

## **TAS5721-TAS5723EVM Evaluation Module**

This manual describes the operation of the TAS5721-TAS5723EVM (EVM) for evaluation of the performance of the TAS5721 and TAS5723 digital input class-D power amplifiers with PWM outputs. The EVM is designed for operation with the Input-USB Board3. The main contents of this document are:

- Details on the proper connection of this EVM and details about the EVM
- Details on installing and using the GUI for programming the EVM
- A Quick-Start Guide for common modes in which the EVM is used

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 I2S is a trademark of Philips Electronics.  
 I<sup>2</sup>C is a trademark of Philips Semiconductor Corp..

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## 1 Overview

This EVM demonstrates the TAS5721DCA or TAS5723DCA integrated circuit power stage from Texas Instruments.

The TAS5721 and TAS5723 are efficient digital audio class D power amplifiers for driving bridge-tied speakers. Both the TAS5721 and TAS5723 drive 10-W stereo operation. Both devices also support 2.1 mode, with two SE outputs and one BTL output, 2 × 10 W + 1 × 15 W operation. The TAS5721 has support for an additional headphone output. Review the device's data sheets at [www.ti.com](http://www.ti.com) for detailed information about the TAS5721 and TAS5723.

Together with a TI Input-USB Board 3, this EVM provides a complete stereo digital audio amplifier system which includes digital input (SPDIF), analog inputs, interface to PC and Digital Audio Processing (DAP) features like digital volume control, input and output mixers, loudness, EQ filters and dynamic range compression (DRC). The EVM software facilitates evaluation by providing access to the TAS5721 and TAS5723 registers through a USB port.

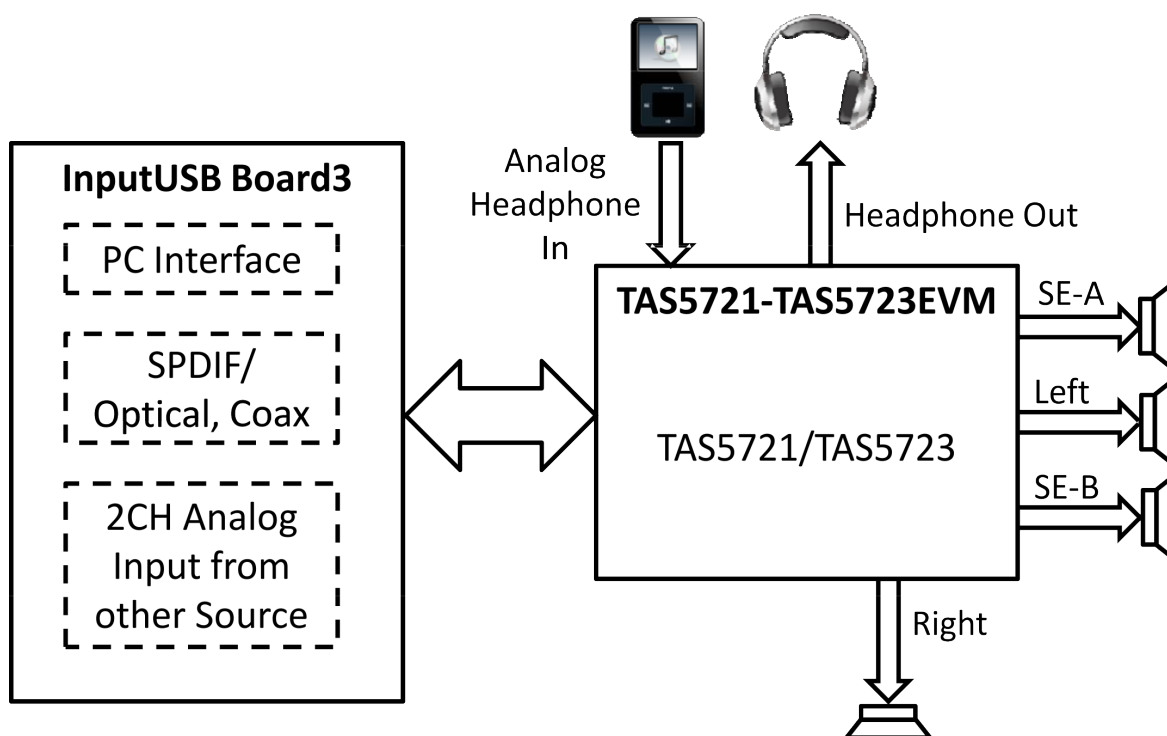
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**NOTE:** The TAS5721-TAS5723EVM is shipped with the current version of TAS5721 installed. Evaluate the current version of TAS5723 by going to the product folder at [www.ti.com](http://www.ti.com) and requesting a free sample; replace TAS5721 with TAS5723.

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### 1.1 TAS5721-TAS5723EVM and Input-USB Board3 Features

- Stereo PurePath™ Digital evaluation module
- Self-contained protection system (overcurrent, overtemperature, and undervoltage).
- Standard I2S™ and I2C™ / Control connector for TI input board
- USB Interface
- Analog input through analog-to-digital converter
- Double-sided plated-through PCB layout, 1-oz copper, 2 mm.
- Ability to control signal gain and DAP features through the EVM-software GUI



**Figure 1. Complete System and EVM Signal Path Overview**

## 2 Installation

This section describes the EVM power supplies, system interfaces, and software installation. It provides information regarding handling and unpacking, absolute operating conditions, and switch and jumper positions. It also provides a step-by-step guide to setting up the EVM for device evaluation.

### 2.1 EVM Installation

The following are the basic tools needed for the initial EVM power up.

- Power Supply Unit (PSU) for Digital Supply (12 V)
- PSU for PVDD (4.5 V to 26 V)
- Banana-style test leads for power supplies
- Optical or coaxial cable for SPDIF interface based on signal source
- USB cable
- EVM Software
- Speaker or loads for outputs

The following sections describe the EVM board in regards to power supplies (PSU) and system interfaces.

#### 2.1.1 Connecting the EVM to the Input-USB Board3

On the right side of the Input-USB Board3 is a terminal block and another is located on the left of the EVM (labeled J1). Carefully place the Input-USB Board3 block above the EVM block and gently push down.

#### 2.1.2 Power Supply Interface

The EVM is powered by two PSUs connected to the Input-USB Board3 controller board: a 12-V PSU ( $V_{IN}$ ), and a 4.5- to 26-V PVDD PSU. The 3.3- and 5.0-V levels are generated on the board by voltage regulators from the 12-V supply.

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**NOTE:** Minimize the length of the PSU cable. Increasing the length of the PSU cable increases the distortion of the amplifier at high output levels and low frequencies.

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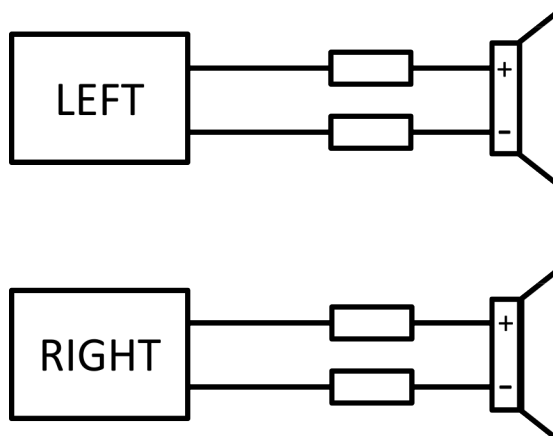
### 2.1.3 Loudspeaker Connectors

#### CAUTION

All BTL speaker outputs are biased at  $V_{CC}/2$  and must not be connected to ground (e.g., through an oscilloscope ground).

#### 2.1.3.1 BTL Mode (2.0)

When connecting a speaker in BTL mode, connect one speaker across the connector labeled LEFT and the other speaker to the connector labeled RIGHT.



**Figure 2. BTL Configuration**

### 2.1.3.2 SE Mode (2.1)

When connecting speakers in single-ended mode, connect one speaker across the connector labeled SE-A and the other speaker to the connector labeled SE-B. To run in 2.1 mode, also connect a BTL speaker across the RIGHT connector (outputs C and D).

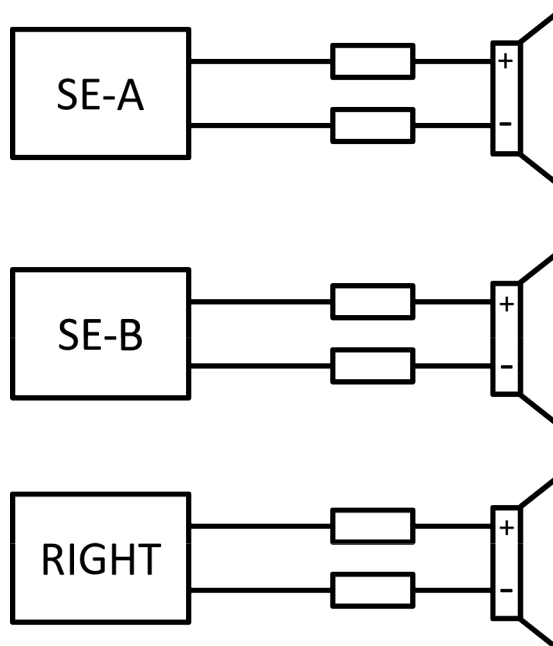


Figure 3. SE/2.1 Mode Configuration

### 2.1.3.3 PBTL Mode

When connecting speakers in a PBTL configuration, short OUT\_A and OUT\_B after the filter (so short the two pins of the connector labeled LEFT). Also short OUT\_C and OUT\_D after the filter (short the two pins of the connector labeled RIGHT). Connect one end of the speaker to OUT\_A/OUT\_B and the other end of the speaker to OUT\_C/OUT\_D

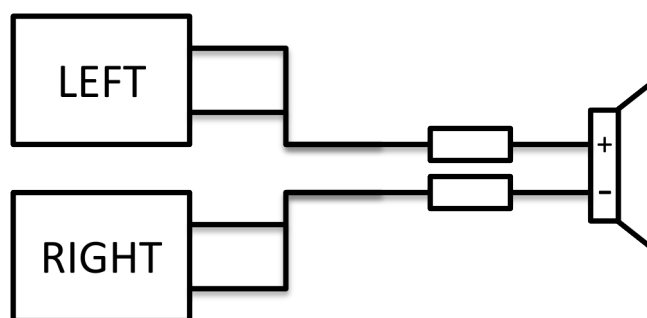


Figure 4. PBTL Configuration

### 2.1.4 Headphone/Line-Driver

The TAS5721 has a stereo output which can be used as a headphone amplifier or line driver that can output  $2\text{-}V_{\text{RMS}}$ . The headphone amplifier/line-driver on the EVM is configured for unity gain, adjusted by modifying R1, R2, R4, and R5.

$$\text{Gain} = R2/R1 = R5/R4$$

The analog input goes into the *HP-IN* headphone jack. Plug the headphones or line-driver load into the *HP-OUT* headphone jack. Use a PWM input signal by installing C2, C3, C5, and C6 onto the EVM. Pressing the HP-SD button on the EVM shuts down the headphone amplifier/line-driver.

### 2.1.5 USB Interface

The TAS5721 and TAS5723 device registers are accessed through I<sup>2</sup>C bus lines SDA and SCL. The USB circuit and USB connector on the Input-USB Board3 board facilitate the connection between a host computer and the device. The EVM USB circuit is powered by the 5-V USB line of the host PC and is independent of the PSU available on the board. The USB device is a TAS1020B from Texas Instruments.

The USB input streams audio. Toggling switch S7 to *USB* selects the USB I2S source over the SPDIF source.

### 2.1.6 Digital Audio Interface SPDIF

The Digital Audio Interface SPDIF (RCA/OPTO) accepts digital audio data using the I<sup>2</sup>S protocol. See the TAS5721 or TAS5723 data sheet for more information.

The RCA connector and the OPTO connector are the two SPDIF interfaces on the Input-USB Board3. The switch, S2, toggles between the OPTO and RCA connector (RCA connector labeled as COAX) accommodating the signal source. When the RCA cable or optical cable is connected and the signal source is powered up, verify that the SPDIF lock indicator LED illuminates, confirming that a viable signal is available to the device. Use switch S7 to connect the SPDIF to the digital source SDIN1.

### 2.1.7 ADC Interface

The PCM1808 ADC is used to convert an analog audio signal to a digital signal for the TAS5721 or TAS5723. The DIR9001 still provides clock signals to the ADC in this process. A 12.288-MHz crystal is installed on the Input-USB Board3. The ADC is an additional feature of this board providing flexibility in sourcing an audio signal to the TAS5721 or TAS5723. Review the PCM1808 data sheet ([SLES177](#)) for a detailed description of the ADC on this EVM. The PCM1808 only accepts up to a 1-V<sub>RMS</sub> input signal. Uninstalling jumpers JP300 and JP301 implements a voltage divider that halves the incoming voltage, allowing input of up to a 2-V<sub>RMS</sub> signal through the ADC1-IN audio jack.

The EVM uses only one analog input jack, the ADC1-IN. If an analog input is connected, it takes precedence over any digital audio signal.

### 2.1.8 General Guidelines for Powering-Up the Board

Connect the Input-USB Board3 and the EVM boards by locating pin 1 on each board, indicated by a small white triangle. The Input-USB Board3 plugs down onto the EVM board (the TAS5721-TAS5727EVM board fits underneath the Input-USB Board3). Pin 1 on each board must be connected to each other.

Install the EVM software on the PC before powering up the board. After connecting the loudspeakers or other loads, PSU, and the data line, power up the PVDD power supply first; then power up the 12-V V<sub>IN</sub> power supply.

## 2.2 Software Installation

Download the TAS57XX Control Console GDE from the TI Web site, located on the TAS5721-TAS5727EVM product page. The TI Web site always has the latest release and any updates to versions of the GUI.

Execute the GUI install program, Setup.exe. Once the program is installed, the program group and shortcut icon is created in Start → Program → Texas Instruments Inc → ControlConsole.

### 3 Using the GUI

This section describes the details of using the TAS57xx ControlConsole Graphical User Interface (GUI) software tool to interface with the TAS5721 or TAS5723 device. The software is available for download at the EVM product page on [www.TI.com](http://www.TI.com). The GUI's main function provides an easy way to manipulate the device register space for attaining the required signal processing flow. Clicking the question mark in the upper right-hand corner of the GUI opens an introductory help file explaining each tab of the GUI. Read the help file for a complete understanding of the full functionality of the GUI.

#### 3.1 ControlConsole Quick start

##### 3.1.1 Launching ControlConsole

Before opening ControlConsole, power the TAS5721-TAS5723EVM and Input-USB Board3, and connect the USB cord from the Input-USB Board3 to the computer. When starting ControlConsole an initialization script runs, turning on the device. If power to the EVM is lost, close ControlConsole and restart it, running the script again. Alternatively, enter the register values manually using the *Direct I2C Access* tab.

Select the correct target when opening ControlConsole with the following steps:

- Navigate to the Texas Instruments Inc title in the start program menu
- Open the ControlConsole folder
- Select the correct target, opening ControlConsole

Double check the names of the tabs at the top of the GUI; the device name should be either TSA5721 or TAS5723 (depending on the IC used). A green circle appears in the lower left-hand corner of the GUI indicating that communication is established with the board.

##### 3.1.2 Process Flow Tab

The Process Flow tab options with their descriptions are shown in [Table 1](#). Select the correct sample rate from the drop-down box in the lower left-hand corner of the GUI. While the TAS5721 and TAS5723 auto-detect the sample rate, the GUI has no way of detecting what the sample rate is.

Make sure the Mode setting in the lower right-hand corner of the GUI is correct. The TAS5721 and TAS5723 operate in 2.0 or 2.1 modes, depending on the desired speaker configuration. There is not a quick PBTL set-up option. [Section 4](#) explains the PBTL set up.

When finished setting-up, make sure the device is out of shutdown. In the lower right-hand corner of the Process Flow tab, the Shutdown button reads *Exit* if it is out of shutdown, and *Enter* if it is in shutdown. Click to toggle between the two.







At this point, the device should stream audio. Use the *Direct I2C Access* tab for writing directly to the TAS572X registers. Use the *TAS5723 Registers* tab for viewing the current register values, as well as for modifications of individual bits.

##### 3.1.3 Summary of Steps

1. Power the TAS5721-TAS5723EVM and Input-USB Board3
2. Connect the Input-USB Board3 to the computer with a USB cable
3. Open ControlConsole GUI with the correct target:
  - (a) Verify that the GUI displays the correct device name
  - (b) Verify that a green dot is displayed in the lower left-hand corner of the screen. If the dot is red, verify that the EVM is powered correctly and that the USB cable is connected from the computer running ControlConsole to the EVM.
4. Go to the *TAS572X Process Flow* tab
5. Set the correct sample rate in the lower left-hand corner
6. Select the correct speaker configuration in the lower right-hand corner under *Mode*
7. Make sure that the device is out of Shutdown

The EVM should now stream audio.

Table 1. ControlConsole Process Flow Icons

Name	Symbol	Function	Interaction
Biquad		Implement IIR filters in the DAP by using the biquad filters. They are often used for speaker equalization.	<ul style="list-style-type: none"> <li>Open the Biquad GUI by double clicking</li> <li>Open the Biquad GUI or the biquad-specific help page by right clicking</li> </ul>
Mixer		Each mixer adds two or more signals together. The dials allow for the user to adjust the scalar multiplier for each input signal.	<ul style="list-style-type: none"> <li>Click the dial and drag up, increasing volume; drag down, decreasing volume. <b>Note:</b> this is a vertical movement, not circular</li> </ul>
Mux		Clicking the MUX changes the active path. This allows the creation of a variety of process flows.	<ul style="list-style-type: none"> <li>Click to change the pass-through path. The active path is black, inactive paths are grayed out</li> </ul>
Dynamic Range Control (DRC)		The DRC tool allows for adjustments to the dynamic range of the signal.	<ul style="list-style-type: none"> <li>Single click turns on and off</li> <li>Right click options: <ul style="list-style-type: none"> <li>Turns on or off</li> <li>Opens DRC GUI</li> <li>Opens DRC-specific help page</li> </ul> </li> </ul>
Volume Ganging		Several volume ganging sets are available. When a particular ganging setting is applied, the matched volume sliders are color coded. Moving one slider will move all sliders of the same color.	<ul style="list-style-type: none"> <li>Clicking and dragging the slider adjusts the volume</li> <li>Type a volume in the text box below the slider (where 0 currently is)</li> <li>Right clicking opens the <i>Volume Ganging</i> menu</li> </ul>
Master Volume		The master volume is a simple way to adjust the final volume of the output. The pre- and post-output volume sliders also adjust the final volume of the audio signal.	<ul style="list-style-type: none"> <li>Clicking and dragging the slider adjusts the volume</li> <li>Type a volume in the text box below the slider (where 8 currently is)</li> <li>Clicking the speaker symbol mutes and unmutes the device</li> <li>Right clicking mutes and unmutes the device</li> </ul>



## 4 Alternate Configurations

The EVM is designed to easily allow for AD modulation in SE or BTL mode. To use BD modulation or PBTL mode, the EVM must be modified.

### 4.1 BD modulation

Hardware:

1. Remove C25 from the EVM.

GUI:

1. On the *TAS572X Block Diagram* tab, click the *Input Mux* block.
2. Select BD mode for channel 1 and channel 2.
3. Enter "0x11" in the address line and B8 in the data line, then click **Write**.
4. Enter "0x12" in the address line and 60 in the data line, then click **Write**.
5. Enter "0x13" in the address line and A0 in the data line, then click **Write**.
6. Enter "0x14" in the address line and 48 in the data line, then click **Write**.

The previous four steps changed the intermodulation delay registers to their optimum values for BD modulation. The device now operates with BD modulation.

### 4.2 PBTL mode

Hardware:

1. Short OUT-A to OUT-B and OUT-C to OUT-D after the filter by shorting the two pins on the AB LEFT connector and the CD RIGHT connector.
2. Connect the speaker as outlined in [Section 2.1.3](#).

GUI:

1. Start the TAS5721-TAS5723 as if in BTL mode.
2. Make sure the device is in shutdown. Change this by selecting the option in the lower right-hand corner of the *TAS5721 Process Flow* tab, *Enter* means the device is in shutdown.
3. Go to the *Direct I2C Access* tab in ControlConsole.
4. Enter "0x25" in the address line (PWM Output MUX Register).
5. Enter "01 00 22 45" in the data line (this outputs PWM1 to OUT\_A/OUT\_B and PWM3 to OUT\_C/OUT\_D).
6. Click **Write**.
7. Enter "0x19" in the address line (PWM Shutdown Group Register).
8. Enter "3A" in the data line (this shuts down the unused PWM outputs).
9. Click **Write**.
10. Exit shutdown by selecting the option in the lower right-hand corner of the *TAS5721 Process Flow* tab, *Exit* means the device is out of shutdown.

The EVM is now operating in PBTL mode.

## 5 Jumpers and Control Utilities on Input-USB Board3

### 5.1 RCA/OPTICAL Jumpers

- **ADC1:** The default is to have a jumper installed on pins 2 and 3. To input an external I2S data signal, remove the jumper and connect the new I2S source using pins 3 and 4.
- **MCLK:** The default is to have a jumper installed on pins 2 and 3. To input an external MCLK signal, remove the jumper and connect the new MCLK source using pins 3 and 4.
- **SCLK:** The default is to have a jumper installed on pins 2 and 3. To input an external SCLK signal, remove the jumper and connect the new SCLK source using pins 3 and 4.
- **LRCLK:** The default is to have a jumper installed on pins 2 and 3. To input an external LRCLK signal, remove the jumper and connect the new LRCLK source using pins 3 and 4.
- **JP300 and JP301:** Install for analog inputs of less than  $1-V_{RMS}$ ; leave uninstalled for analog inputs from  $1-V_{RMS}$  to  $2-V_{RMS}$ .
- All other jumpers on the Input-USB Board3 have no functionality with the TAS5721-TAS5723EVM.

### 5.2 Switches

- **S1 (RESET):** Pressing the RESET switch resets the TAS572X device
- **S2 (COAX/OPTO):** Determines which digital input to use, RCA or optical.
- **S3 (VOL DOWN):** This switch has no function with the EVM
- **S4 (VOL UP):** This switch has no function with the EVM
- **S5 (USB MUTE):** This switch has no function with the EVM
- **S6 (MUTE):** This switch has no function with the EVM
- **S7 (I2S SELECT):** Selects the I2S source. When using the OPTO or RCA inputs, flip this switch to SPDIF.
- **S8 (PDN):** Pressing PDN powers down the TAS572X.

### 5.3 LED Indicators

- **12 V:** 12-V power is valid
- **5 V:** 5-V power is valid
- **3.3 V:** 3.3-V power is valid
- **SPDIF-LOCK:** SPDIF signal locked
- **COAX:** S2 is set to the COAX position
- **OPTO:** S2 is set to the OPTO position
- **USB:** S7 is set to the USB position
- **SPDIF:** S7 is set to the SPDIF position
- **FAULT:** not used with the EVM
- **PDN:** indicates that the PDN switch is asserted
- **MUTE:** not used with the EVM
- **SHUTDOWN:** not used with the EVM
- **OTW:** not used with the EVM
- **DIGITAL:** indicates that the digital input source is active
- **ANALOG:** indicates that the analog input source is active

## 6 Board Layouts, Bill of Materials, and Schematic

### 6.1 TAS5721-TAS5723EVM Board Layouts

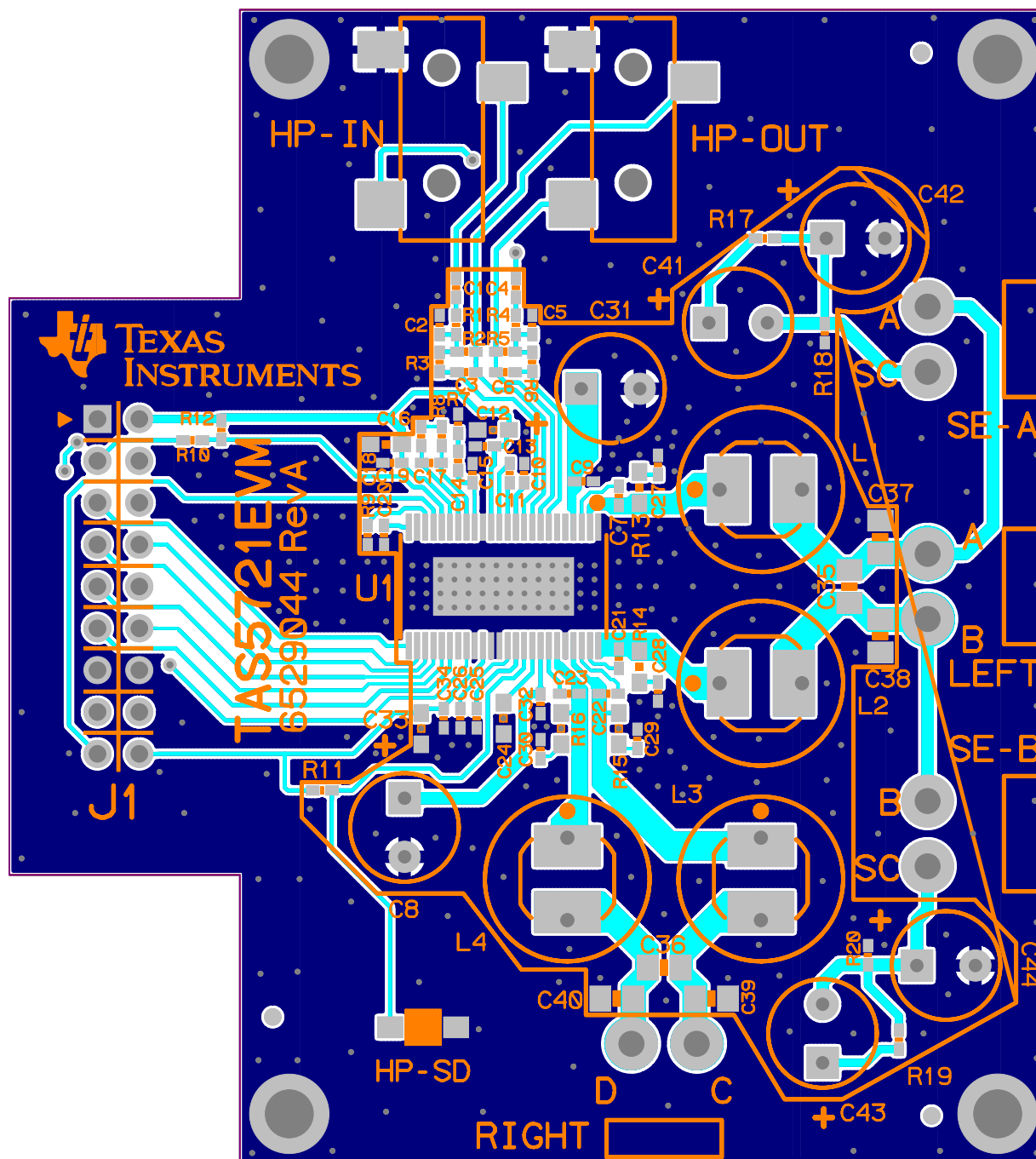


Figure 5. TAS5721-TAS5723EVM Top Composite View

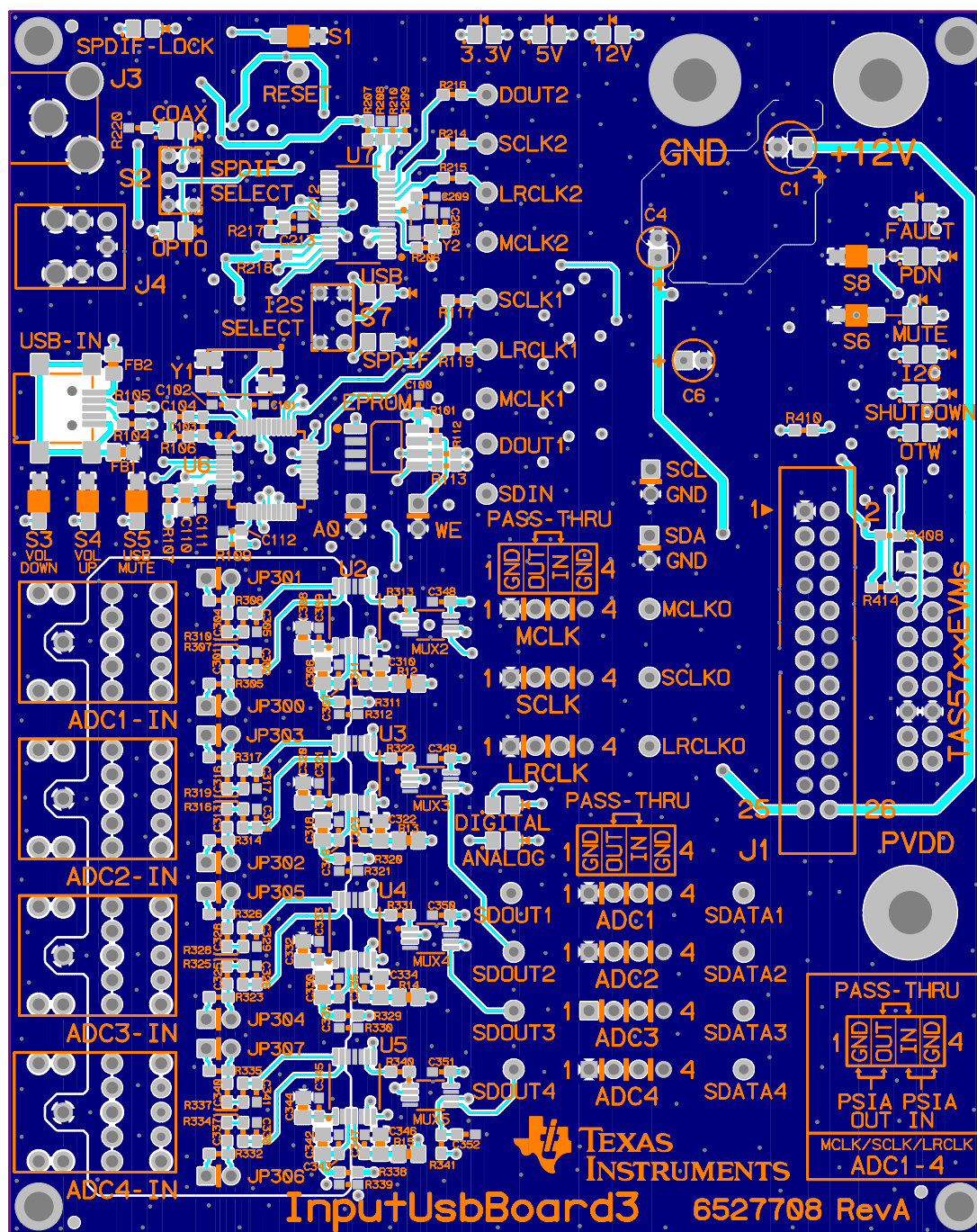


Figure 6. Input-USB Board3 Top Composite View

## 6.2 TAS5721-TAS5723EVM Schematic

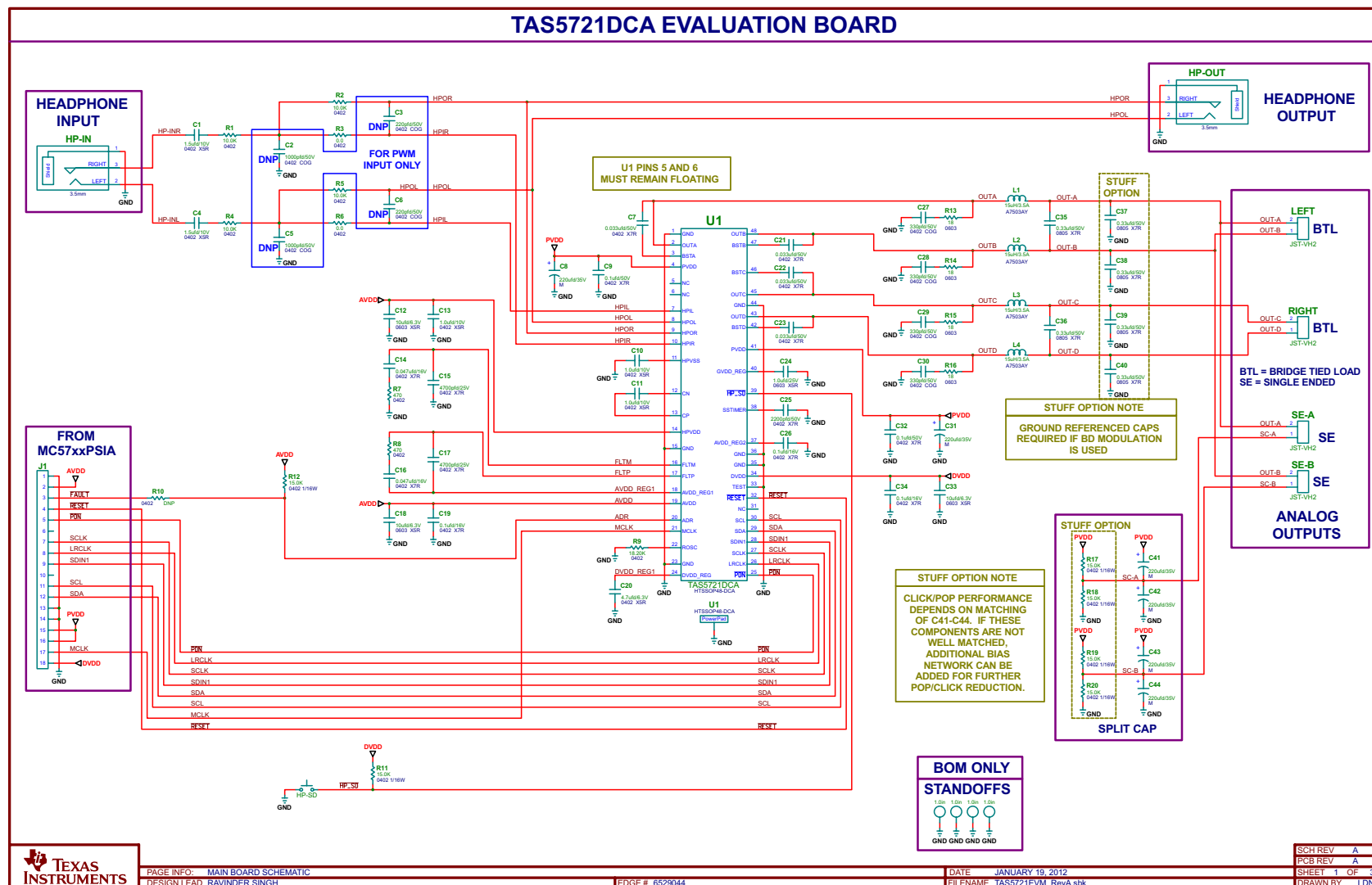


Figure 7. TAS5721-TAS5723EVM Schematic

### 6.3 Input-USB Board3 Schematic

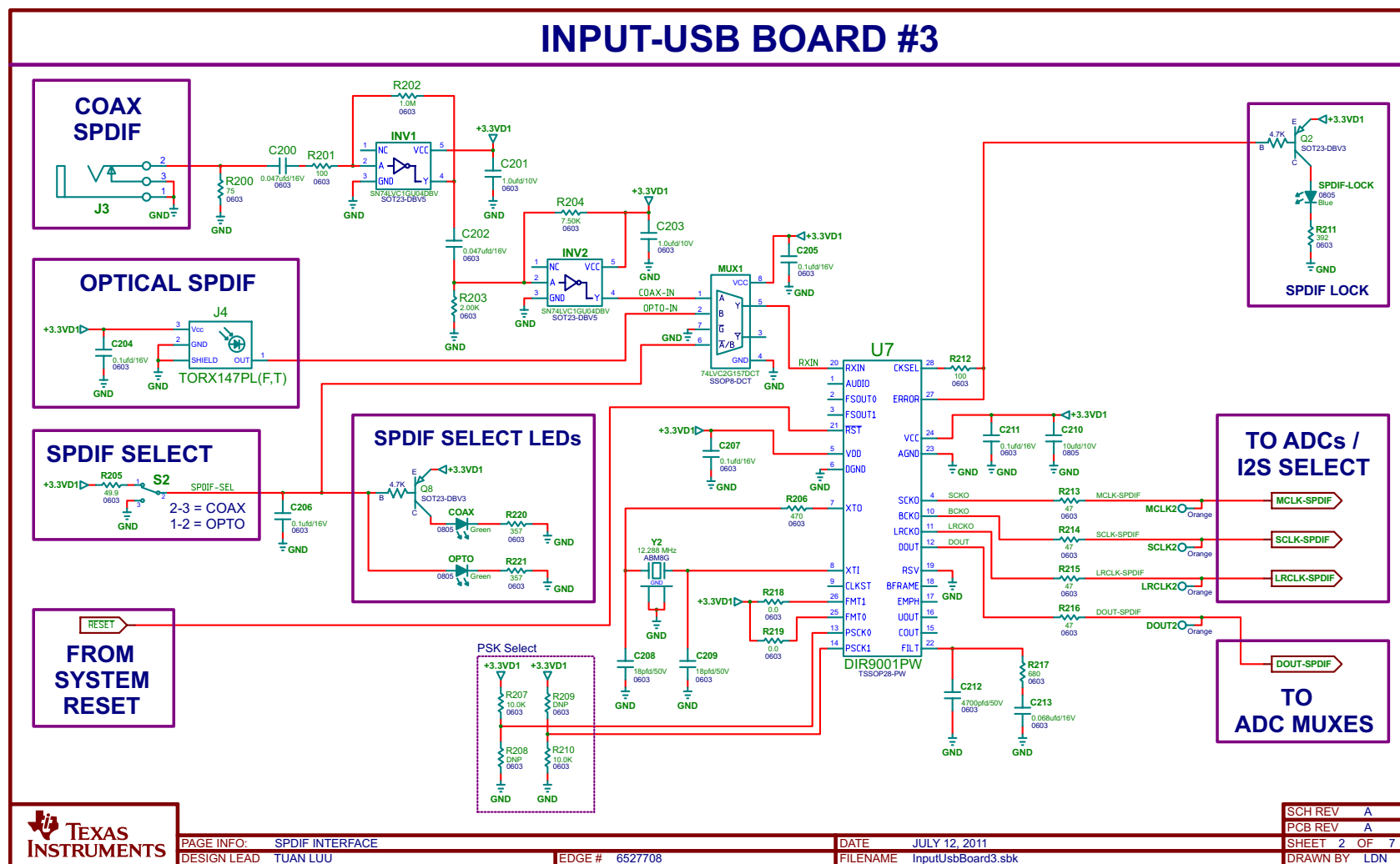


Figure 8. Input - USB Board3 SPDIF Interface

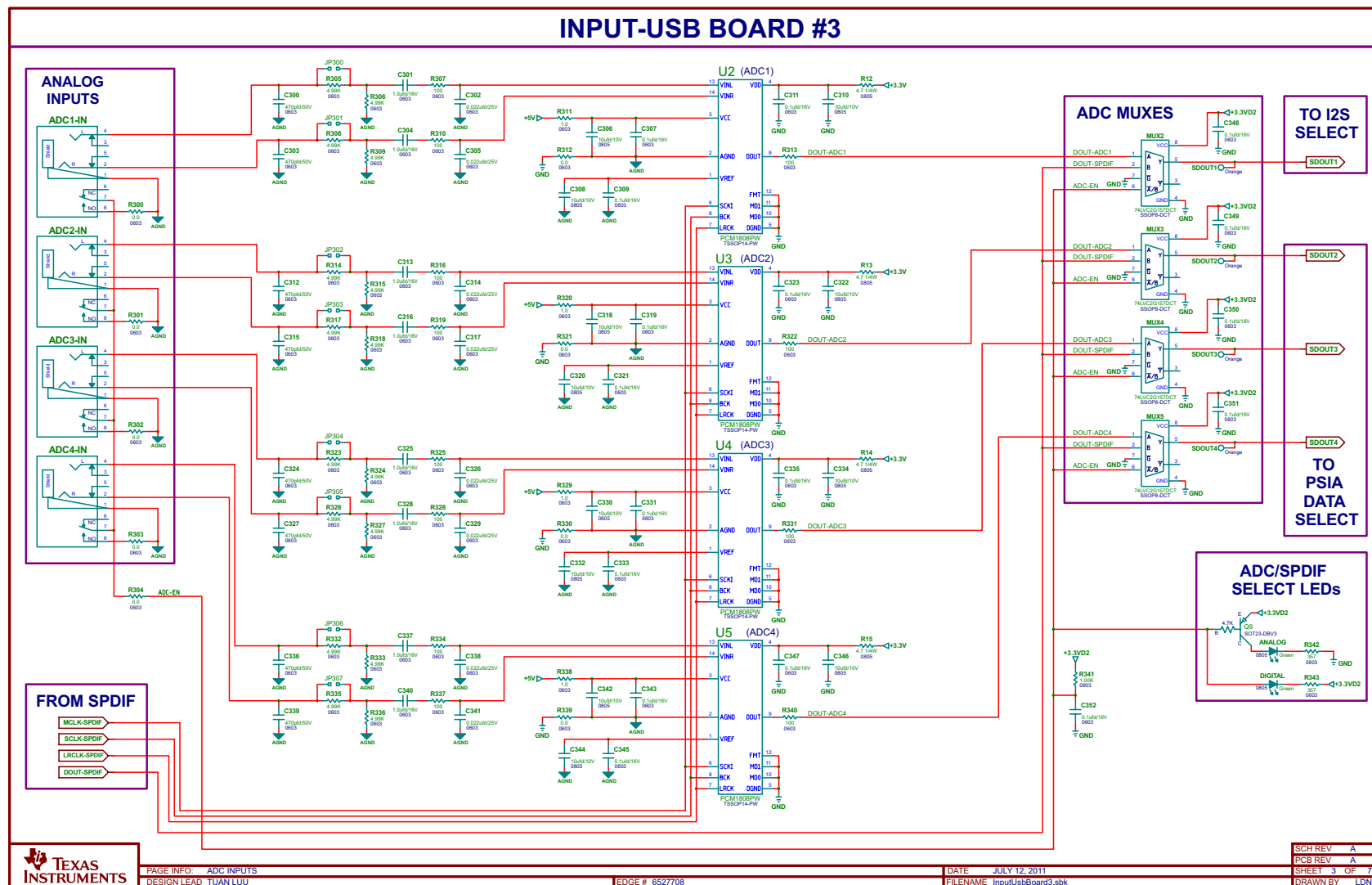


Figure 9. Input - USB Board3 ADC Inputs

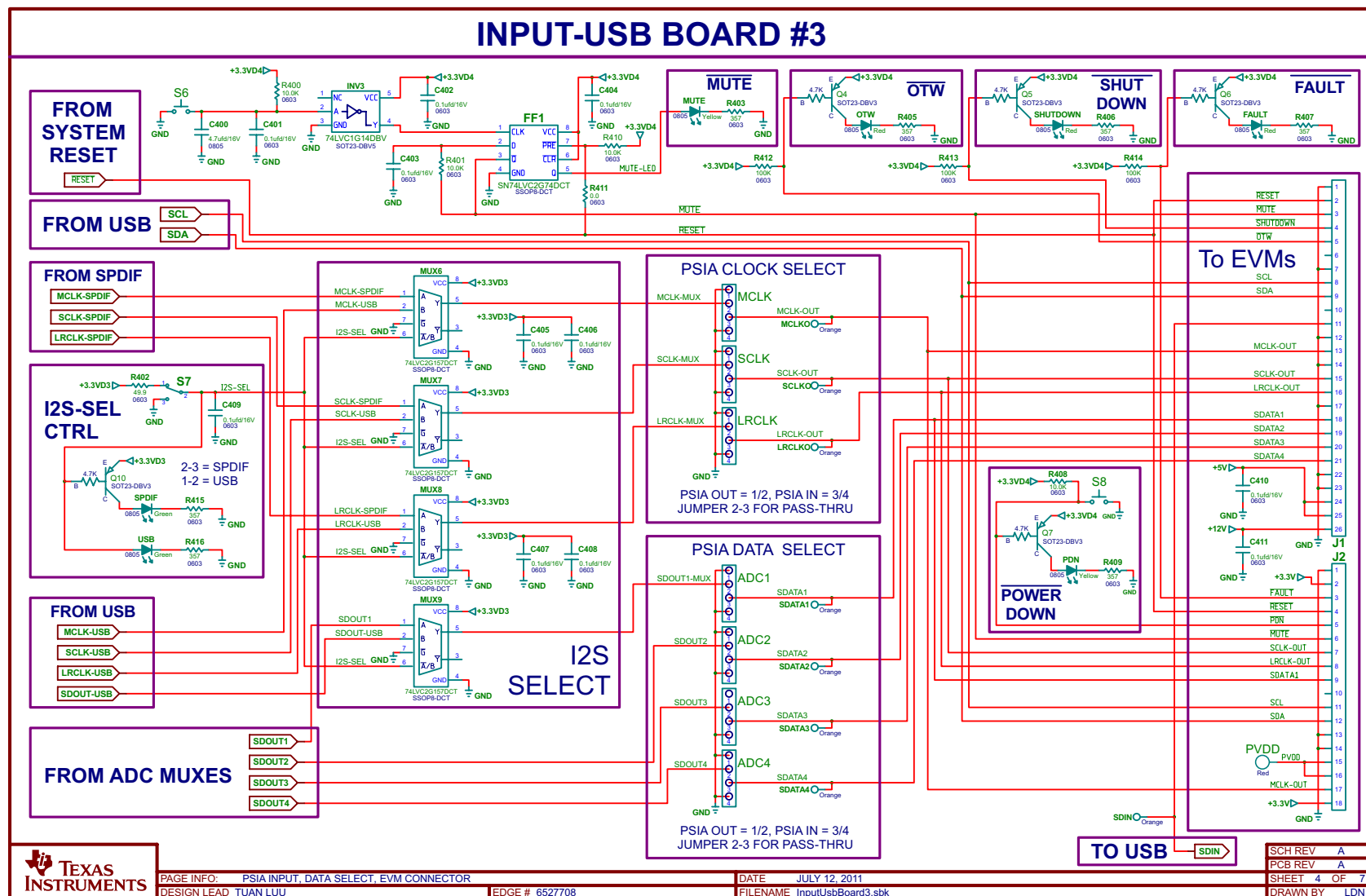


Figure 10. Input - USB Board3 PSIA Input, Data Select, EVM Connector



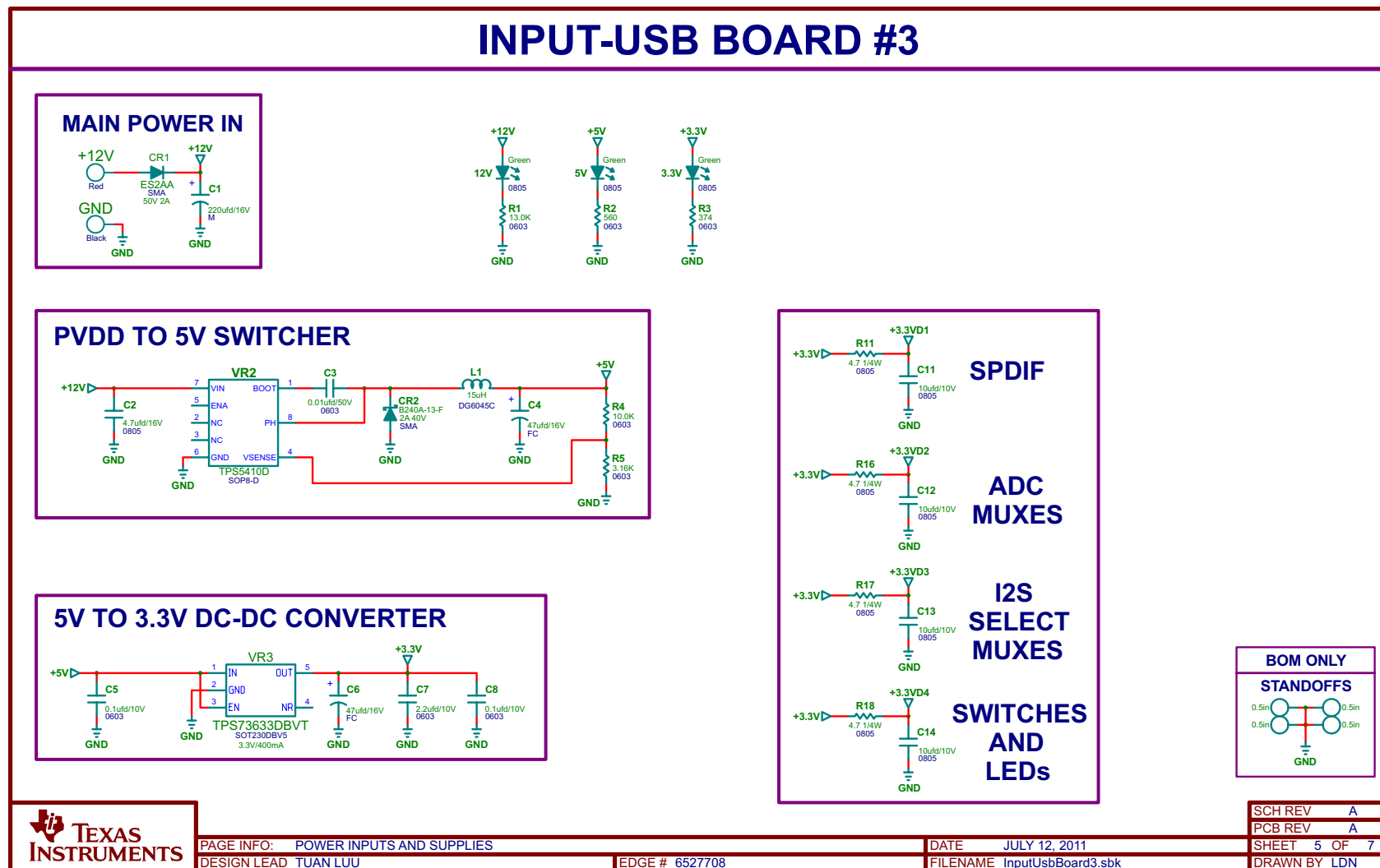


Figure 11. Input - USB Board3 Power Inputs and Supplies

## 6.4 Bill of Materials

**Table 2. Bill of Materials**

TI-SEMICONDUCTORS							
ITEM	MANU PART NUM	QTY	REF DESIGNATORS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
1	TAS5721DCA	1	U1	TAS5721DCA	10-W DIGAMP WITH CAP-FREE HP AMP HTSSOP48-DCA, RoHS	TEXAS INSTRUMENTS	TEXAS INSTRUMENTS
CAPACITORS							
ITEM	MANU PART NUM	QTY	REF DESIGNATORS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
2	GRM1555C1H331JA01D	4	C27, C28, C29, C30	490-1295-1-ND	CAP SMD0402 CERM, 330 pF, 5% 50-V COG, RoHS	DIGI-KEY	MURATA
3	C1005X7R1H222K	1	C25	445-1257-1-ND	CAP SMD0402 CERM, 2200 pF, 50 V, 10% X7R, RoHS	DIGI-KEY	TDK CORP.
4	CC0402KRX7R8BB472	2	C15, C17	311-1039-1-ND	CAP SMD0402 CERM, 4700 pF, 25 V, 10% X7R, RoHS	DIGI-KEY	YAGEO
5	C1005X7R1H333K	4	C7, C21, C22, C23	445-7334-1-ND	CAP SMD0402 CERM, 0.033 µF, 50 V 10%, X7R, RoHS	DIGI-KEY	TDK CORP
6	EMK105B7473KV-F	2	C14, C16	587-1225-1	CAP SMD0402 CERM, 0.047 µF, 16 V, 10% X7R, RoHS	DIGI-KEY	TAIYO YUDEN
7	GRM155R71C104KA88D	3	C19, C26, C34	490-3261-1-ND	CAP SMD0402 CERM, 0.1 µF, 16 V, X7R 10%, RoHS	DIGI-KEY	MURATA
8	C1005X7R1H104K	2	C9, C32	445-5932-1-ND	CAP SMD0402 CERM, 0.1 µF, 50 V, 10% X7R, RoHS	DIGI-KEY	TDK CORP
9	GRM219R71H334KA88D	6	C35, C36, C37, C38, C39, C40	490-3327-1	CAP SMD0805 CERM, 0.33 µF, 50 V, 10% X7R, RoHS	DIGI-KEY	MURATA
10	C1005X5R1A105K	3	C10, C11, C13	445-4114-1-ND	CAP SMD0402 CERM, 1.0 µF, 10 V, 10% X5R, RoHS	DIGI-KEY	TDK CORP
11	TMK107BJ105KA	1	C24	587-1248-1	CAP SMD0603 CERM, 1.0 µF, 25 V, 10% X5R, RoHS	DIGI-KEY	TAIYO YUDEN
12	C1005X5R1A155K	2	C1, C4	445-7390-1-ND	CAP SMD0402 CERM, 1.5 µF, 10 V 10% X5R, RoHS	DIGI-KEY	TDK CORP
13	GRM155R60J475ME87D	1	C20	490-5408-1-ND	CAP SMD0402 CERM, 4.7 µF, 6.3 V X5R 10%, RoHS	DIGI-KEY	MURATA
14	GRM188R60J106ME47D	3	C12, C18, C33	490-3896-1-ND	CAP SMD0603 CERM, 10 µF, 6.3 V, 20% X5R, RoHS	DIGI-KEY	MURATA
15	ECA-1VM221BJ	6	C8, C31, C41, C42, C43, C44	P10419TB	CAP ALUM ELEC M RADIAL 220 µF, 35 V, 20%, RoHS	DIGI-KEY	PANASONIC
RESISTORS							
ITEM	MANU PART NUM	QTY	REF DESIGNATORS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
16	ERJ-3GEYJ180V	4	R13, R14, R15, R16	P18GCT	RESISTOR SMD0603 18 Ω, 5%, 1/10W, RoHS	DIGI-KEY	PANASONIC
17	ERJ-2RKF4700X	2	R7, R8	P470LCT-ND	RESISTOR SMD0402 THICK FILM, 470 Ω, 1/10W, 1%, RoHS	DIGI-KEY	PANASONIC
18	RMCF0402ZT0R00	2	R3, R6	RMCF0402ZT0R00CT	0-Ω JUMPER SMT 0402, 1/16W, 5%, RoHS	DIGI-KEY	PANASONIC
19	CRCW040210K0FKED	4	R1, R2, R4, R5	541-10.0KLCT	RESISTOR SMD0402, 10 kΩ, 1% 1/16W, RoHS	DIGI-KEY	VISHAY
20	RC0402FR-0715KL	6	R11, R12, R17, R18, R19, R20	311-15.0KLRCT-ND	RESISTOR SMD0402 THICK FILM, 15.0 kΩ, 1%, 1/16W, RoHS	DIGI-KEY	YAGEO
21	ERJ-2RKF1822X	1	R9	P18.2KLCT-ND	RESISTOR SMD0402 THICK FILM 18.2 kΩ, 1/10W 1%, RoHS	DIGI-KEY	PANASONIC
INDUCTORS							
ITEM	MANU PART NUM	QTY	REF DESIGNATORS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
22	1255AS-150M	4	L1, L2, L3, L4	DG6045C-150M	INDUCTOR SMT 15 µH, 2.5 A, 63 mΩ 20% DG6045C, RoHS	TOKO JAPAN	TOKO JAPAN
HEADERS AND JACKS							
ITEM	MANU PART NUM	QTY	REF DESIGNATORS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU

**Table 2. Bill of Materials (continued)**

23	PBC09DAAN	1	J1	S2011E-09	HEADER THRU MALE 2 x 9 100 LS 120 TAIL GOLD, RoHS	DIGI-KEY	SULLINS
24	B2PS-VH(LF)(SN)	4	LEFT, SE-A, SE-B, RIGHT	455-1648	JACK JST-VH RA 2-PIN 3.96 mm LS, RoHS	DIGI-KEY	JST
25	SJ-3523-SMT	2	HP-IN, HP- OUT	CP-3523SJCT-ND	JACK AUDIO-STEREO MINI(3.5 mm ,3-COND SMT- RA, RoHS	DIGI-KEY	CUI STACK
<b>SWITCHES</b>							
ITEM	MANU PART NUM	QTY	REF DESIGNATO RS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
26	TL1015AF160QG	1	HP-SD	EG4344CT	SWITCH, MOM, 160G SMT 4X3MM, RoHS	DIGI-KEY	E-SWITCH
<b>STANDOFFS AND HARDWARE</b>							
ITEM	MANU PART NUM	QTY	REF DESIGNATO RS	VENDOR PART NUM	DESCRIPTION	VENDOR	MANU
27	2031	4	NA	2031K	STANDOFF,4-40,1.0 in x 3/16 in, ALUM RND F-F, RoHS	DIGI-KEY	KEYSTONE ELECTRONICS
28	PMSSS 440 0025 PH	4	NA	H703-ND	4-40 SCREW STEEL 0.250 in, RoHS	DIGI-KEY	B&F FASTENER SUPPLY
	Component Count:	80					

## EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used. TI currently deals with a variety of customers for products, and therefore our arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

## REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### 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

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**

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.

### **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

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

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-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.

### **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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **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.

### **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.

## **【Important Notice for Users of this Product in Japan】**

**This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan**

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

**Texas Instruments Japan Limited**  
**(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan**

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### **【ご使用にあたっての注】**

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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。

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## EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

**For Feasibility Evaluation Only, in Laboratory/Development Environments.** Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

**Agreement to Defend, Indemnify and Hold Harmless.** You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

**Safety-Critical or Life-Critical Applications.** If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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

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## REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### 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

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**

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.

**For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

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

**Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-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.

**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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

**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.

**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.

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3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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## EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

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Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

**Agreement to Defend, Indemnify and Hold Harmless.** You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

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