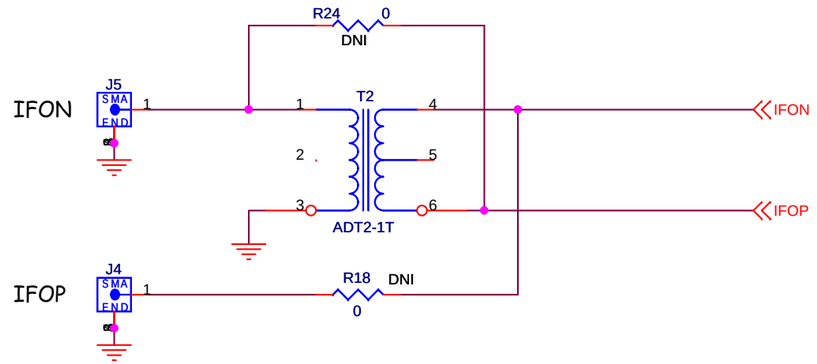
NOTE:
TRF1221 = 3.6pF
TRF1121 = 4.7pF

TEXAS INSTRUMENTS
12500 TI Boulevard. Dallas, Texas 75243

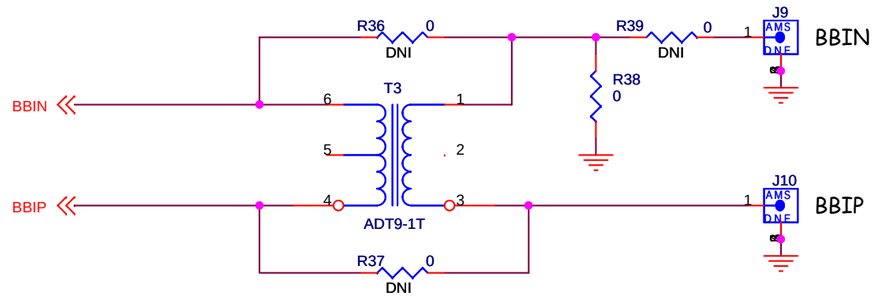
Title	TRF1X21 EVM - SCH		
Size B	Document Number		Rev A
Date: Thursday, July 27, 2006		Sheet 1 of 3	

Engineer:	R. HOPPENSTEIN
Drawn By:	JV SMITH

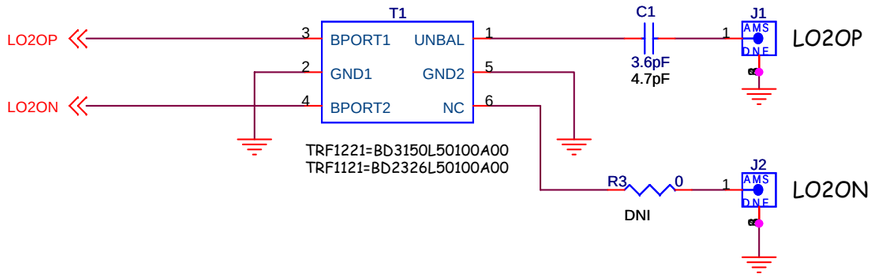
IF OUTPUT



BASEBAND IF INPUT



LO OUTPUT



TEXAS INSTRUMENTS
12500 TI Boulevard, Dallas, Texas 75243

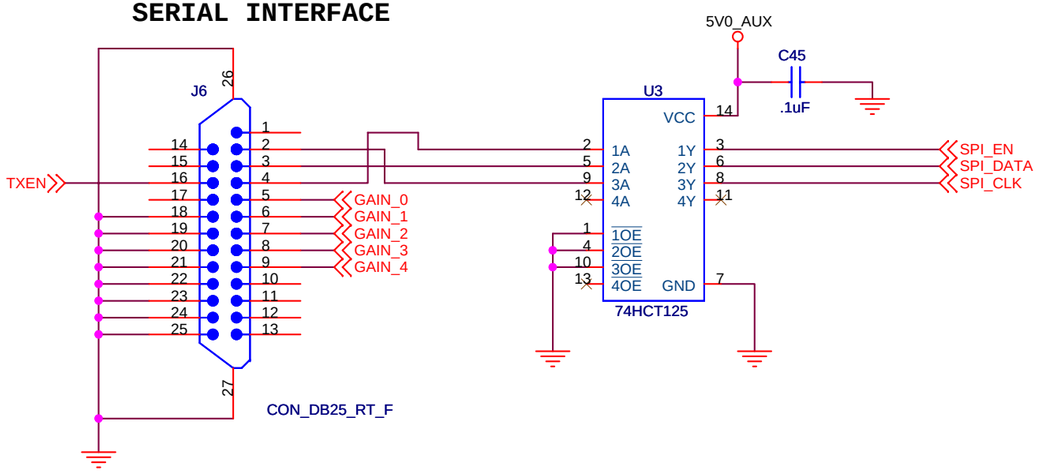
Title

TRF1X21 EVM - SCH

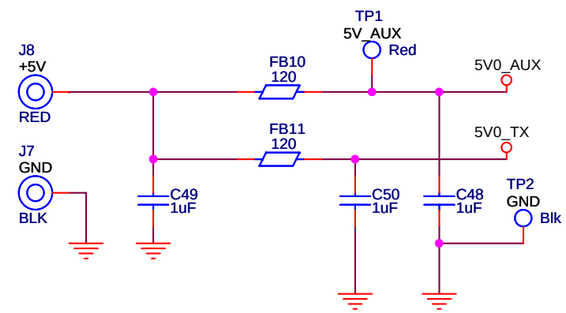
Size	Document Number	Rev
B		A

Date: Thursday, July 27, 2006 Sheet 2 of 3

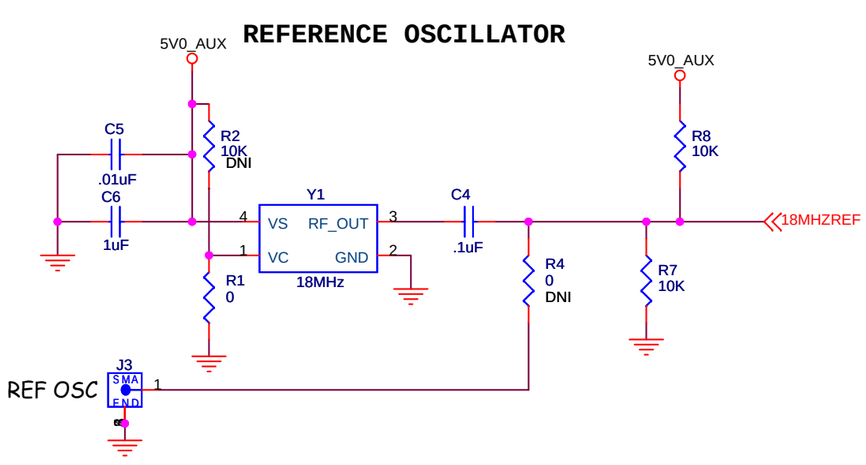
SERIAL INTERFACE

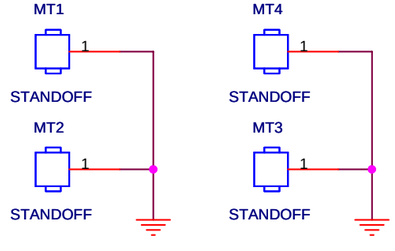


DC POWER PORT



REFERENCE OSCILLATOR





TEXAS INSTRUMENTS
12500 TI Boulevard. Dallas, Texas 75243

Title: ***TRF1X21 EVM - SCH***		
Size: **B**	Document Number:	Rev: **A**
Date: Friday, June 23, 2006	Sheet 3 of 3	

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.

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive.**

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

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. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 0 V to 5 V and the output voltage range of 0 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 85°C. The EVM is designed to operate properly with certain components above 85°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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Telephony	www.ti.com/telephony
Low Power Wireless	www.ti.com/lpw	Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265