TRF1x12 EVM

Contents

List of Figures

List of Tables

1 Introduction

1.1 Overview

This is the user's guide for the TRF1x12 EVM. The TRF1x12 is a receive down-converter with integrated AGC amplifiers and synthesizers for use in a WiMAX system.

1.2 EVM Configuration Options

The EVM can be configured as a TRF1112 or TRF1212. The configuration of the board is marked by a component placed in either the R1112 or R1212 location. The TRF1112 operates in the 2.3 GHz to 2.7 GHz band and the TRF1212 operates in the 3.3 to 3.8 GHz band.

1.3 System Block Diagram

The basic radio system block diagram in Figure 1 demonstrates where the TRF1x12 fits in the overall transceiver. The red box highlights the TRF1x12 device.

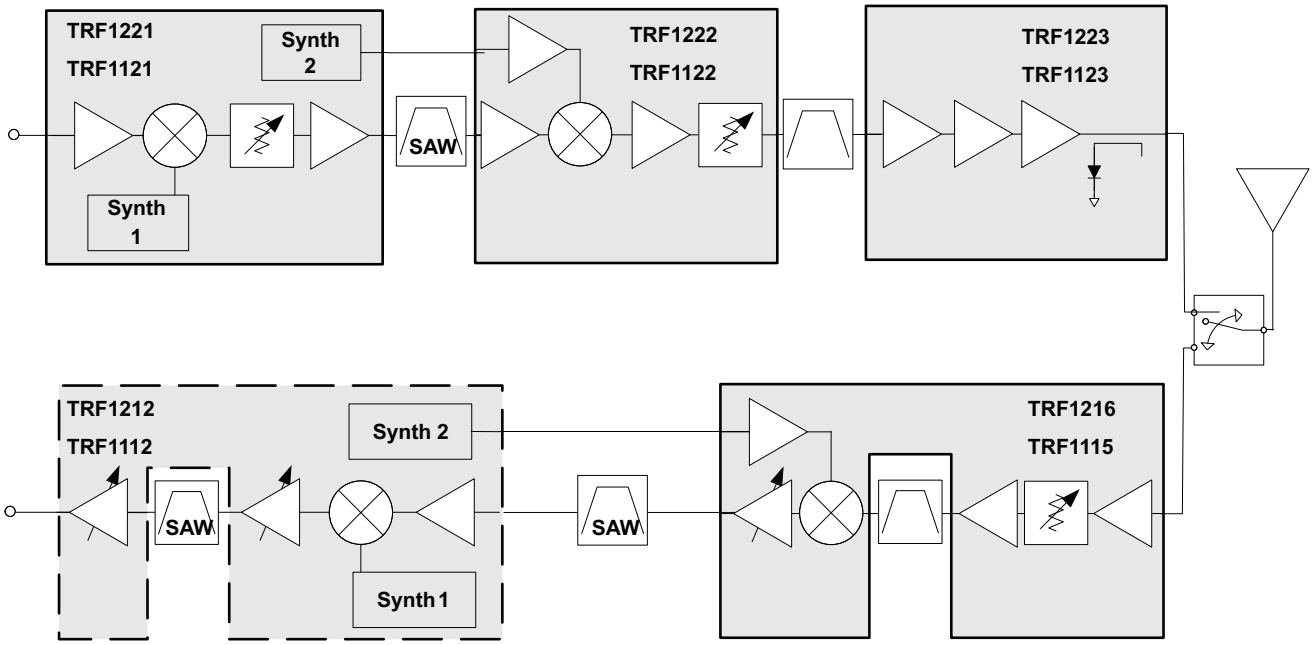


Figure 1. System Block Diagram

2 EVM Test Configuration

2.1 Test Block Diagram

The test set-up for general testing of the TRF1x12 is shown in Figure 2.

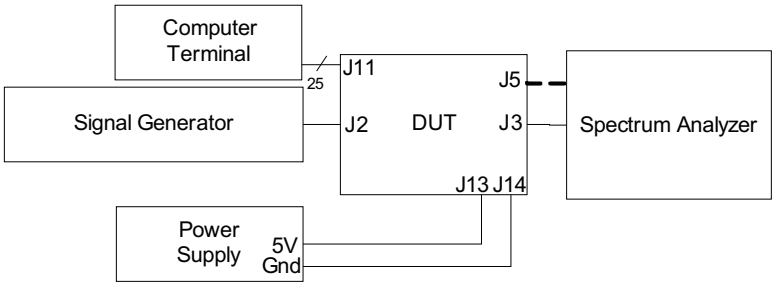


Figure 2. Test Set-Up Block Diagram

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 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 TFX1x12 radial button
- The TRF1x12 GUI is launched as seen in Figure 4

3.3 Software Operation

- Select appropriate RX BB Freq. for desired IF2 output frequency. On board SAW filters are centered at 44 MHz
- Select appropriate RX IF VCO Freq. to set the desired RX IF Freq. input
- Select the desired RX RF VCO Freq.
- Filter Select: toggles between the two on-board filters: one with 7 MHz BW and the other with 3.5 MHz BW
- Write Registers: loads the parameters from the screen to the device
- Reference Freq: the EVM has an on-board 18 MHz TCXO hence there is no need to change this value. If an alternate reference is used then this parameter can be changed

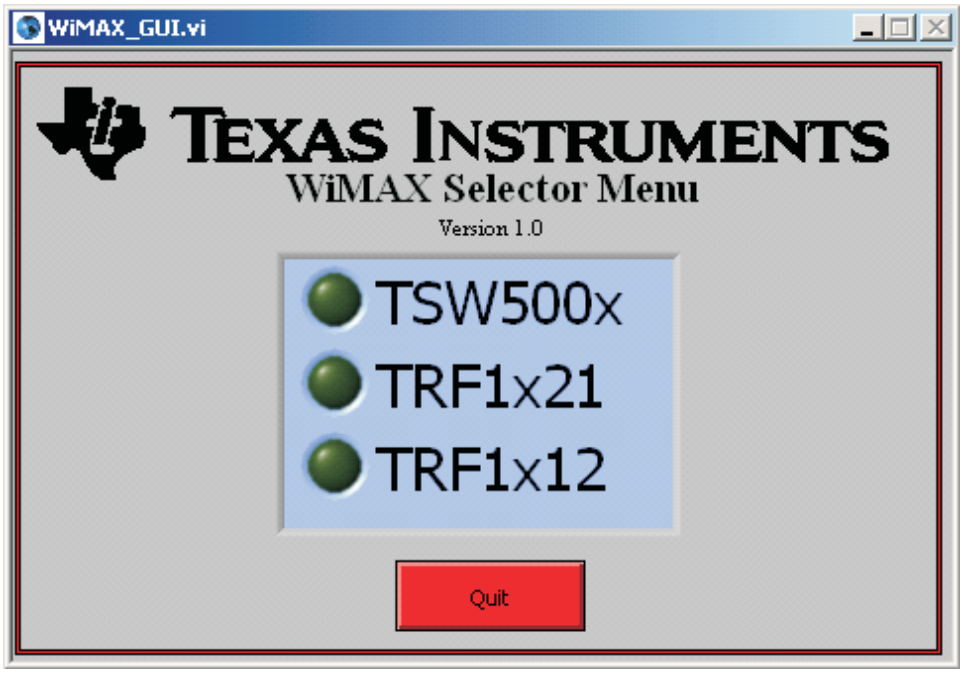


Figure 3. WiMAX GUI Front Panel

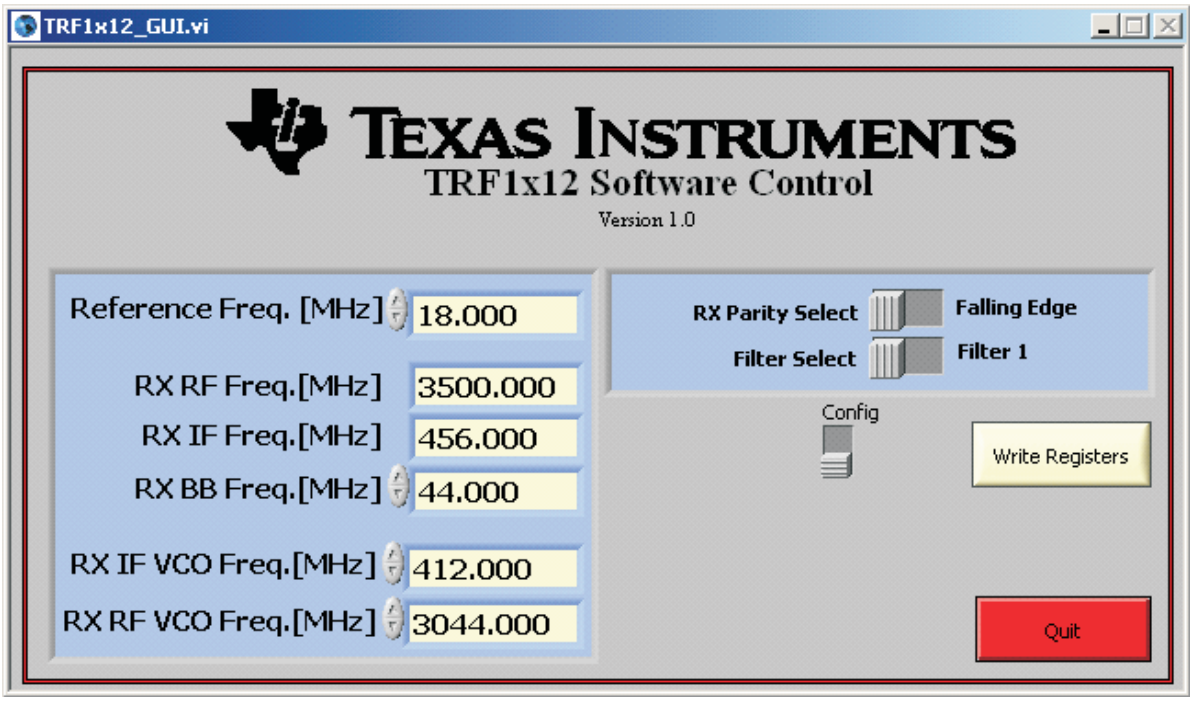


Figure 4. TRF1x12 GUI Front Panel

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 R1112 and R1212 location.

4.2 DC/Programmability Test

- Connect +5V to J13; connect ground to J14.
- Engage power supplies
- Verify current is 225 ±25 mA
- Launch TI_WiMAX_GUI software
- Select the TRF1x12 radio button
- Verify RX BB Freq. is 44 MHz; verify RX IF VCO Freq. is 412 MHz; verify RX RF VCO Freq. is 3044 MHz (TRF1212) or 1944 (TRF1112)
- Press the *Write Registers* button
- Verify LEDs D1 and D2 illuminate

4.3 Basic RF Test

- Inject 456 MHz CW signal in at J3 at –55 dBm
- Connect Spectrum Analyzer at J2
- Set Spectrum analyzer center frequency to: 44 MHz; set span to 10 MHz; set reference level to 10 dBm
- Measure signal at 44 MHz and verify signal at –20 dBm ±3 dB
- Change Signal Generator amplitude to –75 dBm
- Measure signal at 44 MHz and verify signal maintains –20 dBm ±3 dB
- Toggle Filter Select Switch; verify that the signal maintains –20 dBm ±3 dB; verify change in the noise floor shape
- Revert switch back to original position
- Move RF output cable to J5
- Change Spectrum Analyzer center frequency to 3044 MHz (TRF1212) or 1944 MHz (TRF1112)
- Measure RF synthesizer output signal; verify level is at –1.5 dBm (TRF1212) or –2.0 dBm (TRF1112) ±2 dB; ensure the RF cable loss is compensated for.

4.4 Modulated RF Performance

- Inject 456 MHz modulated signal in at J3 at –55 dBm
- Connect Spectrum Analyzer at J2 and initiate WiMAX analysis program
- Set Spectrum Analyzer center frequency to: 44 MHz
- Move Jumper at J12 to EXT
- Adjust pot at R64 until output power is –10 dBm ±0.5 dB
- Adjust reference level offset to appropriate range for output signal
- Verify EVM performance is < –40 dB
- Revert jumper at J12 back to INT

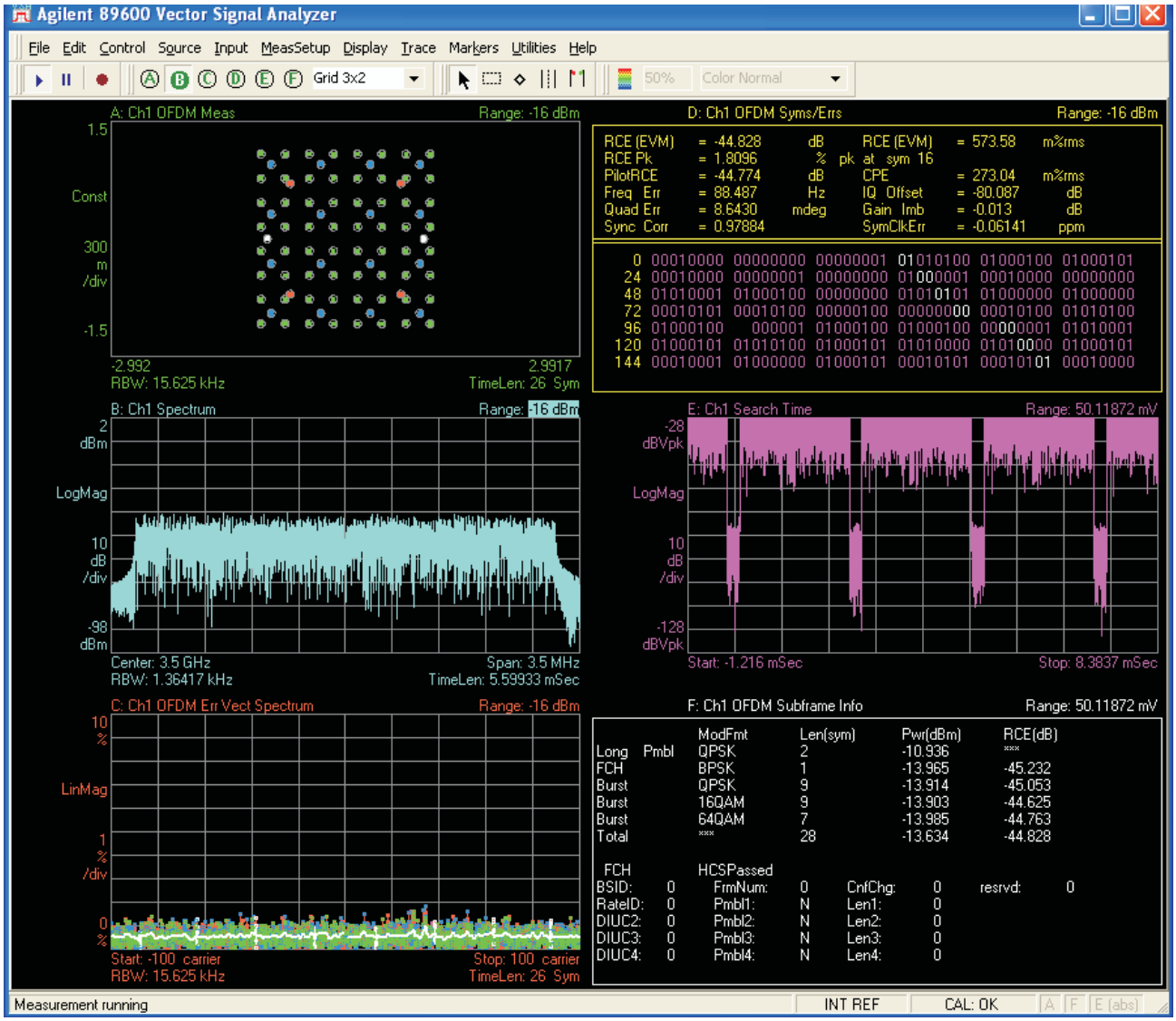


Figure 5. TRF1x12 EVM Performance

5 Optional Configurations

5.1 AGC Operation

The EVM can be configured for internal AGC control or external AGC control. The internal control is set by placing jumper J12 to INT. As configured, the set point output is about –19 dBm. This can be modified by adjusting the voltage divider resistors at R58 and R59.

For external AGC control the jumper at J12 is placed at EXT. This will allow the adjustment of the AGC voltage using the pot at R64. In this mode, the AGC voltage will need to be modified for every change in input power to keep the output power consistent.

5.2 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 J15. To employ this option the following modifications are required.

- Move C49 to R13 location
- Inject reference frequency at J15

5.3 Differential Inputs

The normal configuration uses transformers and baluns to convert the differential signals to single ended in order to facilitate lab 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.

5.3.1 IF Input

- Remove T2
- Place R7: 0 Ω resistor (1210)
- Place R8: 0 Ω resistor
- Differential outputs at J3 and J4

5.3.2 LO Output

- Remove T3
- Jumper across pads of T3 (input to output on each side) using a 0 Ω 0201 resistor
- Place 3.6 pF (TRF1212) or 4.7 pF (TRF1112) at R9
- Differential inputs at J5 and J6

5.3.3 IF2 Output

- Remove T1
- Move R30 to R11 location
- Place R5 and R6 0 Ω 1206 resistors

5.4 External IF2 SAW

The EVM has an option to use an external single ended or differential SAW instead of using the one on the board.

5.4.1 Differential SAW

- Remove L3, L4, C28, C29, R21, R22
- Place R18, R19, R23, R24 with 0 Ω resistor
- External IF SAW inputs connected at J9 and J10; external IF SAW outputs connected to J7 and J8

5.4.2 Single Ended SAW

- Remove L3, L4, C28, C29, R21, R22
- Place R18, R19, R23, R24 with 0 Ω resistor
- Place R20 and R25 with 49.9 Ω resistors
- External IF SAW input connected at J9; external IF SAW output connected to J8

5.5 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 FB9
- Clip 5V lead to TP5 (5V_AUX)

6 Physical Description

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

6.1 Parts List

Table 1 lists the parts used in constructing the EVM.

Table 1. TRF1x12 EVM Parts List

Qty	Reference	Value	Mfr Name	Part Number	Note
3	C1 C6 C24	0.01µF	AVX	0402YC103KAT2A	
9	C2 C9 C11 C12 C14 C23 C26 C53 C55	3.6pF	Murata	GRM1555C1H3R6CZ01D	TRF1212EVM
		4.7pF	Murata	GRM1555C1H4R7CZ01D	TRF1112EVM
8	C3 C5 C10 C32 C33 C37 C39 C54	220pF	Murata	GRM1555C1H221JA01D	
6	C4 C8 C13 C40 C42 C43	10nF	Murata	GRM155R71C103KA01D	
1	C7	820pF	Murata	GRM155R71H821KA01D	
1	C15	680pF	Murata	GRM155R71H681KA01D	
1	C16	15nF	Murata	GRM155R71C153KA01D	
2	C17 C27	4.7pF	Murata	GRM1555C1H4R7CZ01D	
1	C18	270pF	Murata	GRM1555C1H271JA01D	
2	C19 C20	100pF	AVX	0402A101JAT2A	
2	C21 C51	1000pF	AVX	04025C102KAT2A	
4	C22 C30 C34 C38	100nF	Murata	GRM155R61A104KA01D	
4	C25 C46–C48	1µF	Panasonic	ECJ-0EB1A105M	
1	C28	110pF	Murata	GRM1555C1111JA01D	
1	C29	110pF	Murata	GRM1555C1H111JA01D	
1	C31	470pF	Murata	GRM1555C1H471JA01D	
0	C35	100nF	Murata	GRM155R61A104KA01D	DNI
1	C36	22nF	Murata	GRM155R71E223KA61D	
4	C45 C49 C50 C52	0.1µF	AVX	0402YD104KAT2A	
2	D1 D2	PG1112H-TR	Stanley	PG1112H-TR	
10	FB1–FB10	120	Murata	BLM15AG121SNIB	
1	FL1	3.5MHz BW	TAI-SAW TECHNOLOGY	TB0363A	
1	FL2	7MHz BW	TAI-SAW TECHNOLOGY	TB0364A	
11	J1–J10 J15	SMA_END_FLAT	Johnson Components	142-0701-851	
1	J11	CON_DB25_RT_F	AMP	5745536-2	
1	J12	Header_1x3_100	SAMTEC	TSW-103-07-L-S	
1	J13	RED	ALLIED ELECTRONICS	ST-351A	
1	J14	BLK	ALLIED ELECTRONICS	ST-351B	
2	L3 L6	680nH	Coilcraft	0603LS-681XJL	
1	L4	220nH	Coilcraft	0603CS-R22XJL	
1	L5	270nH	Coilcraft	0603CS-R27XJL	

Table 1. TRF1x12 EVM Parts List (continued)

Qty	Reference	Value	Mfr Name	Part Number	Note
4	MT1–MT4	STANDOFF	Keystone	1902CK	STANDOFF
0	R5–R7	0	Panasonic	ERJ-8GEY0R00V	DNI
0	R8 R9 R11 R13 R18 R19 R23 R24	0	Panasonic	ERJ-2GE0R00X	DNI
11	R21 R22 R26–R28 R30 R48–R51	0	Panasonic	ERJ-2GE0R00X	
1	R1112	0	Panasonic	ERJ-2GE0R00X	TRF1112EVM
1	R1212	0	Panasonic	ERJ-2GE0R00X	TRF1212EVM
3	R10 R15 R29	100	Panasonic	ERJ-2RKF1000X	
1	R12	1K	Panasonic	ERJ-2GEJ102X	
3	R14 R16 R17	200	Panasonic	ERJ-2RKF2000X	
0	R20 R25	49.9	Panasonic	ERJ-2RKF49R9X	DNI
1	R33	158	Panasonic	ERJ-2RKF1580X	
1	R47	1.5K	Panasonic	ERJ-2RKF1501X	
6	R52 R58 R60–R63	10K	Panasonic	ERJ-2GEJ103X	
2	R53 R54	100K	Panasonic	ERJ-2GEJ104X	
2	R55 R56	51	Panasonic	ERJ-2GEJ510X	
1	R57	24K	Panasonic	ERJ-2GEJ243X	
1	R59	2K	Panasonic	ERJ-2RKF2001X	
0	R68	10K	Panasonic	ERJ-2GEJ103X	DNI
1	R64	10K	BC COMPONENTS	CT94W103	
2	R65 R66	240	Panasonic	ERJ-2GEJ241X	
1	T1	ADT16-1T	Minicircuits	ADT16-1T	
1	T2	JTX-2-10T	Minicircuits	JTX-2-10T	
1	T3	3150MHz	Anaren	BD3150L50100A00	TRF1212 EVM
		2326MHz	Anaren	BD2326J50100A00	TRF1112 EVM
6	TP1–TP6	Red	Keystone	5000	
1	TP7	Blk	Keystone	5001	
1	U1	TRF1112	TI	TRF1112	TRF1112 EVM
1	U1	TRF1212	TI	TRF1212	TRF1212 EVM
1	U3	LM2904D	TI	LM2904D	
1	U4	74HCT125	TI	SN74HCT125D	
1	Y1	18MHz	Vectron	VTC1-A0CE-18M000	

6.2 PCB Layout and Schematics

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 and the schematics.

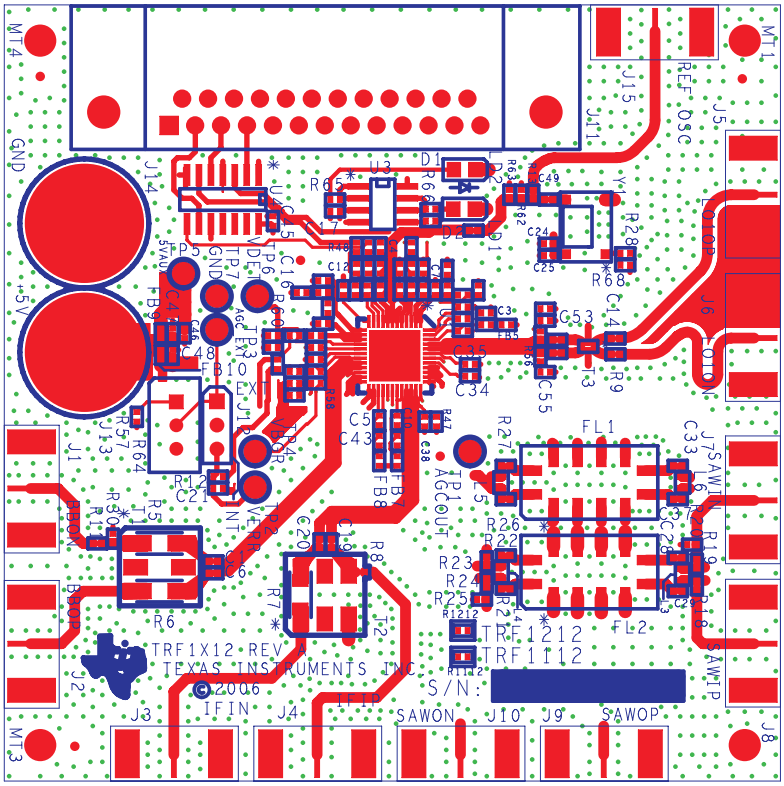


Figure 6. Top Layer 1

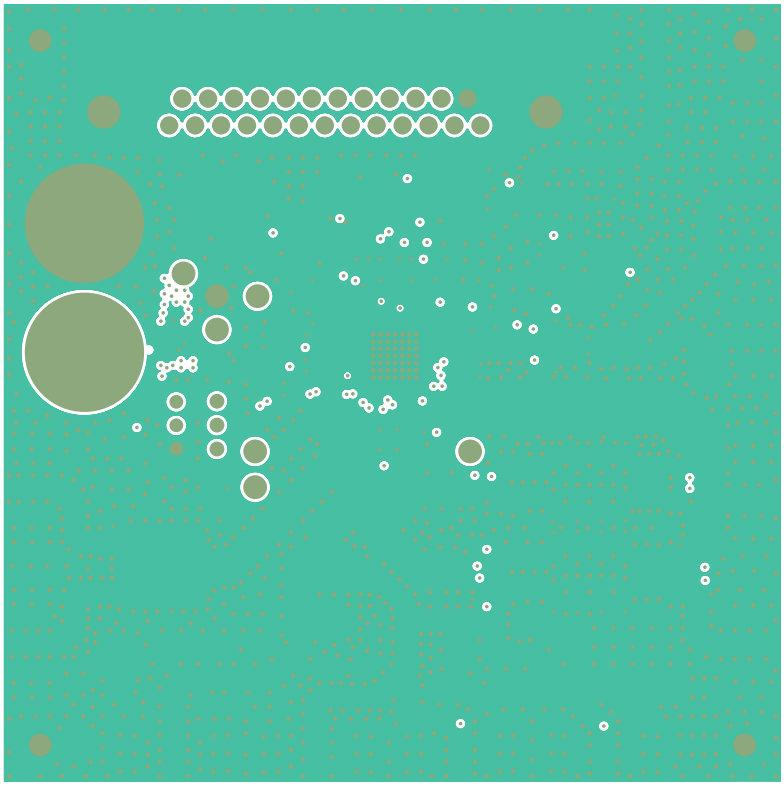


Figure 7. Ground Plane Layer 2

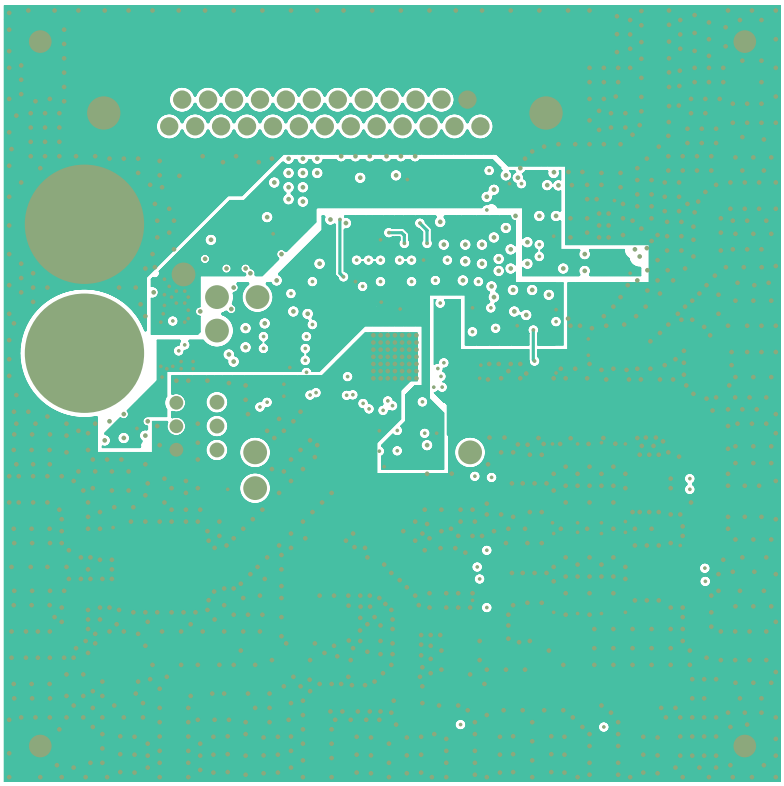


Figure 8. Power Plane Layer 3

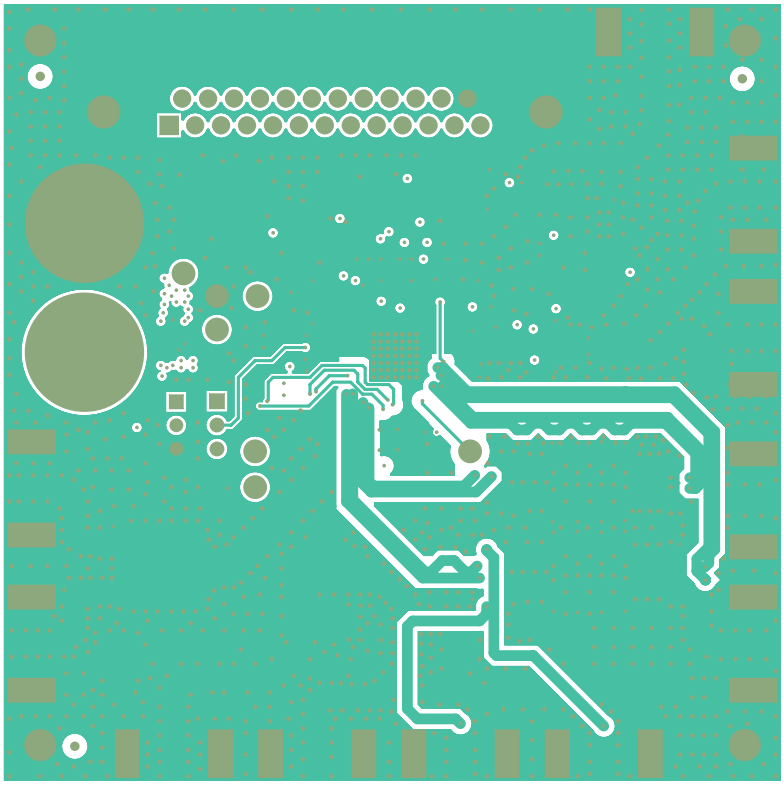


Figure 9. Bottom Layer 4

RX CHAIN: LO / 2ND DOWN CONVERTER

U1
TRF1212/TRF1112

CP20 R15 100 C15 680pF R16 200 C16 15nF C18 270pF
CP10 R29 100 C7 820pF R33 158 C36 22nF C31 470pF
SPI_DATA R48 0
SPI_CLK R50 0
SPI_EN R49 0
C12 3.6pF 4.7pF
C11 3.6pF 4.7pF
C9 3.6pF 4.7pF

AGCI R52 10K
5V0_RX C3 220pF R14 200 R17 200
18MHZREF R51 0

IF2BIN IF2BIP IF2AIN IF2AIP AGCI VREF VFB EXTLO1N EXTLO1P FR LO2TUN LO1TUN IF1IN IF1IP DATA CLK EN VCCLO2 VCCLO1 VCCD2 VCCD1 VCCC VCCB VCCA GND
IF2BON IF2BOP IF2AON IF2AOP AGCO VERR VBGR FRBP CP2O CP1O VDET IFBPB BBON BBOP LF2 LD2 LO2BPB LO2BPA LF1 LD1 LO1BPB LO1BPA LO1OP LO1ON

TP1 AGCOUT Red

R10 100 C4 10nF
C38 100nF
R47 1.5K
R53 100K
C13 10nF
C22 100nF
C30 100nF
FB1 120
FB2 120
C35 100nF DNI
C34 100nF

R1212 0
R1112 0 DNI

R54 100K
C8 10nF
C17 3.9pF
C27 3.9pF
U3A LM2904D
U3B LM2904D
R65 240
R66 240
D1 GREEN PG1112H-TR LD2
D2 GREEN PG1112H-TR LD1

FB4 120
FB5 120
FB6 120
FB8 120
FB7 120
C32 220pF
C2 3.6pF 4.7pF
C54 220pF
C39 220pF
C40 10nF
C5 220pF
C43 10nF
C10 220pF
C42 10nF

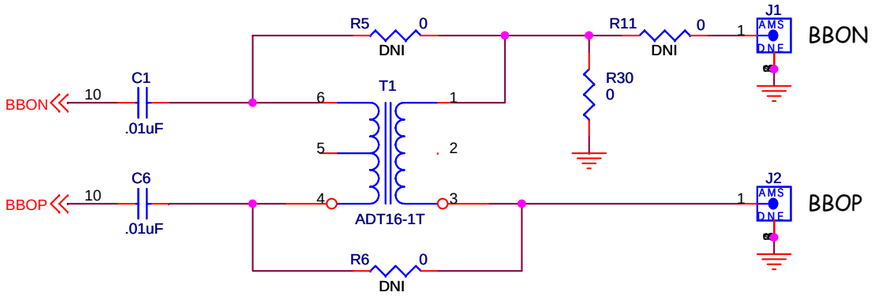
FB3 120
R55 51
R56 51
C53 3.6pF 4.7pF
C55 3.6pF 4.7pF
C23 3.6pF 4.7pF
C26 3.6pF 4.7pF
LO1OP
LO1ON

NOTE:
TRF1212 = 3.6pF
TRF1112 = 4.7pF

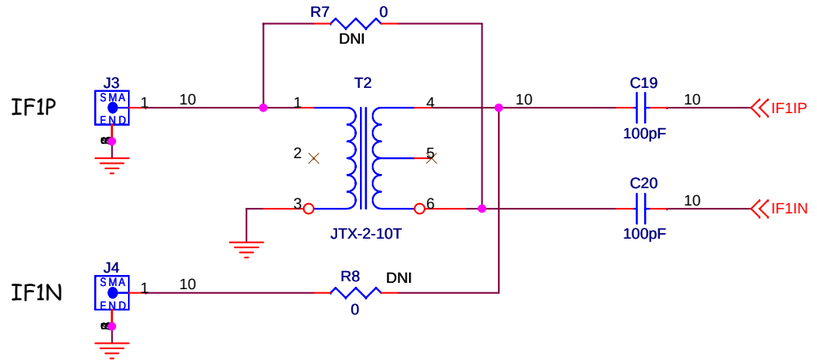
TEXAS INSTRUMENTS

Title	12500 TI Boulevard. Dallas, Texas 75243 **TRF1X12 EVM - SCH**	
Size B	Document Number	Rev A
Date: Thursday, July 27, 2006	Sheet 1 of 3	
Engineer: RJ HOPPENSTEIN		
Drawn By: JV SMITH		

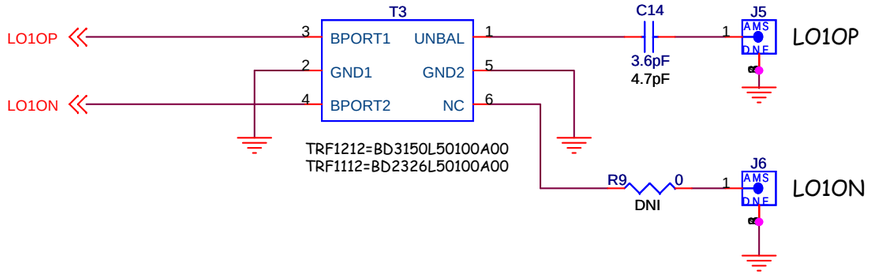
BASEBAND IF OUTPUT

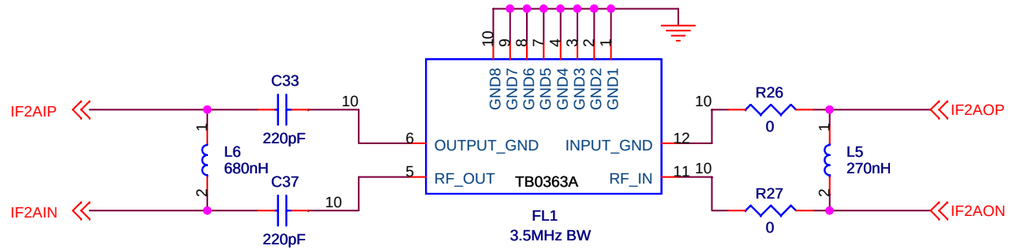


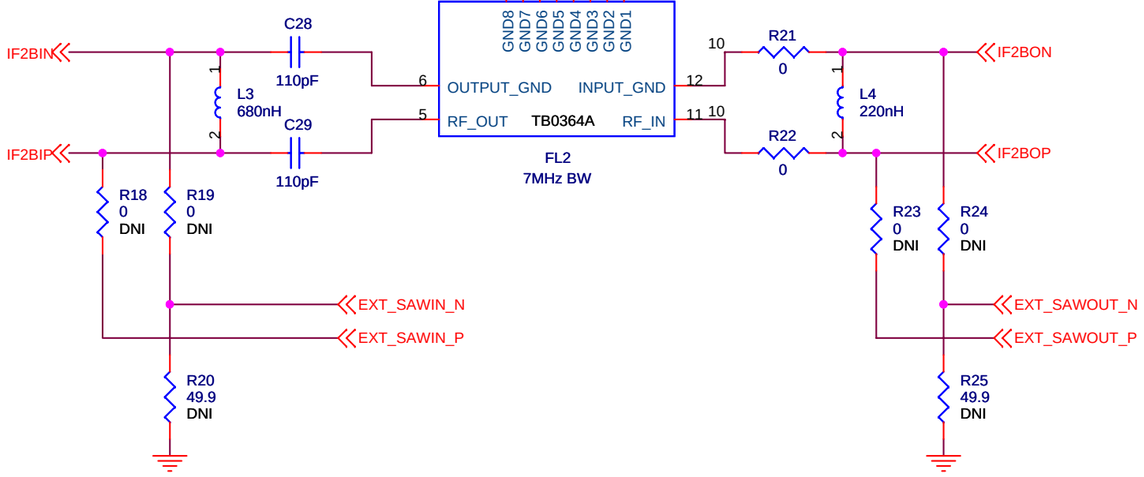
IF INPUT

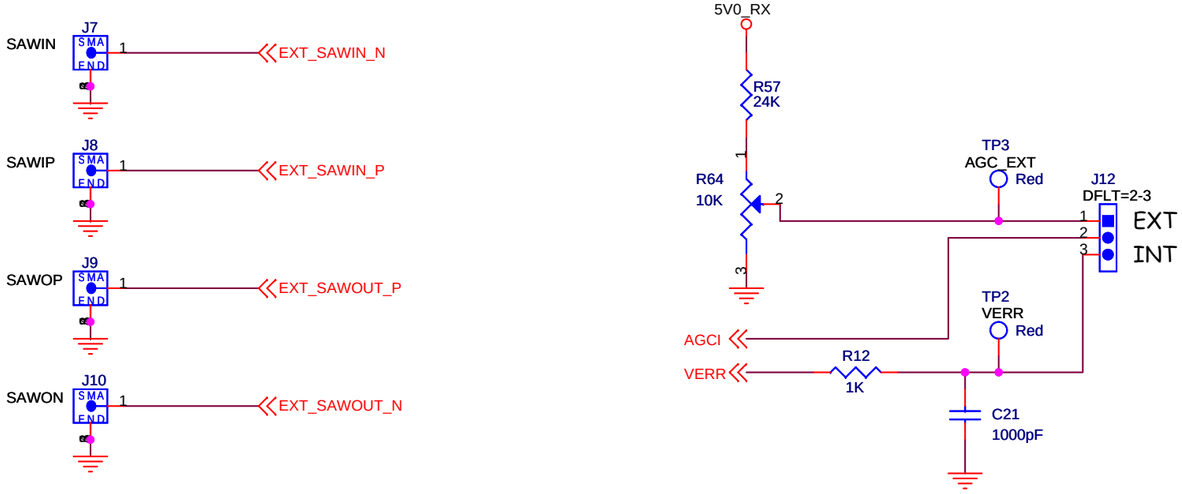


LP #1 OUTPUT





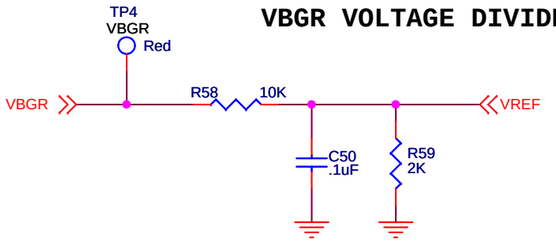




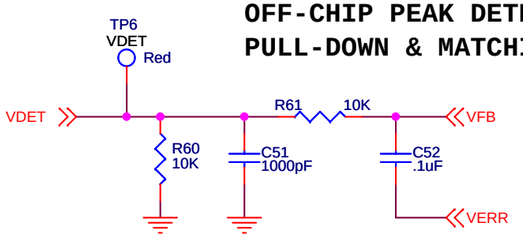
TEXAS INSTRUMENTS
12500 TI Boulevard. Dallas, Texas 75243

Title: ***TRF1X12 EVM - SCH***		
Size: **B**	Document Number:	Rev: **A**
Date: Thursday, July 27, 2006	Sheet 2 of 3	

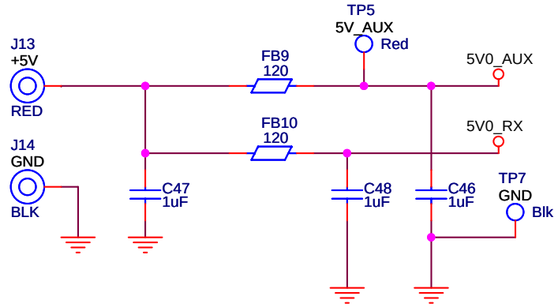
VBGR VOLTAGE DIVIDER



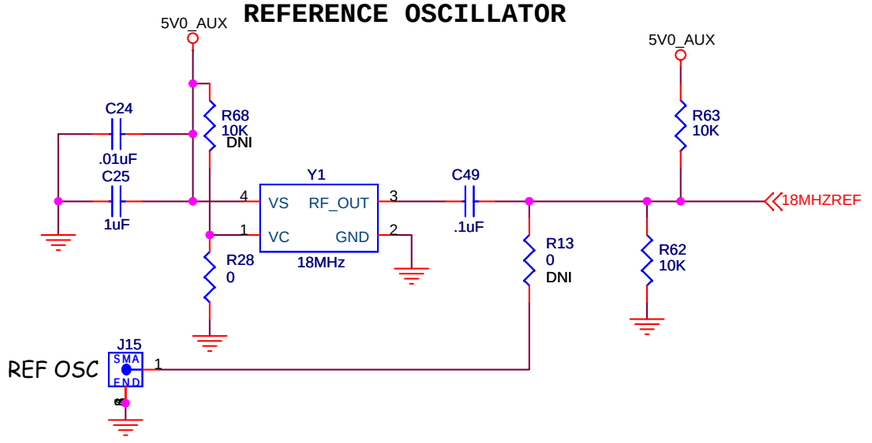
OFF-CHIP PEAK DETECTOR
PULL-DOWN & MATCHING CKT



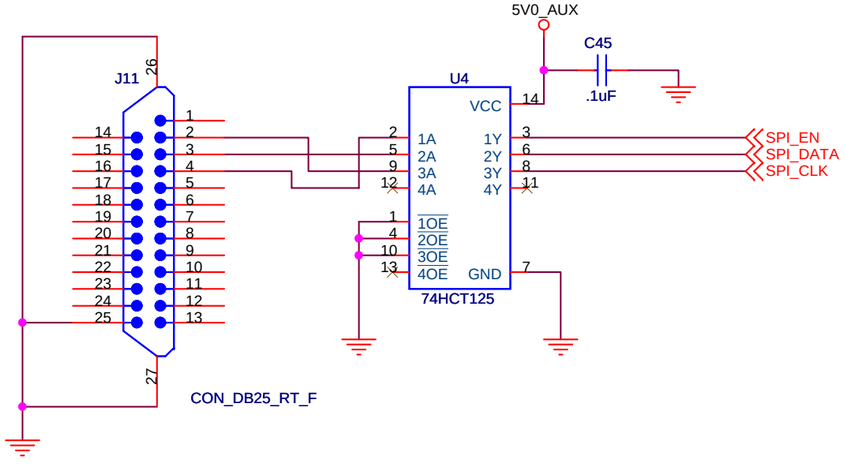
DC POWER PORT

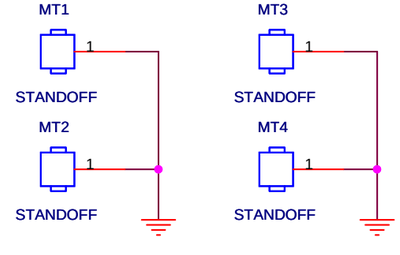


REFERENCE OSCILLATOR



SERIAL INTERFACE & LOCK DETECT PORT





TEXAS INSTRUMENTS
12500 TI Boulevard. Dallas, Texas 75243

Title: *TRF1X12 EVM - SCH*		
Size: B	Document Number	Rev: A
Date: Thursday, July 27, 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