LMH6401 Evaluation Module (EVM)

The LMH6401 evaluation module (EVM) is used to evaluate the single LMH6401, digitally-controlled variable gain amplifier (DVGA) in a 16-lead high performance RF package. The EVM is designed to quickly and easily demonstrate the functionality and performance of LMH6401 across all the gain settings. The EVM is ready to connect to power supplies, signal source, USB, and test instruments through the use of onboard connectors. The board is set up for differential input and output operation. The EVM requires an external 180° phase-shifted combiner to convert single-ended signals to differential signals for use with standard single-ended 50-Ω laboratory equipment. By default, the LMH6401EVM powers up to the –6 dB or minimum gain setting with the board supporting single-supply or split-supply operation. An USB connector on the EVM facilitates programming of the DVGA gain registers using an FTDI USB-to-SPI bus translator chip.

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1 Features

The key features of this EVM include:

- Configured for split-supply operation and easily modified for single supply
- Designed for DC or AC coupled differential input and output connection
- Simple Interface to the Inputs and Outputs using SMA connectors
- USB connector and FTDI USB-to-SPI bus translator chip to successfully program the DVGA gain registers

Figure 1 shows the LMH6401EVM board.

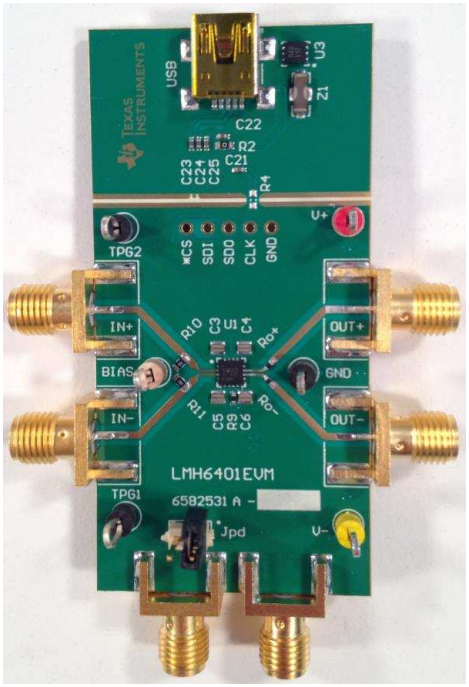

Figure 1. LMH6401EVM Board

2 EVM Specifications

Table 1 lists the EVM specifications.

Table 1. EVM Specifications

Parameter		Value
V_S	Single-supply voltage range (V– = ground)	4 V to 5.25 V
V_S±	Split-supply voltage range (not limited to be symmetric)	±2 V to ±2.625 V
GND	Ground reference pins	([V+] –2 V) to V–
PD	Power down (PD) input voltage	GND to V_S
I_S±	Supply current	69 mA
I_{IN}	Input Voltage	V_S±, Max

3 Evaluation Board Setup Block Diagram

The following sections help in setting up the LMH6401 evaluation board hardware and software required to program the internal registers of the LMH6401.

Figure 2 illustrates the LMH6401 evaluation board setup block diagram.

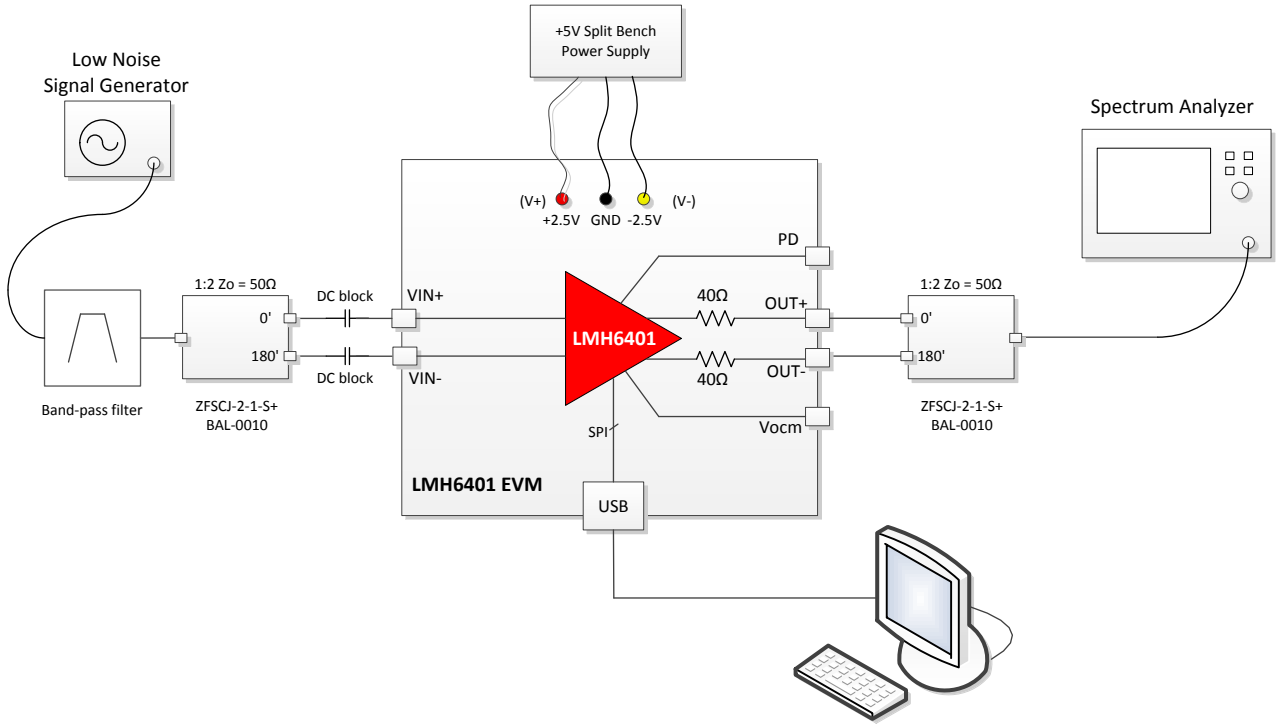

Figure 2. LMH6401 Evaluation Board Setup Block Diagram

4 Setup Procedure

This section describes the hardware setup procedure and the installation of the software to program the LMH6401 registers.

4.1 Connect EVM to an External Balun for Balanced Signal Connection

1. The LMH6401 evaluation board provides the customer flexibility in testing at different input frequencies using external input and output balun as shown in Figure 2. A good suggestion of low- and high-frequency test baluns is also provided in Figure 2.
2. TI recommends to AC couple the inputs using external 50-Ω DC block capacitor like Mini-circuits BLK-89-S+. Also recommended is using external 6-dB attenuator pads at the inputs and outputs while doing harmonic distortion and inter-modulation distortion measurements.

4.2 Connect EVM to a ±2.5-V Split Bench Power Supply

1. While the supplies are turned OFF, connect the evaluation board power supply pins (V+, GND and V–) to a split power supply of +2.5 V, GND, and –2.5 V, as shown in Figure 2 using a low-noise bench power supply. Note that supply voltages do not need to be symmetrical, provided the total supply voltage is between 4.0 V and 5.25 V with any combination of positive and negative supply voltages is acceptable, as long as the minimum positive supply voltage to ground is 2 V, or greater.
2. Turn ON the bench supplies after the power supply connections have been made. The LMH6401 evaluation board should read an approximate DC current of 69 mA for ±2.5-V split supply.
3. To operate as a single supply, connect the power supply pin V– to GND, and apply the positive supply voltage to V+. Inputs and outputs must be biased as in the LMH6401 datasheet (SBOS730) specifications for proper operation.

4.3 VOCM (Output Common Mode Voltage) Input

1. The LMH6401EVM offers a VOCM SMA connector input to control the output common mode voltage of LMH6401 device.
2. By default, the evaluation board is configured with a resistive divider to set the output common mode voltage at the mid-supply voltage. If a different output common-mode voltage is required, the SMA connector can connect to the specified external voltage source.
3. The valid voltage range for the CM pin is approximately ([V+] –2 V) to ([V–] +2 V). See the LMH6401 datasheet (SBOS730) for performance curves that show how performance is impacted by an output common mode voltage that is not at the mid-supply voltage.

4.4 PD (Power Down) Input

1. The LMH6401EVM has a jumper (Jpd) that allows the amplifier to be manually disabled. The LMH6401 EVM consumes close to 9 mA of supply current in power down state.
2. The PD SMA input connector facilitates driving the LMH6401 PD pin with a high-speed signal source. The resistor-capacitor combination (Rsd/C9) in the LMH6401EVM provides high-frequency termination for signals from a 50-Ω pulse generator.

4.5 Connect EVM to the PC and LMH6401 EVM GUI Installation

The LMH6401 EVM GUI is used to control the LMH6401 EVM. It must be used to properly configure the LMH6401 device.

1. Download the LMH6401 EVM GUI (SBOC451) from the TI website. The References section of this document contains links to find the software on the TI website.
2. Extract the files from the zip file.
3. Run setup.exe and follow the installation prompts.
4. Connect the LMH6401EVM to the PC using a mini-USB cable.
5. Open the LMH6401 EVM GUI by going to Start Menu → All Programs → Texas Instruments → LMH6401 EVM GUI.
6. Verify that the green USB Status indicator is lit in the top right corner of the GUI. If it is not lit, click the *Reconnect USB* button and check the USB Status indicator again. If it is still not lit, then verify the EVM is connected to the computer through the included mini-USB cable.
7. Follow the instructions in Section 5: Amplifier Device Register Configuration to correctly use the GUI to program the LMH6401 device registers.
8. The DVGA register address and configuration values are found in the LMH6401 device datasheet (SBOS730).

5 Amplifier Device Register Configuration

The LMH6401 is programmable via the serial programming interface (SPI) bus accessible through the FTDI USB-to-SPI converter chip located on the EVM. A GUI is provided to write instructions on the bus and program the registers of the LMH6401.

The LMH6401 gain can be controlled from –6 dB to 26 dB in 1-dB steps using register address 2h. The amplifier is programmed to the maximum gain (26 dB) when a value 0h is written to register 2h, whereas a value 20h written to register 2h programs the device to the minimum gain (–6 dB) setting. Table 2 shows the default LMH6401 SPI register map on power up. For more information about the registers in the LMH6401, see the LMH6401 datasheet (SBOS730).

Table 2. LMH6401 Default SPI Register Map

Address (A[6:0], Hex)	R/W	Register	Default
0	R	Revision ID	03h
1	R	Product ID	00h
2	R/W	Gain Control	20h (min gain)
3	R/W	Reserved	8Ch
4	R/W	Thermal feedback gain	27h
5	R/W	Thermal feedback frequency	45h

5.1 LMH6401 EVM GUI

The software GUI allows for full register programming control of the LMH6401. Figure 3 shows the front page of the LMH6401 EVM GUI as it should be seen upon opening the GUI. Descriptions for each of the tabs of the GUI are shown in Table 3.

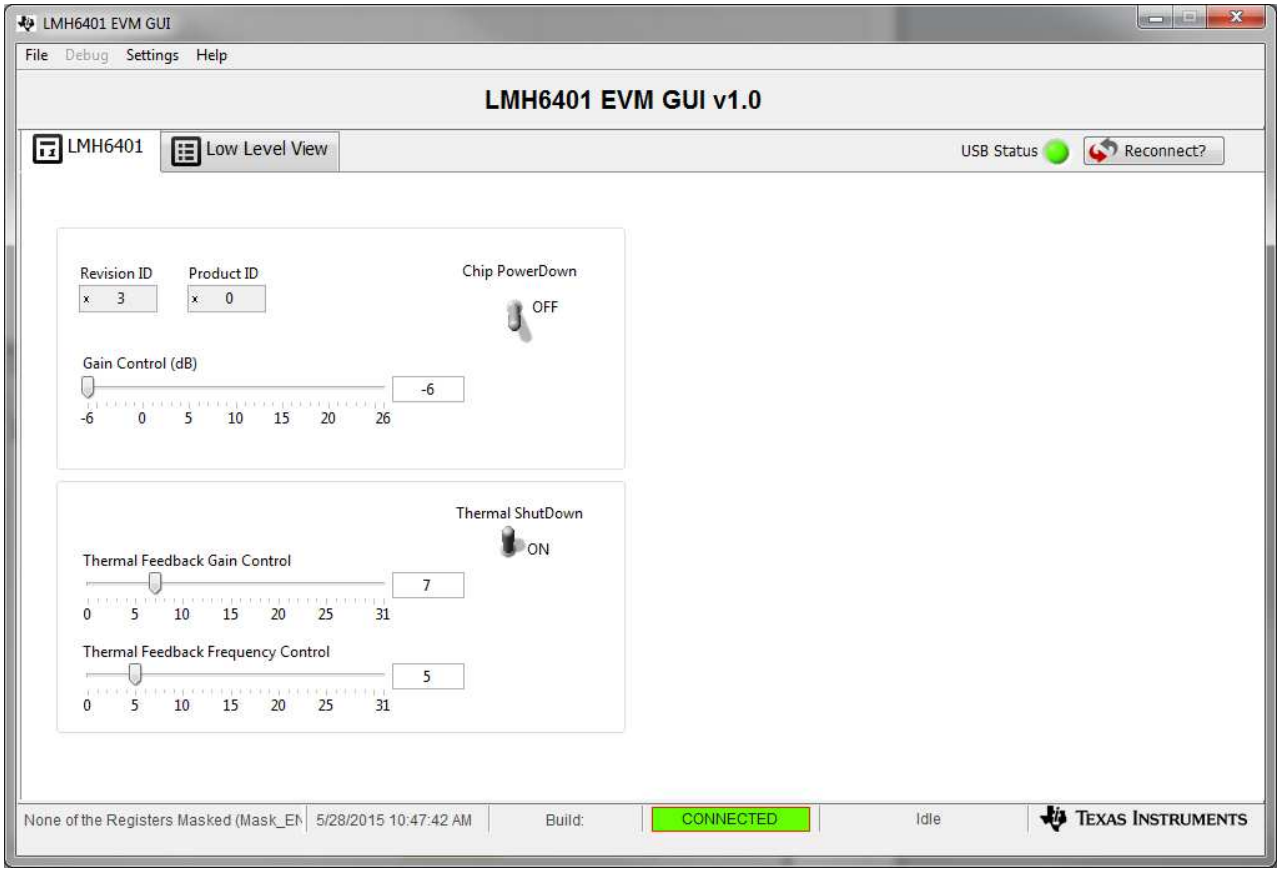

Figure 3. LMH6401 EVM GUI Front Page

Table 3. LMH6401 GUI Tab Descriptions

Tab	Description
LMH6401	Enables control of the LMH6401 features. None of these controls need to be touched for basic operation. Instead, use the Low Level View tab to load configuration files.
Low Level View	Allows write and read access to all device registers. Also allows loading and saving of configuration files. The device configurations can be saved from this tab for use in the user's system. See Figure 4 for more information.

5.2 Low Level View

The Low Level View tab, shown in Figure 4, allows configuration of the devices at the bit and field level. At any time, the controls described in Table 4 may be used to configure or read from the device.

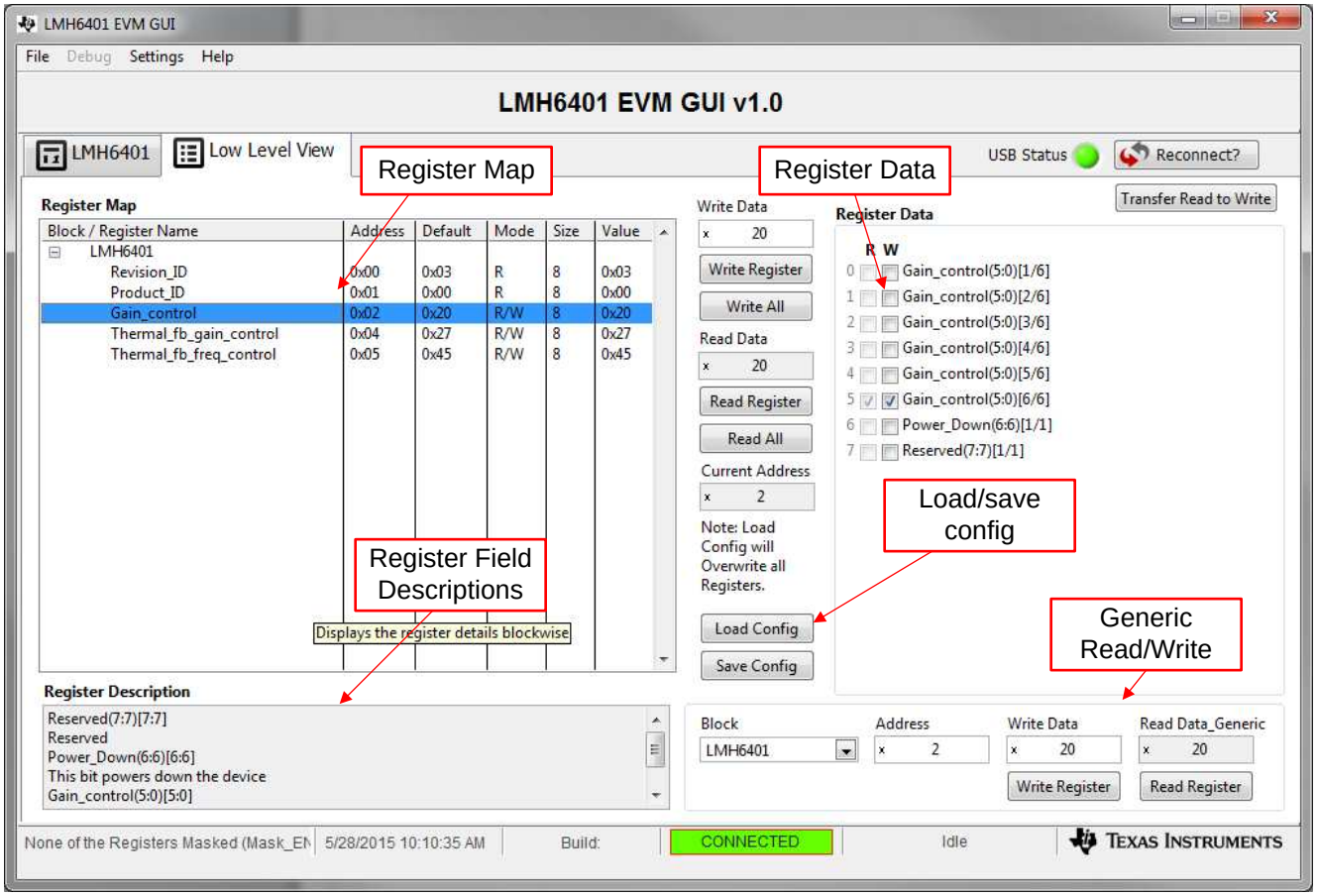

Figure 4. Low Level View Tab

Table 4. Low Level View Controls

Control	Description
Register Map	Displays the devices on the EVM, registers for those devices, and the states of the registers: • Selecting a register field allows bit manipulation in the Register Data section. • The Value column shows the value of the register at the time the GUI was last updated due to a read or write event.
Write Register button	Write to the register highlighted in the Register Map with the value in the Write Data field. This button must be clicked after changing bits in the register data section.
Write All button	Update all registers shown in the Register Map with the values shown in the Register Map log. The log can be viewed by double left clicking in the bottom left status bar of this page.
Read Register button	Read from the register highlighted in the Register Map and display the results in the Value column.
Read All button	Read from all registers in the Register Map and display the current state of hardware. Also updates the controls in the other tabs.
Load Config button	Load a configuration file from disk and write the registers in the file.
Save Config button	Save a configuration file to disk that contains the current register configuration.
Register Data Cluster	Manipulate individual accessible bits of the register highlighted in the Register Map.
Generic Read/Write Register buttons	Perform a generic read or write command to the device shown in the Block drop-down box using the Address and Write Data information.

6 Evaluation Troubleshooting

Issue	Troubleshoot
Problem to read/write the LMH6401 device using the LMH6401 EVM GUI:	Verify that the green USB Status indicator is lit in the top right corner of the GUI. If it is not lit, click the *Reconnect USB* button and check the *USB Status* indicator again. If it is still not lit, then verify the EVM is connected to the computer through the included mini-USB cable.
	Check to see whether the connectors to power supply pins of the LMH6401 EVM are connected properly and turned ON. The nominal supply current for the LMH6401EVM for +5-V supply is approx 69-mA current.
Low Supply Current:	See if the device is disabled by the Jpd jumper. Also, check to see if the power supply is set to the right voltage.
No Supply Current:	See if the power supply cable connections are connected and the power switch of the source is turned ON.
High Supply Current:	It could be the reverse supply protection diodes conducting. Turn off the power switch and make sure the positive supply is connected to the proper pin. Turn the power back on to see if the right supply current is recorded.

7 LMH6401 EVM Schematic, Layer Prints, and Bill of Materials

This section contains the EVM schematic, PCB layouts, and the bill of materials (BOM).

7.1 Schematic

Figure 5 and Figure 6 illustrate the LMH6401EVM schematic

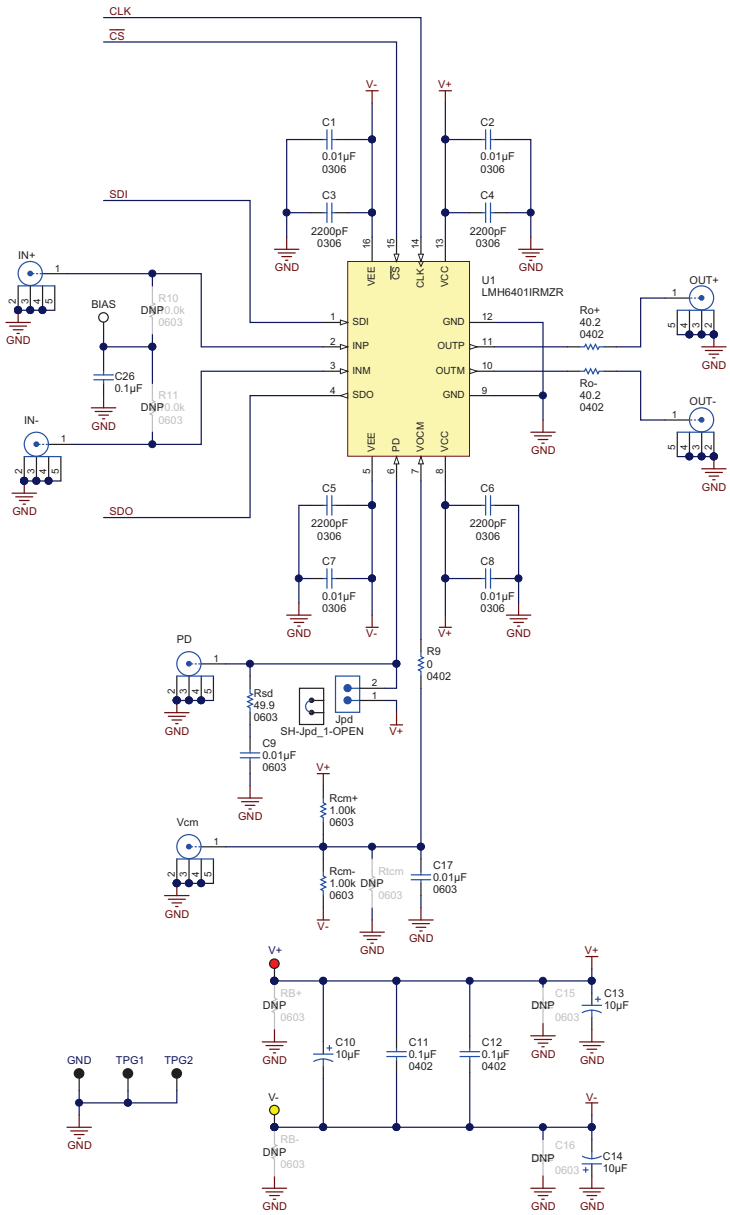

Figure 5. Schematic - Analog

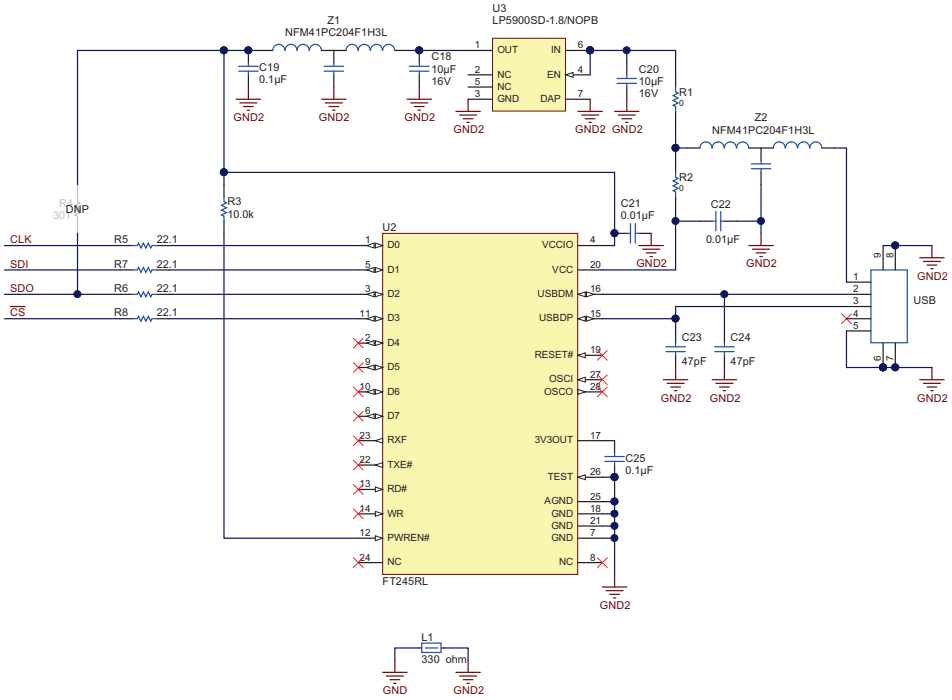

Figure 6. Schematic - Digital

7.2 Layer Prints

Figure 7 through Figure 12 illustrate the LMH6401EVM layer prints.

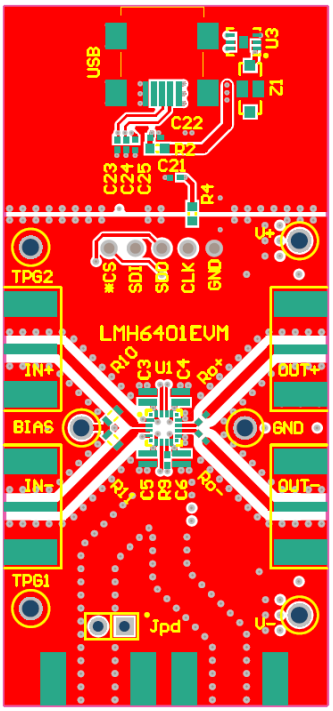

Figure 7. Top Layer

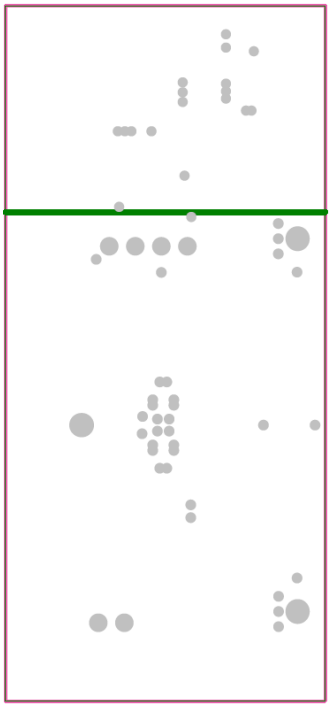

Figure 8. Layer 2 Ground Plane

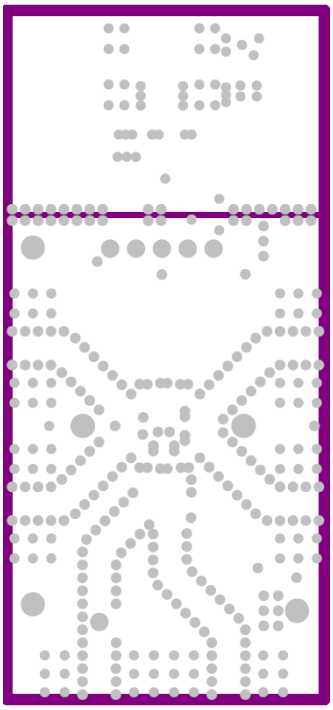

Figure 9. Layer 3 V+ Plane

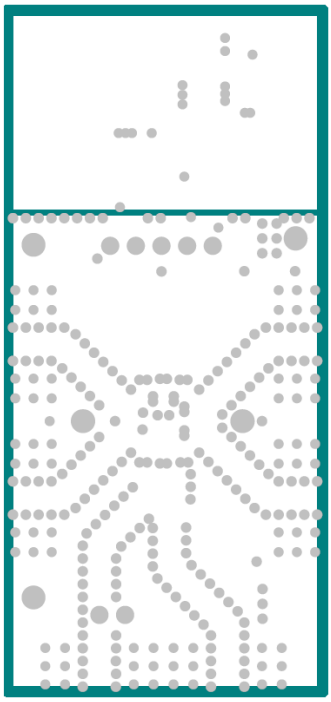

Figure 10. Layer 4 V- Plane

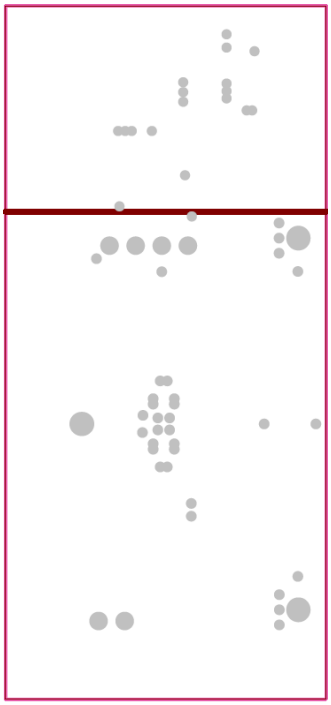

Figure 11. Layer 5 Ground Plane

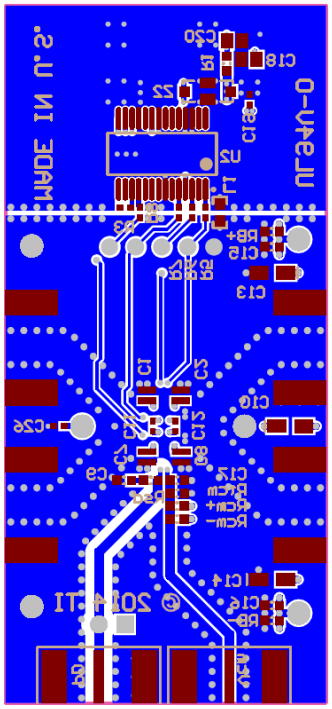

Figure 12. Bottom Layer

7.3 Bill of Materials

Table 5. LMH6401EVM Bill of Materials

Item	Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
1	BIAS	1	White	Test Point, Multipurpose, White, TH	White Multipurpose Test-point	5012	Keystone
2	C1, C2, C7, C8	4	0.01 µF	CAP, CERM, 0.01µF, 25V, +/-20%, X7R, 0306	0306	LLL185R71E103MA01L	Murata
3	C3, C4, C5, C6	4	2200 pF	CAP, CERM, 2200pF, 50V, +/-20%, X7R, 0306	0306	LLL185R71H222MA01L	Murata
4	C9, C17	2	0.01 µF	CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0603	0603	GRM188R71C103KA01D	Murata
5	C10, C13, C14	3	10 µF	CAP, TA, 10uF, 10V, +/-10%, 0.9 ohm, SMD	3216-18	TPSA106K010R0900	AVX
6	C11, C12, C19, C25, C26	5	0.1 µF	CAP, CERM, 0.1uF, 10V, +/-10%, X5R, 0402	0402	C1005X5R1A104K	TDK
7	C18, C20	2	10 µF	CAP, CERM, 10uF, 16V, +/-10%, X5R, 0805	0805	EMK212BJ106KG-T	Taiyo Yuden
8	C21, C22	2	0.01 µF	CAP, CERM, 0.01uF, 16V, +/-10%, X7R, 0402	0402	C1005X7R1C103K	TDK
9	C23, C24	2	47pF	CAP, CERM, 47pF, 50V, +/-5%, C0G/NP0, 0402	0402	GRM1555C1H470JZ01	Murata
10	GND, TPG1, TPG2	3	Black	Test Point, TH, Multipurpose, Black		5011	Keystone Electronics
11	IN+, IN-, OUT+, OUT-, PD, Vcm	6		Connector, SMT, End launch SMA 50 ohm	SMA End Launch	142-0701-851	Emerson Network Power
12	Jpd	1		Header, TH, 100mil, 2x1, Gold plated, 230 mil above insulator	TSW-102-07-G-S	TSW-102-07-G-S	Samtec, Inc.
13	L1	1	330 ohm	1.5A Ferrite Bead, 330 ohm @ 100MHz, SMD	0603	BLM18SG331TN1D	Murata
14	R1, R2	2	0	RES, 0 ohm, 5%, 0.1W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
15	R3	1	10.0k	RES, 10.0k ohm, 1%, 0.063W, 0402	0402	CRCW040210K0FKED	Vishay-Dale
16	R5, R6, R7, R8	4	22.1	RES, 22.1 ohm, 1%, 0.063W, 0402	0402	CRCW040222R1FKED	Vishay-Dale
17	R9	1	0	RES, 0 ohm, 5%, 0.063W, 0402	0402	ERJ-2GE0R00X	Panasonic
18	Rcm+, Rcm-	2	1.00k	RES, 1.00k ohm, 1%, 0.1W, 0603	0603	CRCW06031K00FKEA	Vishay-Dale
19	Ro+, Ro-	2	40.2	RES, 40.2 ohm, 1%, 0.063W, 0402	0402	CRCW040240R2FKED	Vishay-Dale
20	Rsd	1	49.9	RES, 49.9 ohm, 1%, 0.1W, 0603	0603	CRCW060349R9FKEA	Vishay-Dale
21	SH-Jpd_1-OPEN	1	1x2	Shunt, 100mil, Gold plated, Black		382811-6	AMP
22	U1	1		5 GHz Ultra Wideband Digital Variable Gain Amplifier, RMZ0016A	RMZ0016A	LMH6401IRMZR	Texas Instruments
23	U2	1		USB FIFO IC, 28SSOP	SSOP28	FT245RL	FTDI
24	U3	1		Ultra Low Noise, 150mA Linear Regulator for RF/Analog Circuits Requires No Bypass Capacitor, 6-pin LLP, Pb-Free	SDB06A	LP5900SD-1.8/NOPB	Texas Instruments
25	USB	1		MINI USB 2.0 SMT TYPE AB 5 CONTACTS R/A, SMD	9.2x9.9x4 mm	651-305-142-821	Wurth Elektronik eiSos
26	V+	1	Red	Test Point, TH, Multipurpose, Red	Red Multipurpose Testpoint	5010	Keystone Electronics
27	V-	1	Yellow	Test Point, Multipurpose, Yellow, TH	Yellow Multipurpose Testpoint	5014	Keystone Electronics
28	Z1, Z2	2	0.2 µF	Filter, LC, 0.2uF, 1806, SMT	1806	NFM41PC204F1H3L	Murata
29	C15, C16	0		CAP, CERM, xxxF, xxV, [TempCo], xx%, [PackageReference]	0603	Used in BOM report	Used in BOM report
30	R4	0	301	RES, 301 ohm, 1%, 0.1W, 0603	0603	CRCW0603301RFKEA	Vishay-Dale
31	R10, R11	0	10.0k	RES, 10.0k ohm, 1%, 0.1W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
32	RB+, RB-, Rtcm	0		RES, xxx ohm, x%, xW, [PackageReference]	0603	Used in BOM report	Used in BOM report

8 References

- LMH6401EVM GUI Software (SBOC451)
- LMH6401 device datasheet (SBOS730)

Revision History

Changes from Original (April 2015) to A Revision	Page
• Changed organization and content in the *Setup Procedure* section.	4
• Changed *Amplifier Device Register Configuration* content, images, and organization.	5
• Added content in *Evaluation Troubleshooting*.	8
• Added *References* section.	13

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

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

   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 and conditions 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 and conditions 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 any defects that are 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. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, 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:*

      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*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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 by Radio Law of Japan to follow the instructions below with respect to EVMs:

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.

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2. 実験局の免許を取得後ご使用いただく。
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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

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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:*

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