

## **TAS6422-Q1 Evaluation Module**

This manual describes the operations of the TAS6422Q1EVM. The TAS6422Q1EVM is a stand-alone EVM. The PurePath™ Control Console 3 GUI (PPC3) is used to initialize and operate the EVM. The main topics of this document are:

- Hardware implementation and descriptions
- Software implementation and descriptions
- TAS6422 EVM operations (hardware and software)

Required equipment and accessories:

1. TAS6422 EVM
2. USB A male to micro B male cable
3. Power Supply Unit (PSU) up to 26.4 V, > 6 A capable, if J12 is removed and 12 V is provided. If J12 is in, limit the input voltage to 18 V.
4. 1-4 resistive loads or speaker loads
5. 2-6 pair of wires stripped both ends
6. 2-mm slotted screwdriver
7. Optical audio source (optional)
8. Optical SPDIF cable (optional)
9. Desktop or laptop PC with Microsoft® Windows® 7 operating system

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# 1 Hardware Overview

## 1.1 TAS6422 Evaluation Module Description

The TAS6422-Q1 EVM is a stand-alone EVM. It has single power supply input, USB control via PurePath Control Console 3 (PPC3) and two digital (I2S) audio input options. See the EVM block diagram in Figure 1.

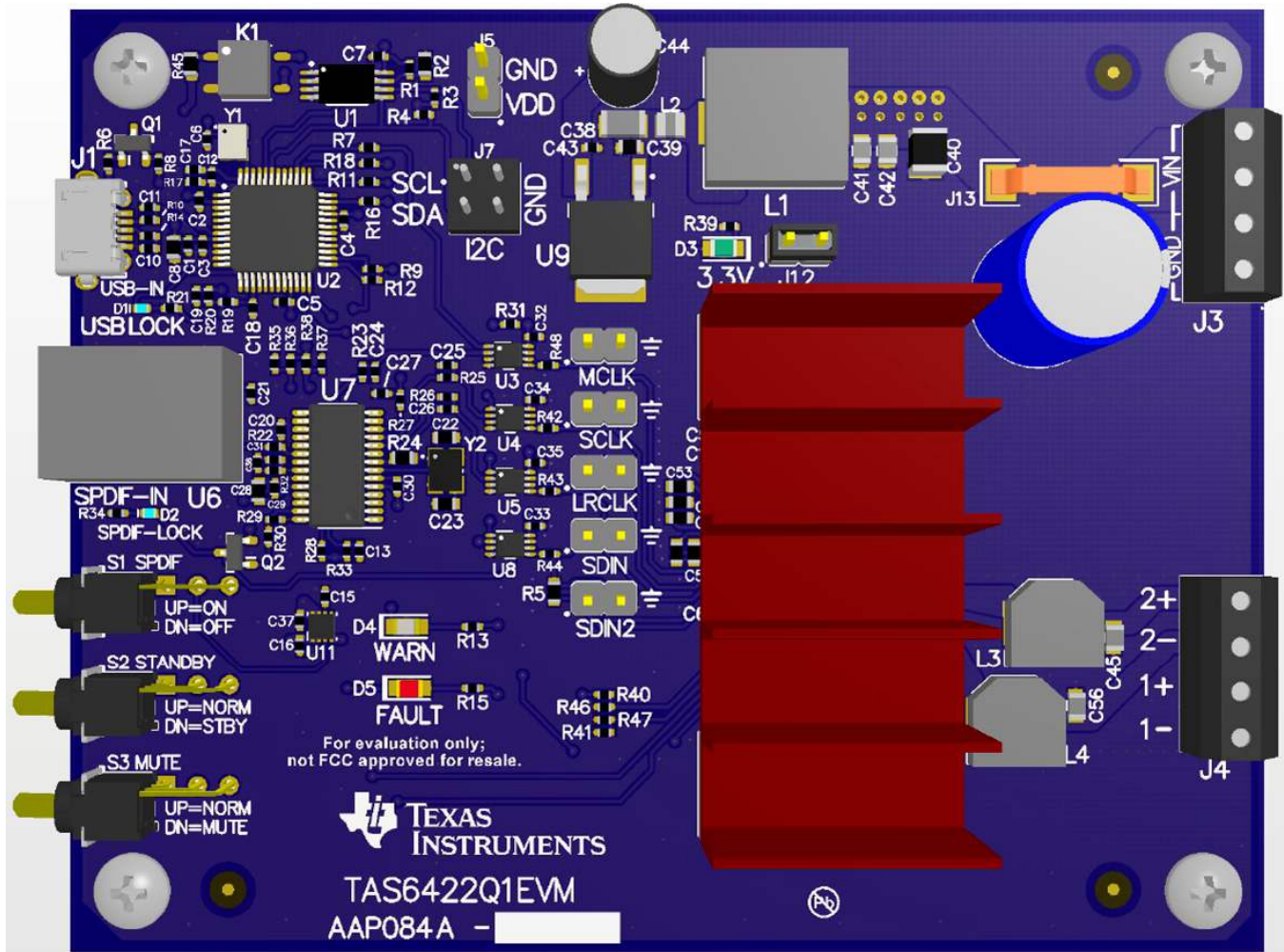
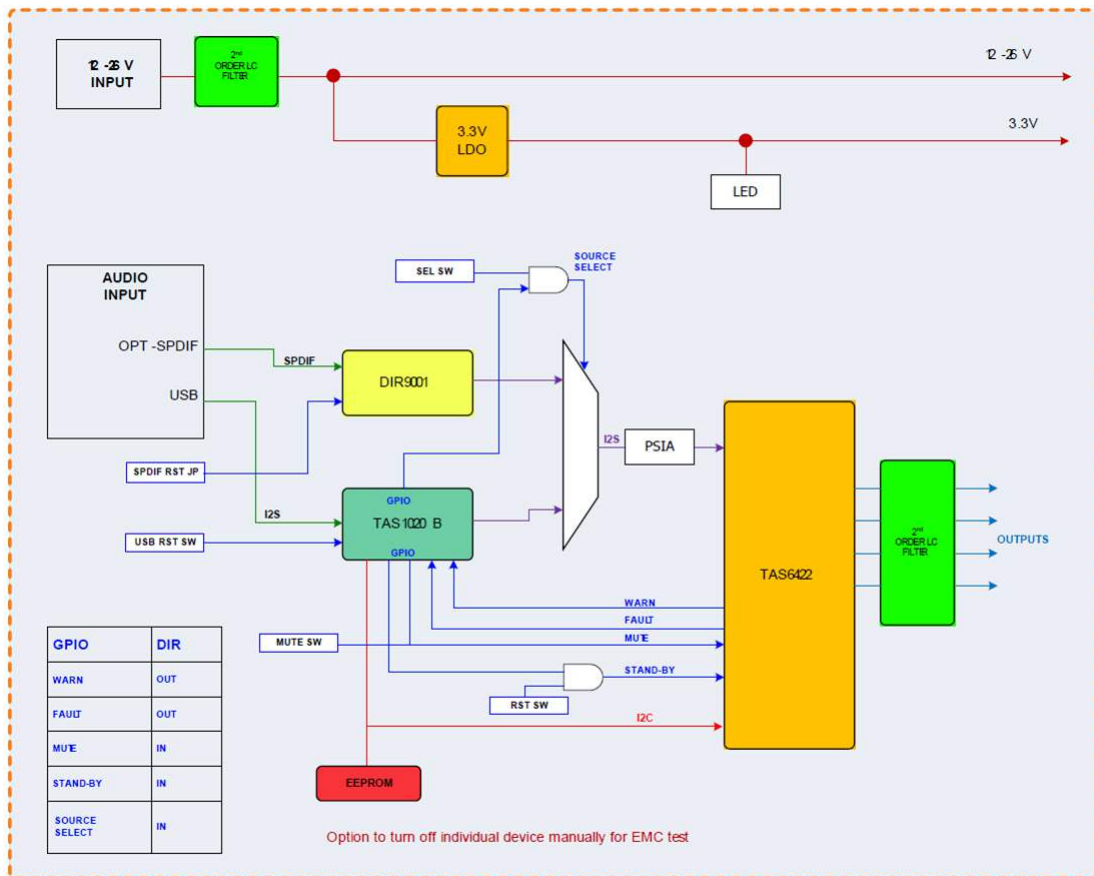


Figure 1. TAS6422-Q1 EVM

The block diagram shows the TAS6422 EVM signal flow.



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Figure 2. EVM Block Diagram

## 2 Hardware Overview

### 2.1 TAS6422 Evaluation Module Functions

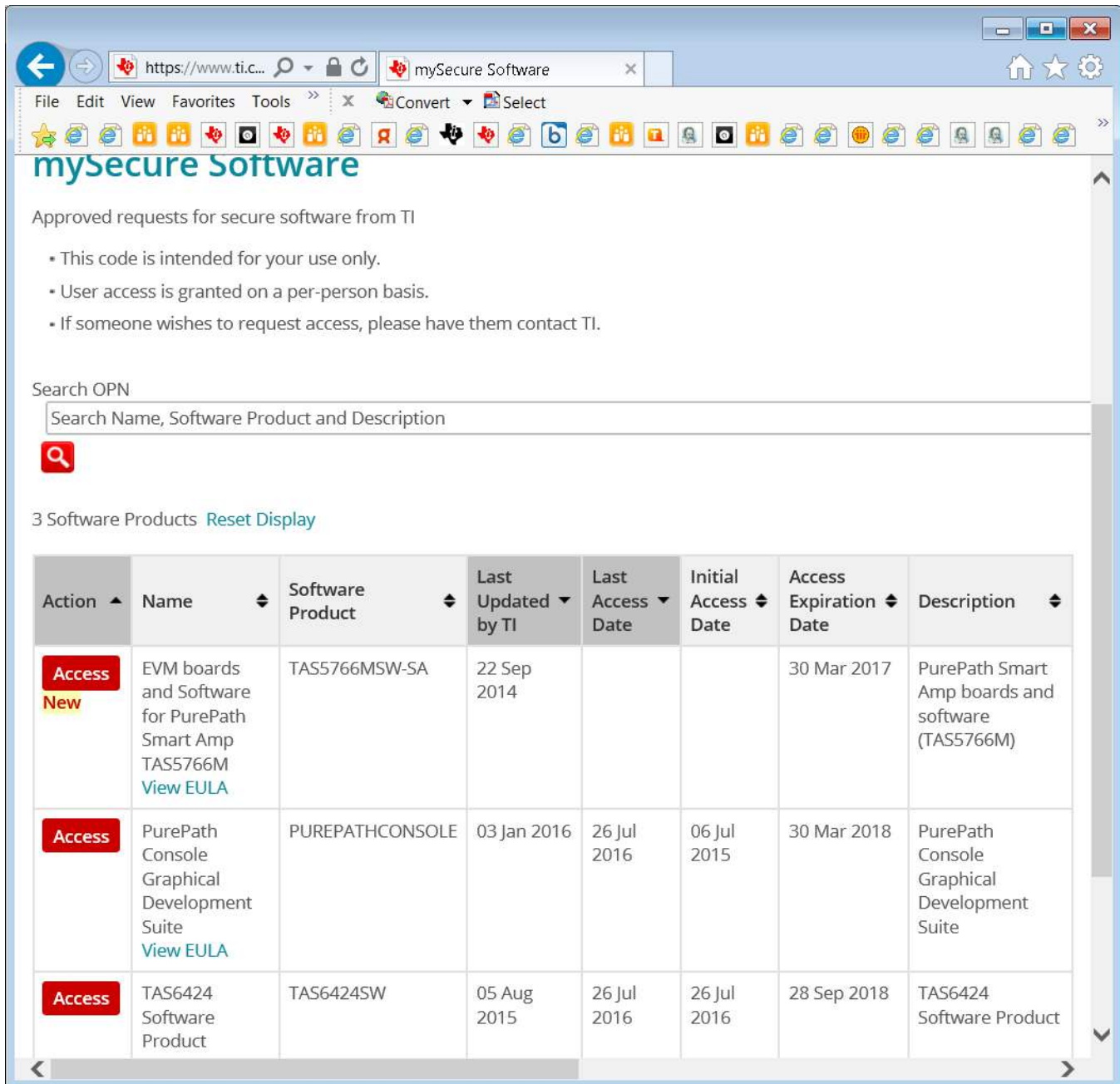
- The EVM only needs single supply to operate
- The VBAT can be separated for PVDD operation higher than 18 V
- Two audio sources can be selected readily
  1. If USB is selected, Windows Media Player can be used to stream audio.
  2. If optical is selected, an optical source such as DVD player can be used to stream audio.
  3. If external digital audio source such as Programmable Serial Interface Adapter (PSIA) from Audio Precision, series resistors on I2S signals can be removed and jumpers can be used to insert external I2S signals.
- There are three switches
  1. SPDIF power switch turns on and off optical to I2S converter.
  2. Standby switch puts the device on or out of standby.
  3. Mute switch stops or starts PWM modulation.
- USB connection also uses as a controller via I2C. The Pure Path Console 3 is the User Interface sending I2C commands to the device. PPC3 will be discussed in a later section.

### 3 Software Overview

#### 3.1 PurePath™ Console 3 (PPC3) Access and Description

The PPC3 is a server-based tool. Access can be requested on <http://www.ti.com/tool/PUREPATHCONSOLE>.

Once approval is given, go to [www.ti.com/mysecuresoftware](http://www.ti.com/mysecuresoftware) to download the software. After login, the user will see this web page with a similar list of software products available for download.



The screenshot shows a web browser window displaying the 'mySecure Software' page. The page title is 'mySecure Software' and the URL is 'https://www.ti.com/mySecure Software'. The page content includes a search bar, a list of software products, and a table of software products.

Approved requests for secure software from TI

- This code is intended for your use only.
- User access is granted on a per-person basis.
- If someone wishes to request access, please have them contact TI.

Search OPN

Search Name, Software Product and Description

3 Software Products [Reset Display](#)

| Action               | Name   | Software Product | Last Updated by TI | Last Access Date | Initial Access Date | Access Expiration Date | Description                                       |
|----------------------|--|------------------|--------------------|------------------|---------------------|------------------------|---|
| <b>Access</b><br>New | EVM boards and Software for PurePath Smart Amp TAS5766M<br><a href="#">View EULA</a> | TAS5766MSW-SA    | 22 Sep 2014        |                  |                     | 30 Mar 2017            | PurePath Smart Amp boards and software (TAS5766M) |
| <b>Access</b>        | PurePath Console Graphical Development Suite<br><a href="#">View EULA</a>            | PUREPATHCONSOLE  | 03 Jan 2016        | 26 Jul 2016      | 06 Jul 2015         | 30 Mar 2018            | PurePath Console Graphical Development Suite      |
| <b>Access</b>        | TAS6424 Software Product   | TAS6424SW        | 05 Aug 2015        | 26 Jul 2016      | 26 Jul 2016         | 28 Sep 2018            | TAS6424 Software Product                          |

**Figure 3. PPC3 Download Window**

Run the installation program. Also download the PPC3 User Manual ([SLOU408](#)) for further instructions. The following window is displayed when first running PPC3.

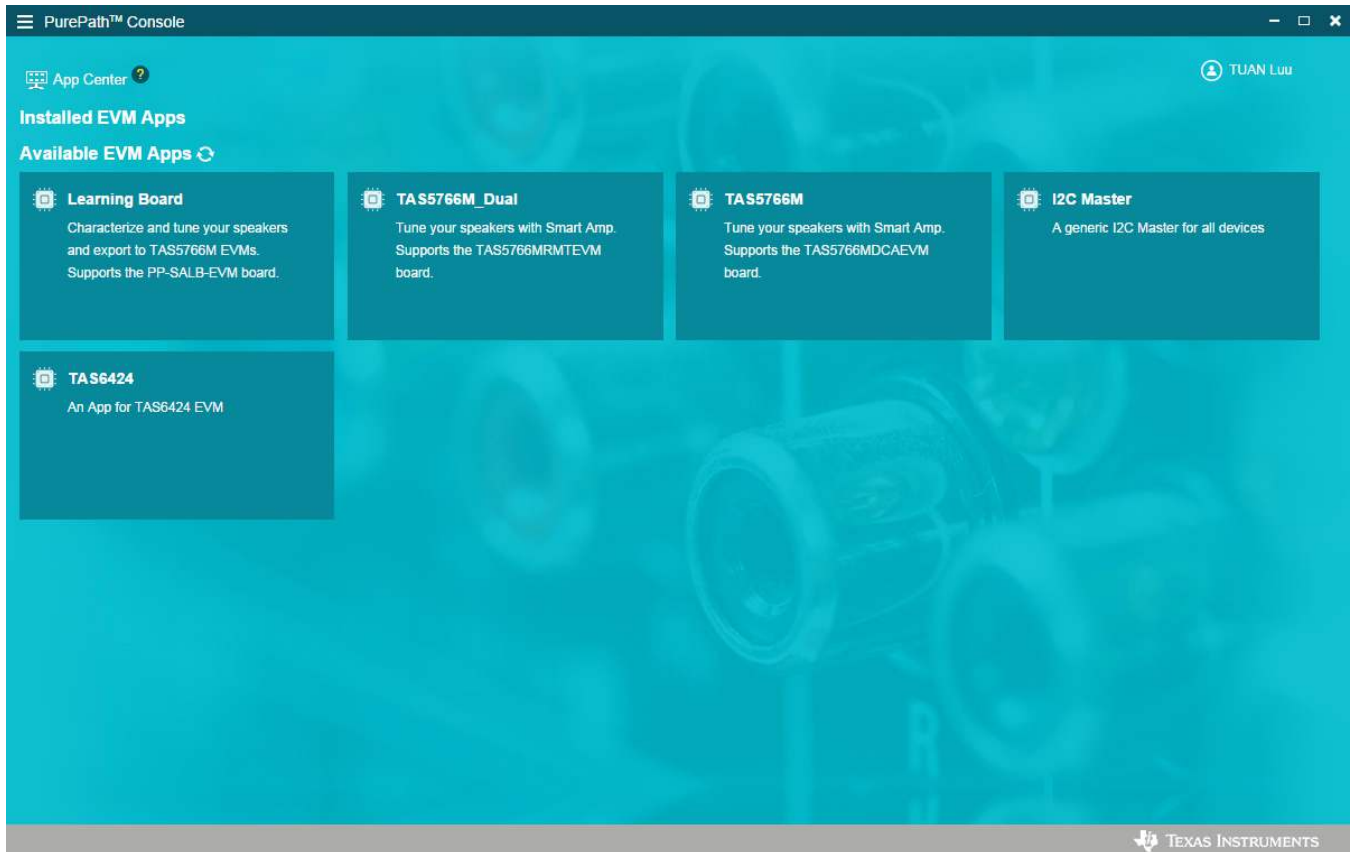


**Figure 4. PPC3 Window**

When the window in [Figure 4](#) is displayed, click on “sign in” to see TAS6422 EVM application. All of the apps shown below may not be displayed for the user.

Click on TAS6422 App box to download TAS6422 application. Installation window will pop up, then click “Install”.

TAS6422 EVM box will appear in “Installed EVM Apps” section, see [Figure 5](#). Click on TAS6422 box to launch TAS6422 App.



**Figure 5. Available Apps Window**

### 3.2 PurePath™ Console 3 – TAS6422 EVM Home Window

When the TAS6422 EVM PPC3 is launched, the Home Window is shown. If the EVM is powered on and the USB is connected to the PC, the Home Window will display “Connect” box in the bottom right hand corner. If the EVM is not powered on or the USB is not connected, only “TAS6422 EVM – Offline” is displayed.

Figure 6 shows the TAS6422 installed application.



**Figure 6. PPC3 Window**

There are three windows available with the TAS6422 EVM PPC3: Home Window, Register Map Window and Device Monitor and Control Window.

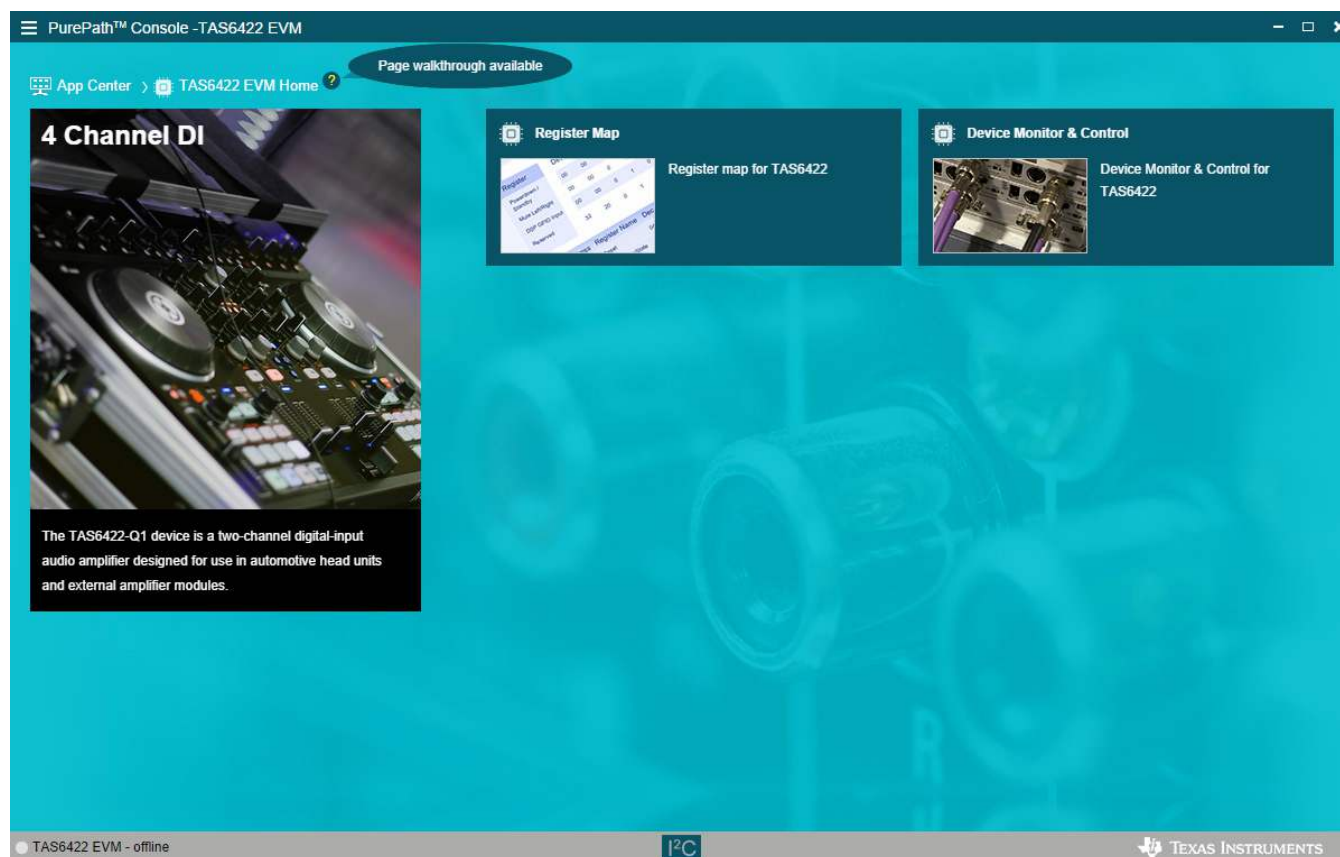


Figure 7. TAS6422 EVM Home Window



### 3.3 PurePath™ Console 3 – TAS6422 EVM Register Map Window

When click on Register Map Box on the Home Window, the Register Map Window is displayed. The Register Map indicates the current setting of all the registers in TAS6422.

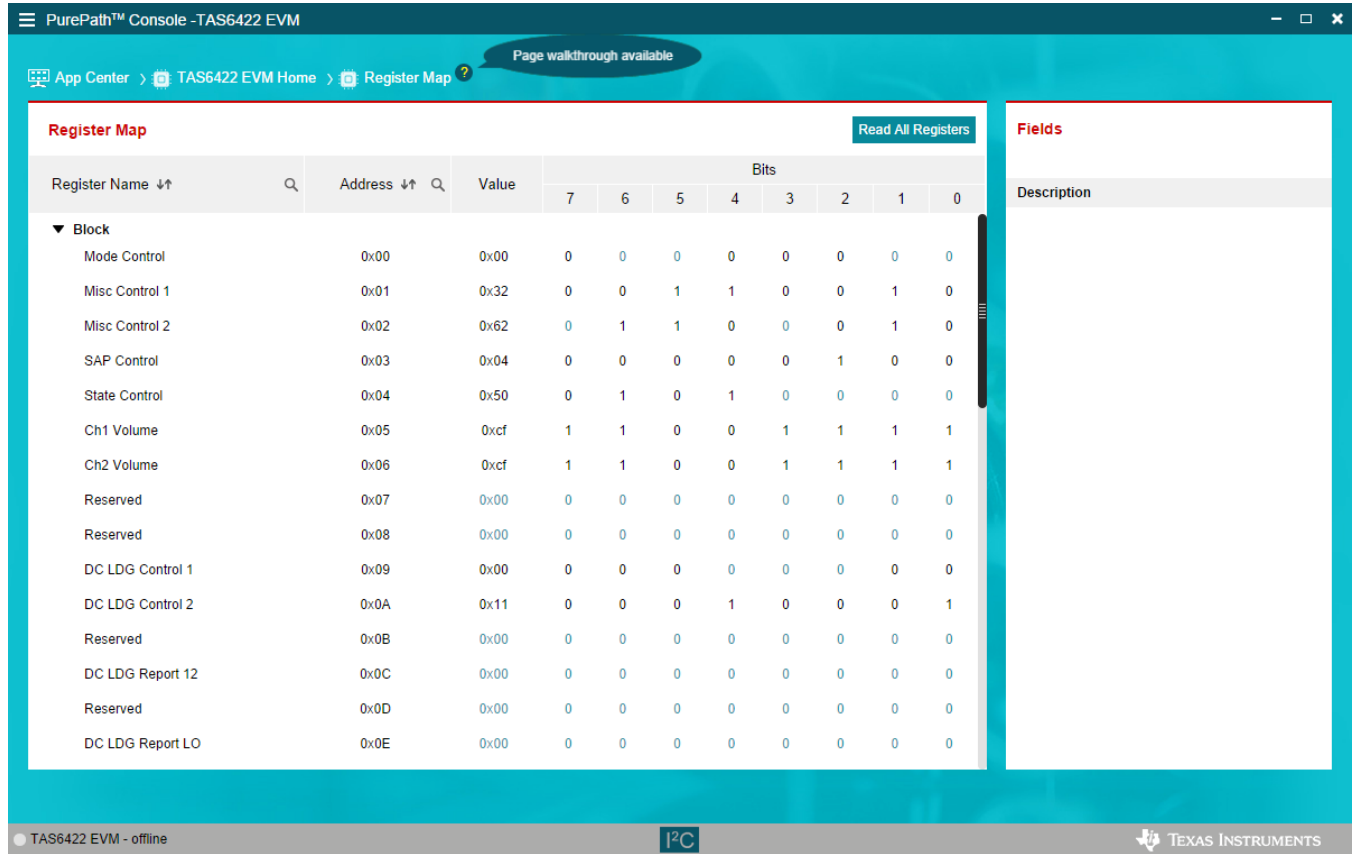


Figure 8. TAS6422 EVM Register Map Window

### 3.4 PurePath™ Console 3 – TAS6422 EVM Monitor and Control Window

When click on Device Monitor and Control Box on the Home Window, the Device Monitor and Control Window is displayed. The Register Map indicates the current setting of all the registers in TAS6422.

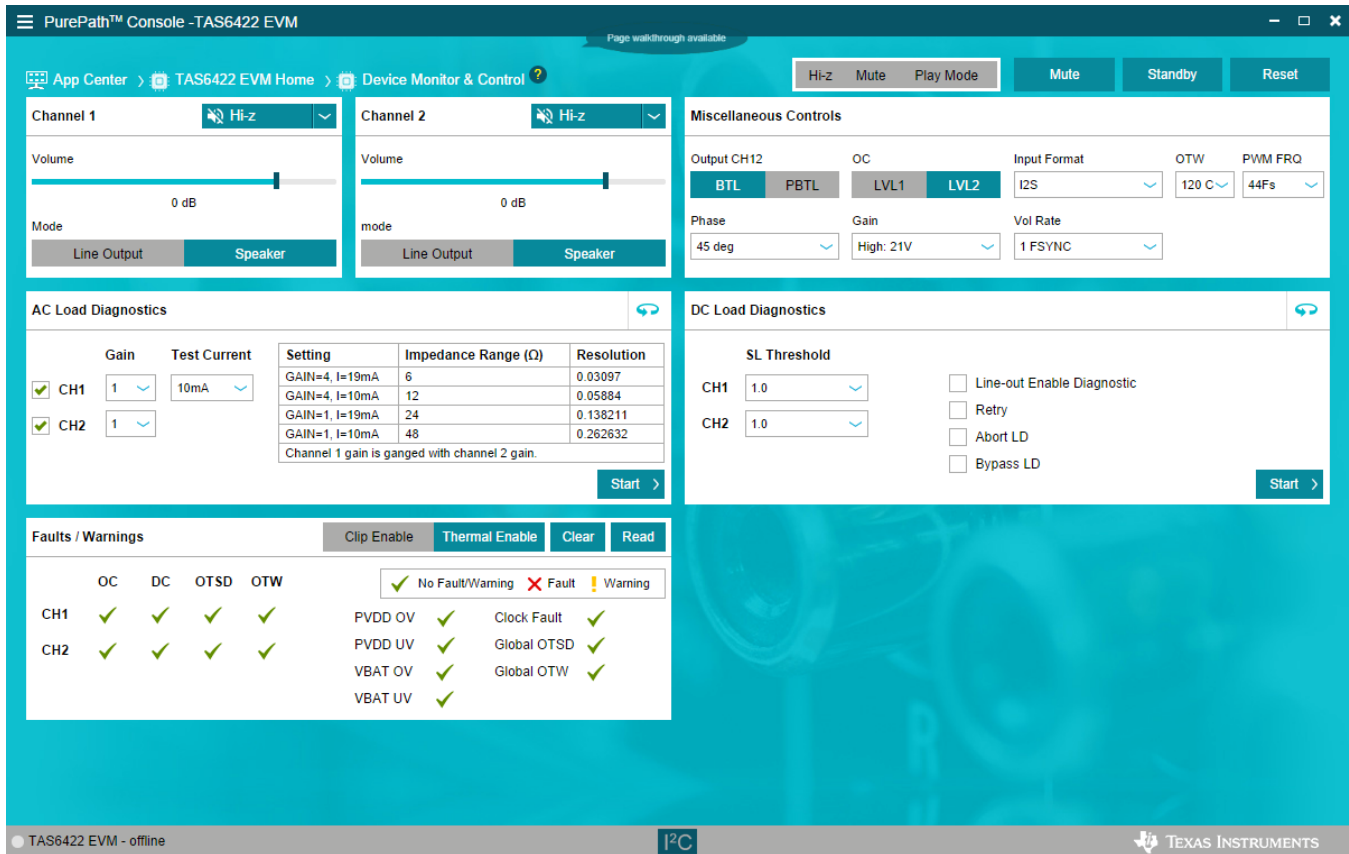


Figure 9. TAS6422 EVM Device Monitor and Control Window

### 3.5 TAS6422 EVM Start Up

This section describes the TAS6422 start-up procedure. Have the equipment and accessories listed on the first page of this document available.

#### 3.5.1 TAS6422 EVM Setup

Hardware and software connections:

- Desk top or laptop PC running Windows 7. Open PPC3 GUI.
- Connect 14.4 VDC PSU to TAS6422 EVM
- Connect speakers or resistive loads to TAS6422 EVM
- Connect USB micro cable from PC to the EVM
- Set the switches (SPDIF, STANDBY, MUTE) to up positions
- Turn on the PSU
- Audio source: This can be a DVD player with optical SPDIF cable or Windows Media Player from PC
- At this point, 3.3 V LED, USB-LOCK LED and SPDIF-LOCK LED (if optical SPDIF is used) are on.
- If the SPDIF LED is not on, the default I2S input is the USB audio source.
- On the PPC3 window, launch TAS6422 EVM application
- The audio can be streamed now to the speakers. Go to the GUI and click on “Device Monitor & Control” box. Click on play button located on the top right of the window.
- The following sections describe in detail the register settings of TAS6422.

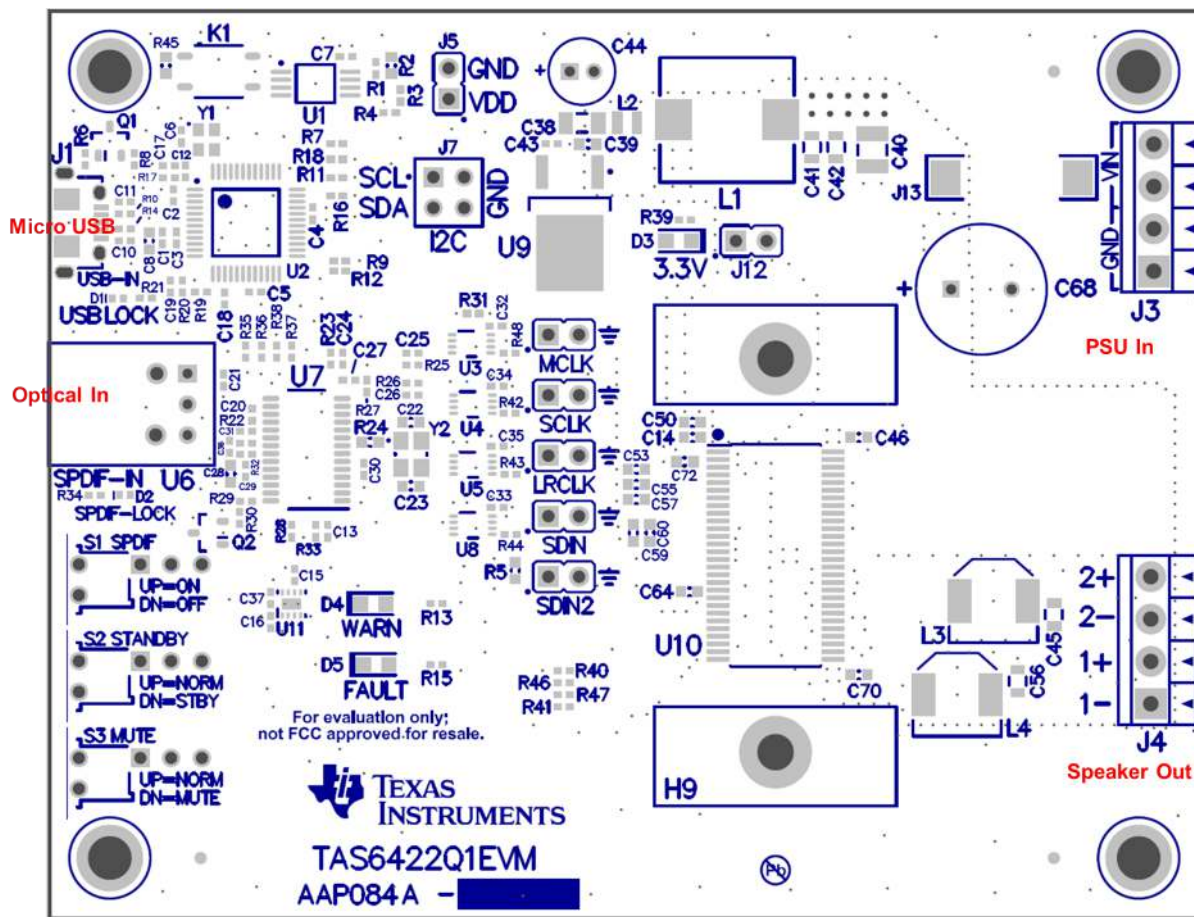


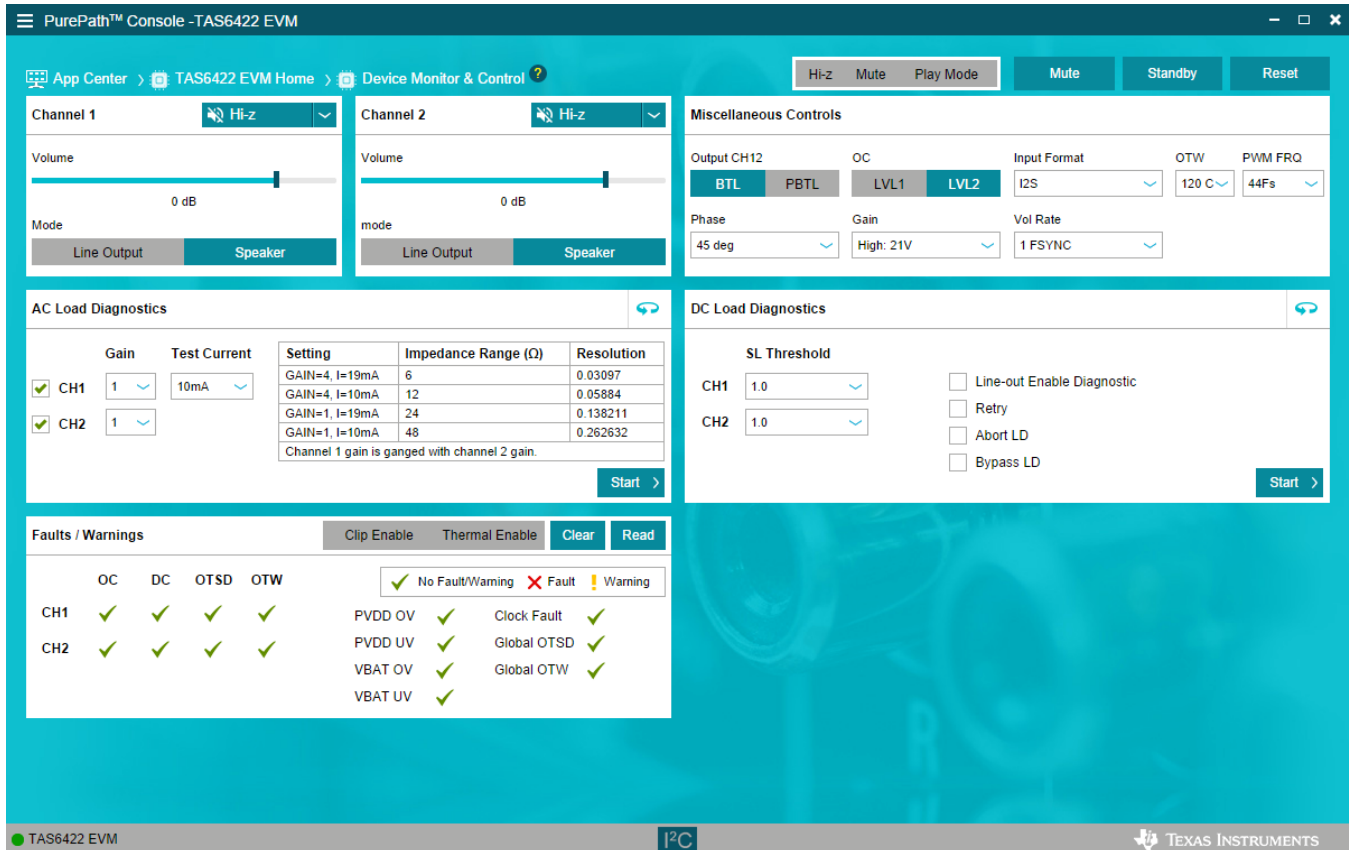
Figure 10. TAS6422 EVM Connection

### 3.5.2 TAS6422 Settings on Device Monitor and Control Window

The TAS6422 Register Map window is for reference. Most of the register settings are done on the Device Monitor and Control window

Click on “CONNECT” button on the bottom left corner of the TAS6422 EVM application window, see [Figure 11](#). The LED next to the TAS6422 EVM changes from gray to green and the “CONNECT” button changes to “DISCONNECT” button.

Click on the TAS6422 Device Monitor and Control box. The following window is displayed.



**Figure 11. Device Monitor and Control Window**

This window has 6 major sections: global control section, channel control section, other control section, faults and warnings section, AC load diagnostics section and DC load diagnostics section.

#### 3.5.2.1 Global Control Section

The Hi-z, Mute and Unmute buttons with the gray background controls all 4 channels at the same time. When Hi-z is selected, all 4 channels are put in Hi-z. The display for each channel in the channel control section will reflect these buttons selections.

The Mute Pin button is the GPIO pin controlling the mute function of the device.

The Standby button is the GPIO pin controlling the standby function of the device.

The Reset button is software reset. This will put the device back in default settings.



**Figure 12. Global Control Section**

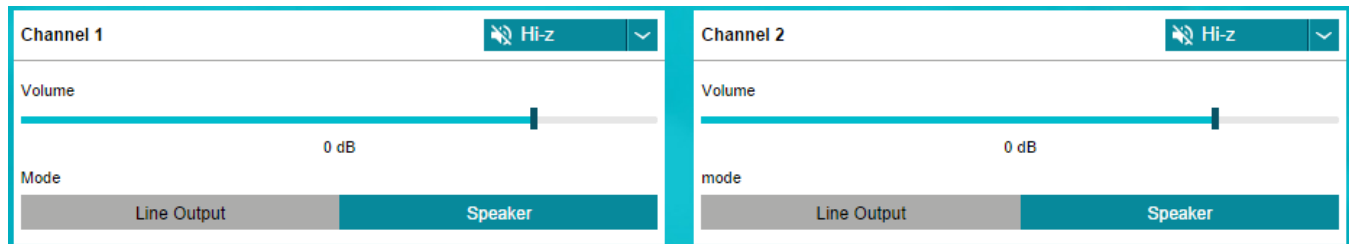
### 3.5.2.2 Channel Control Section

Each channel has the same setting selections: Hi-z, Mute, Unmute, Volume, Line-out mode and Speaker mode.

The drop down menu allows user to select either Hi-z, Mute or Unmute state of each channel.

The volume slide controls the digital gain of each channel.

The default setting for each channel is speaker mode. If line-out is used, select Line Output button.



**Figure 13. Channel Control Section**

### 3.5.2.3 Miscellaneous Control Section

There are miscellaneous settings that are available on the GUI for easy access.

OSR is oversampling bit. For lower idle noise 64X OSR is set as default. For wider bandwidth, 128X OSR can be used. 64X OSR is recommended.

TAS6422 supports parallel Bridge-Tied Load. Channels 1 and 2 can be one PBTL channel and channels 3 and 4 can be the other. Before setting a set of channels to PBTL mode, connect the (+) terminals as PBTL channel (+) and the (-) terminals as PBTL channel (-). Then connect the speaker (+) to the PBTL channel (+) and connect the speaker (-) to the PBTL channel (-).

The over-current has two levels. The lower level is 1. The default is level 2. When running at lower output current, OC level can be set to 1. I2S and TDM are automatically detected. Use the pull down menu from "Input Format" box to manually select the audio format.

If sampling frequency is greater than 48 kHz, select 96 kHz from the "Input FS" pull down.

Over-temperature warning can be programmable, use the pull down menu to choose the OTW temperature. The default setting is 120°C.

The output switching frequency (FSW) or Pulse Width Modulation frequency (PWM) is set at 2.1 MHz. The pull-down menu on the PWM FRQ box is used to choose a lower FSW. LC value should be adjusted when FSW is changed.

The offset phase for each channel is set at 45 degrees. This helps lower the ripple current on the power supply as not all the channels switch at the same time. To choose a different phase offset, use the pull-down menu on the "Phase" box.

There are four gain settings in TAS6422: low, normal, high and maximum. The default setting is high. However, the recommended setting is normal for lower noise performance for driving speakers at 14.4 VDC. The gain setting is selectable via the drop down menu in the "Gain" box.

The volume slew rate is measured with sampling frequency. The default setting is 1 period of sampling frequency (FSYNC or FS). This rate is selectable from 1 to 8 sampling periods with the drop down menu under "Vol Rate" box.

**Miscellaneous Controls**

---

Output CH12

BTL

PBTL

LVL1

LVL2

OC

LVL1

Input Format

I2S v

OTW

120 C v

PWM FRQ

44Fs v

---

Phase

45 deg v

Gain

High: 21V v

Vol Rate

1 FSYNC v

**Figure 14. Other Control Section**

### 3.5.2.4 Faults and Warnings Section

The top right buttons on this box serve as controlling and monitoring faults.

Clip enable route the clip detection bit to the warning pin. This is displayed as yellow LED on the EVM.

Thermal enable route the over-temperature warning bit to the warning pin. This is display as the same yellow LED on the EVM.

Clear button clears all the faults and warnings.

Read button manually read the faults and warnings.

| Faults / Warnings |    |    |      |     | Clip Enable | Thermal Enable   | Clear       | Read |
|-------------------|----|----|------|-----|-------------|--|-------------|------|
|                   | OC | DC | OTSD | OTW |             |  |             |      |
|                   |    |    |      |     |             | <span style="color: green;">✓</span> No Fault/Warning <span style="color: red; margin-left: 10px;">✗</span> Fault <span style="color: orange; margin-left: 10px;">!</span> Warning |             |      |
| CH1               | ✓  | ✓  | ✓    | ✓   | PVDD OV     | ✓  | Clock Fault | ✓    |
| CH2               | ✓  | ✓  | ✓    | ✓   | PVDD UV     | ✓  | Global OTSD | ✓    |
|                   |    |    |      |     | VBAT OV     | ✓  | Global OTW  | ✓    |
|                   |    |    |      |     | VBAT UV     | ✓  |             |      |

**Figure 15. Faults and Warnings Section**

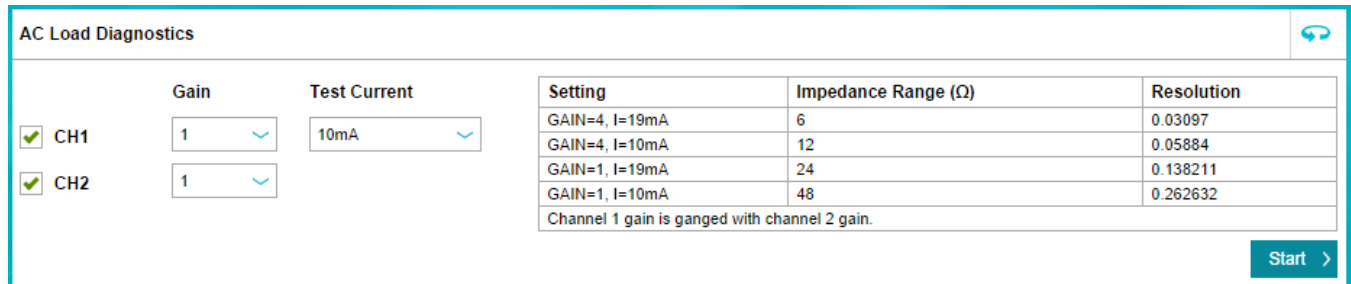
### 3.5.2.5 AC Load Diagnostics Section

AC load diagnostics report speaker impedance and phase. The diagnostics can be performed with one or all four channels.

Select the correct output impedance and click start. Follow the pop up instructions to complete the load diagnostics run.

**NOTE:** Make sure to set the digital input to 0 dBFS (100% full-scale). If the sine wave is provided from the USB audio, turn the audio media volume and PC sound card volume to maximum.

Click on the “flip” icon located on the top right of the AC load diagnostics box to see the results.



| Setting        | Impedance Range ( $\Omega$ ) | Resolution |
|----------------|------------------------------|------------|
| GAIN=4, I=19mA | 6                            | 0.03097    |
| GAIN=4, I=10mA | 12                           | 0.05884    |
| GAIN=1, I=19mA | 24                           | 0.138211   |
| GAIN=1, I=10mA | 48                           | 0.262632   |

Channel 1 gain is ganged with channel 2 gain.

Figure 16. AC Load Diagnostics Section

### 3.5.2.6 DC Load Diagnostics Section

The DC load diagnostics report if a channel is short to power, short to ground, short to load or open.

Select the impedance of the load from 0.5 to 5  $\Omega$ . Click start and then click the “flip” on the top right of the box to view results.

If a channel is selected as a line-out, click on “LO ENA LD” to enable line-out load diagnostics.

“Retry” box is used when DC load diagnostics are run more than one time.

DC load diagnostics can be aborted by click on the “Abort LD” box.

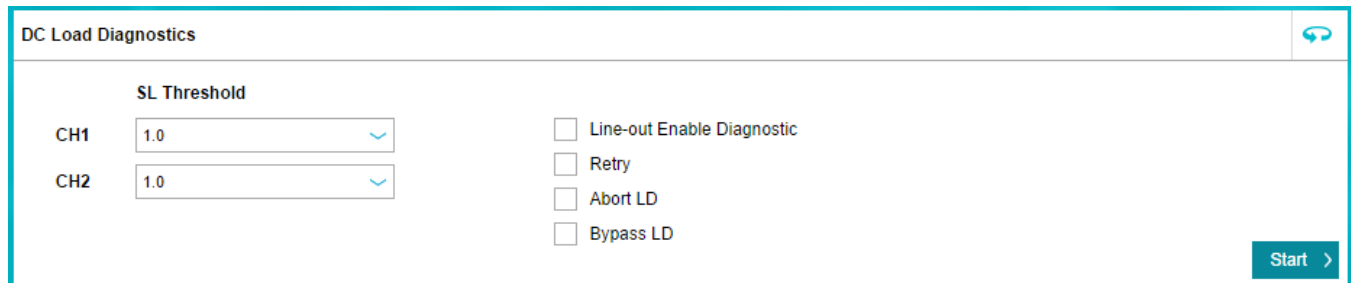
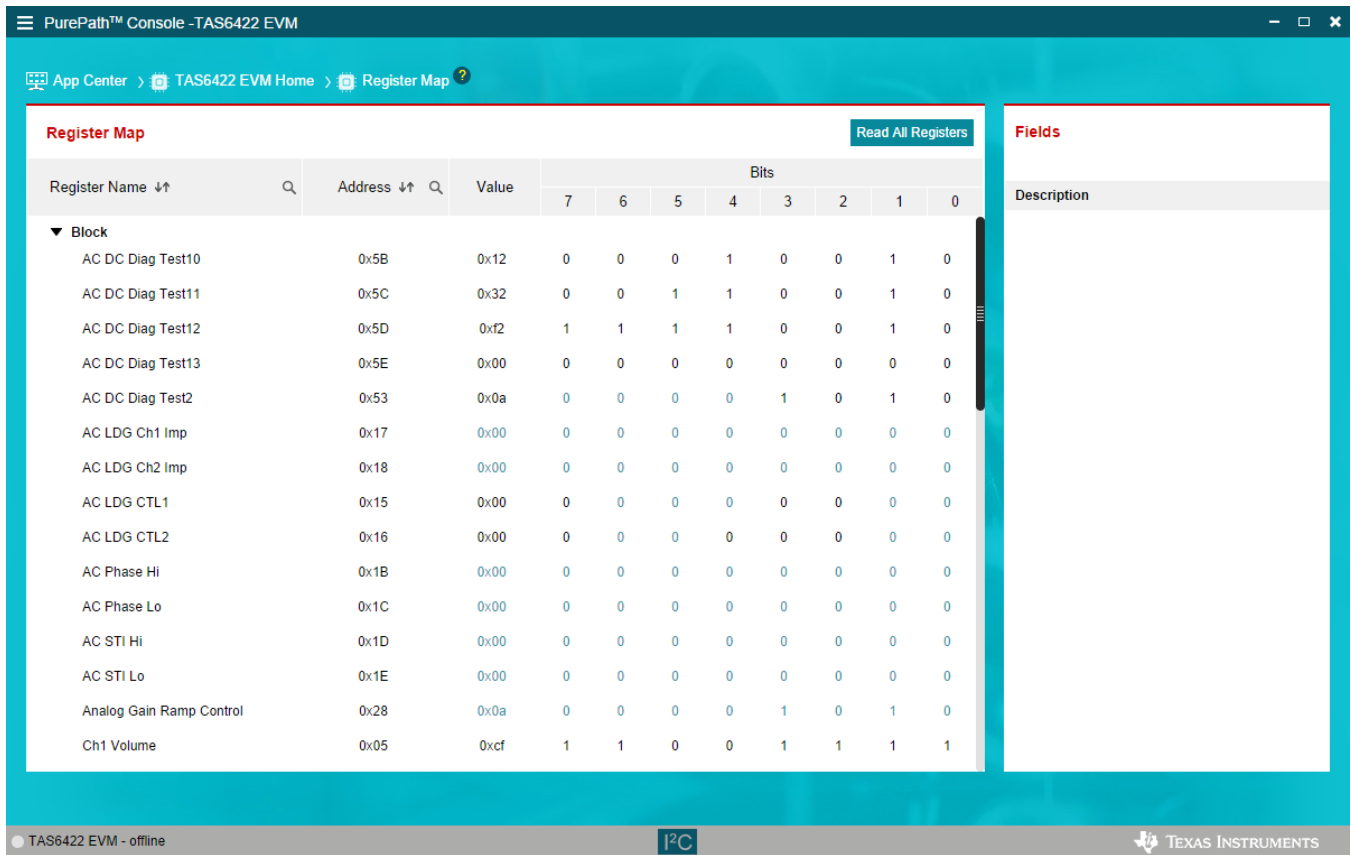


Figure 17. DC Load Diagnostics Section

### 3.5.3 TAS6422 Settings on Register Map Window

The register map can be sorted either alphabetically or numerically (register number).



**Register Map** Read All Registers

| Register Name            | Address | Value | Bits |   |   |   |   |   |   |   | Description |  |
|--------------------------|---------|-------|------|---|---|---|---|---|---|---|-------------|--|
|                          |         |       | 7    | 6 | 5 | 4 | 3 | 2 | 1 | 0 |             |  |
| ▼ Block                  |         |       |      |   |   |   |   |   |   |   |             |  |
| AC DC Diag Test10        | 0x5B    | 0x12  | 0    | 0 | 0 | 1 | 0 | 0 | 1 | 0 |             |  |
| AC DC Diag Test11        | 0x5C    | 0x32  | 0    | 0 | 1 | 1 | 0 | 0 | 1 | 0 |             |  |
| AC DC Diag Test12        | 0x5D    | 0x12  | 1    | 1 | 1 | 1 | 0 | 0 | 1 | 0 |             |  |
| AC DC Diag Test13        | 0x5E    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC DC Diag Test2         | 0x53    | 0x0a  | 0    | 0 | 0 | 0 | 1 | 0 | 1 | 0 |             |  |
| AC LDG Ch1 Imp           | 0x17    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC LDG Ch2 Imp           | 0x18    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC LDG CTL1              | 0x15    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC LDG CTL2              | 0x16    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC Phase Hi              | 0x1B    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC Phase Lo              | 0x1C    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC STI Hi                | 0x1D    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| AC STI Lo                | 0x1E    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |             |  |
| Analog Gain Ramp Control | 0x28    | 0x0a  | 0    | 0 | 0 | 0 | 1 | 0 | 1 | 0 |             |  |
| Ch1 Volume               | 0x05    | 0xcf  | 1    | 1 | 0 | 0 | 1 | 1 | 1 | 1 |             |  |

TAS6422 EVM - offline I<sup>2</sup>C TEXAS INSTRUMENTS

Figure 18. Register Map Window



When a register is selected, the hex value along with the individual bit value is displayed. The name and description for each bit are shown to the right in the "Fields" box.

**Register Map** Read All Registers

| Register Name    | Address | Value | Bits |   |   |   |   |   |   |   |
|------------------|---------|-------|------|---|---|---|---|---|---|---|
|                  |         |       | 7    | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ▼ Block          |         |       |      |   |   |   |   |   |   |   |
| Mode Control     | 0x00    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Misc Control 1   | 0x01    | 0x32  | 0    | 0 | 1 | 1 | 0 | 0 | 1 | 0 |
| Misc Control 2   | 0x02    | 0x62  | 0    | 1 | 1 | 0 | 0 | 0 | 1 | 0 |
| SAP Control      | 0x03    | 0x04  | 0    | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| State Control    | 0x04    | 0x50  | 0    | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| Ch1 Volume       | 0x05    | 0xcf  | 1    | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| Ch2 Volume       | 0x06    | 0xcf  | 1    | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| Reserved         | 0x07    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reserved         | 0x08    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DC LDG Control 1 | 0x09    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DC LDG Control 2 | 0x0A    | 0x11  | 0    | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Reserved         | 0x0B    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DC LDG Report 12 | 0x0C    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reserved         | 0x0D    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DC LDG Report LO | 0x0E    | 0x00  | 0    | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Fields**

| Field  | Value |
|--|-------|
| Mode Control                                 |       |
| Reset  | 0     |
| Reserved                                     | 0     |
| Reserved                                     | 0     |
| PBTL 12                                      | 0     |
| CH1 LO Mode                                  | 0     |
| CH2 LO Mode                                  | 0     |
| Reserved [1:0]                               | 0x00  |
| <b>Description</b>                           |       |
| <b>Device Reset</b>                          |       |
| Reserved                                     |       |
| Reserved                                     |       |
| Parallel BTL Mode Control for Channels 1 & 2 |       |
| Channel 1 Line Output Mode Control           |       |
| Channel 2 Line Output Mode Control           |       |
| Reserved                                     |       |

**Figure 19. Register Map Window - Expanding**

Double click on any bit, the bit will change state. This state is executed at the end of the click.

### 3.5.4 I2C Window

The PPC3 has an I2C monitor and also configuration program options.

When this window is first open, the round button is green. To record I2C commands, click on this button and it will turn red. The recording can be saved for later used by clicking the save icon.

The I2C commands can also be copied to clip board by clicking the icon next to trash bin icon.

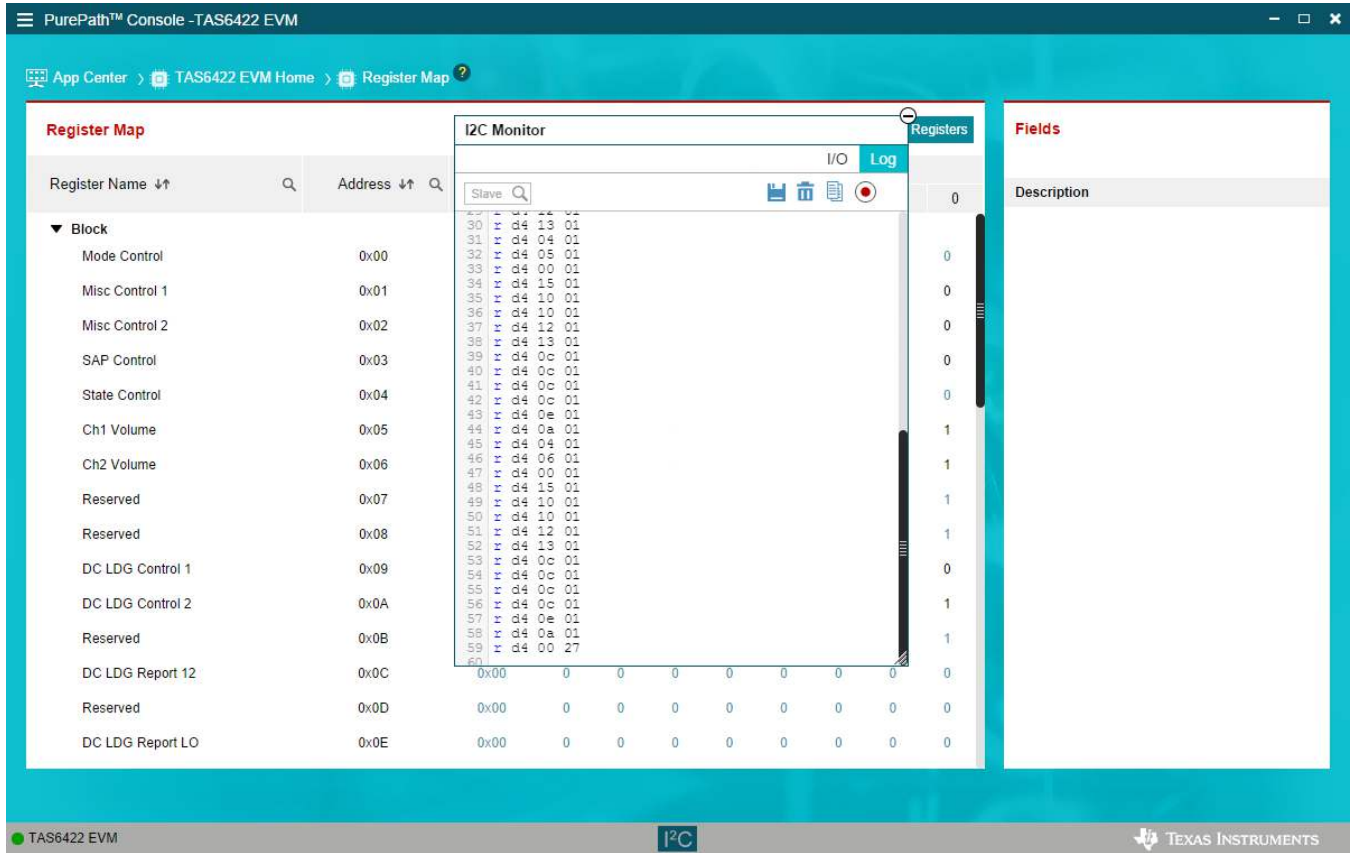
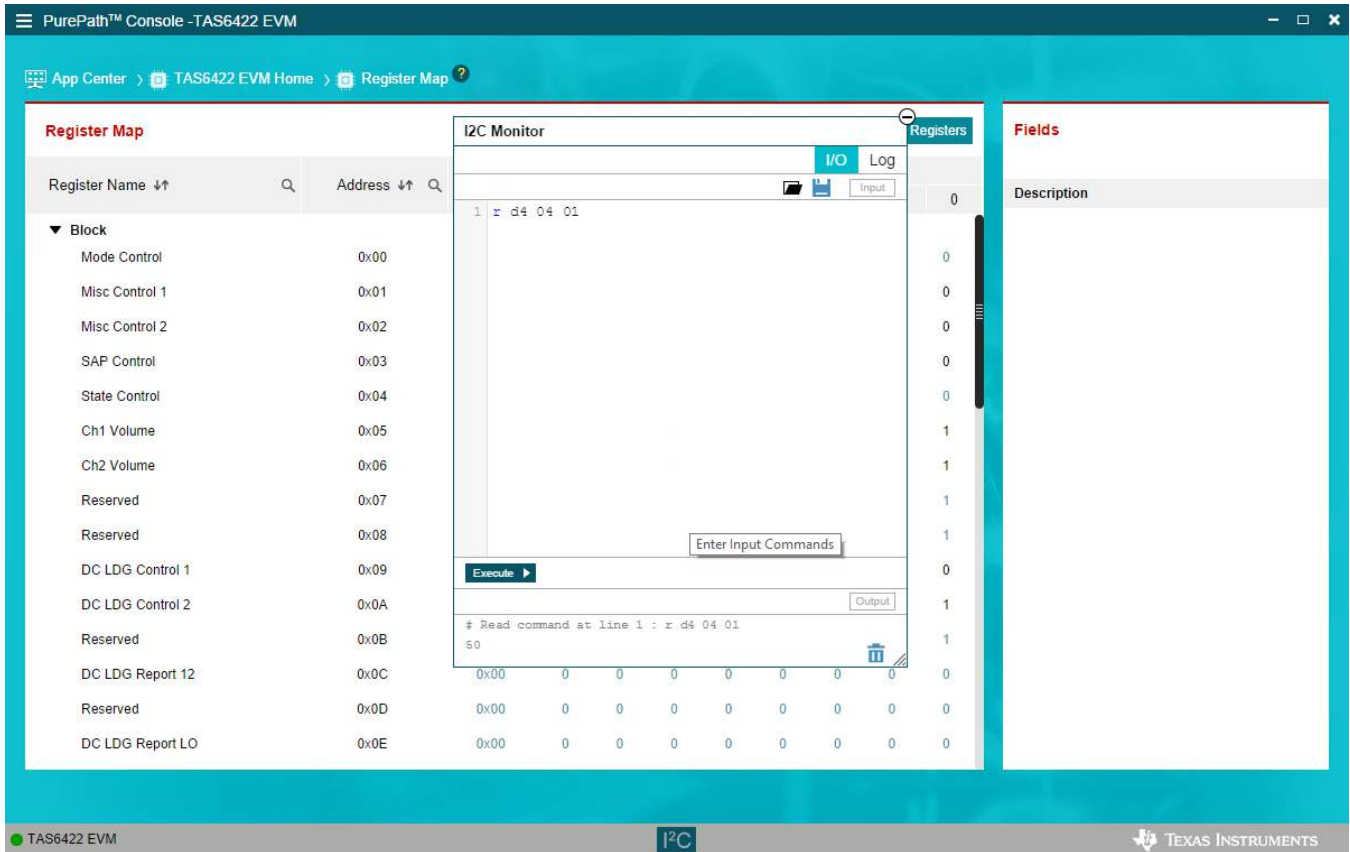


Figure 20. I2C Window – I2C Logging

A set of I2C commands can be loaded and executed from this window. On the top right corner, click on “I/O” button to display the above window. Write I2C commands here or open an existing \*.cfg file then click “Execute” button on the bottom left corner. The I2C commands are sent to the device when the “Execute” button is pressed.



**Figure 21. I2C Window – Sending I2C Commands**

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

### 4.1 TAS6422 EVM Layouts

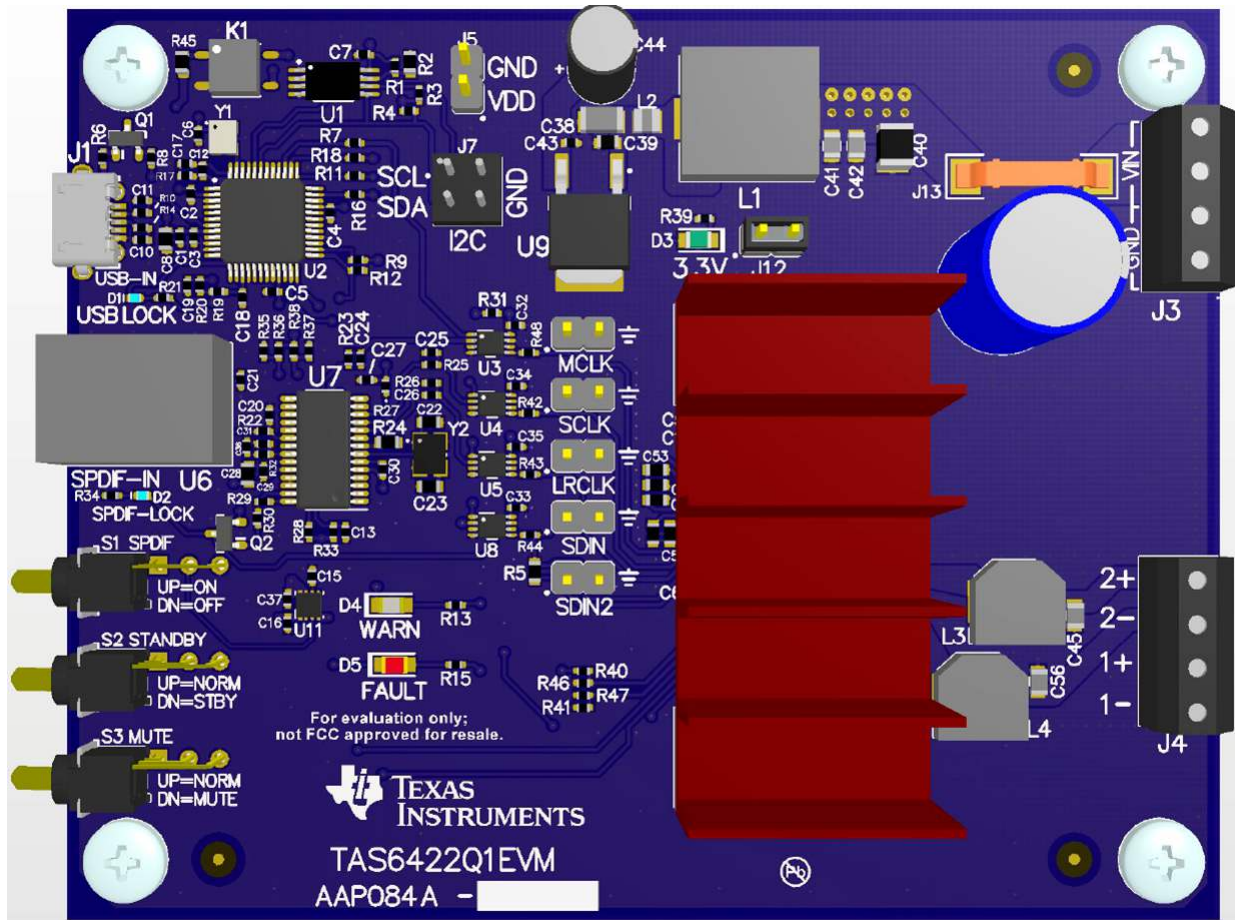


Figure 22. TAS6422 EVM Top

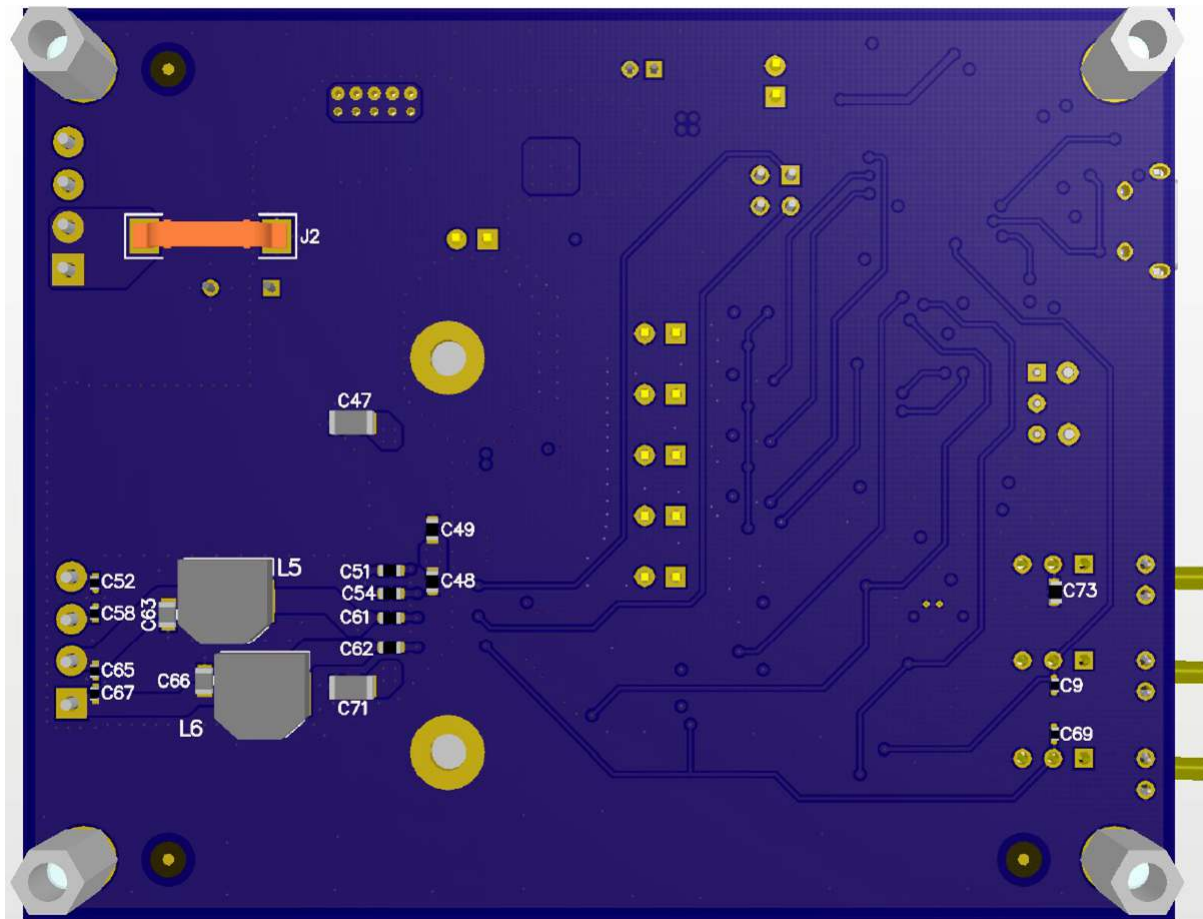
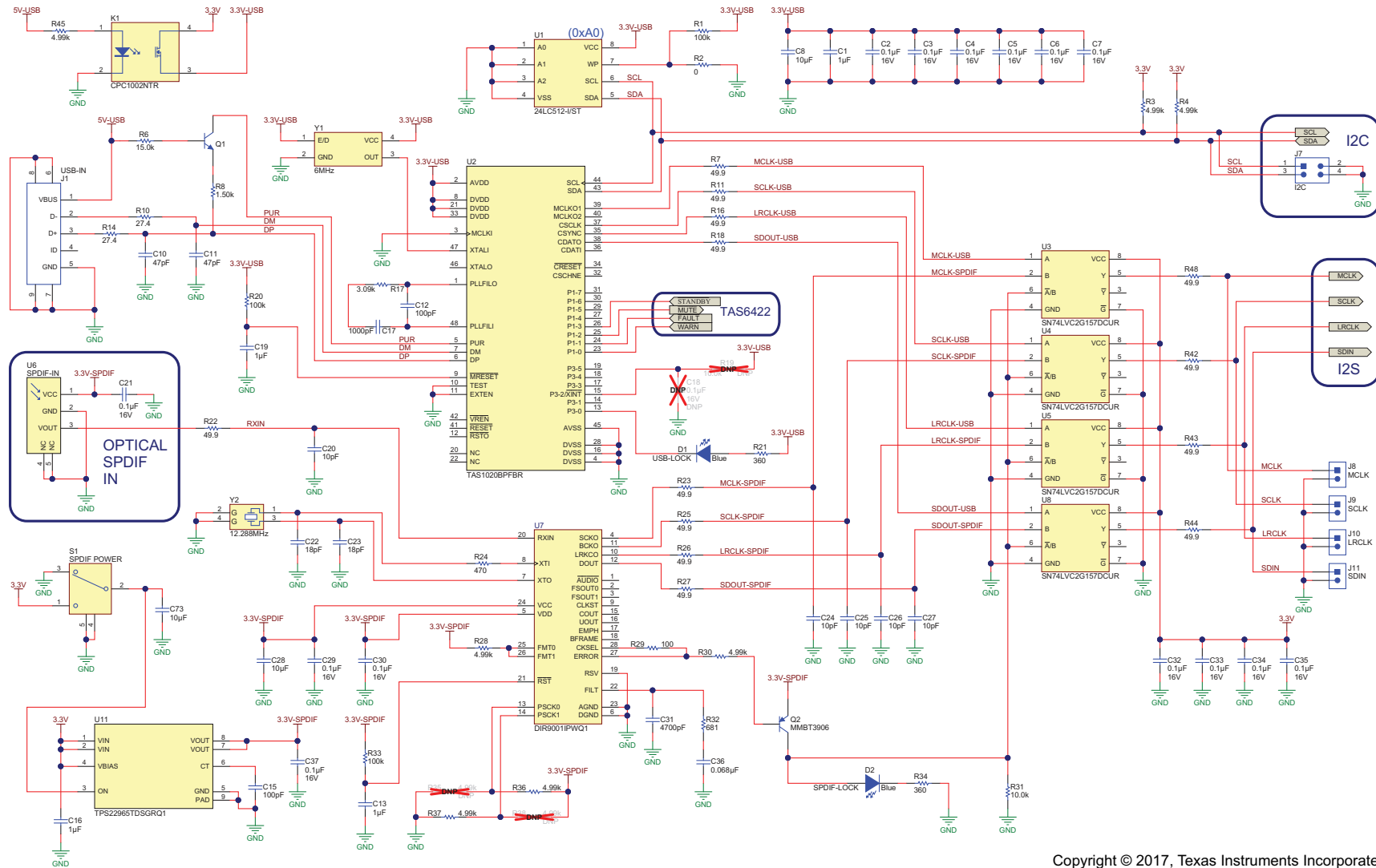


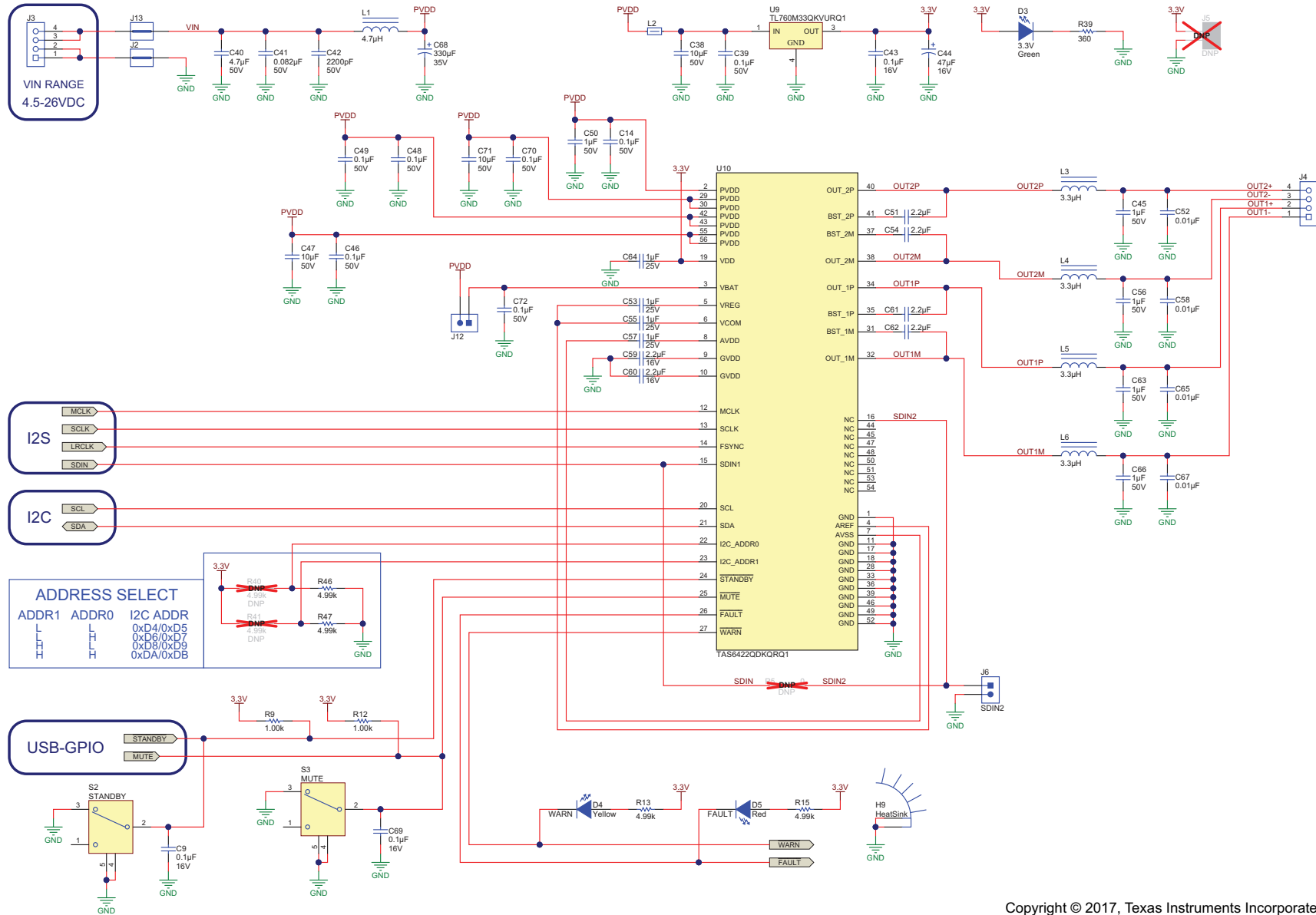
Figure 23. TAS6422 EVM Bottom

## 4.2 TAS6422 EVM Schematic



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Figure 24. Schematic (Page 1)



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Figure 25. Schematic (Page 2)

### 4.3 Bill of Materials

Table 1 lists the TAS6422Q1EVM bill of materials.

**Table 1. TAS6422Q1EVM Bill of Materials**

| Designator   | Qty | Value   | Description   | Package Reference                       | Part Number            | Manufacturer       | Alternate Part Number |
|--|-----|---------|---|---|------------------------|--------------------|-----------------------|
| PCB1   | 1   |         | Printed Circuit Board                                 |   | AAP084                 | Any                |                       |
| C1, C13, C16, C19  | 4   | 1uF     | CAP, CERM, 1 $\mu$ F, 6.3 V, +/- 20%, X5R, 0402       | 0402                                    | C1005X5R0J105M050BB    | TDK                |                       |
| C2, C3, C4, C5, C6, C7, C9, C21, C29, C30, C32, C33, C34, C35, C37, C43, C69 | 17  | 0.1uF   | CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402              | 0402                                    | GRM155R71C104KA88D     | Murata             |                       |
| C8, C28, C73   | 3   | 10uF    | CAP, CERM, 10 $\mu$ F, 10 V, +/- 20%, X5R, 0603       | 0603                                    | C1608X5R1A106M080AC    | TDK                |                       |
| C10, C11   | 2   | 47pF    | CAP, CERM, 47pF, 25V, +/-5%, C0G/NP0, 0402            | 0402                                    | GRM1555C1E470JA01D     | Murata             |                       |
| C12, C15   | 2   | 100pF   | CAP, CERM, 100pF, 50V, +/-5%, C0G/NP0, 0402           | 0402                                    | GRM1555C1H101JA01D     | Murata             |                       |
| C14, C39, C46, C48, C49, C70, C72  | 7   | 0.1uF   | CAP, CERM, 0.1 $\mu$ F, 50 V, +/- 10%, X7R, 0603      | 0603                                    | GCM188R71H104KA57D     | Murata             |                       |
| C17  | 1   | 1000pF  | CAP, CERM, 1000pF, 50V, +/-5%, C0G/NP0, 0402          | 0402                                    | GRM1555C1H102JA01D     | Murata             |                       |
| C20, C24, C25, C26, C27  | 5   | 10pF    | CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0402         | 0402                                    | GRM1555C1H100JA01D     | Murata             |                       |
| C22, C23   | 2   | 18pF    | CAP, CERM, 18 pF, 50 V, +/- 5%, C0G/NP0, 0603         | 0603                                    | GRM1885C1H180JA01D     | Murata             |                       |
| C31  | 1   | 4700pF  | CAP, CERM, 4700 pF, 25 V, +/- 10%, X7R, 0402          | 0402                                    | GRM155R71E472KA01D     | Murata             |                       |
| C36  | 1   | 0.068uF | CAP, CERM, 0.068 $\mu$ F, 50 V, +/- 10%, X7R, 0402    | 0402                                    | C1005X7R1H683K050BB    | TDK                |                       |
| C38, C47, C71  | 3   | 10uF    | CAP, CERM, 10 $\mu$ F, 50 V, +/- 10%, X5R, 1206       | 1206                                    | GRM31CR61H106KA12L     | Murata             |                       |
| C40  | 1   | 4.7uF   | CAP, CERM, 4.7 $\mu$ F, 50 V, +/- 10%, X7R, 1210      | 1210                                    | GRM32ER71H475KA88L     | Murata             |                       |
| C41  | 1   | 0.082uF | CAP, CERM, 0.082 $\mu$ F, 50 V, +/- 10%, X7R, 0805    | 0805                                    | 08055C823KAT2A         | AVX                |                       |
| C42  | 1   | 2200pF  | CAP, CERM, 2200 pF, 50 V, +/- 5%, C0G/NP0, 0805       | 0805                                    | GRM2165C1H222JA01D     | Murata             |                       |
| C44  | 1   | 47uF    | CAP, AL, 47 $\mu$ F, 16 V, +/- 20%, 0.8 ohm, TH       | D5xL11mm                                | EEU-FC1C470            | Panasonic          |                       |
| C45, C56, C63, C66   | 4   | 1uF     | CAP, CERM, 1 $\mu$ F, 50 V, +/- 10%, X7R, 0805        | 0805                                    | GRM21BR71H105KA12L     | Murata             |                       |
| C50  | 1   | 1uF     | CAP, CERM, 1 $\mu$ F, 50 V, +/- 10%, X7R, 0603        | 0603                                    | UMK107AB7105KA-T       | Taiyo Yuden        |                       |
| C51, C54, C59, C60, C61, C62   | 6   | 2.2uF   | CAP, CERM, 2.2 $\mu$ F, 16 V, +/- 10%, X7R, 0603      | 0603                                    | GRM188Z71C225KE43      | Murata             |                       |
| C52, C58, C65, C67   | 4   | 0.01uF  | CAP, CERM, 0.01 $\mu$ F, 50 V, +/- 10%, C0G/NP0, 0402 | 0402                                    | GCM155R71H103KA55D     | Murata             |                       |
| C53, C55, C57, C64   | 4   | 1uF     | CAP, CERM, 1 $\mu$ F, 25 V, +/- 10%, X7R, 0603        | 0603                                    | GRM188R71E105KA12D     | Murata             |                       |
| C68  | 1   | 330uF   | CAP, AL, 330 $\mu$ F, 35 V, +/- 20%, ohm, TH          | D10xL20mm                               | UBT1V331MPD1TD         | Nichicon           |                       |
| D1, D2   | 2   | Blue    | LED, Blue, SMD  | Blue LED                                | SMLP12BC7TT86          | Rohm               |                       |
| D3   | 1   | Green   | LED, Green, SMD                                       | LED_0805                                | LTST-C170KGKT          | Lite-On            |                       |
| D4   | 1   | Yellow  | LED, Yellow, SMD                                      | LED_0805                                | LTST-C170KSKT          | Lite-On            |                       |
| D5   | 1   | Red     | LED, Red, SMD   | Red 0805 LED                            | LTST-C170KRKT          | Lite-On            |                       |
| H1, H2, H3, H4   | 4   |         | MACHINE SCREW PAN PHILLIPS M3                         | M3 Screw                                | RM3X8MM 2701           | APM HEXSEAL        |                       |
| H5, H6, H7, H8   | 4   |         | Standoff, Hex, 12mm, M3, Aluminum                     | Aluminum M3 12mm Hex Standoff           | 24434                  | Keystone           |                       |
| H9   | 1   |         | Heat Sink for DKQ Packages, 41.4x20 mm                | Heat Sink for DKQ Packages, 41.4x20 mm  | HS-DKQ56_20X41.4X32.77 | Any                |                       |
| H10  | 1   |         | Arctic Silver 5 Thermal Paste                         | Used in PnP output and some BOM reports | ARCTIC SILVER 5        | ARTIC SILVER, INC. | -                     |



**Table 1. TAS6422Q1EVM Bill of Materials (continued)**

| Designator                                     | Qty | Value   | Description  | Package Reference                            | Part Number        | Manufacturer                | Alternate Part Number |
|--|-----|---------|--|--|--------------------|-----------------------------|-----------------------|
| J1   | 1   |         | Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT                      | Connector, USB Micro AB                      | DX4R205JJAR1800    | JAE Electronics             |                       |
| J2, J13  | 2   |         | JUMPER TIN SMD, SMT  | JUMPER TIN SMD                               | S1621-46R          | Harwin                      |                       |
| J3, J4   | 2   |         | Terminal Block, 3.5mm Pitch, 4x1, TH   | 14x8.2x6.5mm                                 | ED555/4DS          | On-Shore Technology         |                       |
| J6, J8, J9, J10, J11, J12                      | 6   |         | Header, 100mil, 2x1, Gold, TH  | Sullins 100mil, 1x2, 230 mil above insulator | PBC02SAAN          | Sullins Connector Solutions |                       |
| J7   | 1   |         | Header, 100mil, 2x2, Tin, TH   | Header, 2x2, 2.54mm, TH                      | PEC02DAAN          | Sullins Connector Solutions |                       |
| K1   | 1   |         | Relay, SPST-NO (1 Form A), 0.7 A, , SMD  | 4.089x3.81mm                                 | CPC1002NTR         | IXYS                        |                       |
| L1   | 1   | 4.7uH   | Inductor, Shielded, 4.7 μH, 9.7 A, 0.016 ohm, AEC-Q200 Grade 1, SMD                  | 10.8x10mm                                    | DFEG10040D-4R7M=P3 | Murata Toko                 |                       |
| L2   | 1   | 180 ohm | Ferrite Bead, 180 ohm @ 100 MHz, 3.4 A, 0806   | 0806   | NFZ2MSM181SN10L    | Murata                      |                       |
| L3, L4, L5, L6                                 | 4   | 3.3uH   | Inductor, Shielded, Metal Composite, 3.3 μH, 6.7 A, 0.024 ohm, AEC-Q200 Grade 1, SMD | 7x6.6mm                                      | DFEG7030D-3R3M=P3  | Murata Toko                 |                       |
| Q1   | 1   | 0.3V    | Transistor, NPN, 40V, 0.15A, SOT-23  | SOT-23                                       | MMBT2222A          | Fairchild Semiconductor     |                       |
| Q2   | 1   | 40 V    | Transistor, PNP, 40 V, 0.2 A, SOT-23   | SOT-23                                       | MMBT3906           | Fairchild Semiconductor     |                       |
| R1, R20, R33                                   | 3   | 100k    | RES, 100k ohm, 1%, 0.063W, 0402  | 0402   | CRCW0402100KFKED   | Vishay-Dale                 |                       |
| R2   | 1   | 0       | RES, 0, 5%, 0.1 W, 0603  | 0603   | CRCW06030000Z0EA   | Vishay-Dale                 |                       |
| R3, R4, R13, R15, R28, R30, R36, R37, R46, R47 | 10  | 4.99k   | RES, 4.99k ohm, 1%, 0.063W, 0402   | 0402   | CRCW04024K99FKED   | Vishay-Dale                 |                       |
| R6   | 1   | 15.0k   | RES, 15.0k ohm, 1%, 0.063W, 0402   | 0402   | CRCW040215K0FKED   | Vishay-Dale                 |                       |
| R7, R11, R16, R18, R22, R23, R25, R26, R27     | 9   | 49.9    | RES, 49.9 ohm, 1%, 0.063W, 0402  | 0402   | CRCW040249R9FKED   | Vishay-Dale                 |                       |
| R8   | 1   | 1.50k   | RES, 1.50k ohm, 1%, 0.063W, 0402   | 0402   | CRCW04021K50FKED   | Vishay-Dale                 |                       |
| R9, R12  | 2   | 1.00k   | RES, 1.00 k, 1%, 0.063 W, 0402   | 0402   | CRCW04021K00FKED   | Vishay-Dale                 |                       |
| R10, R14                                       | 2   | 27.4    | RES, 27.4 ohm, 1%, 0.063W, 0402  | 0402   | CRCW040227R4FKED   | Vishay-Dale                 |                       |
| R17  | 1   | 3.09k   | RES, 3.09k ohm, 1%, 0.063W, 0402   | 0402   | CRCW04023K09FKED   | Vishay-Dale                 |                       |
| R21, R34, R39                                  | 3   | 360     | RES, 360 ohm, 5%, 0.063W, 0402   | 0402   | CRCW0402360RJNED   | Vishay-Dale                 |                       |
| R24  | 1   | 470     | RES, 470, 1%, 0.1 W, 0603  | 0603   | RC0603FR-07470RL   | Yageo America               |                       |
| R29  | 1   | 100     | RES, 100, 1%, 0.1 W, 0402  | 0402   | ERJ-2RKF1000X      | Panasonic                   |                       |
| R31  | 1   | 10.0k   | RES, 10.0 k, 1%, 0.063 W, 0402   | 0402   | CRCW040210K0FKED   | Vishay-Dale                 |                       |
| R32  | 1   | 681     | RES, 681, 1%, 0.063 W, 0402  | 0402   | CRCW0402681RFKED   | Vishay-Dale                 |                       |
| R42, R43, R44, R48                             | 4   | 49.9    | RES, 49.9, 1%, 0.063 W, 0402   | 0402   | CRCW040249R9FKED   | Vishay-Dale                 |                       |
| R45  | 1   | 4.99k   | RES, 4.99 k, 1%, 0.1 W, 0603   | 0603   | CRCW06034K99FKEA   | Vishay-Dale                 |                       |
| S1, S2, S3                                     | 3   |         | Switch, SPDT, On-On, 1 Pos, 0.4A, 28 VDC, TH   | 5.6x5.4mm                                    | FT1D-4M-Z          | Copal Electronics           |                       |
| SH1  | 1   |         | Shunt, 2.54mm, Gold, Black   | Shunt, 2.54mm, Black                         | 60900213421        | Würth Elektronik            |                       |
| U1   | 1   |         | EEPROM, 512KBIT, 400KHZ, 8TSSOP  | TSSOP-8                                      | 24LC512-I/ST       | Microchip                   |                       |
| U2   | 1   |         | USB Streaming Controller, PFB0048A, NRND   | PFB0048A                                     | TAS1020BPFB        | Texas Instruments           | TAS1020BPFB           |
| U3, U4, U5, U8                                 | 4   |         | Single 2-Line to 1-Line Data Selector Multiplexer, DCU0008A                          | DCU0008A                                     | SN74LVC2G157DCUR   | Texas Instruments           | SN74LVC2G157DCUT      |
| U6   | 1   |         | Photolink- Fiber Optic Receiver, TH  | 13.5x10x9.7mm                                | PLR135/T10         | Everlight                   |                       |

**Table 1. TAS6422Q1EVM Bill of Materials (continued)**

| Designator                         | Qty | Value | Description   | Package Reference                            | Part Number              | Manufacturer                | Alternate Part Number |
|------------------------------------|-----|-------|---|--|--------------------------|-----------------------------|-----------------------|
| U7                                 | 1   |       | Automotive Catalog 96-kHz 24-Bit Digital Audio Interface Receiver, 50 ps Jitter, 3.3V, -40 to 85 degC, 28-Pin TSSOP (PW), Green (RoHS & no Sb/Br) | PW0028A                                      | DIR9001IPWQ1             | Texas Instruments           | Equivalent            |
| U9                                 | 1   |       | Single Output Automotive LDO, 500 mA, Fixed 3.3 V Output, 3.8 to 26 V Input, 3-pin PFM (KVU), -40 to 125 degC, Green (RoHS & no Sb/Br)            | KVU0003A                                     | TL760M33QKVURQ1          | Texas Instruments           | Equivalent            |
| U10                                | 1   |       | 75-W, 2-MHz Digital Input 2-Channel Automotive Class-D Audio Amplifier With Load-Dump Protection and I2C Diagnostic, DKQ0056A (SSOP-56)           | DKQ0056A                                     | TAS6422QDKQRQ1           | Texas Instruments           | TAS6422QDKQQ1         |
| U11                                | 1   |       | 5.5-V, 4-A, 16-mOhm On-Resistance Load Switch, DSG0008B (WSON-8)  | DSG0008B                                     | TPS22965TDSGRQ1          | Texas Instruments           | TPS22965TDSGTQ1       |
| Y1                                 | 1   |       | Oscillator, 6MHz, 3.3V, SMD   | 2.5x1x2.5mm                                  | 625L3I006M00000          | CTS Electrocomponents       |                       |
| Y2                                 | 1   |       | Crystal, 12.288MHz, 18pF, SMD   | Crystal, 2.5x1x3.2mm                         | ABM8G-12.288MHZ-18-D2Y-T | Abracon Corporation         |                       |
| C18                                | 0   | 0.1uF | CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402  | 0402   | GRM155R71C104KA88D       | Murata                      |                       |
| FID1, FID2, FID3, FID4, FID5, FID6 | 0   |       | Fiducial mark. There is nothing to buy or mount.  | Fiducial                                     | N/A                      | N/A                         |                       |
| J5                                 | 0   |       | Header, 100mil, 2x1, Gold, TH   | Sullins 100mil, 1x2, 230 mil above insulator | PBC02SAAN                | Sullins Connector Solutions |                       |
| R5                                 | 0   | 0     | RES, 0, 5%, 0.1 W, 0603   | 0603   | CRCW06030000Z0EA         | Vishay-Dale                 |                       |
| R19                                | 0   | 10.0k | RES, 10.0 k, 1%, 0.063 W, 0402  | 0402   | CRCW040210K0FKED         | Vishay-Dale                 |                       |
| R35, R38, R40, R41                 | 0   | 4.99k | RES, 4.99k ohm, 1%, 0.063W, 0402  | 0402   | CRCW04024K99FKED         | Vishay-Dale                 |                       |

## Revision History

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

| <b>Changes from Original (Marhc 2017) to A Revision</b>   | <b>Page</b> |
|---|-------------|
| • Changed list item 3 From: "...if J2 is removed and 12 V is provided. If J2 is in,..." To: "...if J12 is removed and 12 V is provided. If J12 is in,..." ..... | <b>1</b>    |

## STANDARD TERMS FOR EVALUATION MODULES

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

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

### CAUTION

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

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

### FCC Interference Statement for Class A EVM devices

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

## FCC Interference Statement for Class B EVM devices

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

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

## 3.2 Canada

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

### Concerning EVMs Including Radio Transmitters:

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

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

### Concernant les EVMs avec appareils radio:

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

### Concerning EVMs Including Detachable Antennas:

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

### Concernant les EVMs avec antennes détachables

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

## 3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see [http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。  
[http://www.tij.co.jp/lstds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/lstds/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.

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see [http://www.tij.co.jp/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)  
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#### 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.

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