

EVM User's Guide: LMX1205EVM

LMX1205 Evaluation Module



Description

The LMX1205 evaluation module (EVM) is designed to evaluate the performance of the LMX1205, which is a four-output, ultra-low additive jitter radio-frequency (RF) buffer, divider and multiplier. The device can buffer RF frequencies up to 12.8GHz, multiply RF outputs up to 12.8GHz, and divide outputs by up to 12.8GHz. This board consists of an LMX1205 device and an integrated USB2ANY programmer.

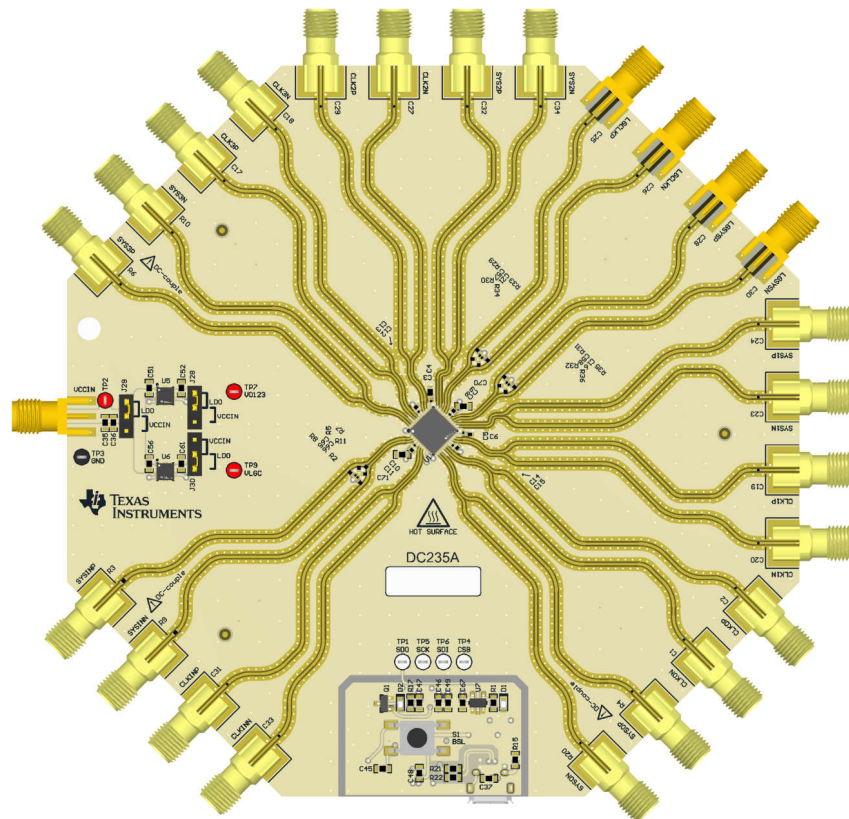
Features

- 300MHz to 12.8GHz output frequency
- 4 high-frequency clocks with corresponding SYSREF outputs
 - Shared divide by 2, 3, 4, 5, 6, 7 and 8
 - Shared multiply by 2, 3, 4, 5, 6, 7 and 8
- Noiseless adjustable input delay up to 25ps with 1ps resolution

- Individual adjustable output delays up to 10ps with 0.5ps resolution
- 3.3V supply voltage (with onboard 2.5V LDOs) or 2.5V supply voltage (with LDOs bypassed)
- -40°C to +85°C operating temperature

Applications

- **Test and measurement:**
 - Oscilloscope
 - Wireless equipment testers
- **Aerospace and defense:**
 - Radar
 - Electronic warfare
 - Seeker front end
- **General purpose:**
 - Data converter clocking
 - Clock buffer distribution and division



1 Evaluation Module Overview

1.1 Introduction

The LMX1205 is an ultra-low additive-jitter RF buffer, divider, and multiplier, with integrated SYSREF generation capability. A separate auxiliary clock divider can be used for FPGAs or other logic ICs. Each RF output (and the logic clock) is paired with a complementary SYSREF output with picosecond-precision delay-tuning capability, and can be operated as a generator (with synchronization capability across multiple devices) or as a repeater.

The EVM can be operated with a 3.3V supply voltage when the onboard LDOs are utilized. The LDOs can be bypassed, in this case the supply voltage is 2.5V.

The EVM contains LMX1205, two LDOs and a microcontroller.

1.2 Kit Contents

Included within each evaluation kit is:

- One LMX1205 EVM board (DC235) with integrated USB2ANY controller
- One USB cable

1.3 Specification

Table 1-1. LMX1205 EVM Specification

Parameter	Value	Conditions	
Supply voltage	3.0V to 3.4V	Onboard LDOs output are 2.5V	
	2.5V	Onboard LDOs are bypassed	
Supply current	1.3A max.	Various configurations	
CLKIN input frequency	300MHz to 12.8GHz	Buffer mode	
	300MHz to 12.8GHz	Divider mode	
	3.2GHz to 6.4GHz	Multiplier mode	CLK_DIV = ×2
	2.133GHz to 4.266GHz		CLK_DIV = ×3
	1.6GHz to 3.2GHz		CLK_DIV = ×4
	1.28GHz to 2.56GHz		CLK_DIV = ×5
	1.067GHz to 2.133GHz		CLK_DIV = ×6
	0.914GHz to 1.828GHz		CLK_DIV = ×7
	800MHz to 1.6GHz		CLK_DIV = ×8

1.4 Device Information

The high-frequency capability and extremely low jitter of this device, makes a great design to clock precision, high-frequency data converters without degradation to the signal-to-noise ratio. Each of the four high-frequency clock outputs, and additional LOGICLK output with larger divider range, is paired with a SYSREF output clock signal. The SYSREF signal for JESD interfaces can either be internally generated or passed in as an input and re-clocked to the device clocks. For data converter clocking applications, to have the jitter of the clock be less than the aperture jitter of the data converter is critical. In applications where more than four data converters must be clocked, a variety of cascading architectures can be developed using multiple devices to distribute all the high-frequency clocks and SYSREF signals required. With low jitter and noise floor, this device combined with an ultra-low noise reference clock source is an exemplary design for clocking data converters, especially when sampling above 3GHz.

2 Hardware

2.1 Jumper Information

Jumper J28, J29 and J30 determines the supply voltage to the board.

- When using the onboard LDOs, set these jumpers to the "LDO" position. This is the default EVM configuration.
- To bypass the LDOs, set these jumpers to the "VCCIN" position.

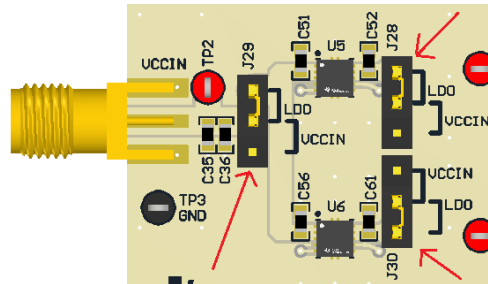


Figure 2-1. Jumper Configuration

2.2 Setup

2.2.1 Evaluation Setup Requirement

At a minimum, evaluation of the buffer mode requires:

- A DC power supply capable of at least 3.0V, 2A
- A high-quality signal source, such as an SMA100B
- A spectrum analyzer or phase noise analyzer
- A PC running Windows 7 or a more recent version with [TICS Pro software](#) installed

Full evaluation requires the following additional hardware:

- A high-speed 4-CH oscilloscope capable of resolving 5ps step size for SYSREF delay tuning
- A 2-CH arbitrary function generator or other pulse source capable of outputting complementary LVDS pulses and DC levels (1.25V ± 0.2V, differential, into 100Ω DC load) for triggering SYSREF, SYNCing the dividers, and determining SYSREF windowing values

2.2.2 Connection Diagram

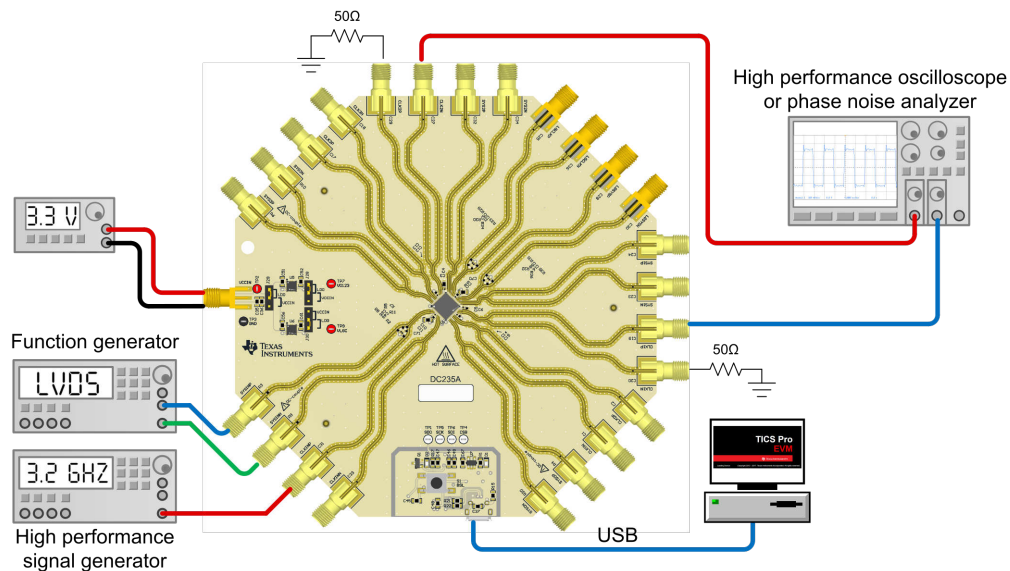


Figure 2-2. Connection Diagram

2.3 Power Requirements

When using the onboard LDOs, apply 3.3V to VCCIN SMA connector. The acceptable supply voltage range is 3.0V to 3.4V. The LDOs have about 40mA ground current for converting 3.3V to 2.5V supply. If the LDOs are bypassed, apply 2.5V to VCCIN SMA connector.

The board can draw up to 1.3A during operation, so the resistance of the power cable is matter. Enabling or disabling various system functions can change the board current by 50% or more.

2.4 Reference Clock

Connect the CLKINP SMA connector to a high-quality signal source such as an SMA100B signal generator. Set the output power of the signal generator to 10dBm. Both CLKIN inputs are terminated internally with 50Ω to AC-GND (that is, GND connection is formed by an internal capacitor), so no external termination is required. Input can be driven differentially, connect both CLKINP and CLKINN SMA connectors to a balun or a differential clock source.

The default EVM profile configures the device in buffer mode. The input frequency can be modified per the operating range of each functional element if desired. This EVM setup guide and related plots assume 3200MHz input at CLKIN for buffer mode.

To evaluate SYSREF repeater mode, connect the SYSREF input SMAs to a differential output source such as an arbitrary function generator. The EVM connections for the SYSREF input are DC-coupled and provide internal 100Ω termination. In DC-coupled mode, the common mode bias on the SYSREFREQ pins must be between 1V and 2V. The input common mode requirements can be fulfilled with a standard LVDS output buffer.

For evaluating SYNC mode and SYSREF windowing, to have a SYSREFREQ input source capable of consistently meeting setup and hold requirements for a single cycle of the input clock is critical. This can become very challenging at higher frequencies where set up and hold requirements can be < 50ps. Another device capable of picosecond-precision timed pulses, such as LMX2820 or LMX2594, can be used as a reference input to both CLKIN and SYSREF for evaluating these features.

2.5 Output Connections

All CLKOUT connections are AC-coupled and can be connected directly to RF instruments with 0VDC requirements; an additional DC block is not required. The unused CLKOUT SMA connector must be terminated with a 50Ω load, or a differential connection can be used if a balun with the best frequency range is available.

Two SYSREF outputs are DC-coupled, making them easier to cascade with the SYSREF input of another LMX1205 EVM or other JESD204B device. The other two SYSREF outputs are AC-coupled.

LOGICCLK and LOGISYSREF outputs are AC-coupled and output formats are programmable. Hardware change is required to match the output format.

2.6 Test Points

Table 2-1. SPI Test Points

Test Point	Net
TP1	SDO
TP4	CSB
TP5	SCK
TP6	SDI

Table 2-2. Supply Voltage Test Points

Test Point	Net
TP2	VCCIN
TP7	V0123
TP9	VLGC
TP3	GND

3 Software

3.1 Software Description

Texas Instruments Clocks and Synthesizers (TICS) Pro software is used to program this evaluation module (EVM) through the on-board USB2ANY interface.

3.2 Software Installation

Download and install TICS Pro software from www.ti.com/tool/ticspro-sw.

3.3 USB2ANY Interface

The on-board USB2ANY interface provides a bridge between TICS Pro software and the LMX1205 device. When the on-board USB2ANY controller is first connected to a PC, or if the firmware revision for the controller does not match with the version used by TICS Pro, a firmware update to the controller is required.

1. Connect the USB cable from the PC to the EVM. The USB interface provides the necessary power to enable the on-board USB2ANY controller.
2. After Windows has set up a USB device, run TICS Pro in the PC.
3. The next screen looks like the image below.

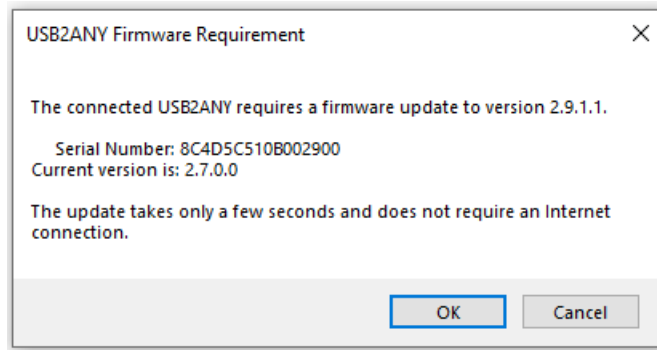


Figure 3-1. Firmware Update Request

4. Click *OK*, then the screen looks like the image below. Click *Update Firmware*.

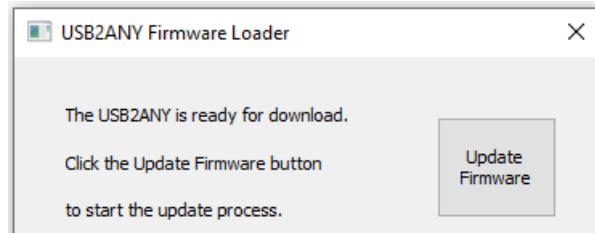


Figure 3-2. Firmware Loader

5. Then the screen below appears.

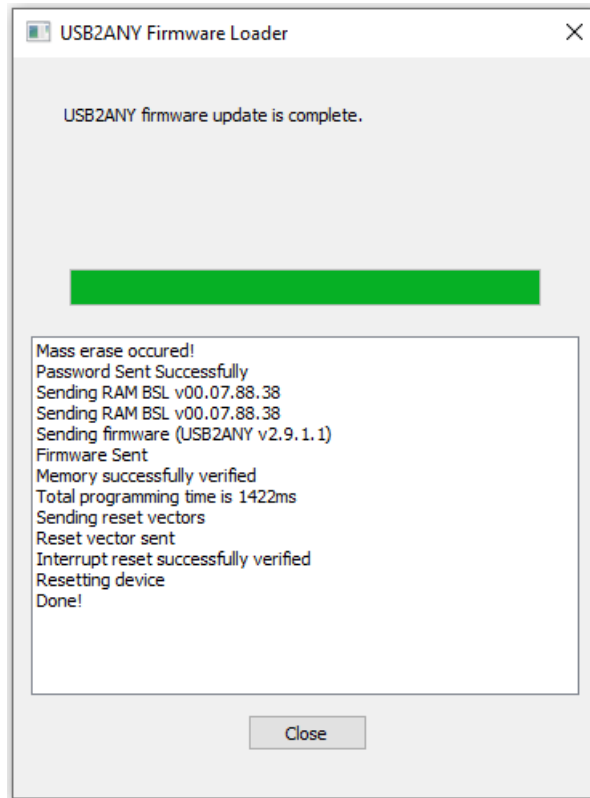


Figure 3-3. Firmware Update Complete

6. Click the *Close* button to close the window.
 7. A TICS Pro default device pops up. Check to make sure that we get a green light on Connection Mode at the bottom of the GUI.

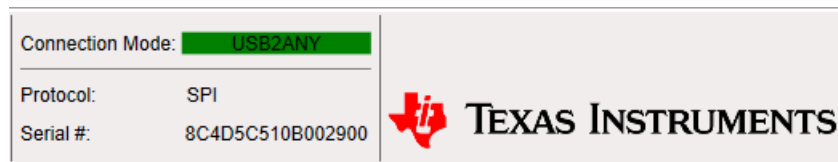


Figure 3-4. Connection Mode

8. Go to the menu bar, click *USB Communications*, then select *Interface*.

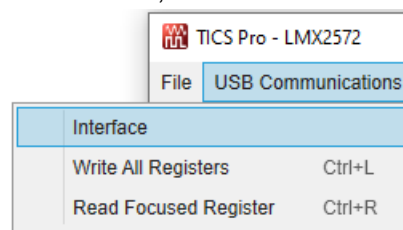


Figure 3-5. USB Communications

- Click the *Identify* button, the LED in the USB2ANY interface flashes.

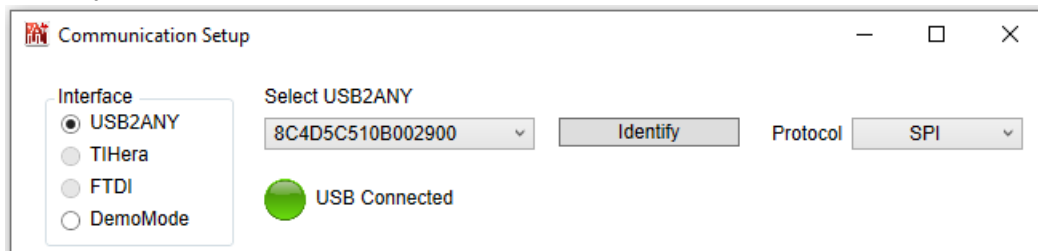


Figure 3-6. Identify USB2ANY Controller

- Now, the USB2ANY is ready to use. Click the Close button to close the window.

4 Implementation Results

4.1 Buffer Mode

After a POR or a soft reset, LMX1205 silicon default is buffer mode with all outputs enabled with maximum output power. LOGICLK is also enabled in this mode with a fixed divider value of 64. All SYSREF clocks are disabled. To evaluate the device in a different configuration, use TICS Pro.

From the top-menu, click *Default Configuration* → *3200MHz Buffer Mode*. This automatically loads the buffer mode profile.

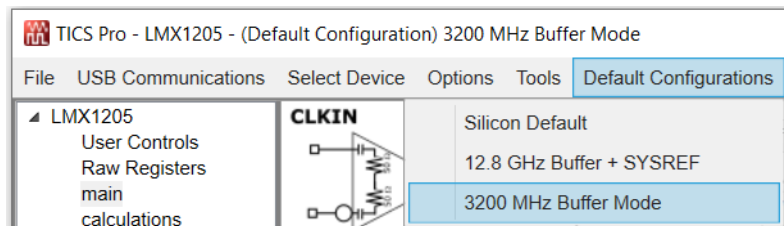


Figure 4-1. Buffer Mode

If termination is not applied on all output pins, then manually disable the unused outputs using the CHx_EN fields (to completely power down unused channels) or the CLKOUTx_EN fields (to power down output buffers only). Powering down unused channels greatly reduces current consumption.

After the profile is loaded and required any changes have been made, click *USB Communications* → *Write All Registers* to program the device. In all of the following plots, the blue trace is the 3.2GHz reference clock from SMA100B and the black trace is the output clock from the device.

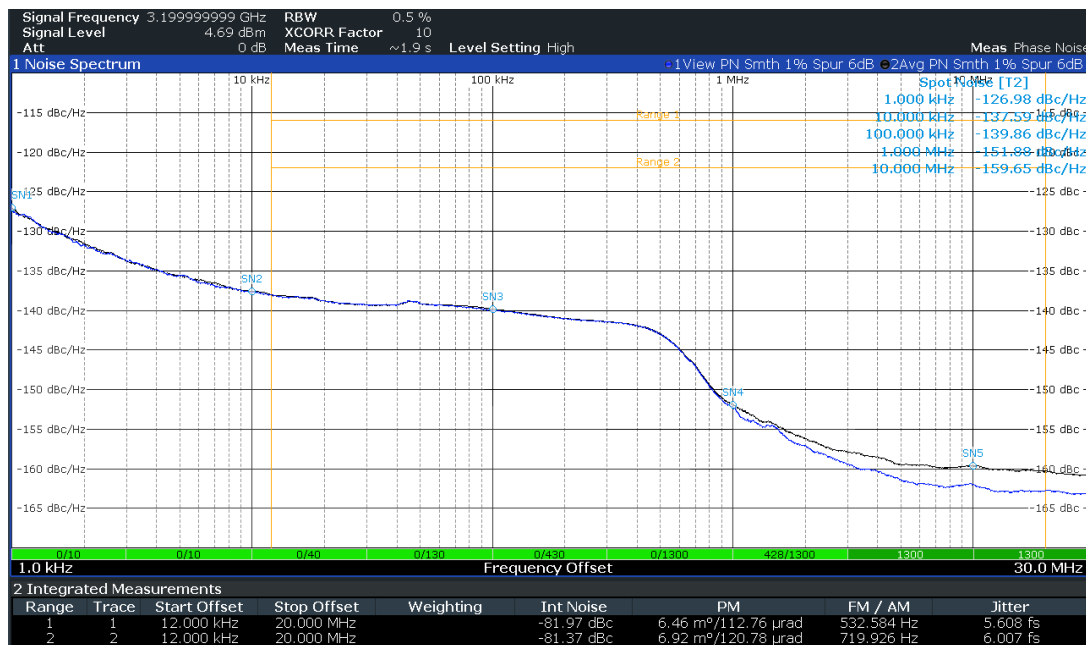


Figure 4-2. Buffer Mode Output

4.2 Divider Mode

To set LMX1205 to divider mode, do the following:

1. Set CLK_MUX = Divide.
2. Set CLK_DIV = appropriate divider value for respective CLKIN frequency.

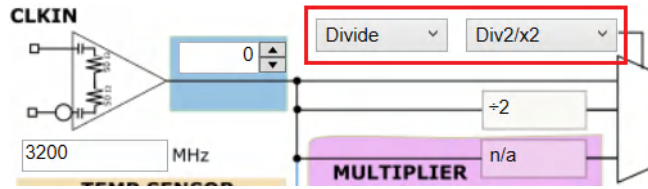


Figure 4-3. Divider Mode



Figure 4-4. Divider Mode Output

4.3 Multiplier Mode

To set LMX1205 to multiplier mode, follow the steps below:

1. Set CLK_MUX = Multiply.
2. Set CLK_DIV = appropriate multiplier value for respective CLKIN frequency.
3. Click Calibrate Multiplier button in GUI.

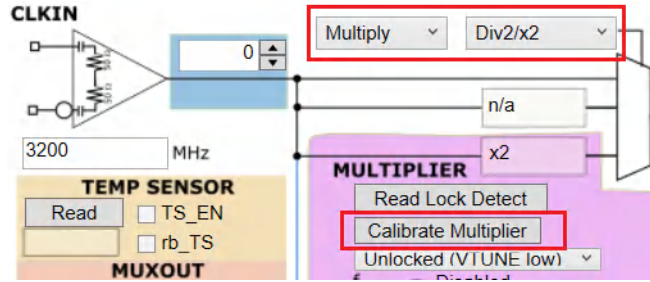


Figure 4-5. Multiplier Mode

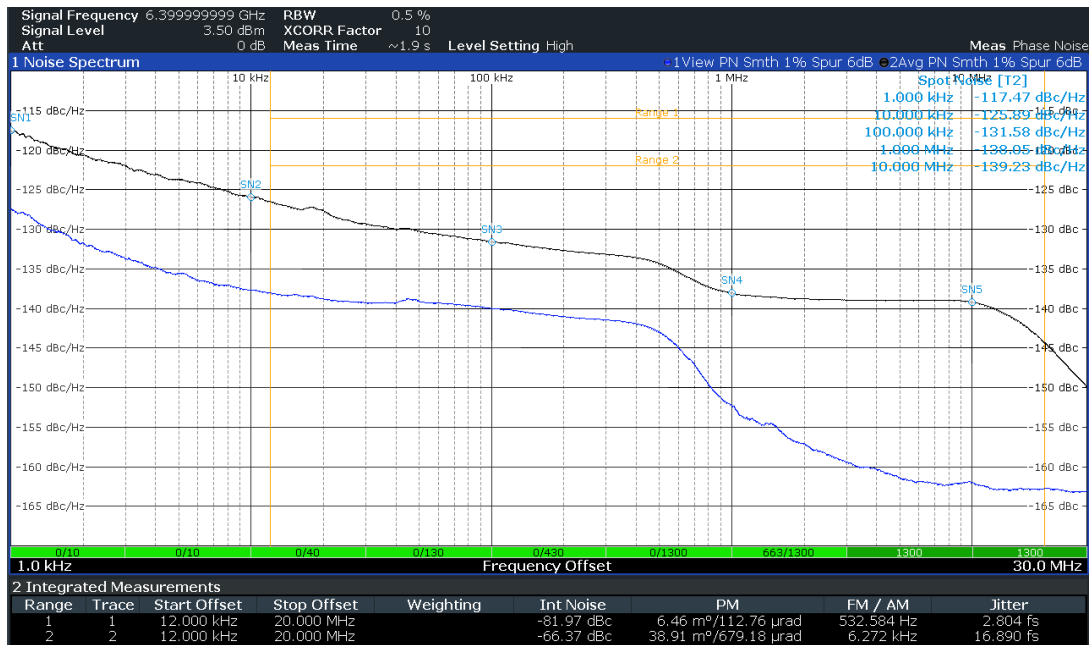


Figure 4-6. Multiplier Mode Output

4.4 SYSREF Generation

To generate a continuous SYSREF clock signal, proceed with the following steps:

1. Set SYSREFREQ_MODE = SYSREF
2. Set SYSREF_MODE = Continuous
3. Set SYSREF_EN = HIGH
4. Provide a logic HIGH to SYSREFREQ pins. For example, SYSINP = 1.4V; SYSINN = 1.0V

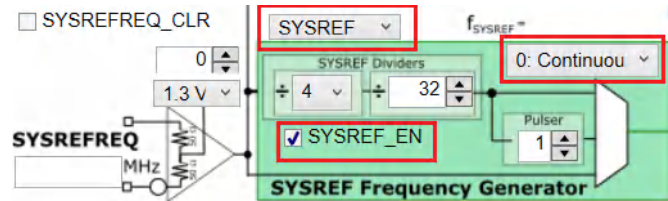


Figure 4-7. SYSREF Continuous Mode Configuration

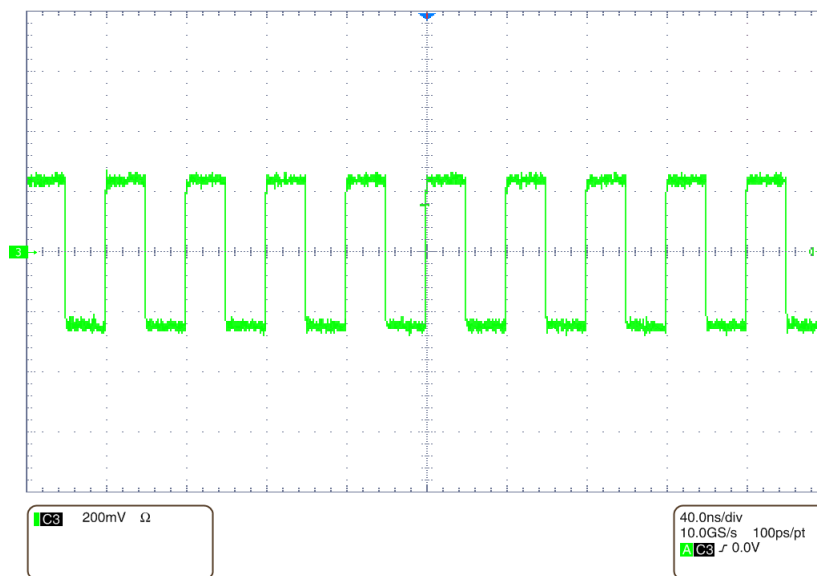


Figure 4-8. SYSREF Continuous Clock Generation (AC-coupled to a scope)

To generate SYSREF pulses:

1. Change SYSREF_MODE = Pulser and set SYSREF_PULSE_CNT to the desired value.
2. Provide a LOW to HIGH transition to SYSREFREQ pins.

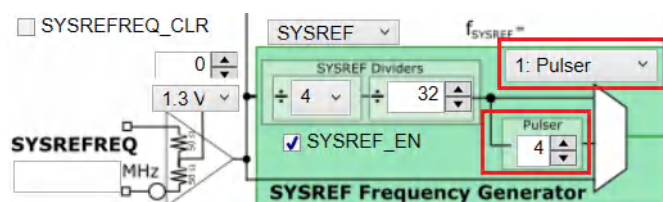


Figure 4-9. SYSREF Pulser Mode Configuration

5 Hardware Design Files

5.1 Schematics

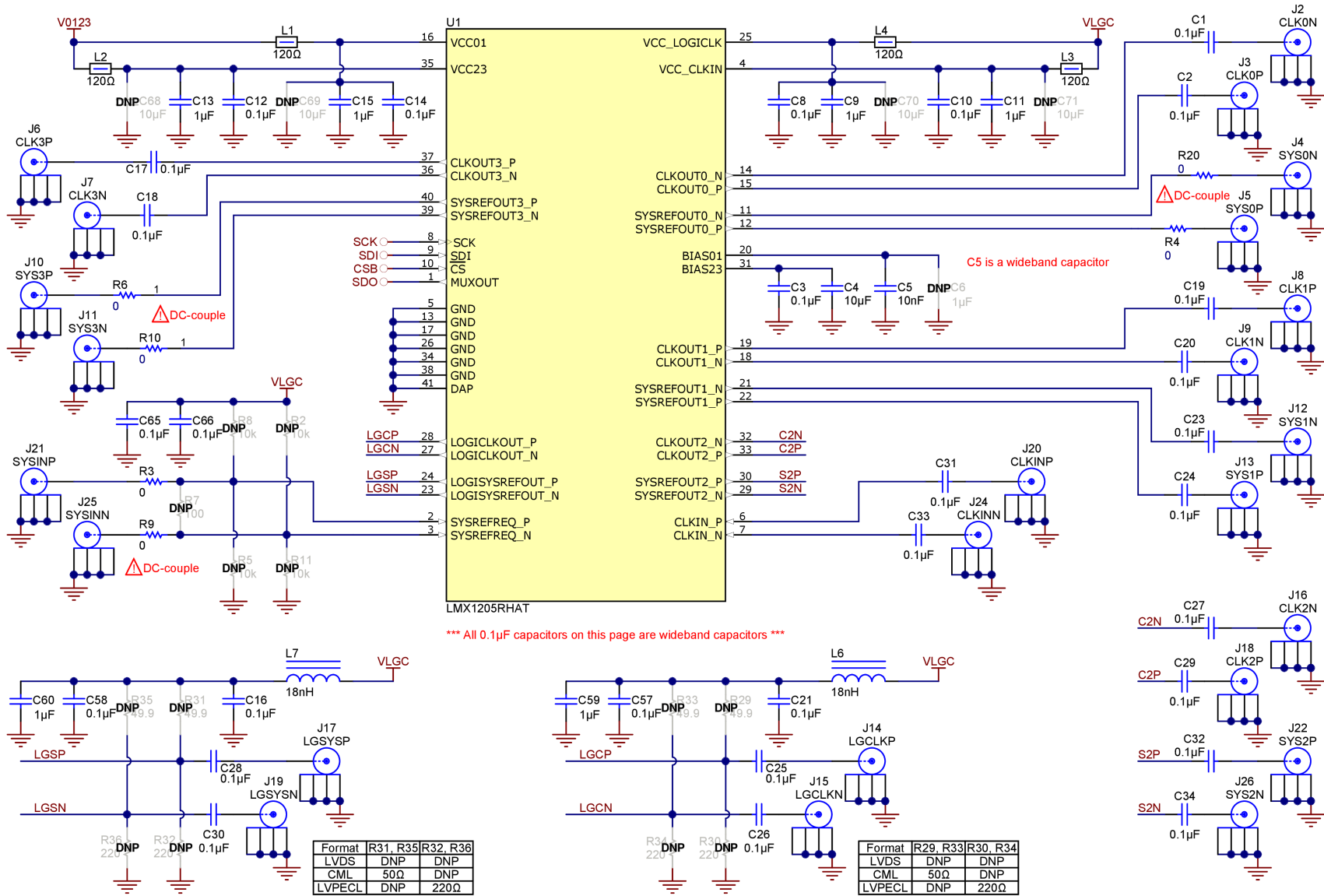


Figure 5-1. LMX1205

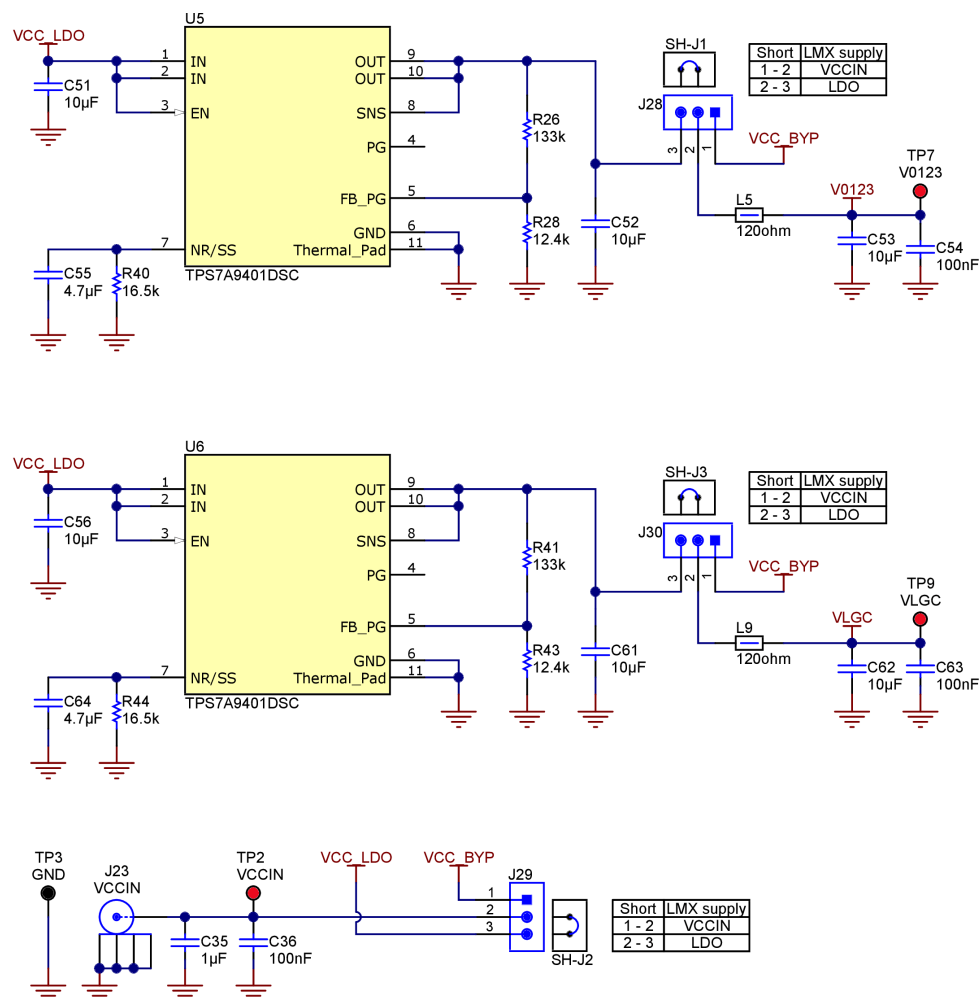


Figure 5-2. Power Supply

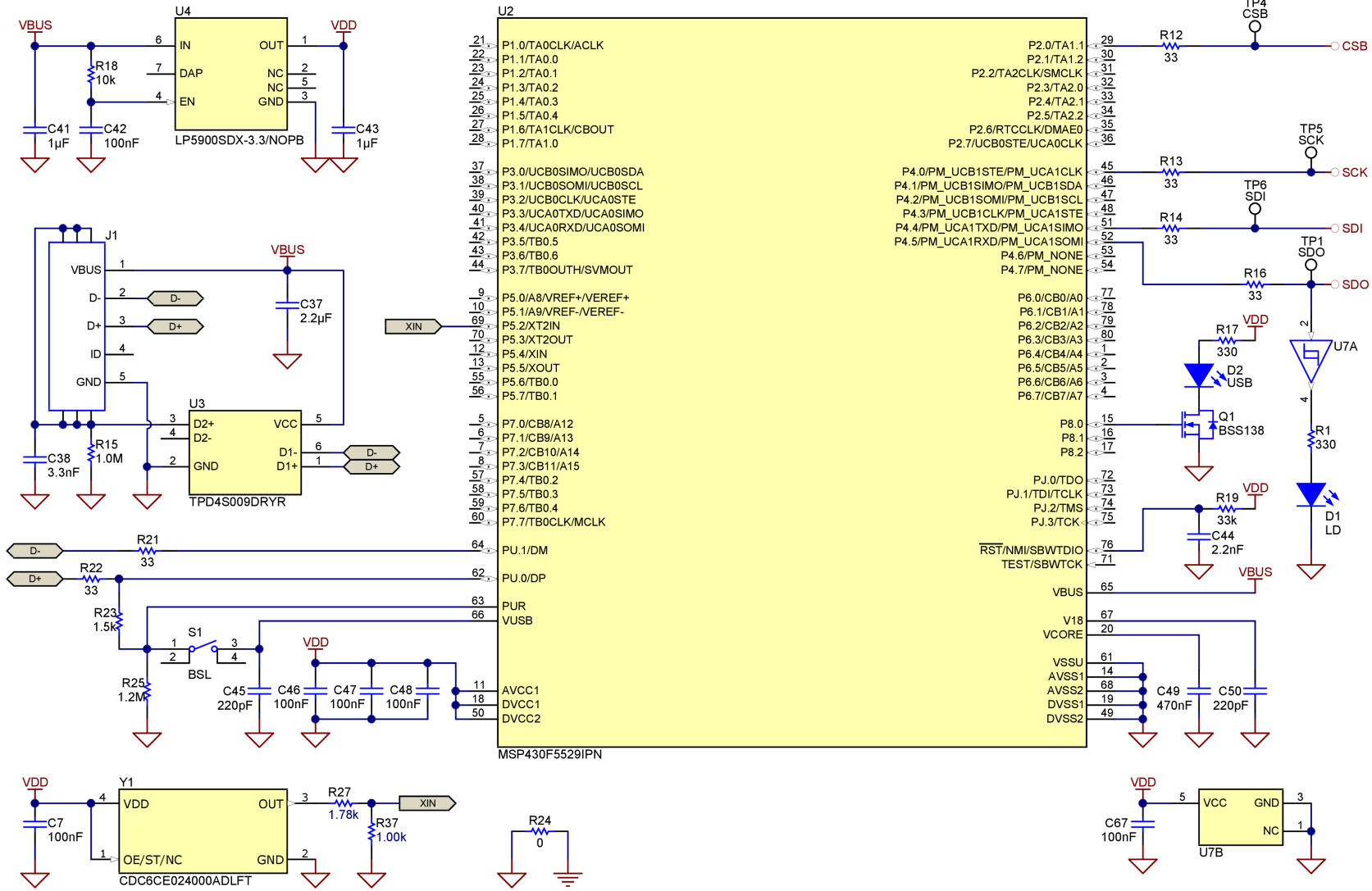


Figure 5-3. USB2ANY

5.2 PCB Layouts

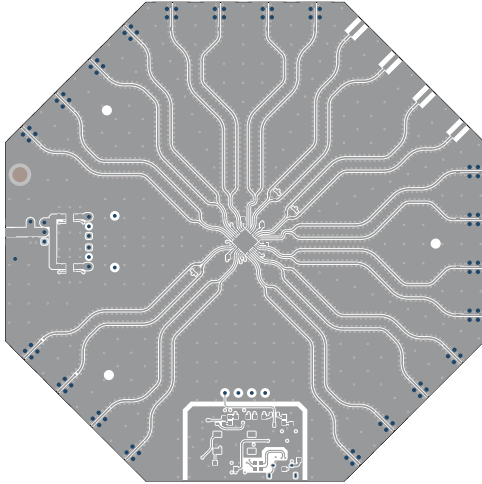


Figure 5-4. Top Layer

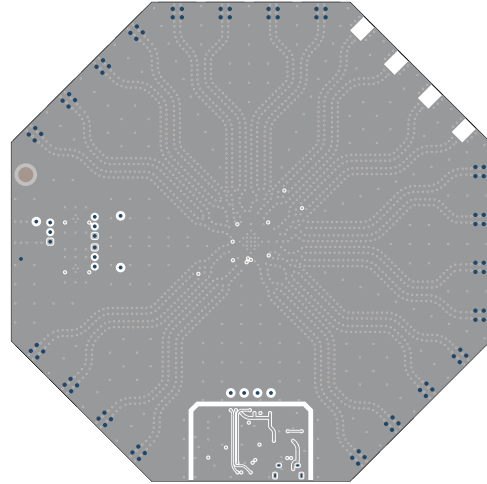


Figure 5-5. Layer 2 (RF GND)

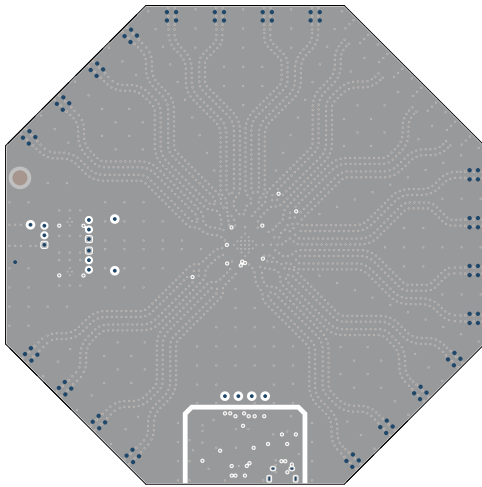


Figure 5-6. Layer 3 (GND)

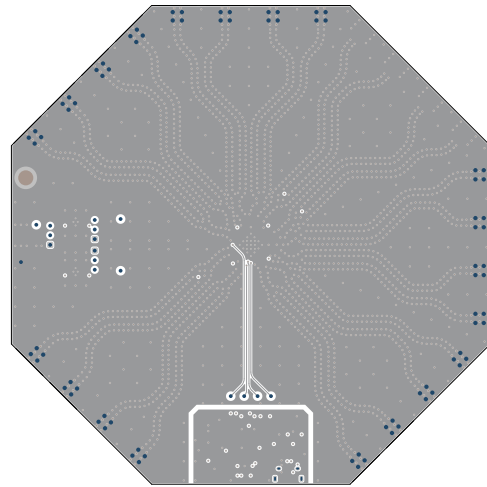


Figure 5-7. Layer 4 (GND)

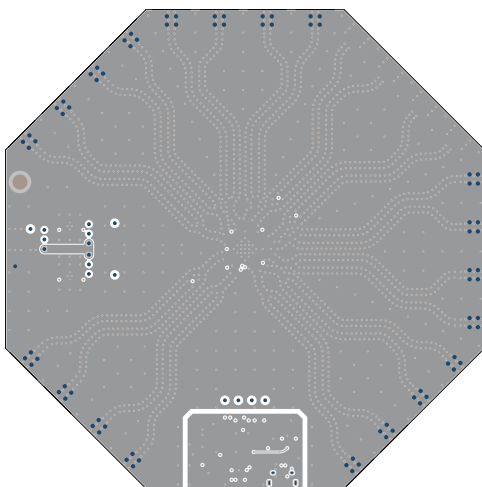


Figure 5-8. Layer 5 (GND)

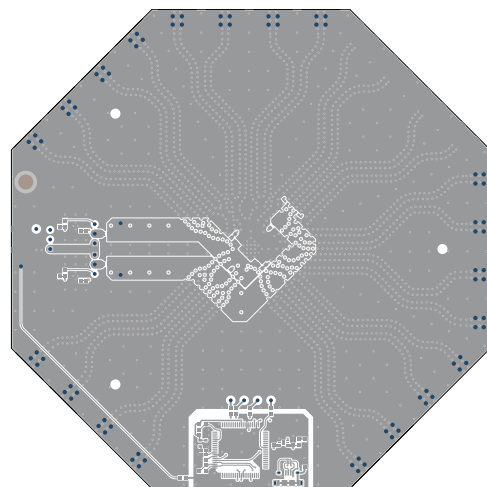


Figure 5-9. Bottom Layer

5.3 Bill of Materials (BOM)

Table 5-1. Bill of Materials

Designator	Description	Package	Part Number	Manufacturer
C1, C2, C3, C8, C10, C12, C14, C16, C17, C18, C19, C20, C21, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C57, C58, C65, C66	CAP, CERM, 0.1 μ F, 10V,+/- 10%, X5R, 0201	0201	530Z104KT10T	American Technical Ceramics
C4, C51, C52, C53, C56, C61, C62	CAP, CERM, 10 μ F, 10V,+/- 10%, X5R, 0603	0603	GRM188R61A106KAALD	MuRata
C5	CAP, CERM, 10nF, 6. V, +100/-0%, C0G/NP0, 0201	0201	550Z103PTT	AT Ceramics
C7, C36, C42, C46, C47, C48, C54, C63, C67	CAP, CERM, 0.1 μ F, 16V, +/- 10%, X7R, 0603	0603	885012206046	Würth Elektronik
C9, C11, C13, C15, C59, C60	CAP, CERM, 1 μ F, 25V, +/- 10%, X5R, 0402	0402	GRM155R61E105KA12D	MuRata
C35, C41, C43	CAP, CERM, 1 μ F, 16V, +/- 10%, X7R, 0603	0603	885012206052	Würth Elektronik
C37	CAP, CERM, 2.2 μ F, 16V, +/- 20%, X5R, 0603	0603	885012106018	Würth Elektronik
C38	CAP, CERM, 3300pF, 50V,+/- 10%, X7R, 0603	0603	885012206086	Würth Elektronik
C44	CAP, CERM, 2200pF, 16V, +/- 10%, X7R, 0603	0603	885012206036	Würth Elektronik
C45, C50	CAP, CERM, 220pF, 50V, +/- 5%, C0G/NP0, 0603	0603	C0603C221J5GACTU	Kemet
C49	CAP, CERM, 0.47 μ F, 16V, +/- 10%, X7R, 0603	0603	GRM188R71C474KA88D	MuRata
C55, C64	CAP, CERM, 4.7 μ F, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
D1, D2	LED, Green, SMD	0603	LTST-C190GKT	Lite-On
H1, H2, H3, H4	BUMPER CYLIN	0.312" DIA	SJ61A6	3M
J1	USB 2.0, Micro-USB Type B	SMT	10118194-0001LF	FCI
J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J12, J13, J16, J18, J20, J21, J22, J24, J25, J26	Connector, End launch SMA 50 ohm, TH	End launch SMA	142-0761-881	Cinch Connectivity
J14, J15, J17, J19, J23	CONN SMA JACK STR	EDGE MNT	CON-SMA-EDGE-S	RF Solutions Ltd.
J28, J29, J30	Header, 100mil, 3x1, Gold	TH	TSW-103-07-G-S	Samtec
L1, L2, L3, L4, L5, L9	Ferrite Bead, 120 ohm at 100MHz, 3A	0603	BLM18SG121TN1D	MuRata
L6, L7	Inductor, 18nH, 0.3A, 0.36 ohm, SMD	0402	LQG15HS18NJ02D	MuRata
Q1	MOSFET, N-CH, 50V, 0.22A	SOT-23	BSS138	Fairchild
R1, R17	RES, 330, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603330RJNEA	Vishay-Dale
R3, R9	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R4, R6, R10, R20	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
R12, R13, R14, R16, R21, R22	RES, 33, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333R0JNEA	Vishay-Dale
R15	RES, 1.0M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M00JNEA	Vishay-Dale
R18	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0JNEA	Vishay-Dale
R19	RES, 33 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333K0JNEA	Vishay-Dale

Table 5-1. Bill of Materials (continued)

Designator	Description	Package	Part Number	Manufacturer
R23	RES, 1.5 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K50JNEA	Vishay-Dale
R24	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R25	RES, 1.2M, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M20JNEA	Vishay-Dale
R26, R41	RES, 133 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603133KFKEA	Vishay-Dale
R27	RES, 1.78 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K78FKED	Vishay-Dale
R28, R43	RES, 12.4 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060312K4FKEA	Vishay-Dale
R37	RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K00FKED	Vishay-Dale
R40, R44	RES, 16.5 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060316K5FKEA	Vishay-Dale
S1	Switch, Tactile, SPST	6x6 mm	FSM4JSMA	TE Connectivity
SH-J1, SH-J2, SH-J3	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP4, TP5, TP6	Test Point, Miniature, White,	TH	5002	Keystone
TP2, TP7, TP9	Test Point, Miniature, Red	TH	5000	Keystone
TP3	Test Point, Miniature, Black	TH	5001	Keystone
U1	High-Frequency JESD Buffer/Multiplier/Divider	VQFN40	LMX1205RHAT	Texas Instruments
U2	25MHz Microcontroller	PN0080A	MSP430F5529IPN	Texas Instruments
U3	4-Channel ESD diode	DRY0006A	TPD4S009DRYR	Texas Instruments
U4	Ultra Low Noise, 150mA LDO	NGF0006A	LP5900SDX-3.3/NOPB	Texas Instruments
U5, U6	1A, Ultra-Low Noise, RF LDO	WSON10	TPS7A9401DSC	Texas Instruments
U7	Single Schmitt-Trigger Buffer	DBV0005A	SN74LVC1G17DBVR	Texas Instruments
Y1	High-Performance BAW Oscillator	VSON4	CDC6CE024000ADLFT	Texas Instruments

6 Additional Information

6.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductor products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 <https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html>

3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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- 4 *EVM Use Restrictions and Warnings:*
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 *Safety-Related Warnings and Restrictions:*
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user 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, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
 5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
 6. *Disclaimers:*
 - 6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.
 - 6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.
 7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.
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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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