LMH0324-8EVM

User's Guide

Literature Number: SNLU192A
March 2016–Revised June 2018

Contents

List of Figures

List of Tables

LMH0324-18EVM Evaluation Board

1 Overview

The LMH0324-18EVM is an evaluation module designed for high speed performance and functional evaluation of the Texas Instruments LMH0324 3 Gbps SDI Cable Equalizer with Integrated Reclocker and LMH0318 3 Gbps SDI Reclocker with Integrated Cable Driver. With this kit, users can quickly evaluate the cable reach and output signal integrity supported by the LMH0324 and LMH0318. A high performance edge mount BNC connector is used at the 75-Ω input port of the cable equalizer and the 75-Ω output port of the cable driver while 100-Ω differential input and output ports are routed to edge mount SMA connectors. These connectors facilitate connection to lab equipment or user systems for performance evaluation. An on-board MSP430 MCU is included to support an optional SMBus or SPI serial control interface when configuring the LMH0324 and LMH0318 operating modes.

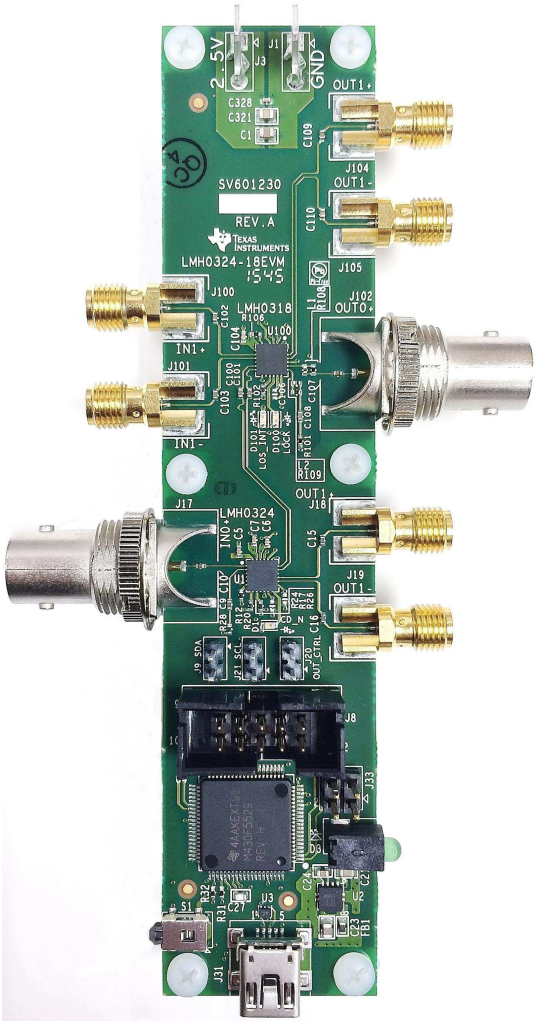

Figure 1. LMH0324-18EVM

2 Features

- **LMH0324:**
  - Locks to standard SDI (2.97 Gbps, 1.485 Gbps, or divide-by-1.001 sub-rates) and DVB-ASI (270 Mbps)
  - Adaptive Cable Equalizer at 75 Ω single-ended input port IN0+
  - 100 Ω Output Drivers with De-Emphasis
  - SPI or SMBus Interface
  - Single or double supply operation: VDD = 2.5V ± 5% & VDD = 1.8 ± 5%
- **LMH0318:**
  - Locks to standard SDI (2.97 Gbps, 1.485 Gbps, or divide-by-1.001 sub-rates) and DVB-ASI (270 Mbps)
  - Integrated 2:1 100 Ω mux on input
  - 75 Ω and 100 Ω Transmitter Outputs
  - Programmable by SPI or SMBus Interface
  - Single supply operation: VDD = 2.5V ± 5%

3 Applications

- Digital Video Routers and Switches
- Digital Video Processing and Editing
- DVB-ASI
- Distribution Amplifiers

4 Ordering Information

Table 1. LMH0324-18EVM Ordering Information

EVM ID	DEVICE ID	DEVICE PACKAGE
LMH0324-18EVM	LMH0318RTW & LMH0324RTW	WQFN

5 Setup

This section describes the jumpers and connectors on the EVM as well as how to connect, set up, and use the LMH0324-18EVM. When operating the LMH0324-18EVM, signal inputs and outputs can be connected as shown in Figure 2.

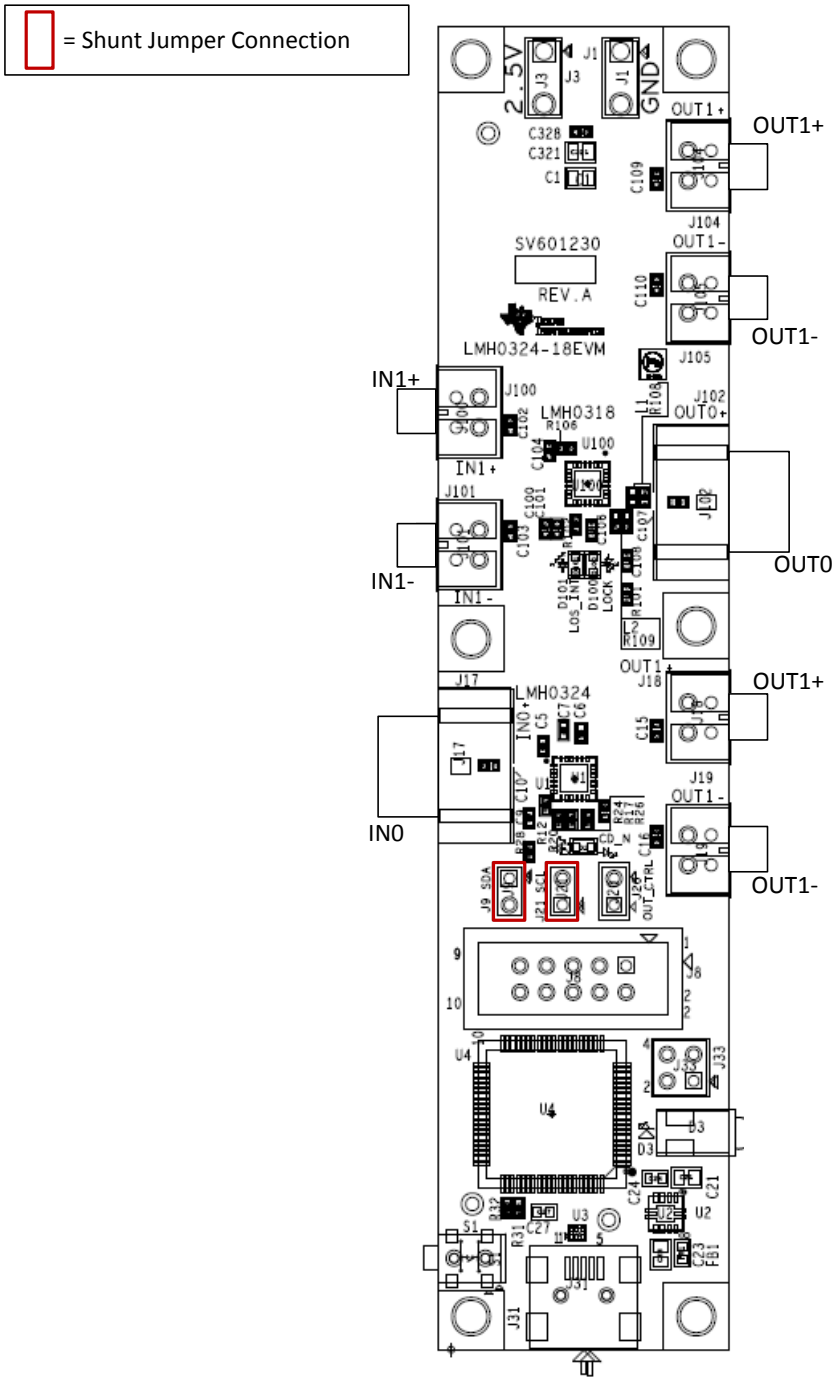

Figure 2. LMH0324-18EVM Input and Output Pins

Table 2. Input and Output Channel Connections

Signal Inputs and Outputs	
Junction Numbers	**Function**
J17	IN0+ (BNC Single-ended)
J100, J101	IN1+, IN1- (SMA)
J102	OUT0 (BNC Single-ended)
J19, J18	OUT1+, OUT1- (SMA)
J104, J105	OUT1+, OUT1- (SMA)

5.1 Modes of Operation

The LMH0324 and the LMH0318 can be programmed in one of two modes:

1. **SPI Mode** – Provides full access to the LMH0324 and LMH0318 settings via MISO, MOSI, SCK, and SSN pins.
2. **SMBus Mode** – Provides full access to the LMH0324 and LMH0318 settings via SDA, SCL, and GND pins. ADDR0 and ADDR1 pins are used for SMBus address strap.

Using either of these two modes, users have full access to all register controls in the LMH0324 and LMH0318. For convenience, the LMH0324-18EVM features an on-chip MSP430 that is configured as a USB2ANY interface between LMH0324 and LMH0318 and PC via the mini-USB port header on J31.

NOTE: Currently, the interface from PC to on-board MSP430 can only support SMBus communication.

The external control pins on the LMH0324-18EVM are used to configure the default start-up device settings. In SPI and SMBus modes, the jumpers on the LMH0324-18EVM control different functions. See Table 3 for jumper descriptions.

Table 3. Description of Connections in SMBus Mode (MODE_SEL = Level L)

Component	Name	Description/Function
J1	GND	GND power supply
J2	VDD	2.5 V VDD power supply
J9	SDA	For SDA pull-up tie Pins 1-2.
J21	SCL	For SCL pull-up tie Pins 1-2.
J103	ENABLE	Leave Pins 1 and 2 open.
J33	LOS-INT	Refer to LMH0324 and LMH0318 data sheets for detailed controls.
J16	LOCK_B	Reclocker lock indicator. Shunt Pins 1 and 2 for proper operation. Refer to LMH0324 data sheet for detailed controls.
J20	OUT_CTRL	Do not populate.

5.2 Software/Hardware Description and Setup

By factory default, the LMH0324-18EVM is configured to accept a valid SDI signal on IN0 and output the retimed data on OUT0 without programming the LMH0324-18EVM beforehand. The general procedure for setting up and testing with the LMH0324-18EVM is as follows. For hardware setup and connections in the steps below, reference the illustration in Figure 3

The general procedure for setting up and evaluating with the LMH0324-18EVM is as follows. For hardware setup and connections in the steps below, reference the illustration in Figure 3 to implement the appropriate setup.

1. Connect 2.5 V power (1 A maximum) to the EVM and install the appropriate shunt jumpers to operate in Single Supply, SMBus Mode:
    1. Connect J3: VIN = 2.5 V and J1: GND.

2. Set the control jumper shunts for appropriate operation. Reference Figure 3.
    1. Install shunt jumper on J9 Pins 1-2 for SDA pull-up.
    2. Install shunt jumper on J21 Pins 3-5 for SCL pull-up.
    3. Install shunt jumper on J16 Pins 1-2 to enable reclocker lock indicator.
2. Connect the LMH0324-18EVM to the system under test, reference Figure 3. The LMH0324-18EVM's default mode is a Distribution Amplifier. The input signal IN0, J17, is being equalized and retimed on LMH0324 and being sent to the input, IN0, of the LMH0318. Reference the block diagram in Figure 8.
    1. Using a 75 Ω coax cable, connect the output of the video pattern generator to the LMH0324-18EVM IN0 (J17).
    2. The LMH0324 output signals on OUT1- (J19) and OUT1+ (J18) can be connected with matched 100 Ω differential cables to an oscilloscope for output eye monitor or an external cable driver. This output can also be used as a secondary input to the LMH0318 through IN1+ (J100) and IN1- (J101).
    3. The output signals on the LMH0318's OUT1+ (J104) and OUT1- (J105) can be connected with matched 100 Ω differential cables to an oscilloscope for output eye monitor. Alternatively, LMH0318's OUT0 (J102) can be connected with 75 Ω coax cable to a video analyzer.

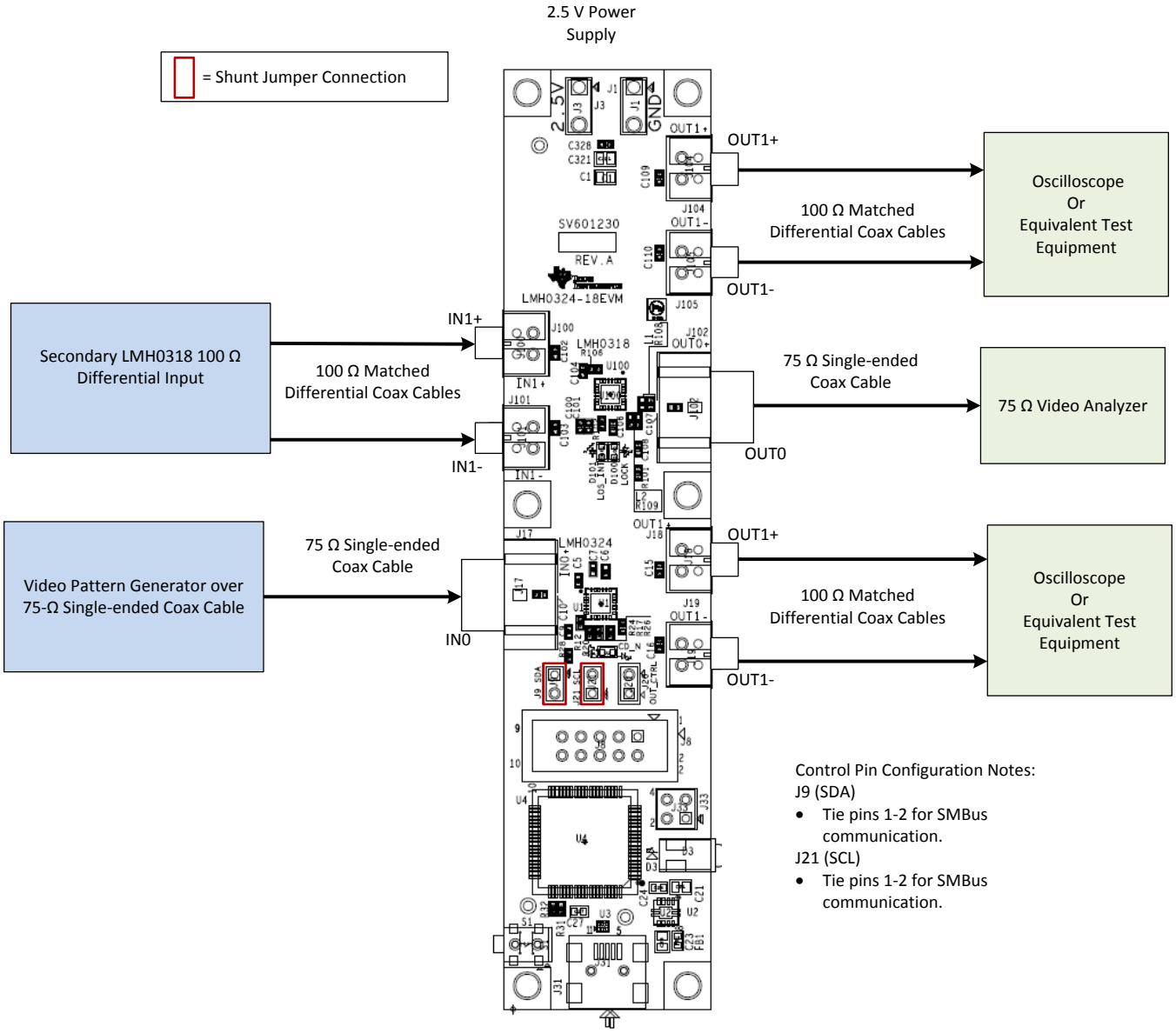

Figure 3. LMH0324-18EVM Configured for Single Supply, SMBus Operation

6 Example Waveforms

6.1 *LMH0324 Jitter vs. Cable Measurements*

Figure 4 and Figure 5 show LMH0324 OUT1 eye diagram under the following conditions:

- Input signal pattern: PRBS10
- VID: 800 mVp-p
- VIN = 2.5 V, T = 25°C

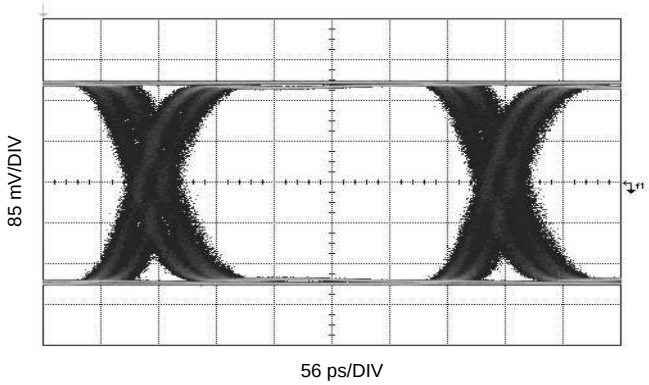

Figure 4. 2.97 Gbps - 150 m Belden 1694A PRBS10

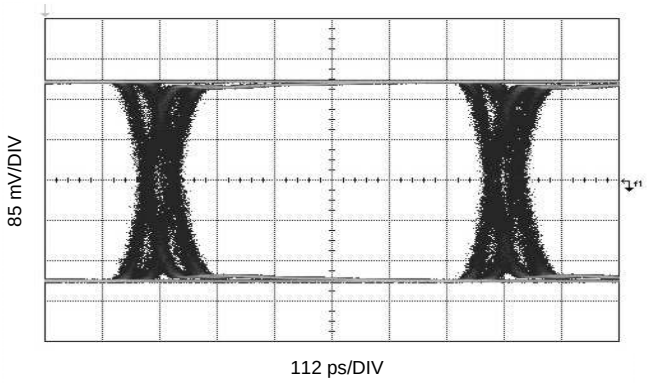

Figure 5. 1.485 Gbps - 200 m Belden 1694A PRBS10

6.2 LMH0318 OUT0 Eye Diagram

Figure 6 show LMH0318 OUT0 eye diagram under the following conditions:

- Input Signal Pattern: PRBS10
- Measured Rise / Fall Time (Tr / Tf) at 20% to 80%
- VIN = 2.5 V, T = 25°C

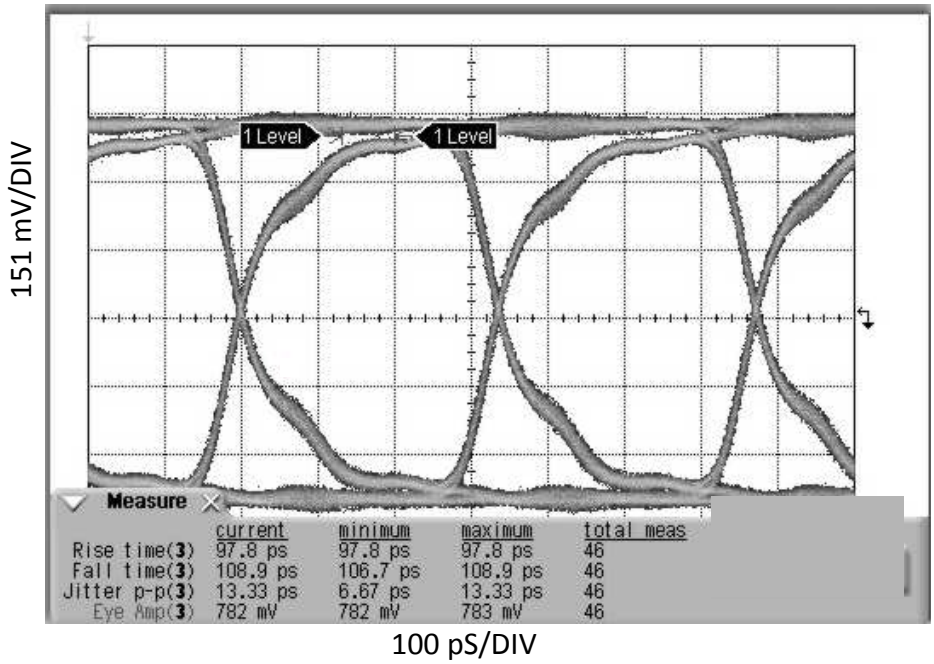

Figure 6. LMH0318 2.97 Gbps PRBS10

6.2.1 Input and Output Return Loss

Figure 7 show LMH0318 OUT0 and LMH0324 IN0 return loss under the following conditions:

- LMH0318 OUT0 muted
- VIN = 2.5 V, T = 25°C

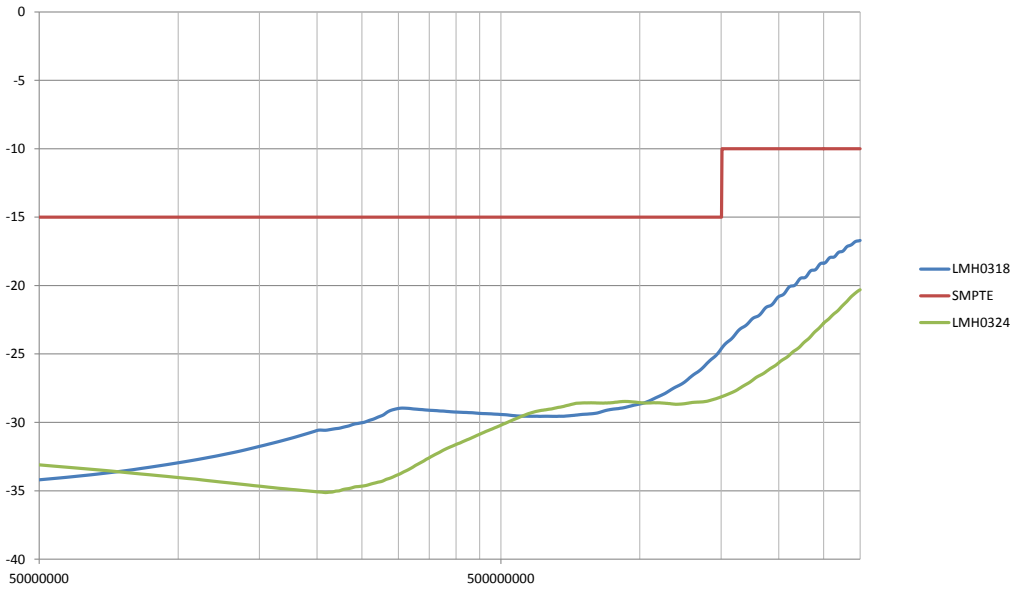

Figure 7. LMH0318 and LMH0324 Return Loss vs SMPTE Specification

7 Bill of Materials

#	Quantity	Designator	Value	Manufacturer	Part Number	Description
1	1	PCB		Any	Any	Printed Circuit Board
2	1	C1	10uF	AVX	0805YD106MAT2A	CAP CER 10uF 16V 20% X5R 0805
3	6	C5,C6,C7,C8, C104, C328	0.1uF	TDK	C1005X5R0J104K050BA	CAP CERM 4.7 µF 10 V 10% X5R 0402
4	4	C9, C10, C15, C16	4.7uF	TDK	C1005X5R1A475K050BC	CAP CER 4.7UF 10V 10% X5R 0402
5	2	C17, C105	1uF	TDK	C1005X5R0J105M050BB	CAP CER 1UF 6.3V 20% X5R 0402
6	2	C21, C321	2.2uF	AVX	0805YD225KAT2A	CAP CER 2.2UF 16V 10% X5R 0805
7	1	C22	22uF	Panasonic - ECG	EEE-1AA220WR	CAP ALUM 22UF 10V 20% SMD
8	1	C23	1uF	AVX	C2012X7R1C105K/1.25	CAP CER 1UF 16V 10% X7R 0805
9	1	C24	0.01uF	TDK	C1608X7R1H103K080AA	CAP CER 10000PF 50V 10% X7R 0603
10	4	C25,C31,C32,C34	0.1uF	AVX	0603YC104JAT2A	CAP CER 0.1UF 16V 5% X7R 0603
11	2	C26,C27	220pF	AVX	06035A221FAT2A	CAP CER 220PF 50V 1% NP0 0603
12	2	C28,C29	30pF	MuRata	GRM1885C2A300JA01D	CAP CER 30PF 100V 5% NP0 0603
13	1	C30	2200pF	Kemet	C0603X222K5RACTU	CAP CER 2200PF 50V 10% X7R 0603
14	1	C33	0.47uF	Murata	GRM188R71A474KA61D	CAP CER 0.47UF 100V 10% X7R 0603
15	8	C100, C101, C102, C103, C107, C108, C109, C110	4.7uF	TDK	C1005X5R0J475M050BC	LED 565NM GRN DIFF 0603 SMD
16	1	C106	0.022uF	MuRata	GRM155R61C223KA01D	DIODE ZENER 7.5V 550mW SMB
17	3	D1, D100, D101	Green	Lumex	SML-LX0603GW-TR	LED 3MM RA GREEN DIFFUSED SMD
18	1	D2	7.5V	ON Semiconductor	1SMB5922BT3G	FERRITE BEAD 60 OHM 0603
19	1	D3	Green	Lumex	SSF-LXH305GD-TR	Fiducial mark. There is nothing to buy or mount.
20	1	FB1	60 ohm	Taiyo Yuden	BK1608HS600-T	Ferrite Bead, 60 ohm @ 100 MHz, 0.8 A, 0603
21	6	H1, H2, H3, H4, H5, H6		B&F Fastener Supply	NY PMS 440 0025 PH	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead
22	6	H7, H8, H9, H10, H11, H12		KeyStone	1902C	Standoff, Hex, 0.5"L #4-40 Nylon
23	2	J1, J3		KeyStone	1212-ST	Disconnect Terminal, 5.08mm, 2x1, Tin, TH
24	1	J8		TE Connectivity	5103308-1	Header (shrouded), 100mil, 5x2, Gold, TH
25	3	J9, J20, J21		TE Connectivity	5-146278-2	Header, 100mil, 2x1, Tin, TH
26	2	J17, J102		Samtec	BNC7T-J-P-GN-ST-EM1D	Connector, BNC Edge Mount, SMD
27	6	J18, J19, J100, J101, J104, J105		Emerson Network Power	142-0771-821	Connector, TH, End launch SMA 50 ohm
28	1	J31		TE Connectivity	1734035-2	Connector, Receptacle, Mini-USB Type B, R/A, Top Mount SMT
29	1	J33		Samtec	TSW-102-07-G-D	Header, 100mil, 2x2, Gold, TH
30	2	L1, L2	3.3 nH	Murata	LQG15HS3N3S02D	Inductor, 3.3nH, 0402

#	Quantity	Designator	Value	Manufacturer	Part Number	Description
31	1	Q1	50V	Fairchild Semiconductor	BSS138	MOSFET, N-CH, 50 V, 0.22 A, SOT-23
32	2	R1,R2	2.00k	Vishay-Dale	CRCW04022K00FKED	RES, 2.00k ohm, 1%, 0.063W, 0402
33	11	R12, R16, R17, R20, R23, R24, R25, R102, R103, R104, R106	1.00k	Vishay-Dale	CRCW04021K00FKED	RES 1.00K OHM 0.063W 1% 0402 SMD
34	3	R21, R105, R107	220	Vishay-Dale	CRCW0402220RJNED	RES, 220 ohm, 5%, 0.063W, 0402
35	2	R28, R101	75.0	Vishay-Dale	CRCW040275R0FKED	RES, 75.0 ohm, 1%, 0.063W, 0402
36	2	R31, R32	33	Vishay-Dale	CRCW040233R0JNED	RES, 33 ohm, 5%, 0.063W, 0402
37	1	R33	1.5k	Vishay-Dale	CRCW04021K50JNED	RES, 1.5k ohm, 5%, 0.063W, 0402
38	2	R34, R36	33k	Vishay-Dale	CRCW040233K0JNED	RES, 33k ohm, 5%, 0.063W, 0402
39	1	R35	1.2Meg	Vishay-Dale	CRCW06031M20JNEA	RES, 1.2Meg ohm, 5%, 0.1W, 0603
40	1	R37	200	Vishay-Dale	CRCW0603200RFKEA	RES, 200 ohm, 1%, 0.1W, 0603
41	2	R26, R27	0	Vishay-Dale	CRCW06030000Z0EA	RES, 0, 5%, 0.1 W, 0603
42	2	R108, R109	75	Vishay-Dale	RC0402FR-0775RL	Resistor, 75-ohm, 1/16W, 1%, 0402
43	1	S1		Panasonic	EVQ-PSD02K	Switch, Tactile, SPST-NO, SMT
44	7	SH-J9, SH-J20, SH-J21	1x2	3M	969102-0000-DA	Shunt, 100mil, Gold plated, Black
45	1	u1		Texas Instruments	LMH0324RTWR	3G HD/SD SDI Adaptive Cable Equalizer, RTW0024A
46	1	U2		Texas Instruments	TPS73533DRBR	500mA, Low Quiescent Current, Ultra-Low Noise, High PSRR Low-Dropout Linear Regulator, DRB0008A
47	1	U3		Texas Instruments	TPD4E004DRY	IC, 4-Chan ESD-Protection Array
48	1	U4		Texas Instruments	MSP430F5529IPN	25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)
49	1	U100		Texas Instruments	LMH0318RTWR	Low Power Ultra HD Cable Driver with Integrated Reclocker, RTW0024A
50	1	Y1		ECS Inc	ECS-240-20-5PX-TR	CRYSTAL 24MHZ 20PF SMD
51	6	FID1, FID2, FID3, FID4, FID5, FID6		N/A	N/A	Fiducial mark. There is nothing to buy or mount.

8 Block Diagram and Schematic

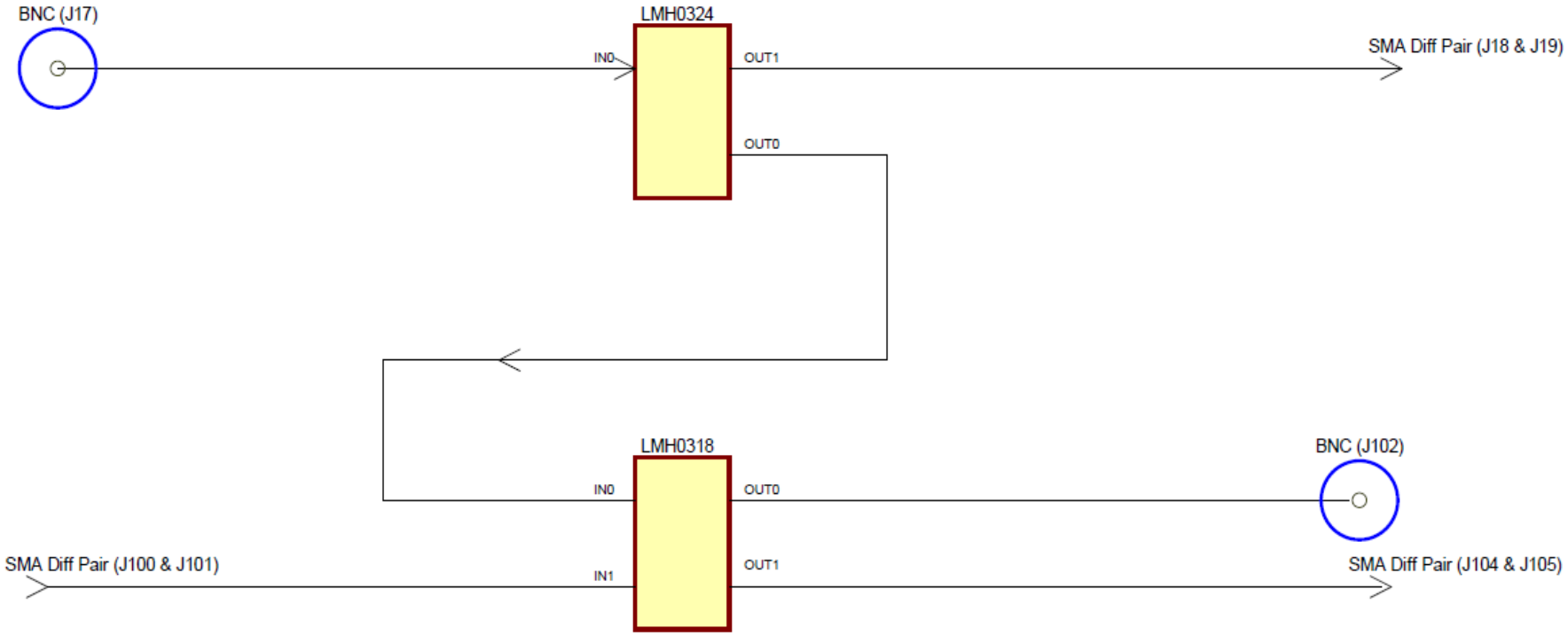

Figure 8. LMH0324-18EVM Block Diagram

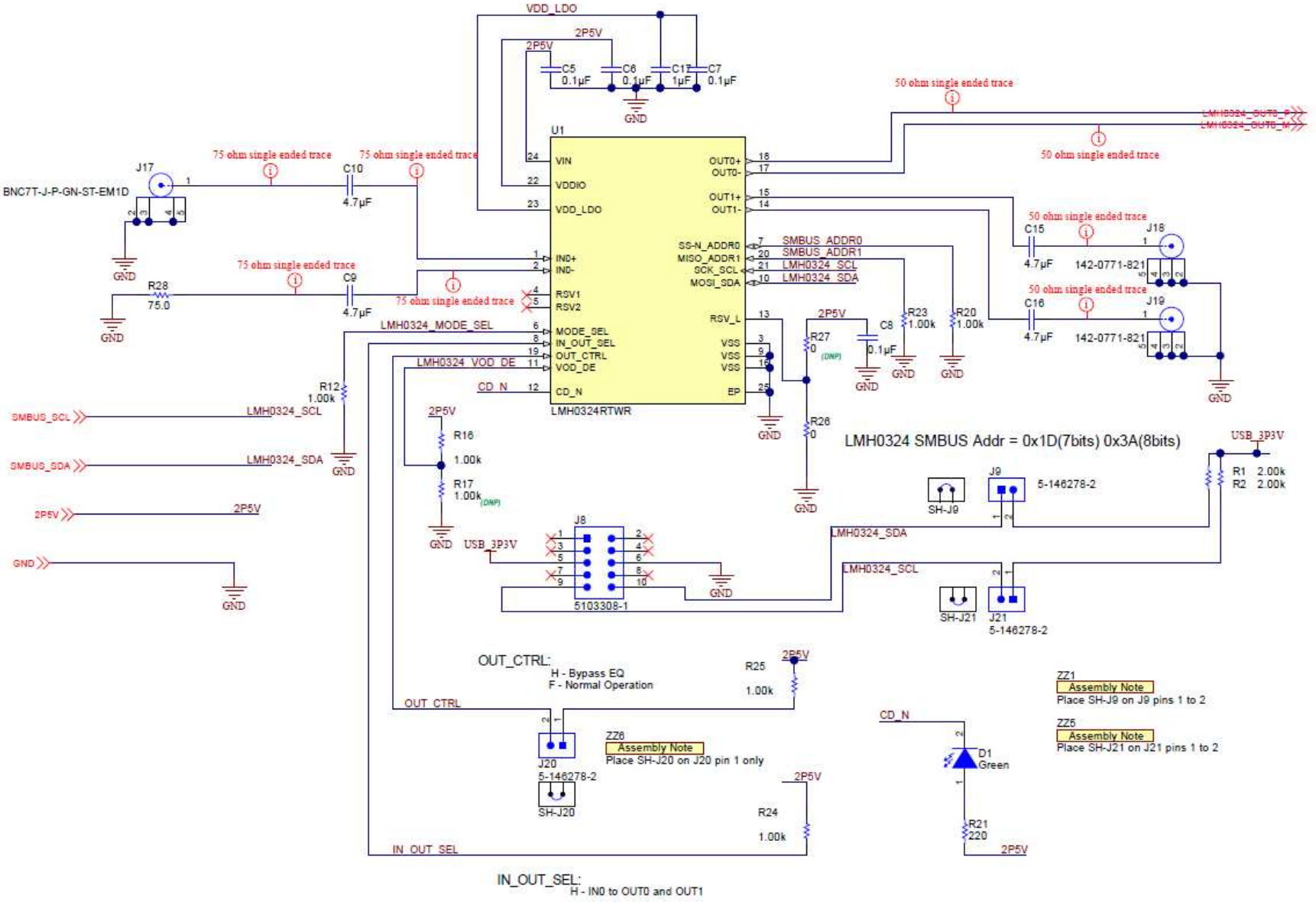

Figure 9. LMH0324 Schematic Page

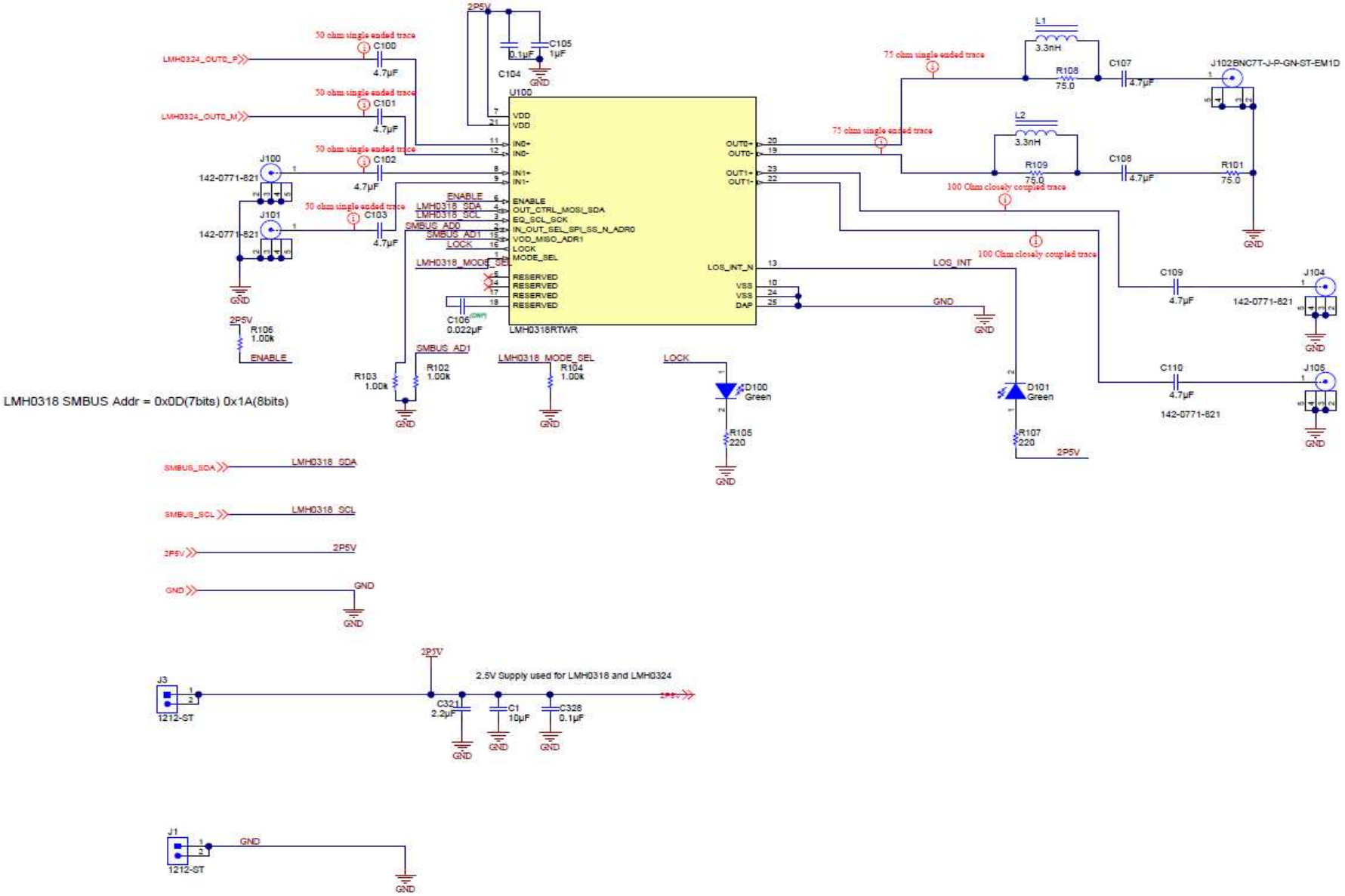

Figure 10. LMH0318 Schematic Page

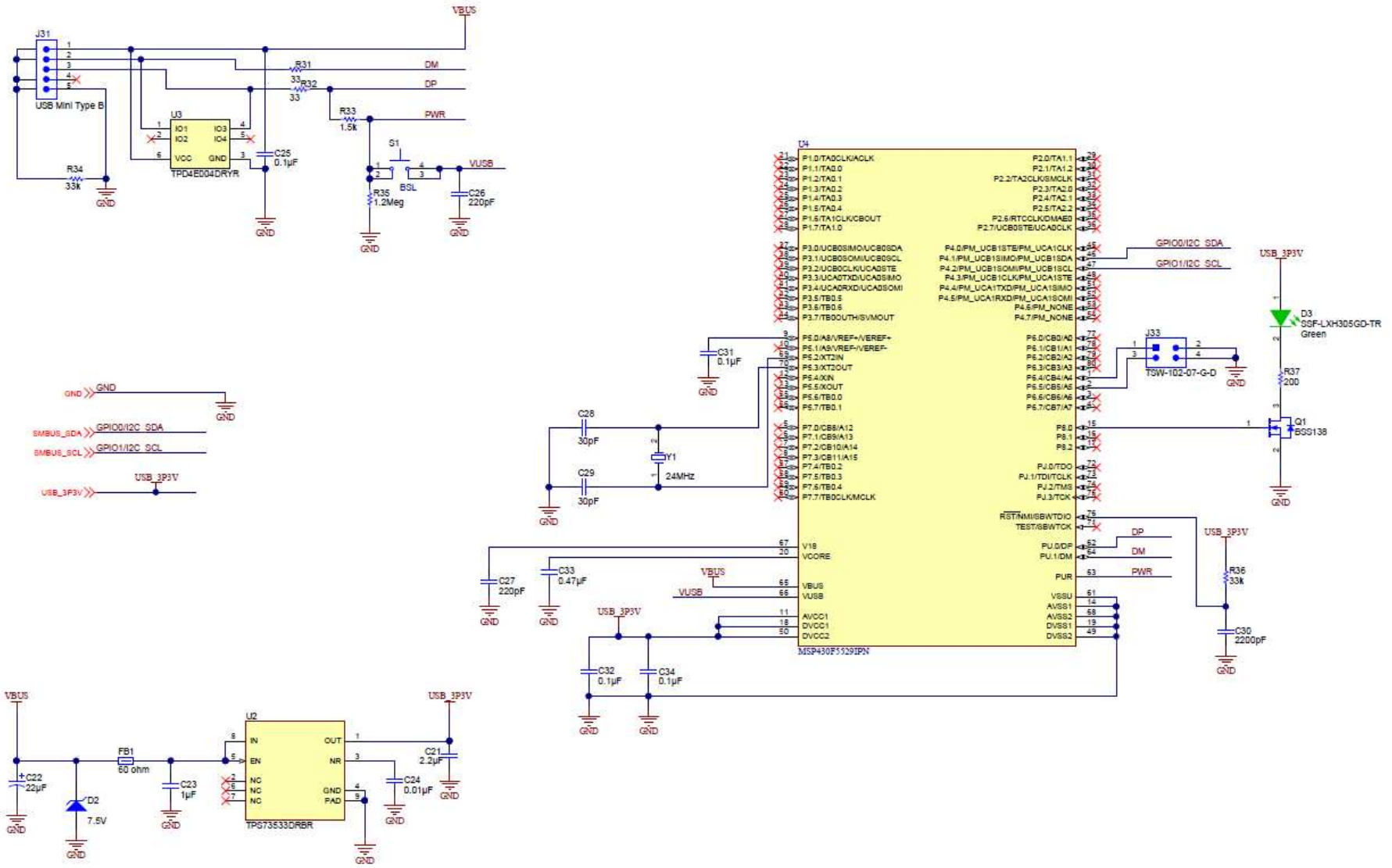

Figure 11. MSP430 USB2ANY Schematic Page

9 EVM Layout

Figure 12 and Figure 13 show the LMH0324-18EVM layout. The evaluation board controls signal integrity control settings via jumper pins.

The LMH0324-18EVM allows input access to LMH0318 IN1+/- and LMH0324 IN0+. The LMH0324's OUT0± is routed internally to LMH0318's IN0± . The LMH0318's IN1± is routed to 100 Ω differential SMA connectors. The LMH0324's IN0+ is routed to a single-ended BNC connector. The LMH0324-18EVM allows access to all output channels. The LMH0324 has two 100 Ω differential outputs. The OUT1± is routed to J18 and J19. The LMH0318's OUT1± is routed to J104 and J105. The WQFN package offers an exposed thermal pad to enhance electrical and thermal performance. This must be soldered to the copper landing on the PCB.

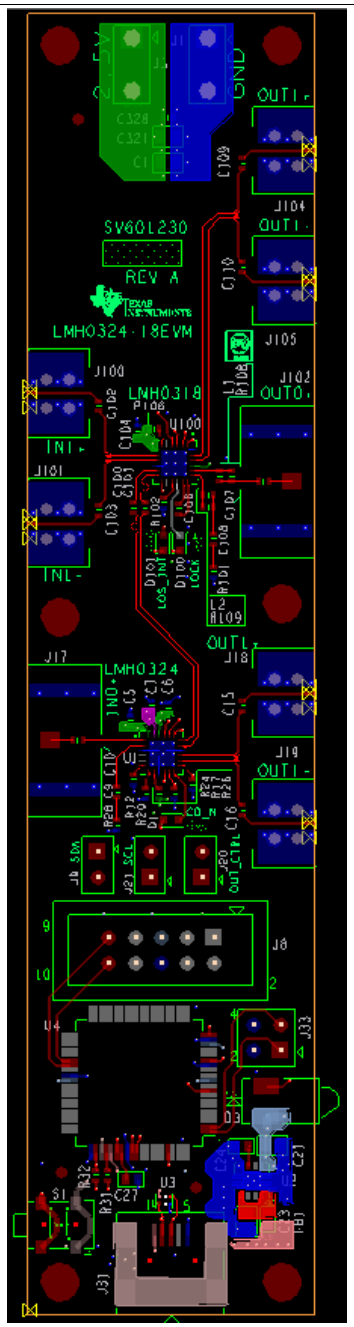

Figure 12. LMH0324-18EVM Top Layer

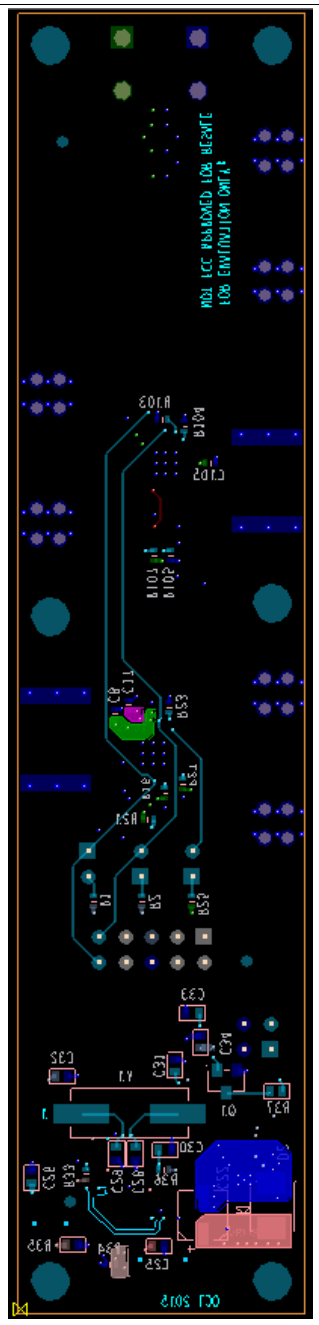

Figure 13. LMH0324-18EVM Bottom Layer

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Original (March 2016) to A Revision	Page
• First release to Web	4

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 semiconductors 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.

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/lsds/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。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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２４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/lsds/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。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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.

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.

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, INDEMITY 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.

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

IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ('TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications that include TI products, you will thoroughly test such applications and the functionality of such TI products as used in such applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources 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.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your non-compliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products http://www.ti.com/sc/docs/stdterms.htm), evaluation modules, and samples (http://www.ti.com/sc/docs/sampterms.htm).

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