User's Guide

TAS6424R-Q1 Evaluation Module

ABSTRACT

This manual describes the operations of the TAS6424R-Q1 EVM. The TAS6424R-Q1 EVM 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
- TAS6424R-Q1 EVM operations (hardware and software)

Required equipment and accessories:

1. TAS6424R-Q1 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 TAS6424R-Q1 Evaluation Module Description

The TAS6424R-Q1 EVM is a stand-alone EVM. The EVM 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 1-1.

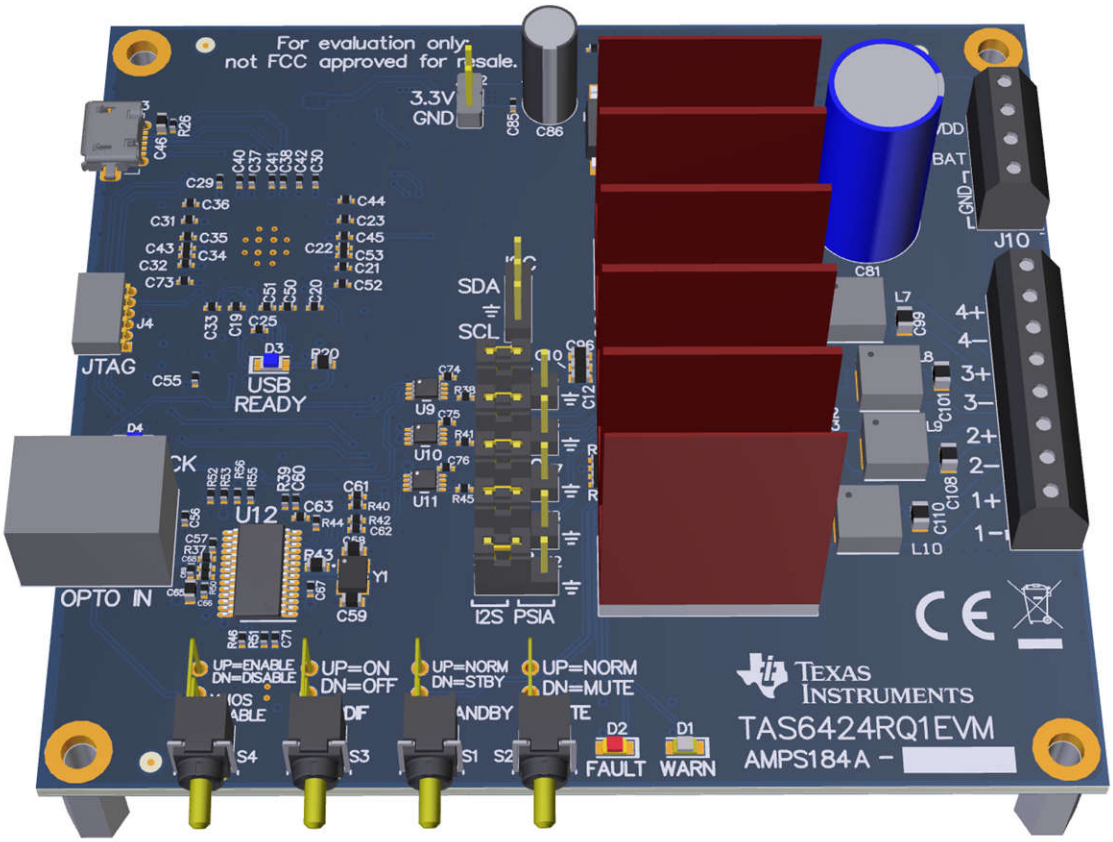

Figure 1-1. TAS6424R-Q1 EVM

The block diagram shows the TAS6424R-Q1 EVM signal flow.

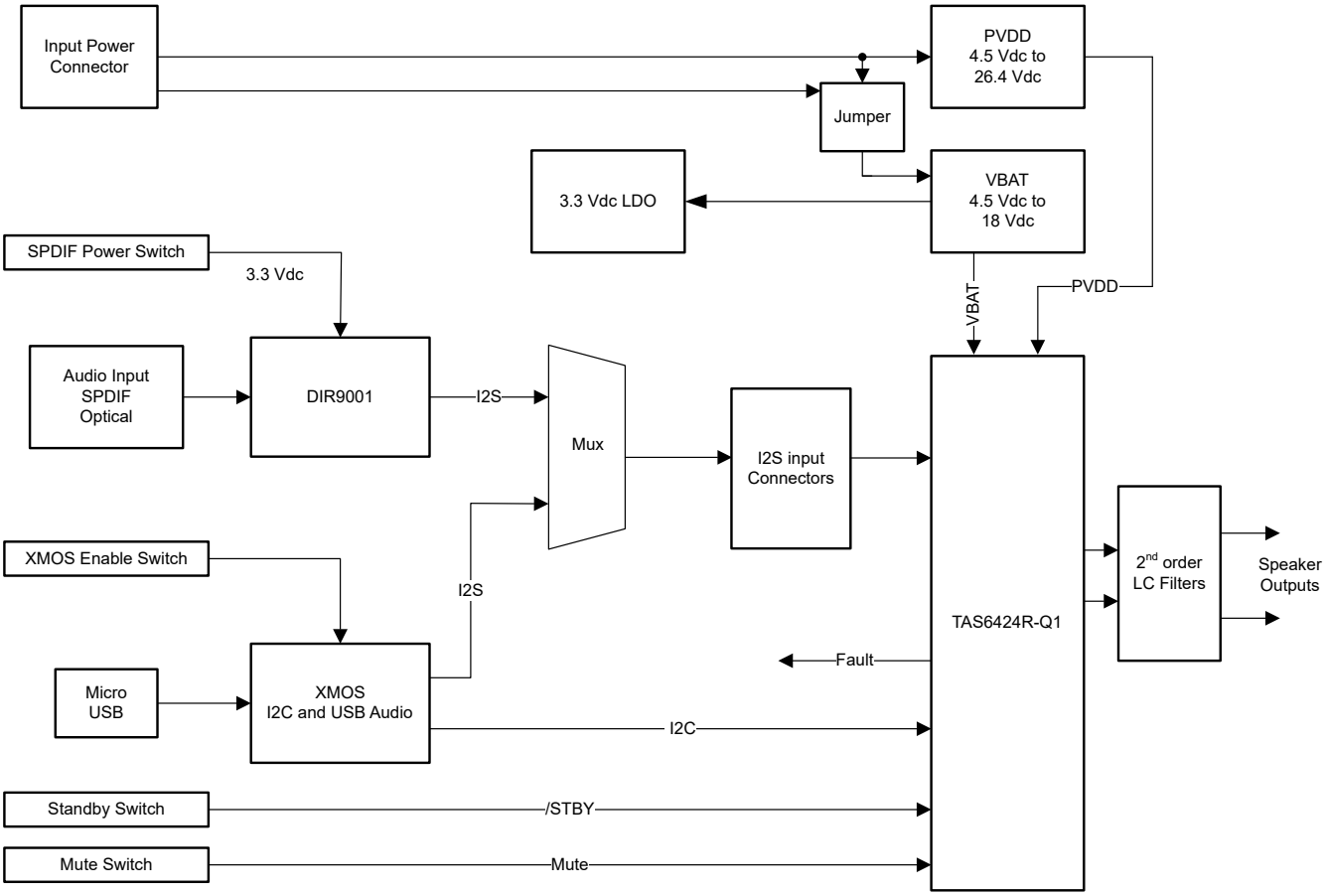

Figure 1-2. EVM Block Diagram

2 Software Overview

2.1 PurePath Console 3 (PPC3) Access and Description

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

Note

This EVM uses the PPC3 plug-in for the TAS6424E.

Once approval is given, go to www.ti.com/mysecuresoftware to download the software. After login, the web page with a similar list of software products available for download is shown.

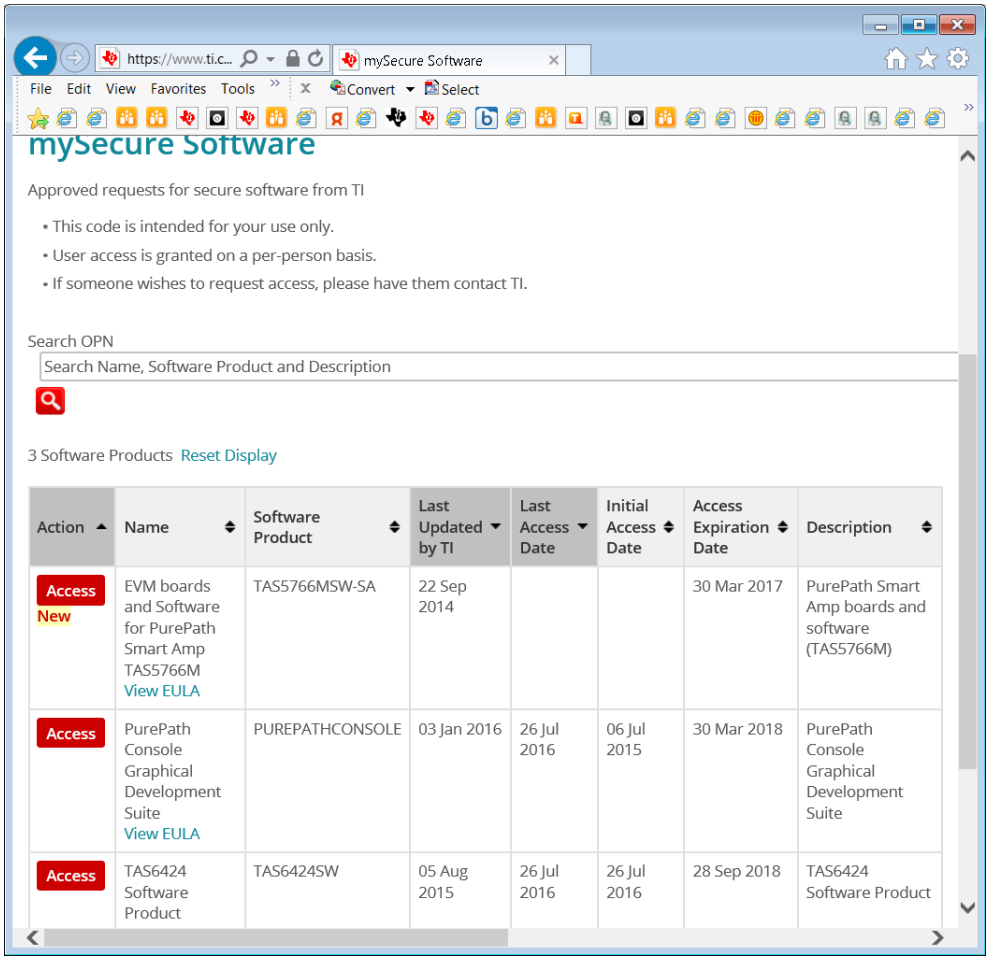

Figure 2-1. PPC3 Download Window

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

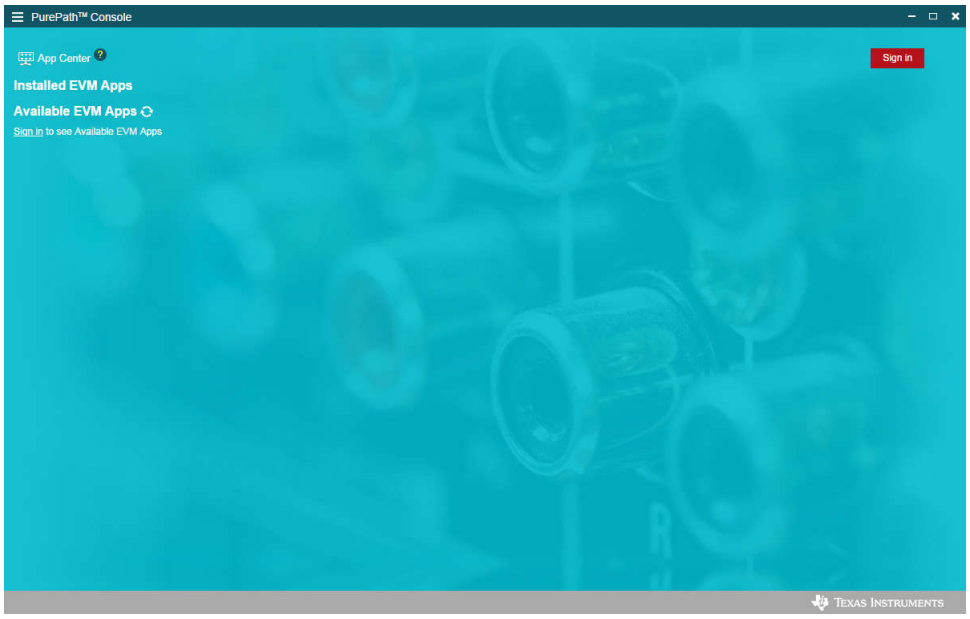

Figure 2-2. PPC3 Window

When the window in Figure 2-2 is displayed, click on the *sign-in* button to see the TAS6424E EVM application. All of the apps shown below may not be displayed for the user.

Click on TAS6424E app box to download TAS6424E application. After the installation window pops up, click *Install*.

TAS6424E EVM box appears in *Installed EVM Apps* section, see Figure 2-3. Click on TAS6424E box to launch the TAS6424E App.

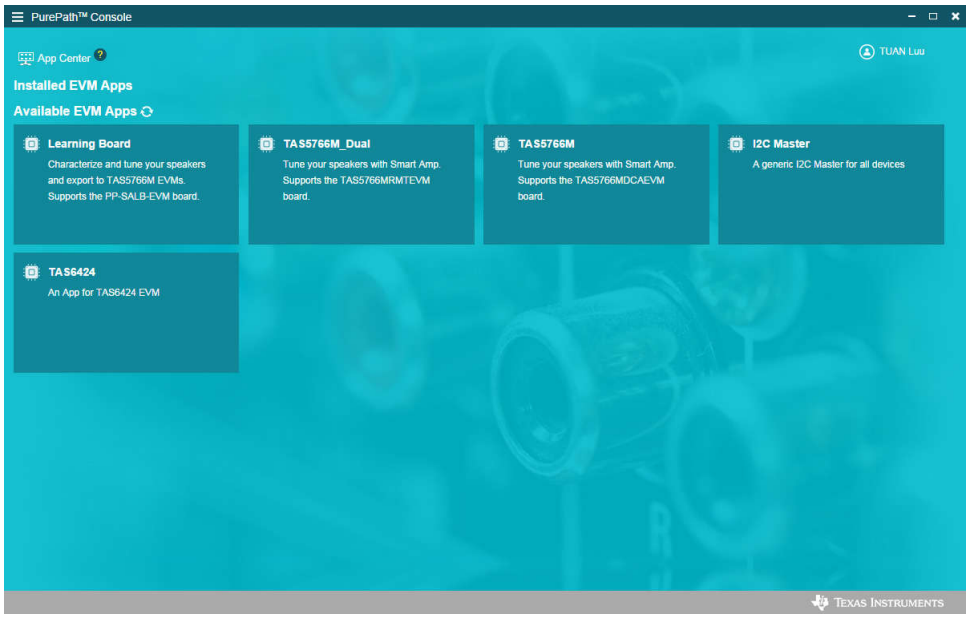

Figure 2-3. Available Apps Window

2.2 PurePath Console 3 – TAS6424E EVM Home Window

When the TAS6424E EVM PPC3 is launched, the Home Window is shown. If the EVM is powered on and the USB is connected to the PC, then the Home Window displays the *Connect* box in the bottom right hand corner. If the EVM is not powered on or the USB is not connected, then only the *TAS6424E EVM – Offline* is displayed.

Figure 2-4 shows the downloading progress of TAS6424E application.

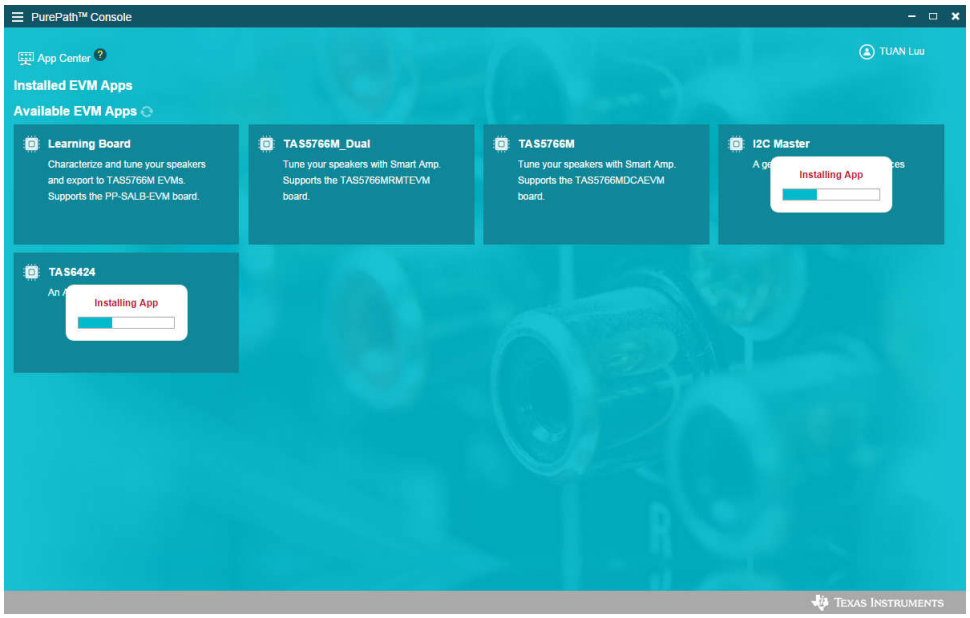

Figure 2-4. PPC3 Window

There are three windows available with the TAS6424E EVM PPC3: Home Window, Register Map Window and Device Monitor, and Control Window.

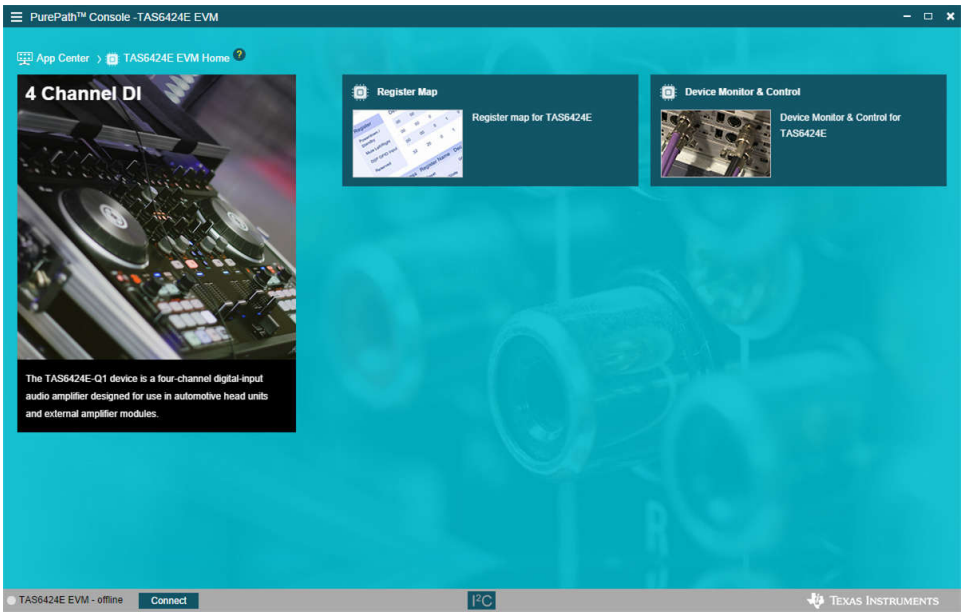

Figure 2-5. TAS6424E EVM Home Window

2.3 PurePath Console 3 – TAS6424E EVM Register Map Window

When clicking on the 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 TAS6424R-Q1.

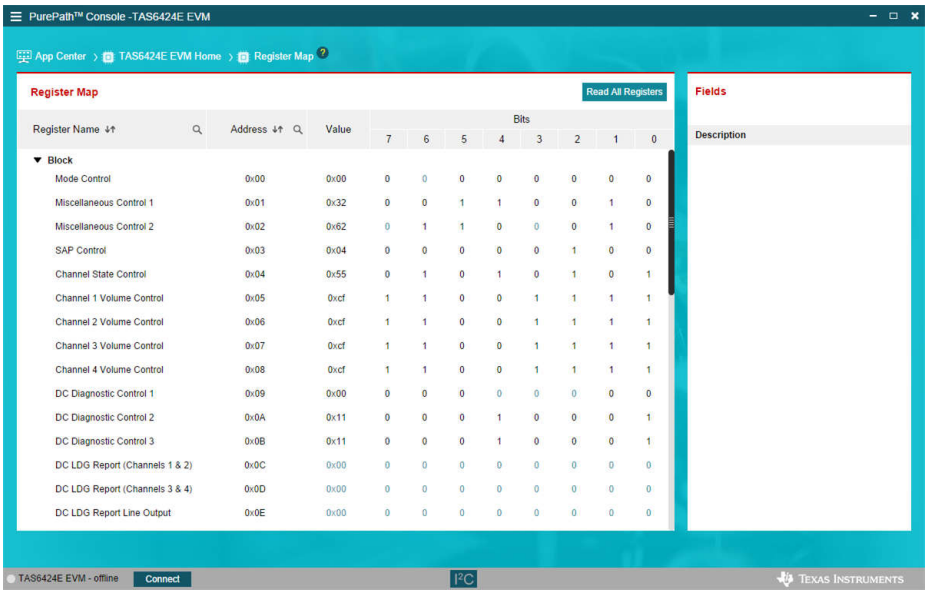

Figure 2-6. TAS6424E EVM Register Map Window

2.4 PurePath Console 3 – TAS6424E EVM Monitor and Control Window

By clicking on the *Device Monitor and Control Box* on the Home Window, the Device Monitor and Control Window is displayed. See Figure 2-7 below.

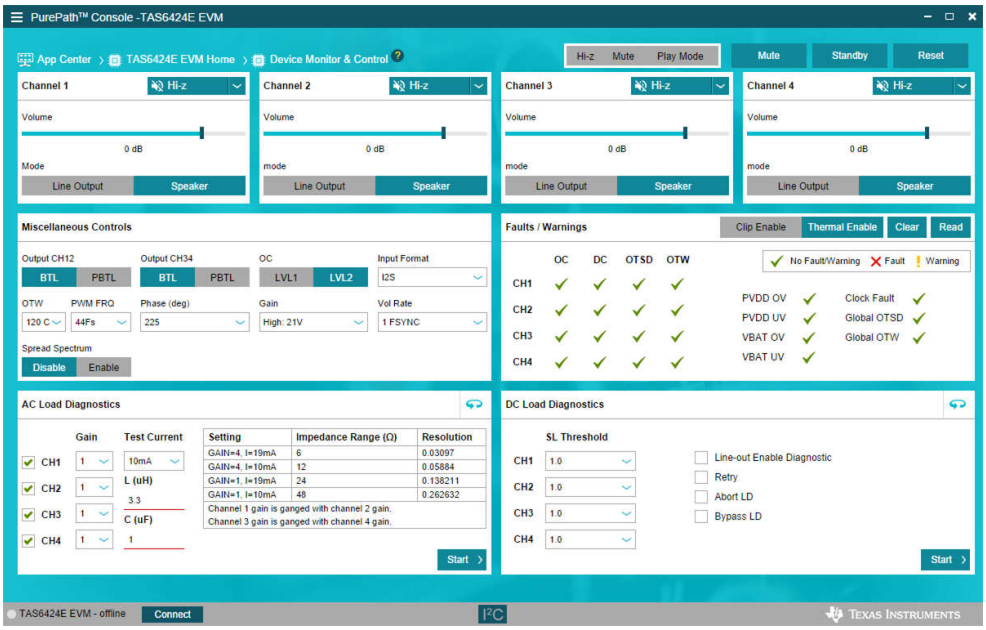

Figure 2-7. TAS6424E EVM Device Monitor and Control Window

2.5 TAS6424R-Q1 EVM Start-Up Procedure

This section describes the TAS6424R-Q1 start-up procedure. The required equipment and accessories listed on the first page of this document must be available.

2.5.1 TAS6424R-Q1 EVM Setup

Hardware and software connections:

1. Make sure that a desktop or laptop PC running Windows 7 is used.
2. Open PPC3 GUI.
3. Connect 14.4 VDC PSU to TAS6424R-Q1 EVM.
4. Connect speakers or resistive loads to TAS6424R-Q1 EVM.
5. Connect USB micro cable from PC to the EVM.
6. Set the switches (SPDIF, STANDBY, MUTE) to up positions.
7. Turn on the PSU.
8. Audio source: this can be a DVD player with optical SPDIF cable or Windows Media Player from PC.
9. At this point, 3.3 V LED, USB-LOCK LED and SPDIF-LOCK LED (if optical SPDIF is used) are on.
10. If the SPDIF LED is not on, then the default I2S input is the USB audio source.
11. On the PPC3 window, launch TAS6424E EVM application.
12. 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.

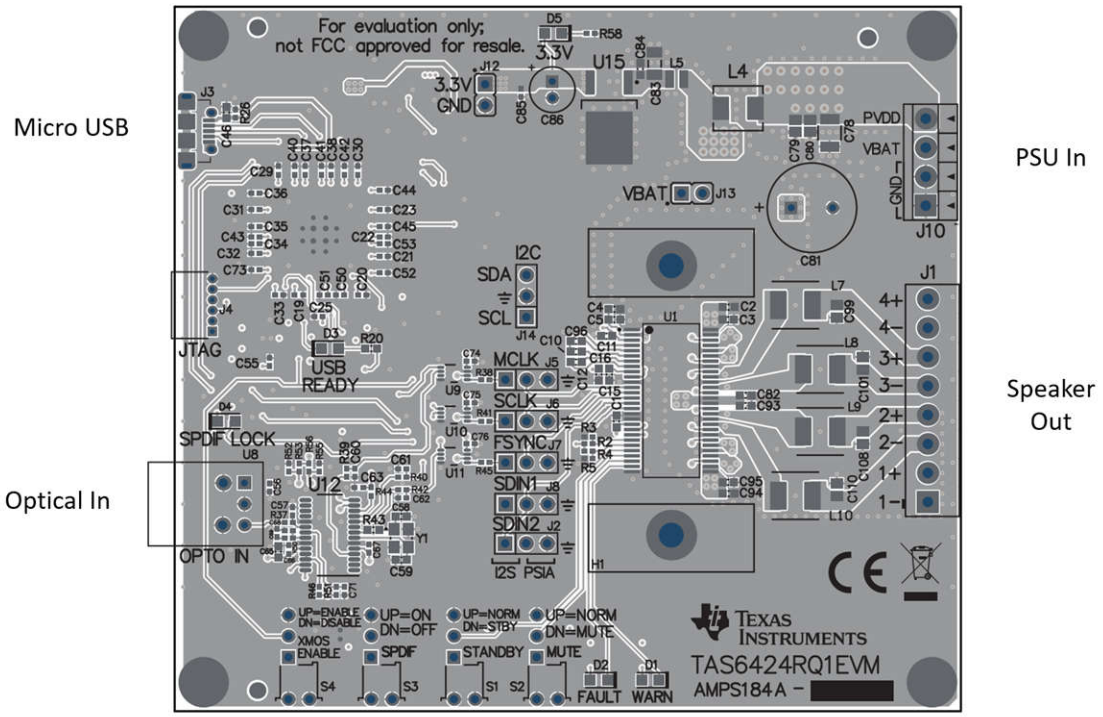

Figure 2-8. TAS6424R-Q1 EVM Connection

The following sections describe the register settings of TAS6424R-Q1 in detail.

2.5.2 TAS6424R-Q1 Settings on Device Monitor and Control Window

The TAS6424E Register Map window is for reference. Most of the register settings are done on the Device Monitor and Control window.

Click on the *CONNECT* button at the bottom left corner of the TAS6424E EVM application window, see Figure 2-9. The LED next to the TAS6424E EVM changes from gray to green and the *CONNECT* button changes to a *DISCONNECT* button.

Click on the TAS6424E Device Monitor and Control box. Figure 2-9 shows how the window is displayed.

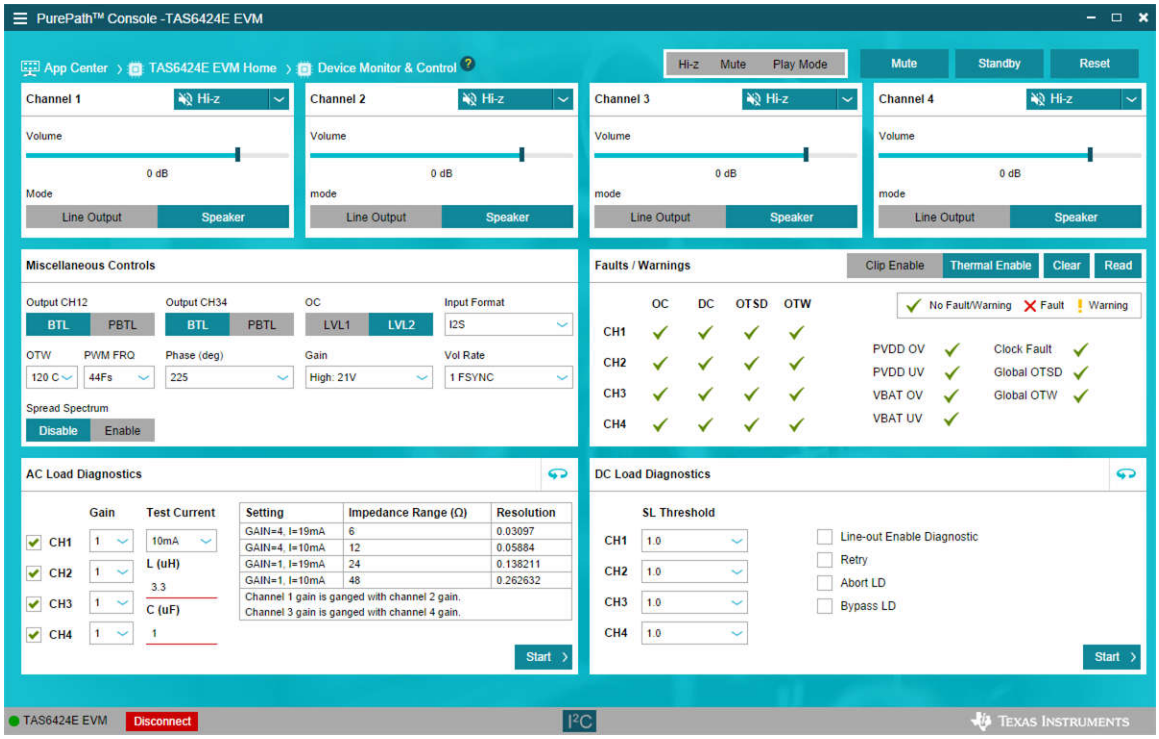

Figure 2-9. Device Monitor and Control Window

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

2.5.2.1 Global Control Section

The Hi-Z, Mute, and Unmute buttons with the gray background controls all four channels at the same time. When Hi-Z is selected, all four channels are put in Hi-Z. The display for each channel in the channel control section 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 and puts the device back in default settings.

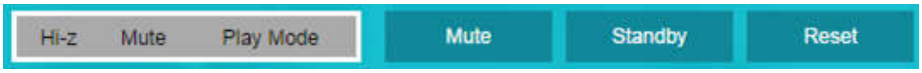

Figure 2-10. Global Control Section

2.5.2.2 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 the user to select either the 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 a line-out needs to be used, then select *Line Output* button.

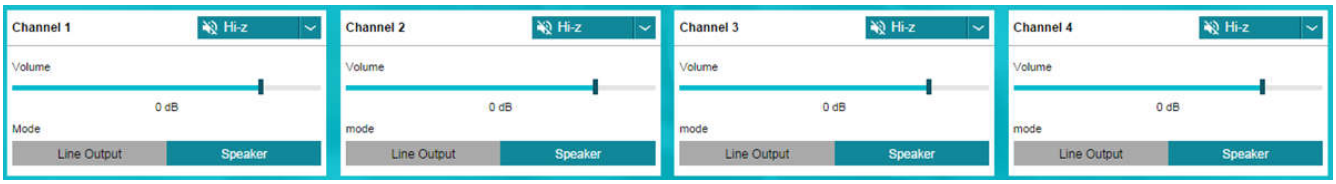

Figure 2-11. Channel Control Section

2.5.2.3 Miscellaneous Control Section

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

1. OSR is the oversampling bit. For lower idle noise, 64X OSR is set as default. For wider bandwidth, 128X OSR can be used. 64X OSR is recommended.
2. TAS6424R-Q1 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 (-).
3. The overcurrent has two levels. The lower level is 1. The default is level 2. When running at a lower output current, the OC level can be set to 1. I2S and TDM are automatically detected. Use the pull-down menu from the *Input Format* box to manually select the audio format.
4. If the sampling frequency is greater than 48 kHz, then select 96 kHz from the *Input FS* pull-down.
5. Overtemperature warning can be programmed by using the pull-down menu to choose the OTW temperature. The default setting is 120°C.
6. 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. The LC value must be adjusted when FSW is changed.
7. The offset phase for each channel is set at 45 degrees and 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.
8. There are four gain settings in TAS6424R-Q1: 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 can be selected via the drop-down menu in the *Gain* box.
9. The volume slew rate is measured with the sampling frequency. The default setting is 1 period of the sampling frequency (FSYNC or FS). This rate can be selected from 1 to 8 sampling periods with the drop-down menu under *Vol Rate* box.

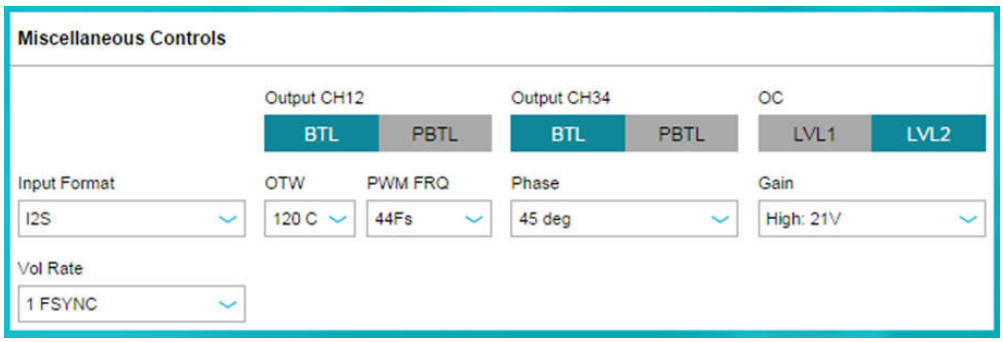

Figure 2-12. Miscellaneous Control Section

2.5.2.4 Faults and Warnings Section

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

1. *Clip enable button*: route the clip detection bit to the warning pin. This button is displayed as yellow LED on the EVM.
2. *Thermal enable button*: route the overtemperature warning bit to the warning pin. This button is displayed as the same yellow LED on the EVM.
3. *Clear button*: clears all the faults and warnings.
4. *Read button*: manually read the faults and warnings.

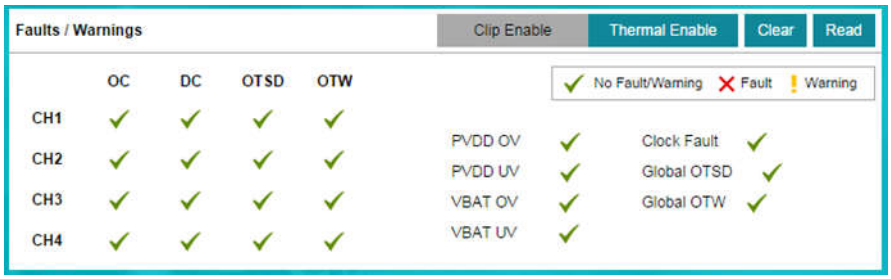

Figure 2-13. Faults and Warnings Section

2.5.2.5 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, then 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.

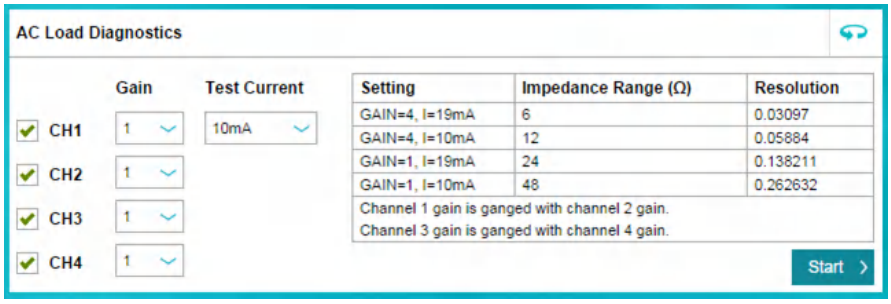

Figure 2-14. AC Load Diagnostics Section

2.5.2.6 DC Load Diagnostics Section

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

1. Select the impedance of the load from 0.5 to 5 Ω. Click *Start* and then click the *flip* on the top right of the box to view results.
2. If a channel is selected as a line-out, then click on *Line-out Enable Diagnostic* to enable the line-out load diagnostics.
3. The *Retry* box is used when DC load diagnostics are run more than one time.
4. DC load diagnostics can be aborted by clicking on the *Abort LD* box.

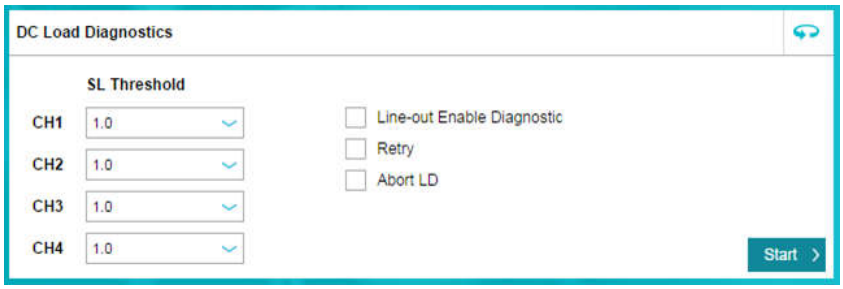

Figure 2-15. DC Load Diagnostics Section

2.5.3 TAS6424R-Q1 Settings on Register Map Window

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

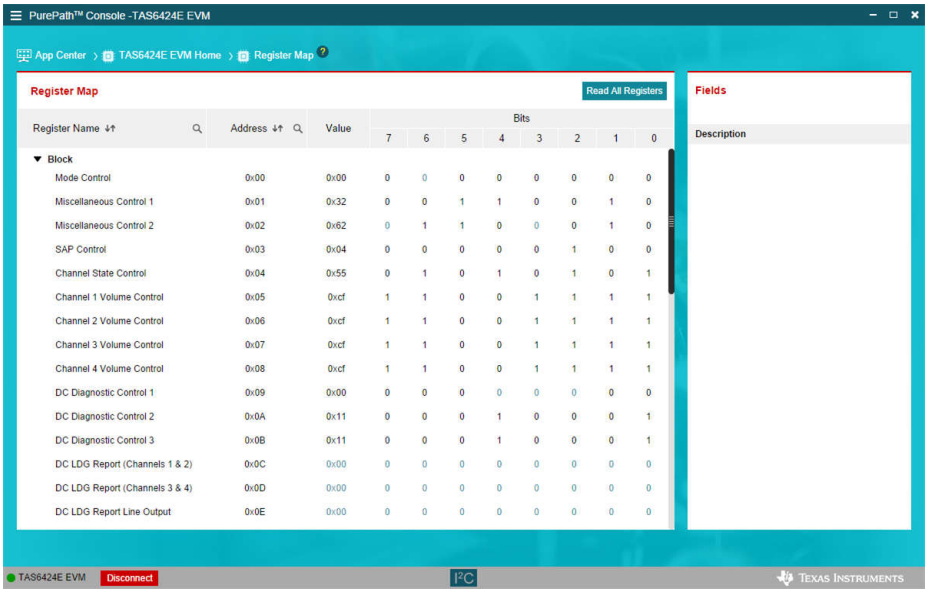

Figure 2-16. Register Map Window

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.

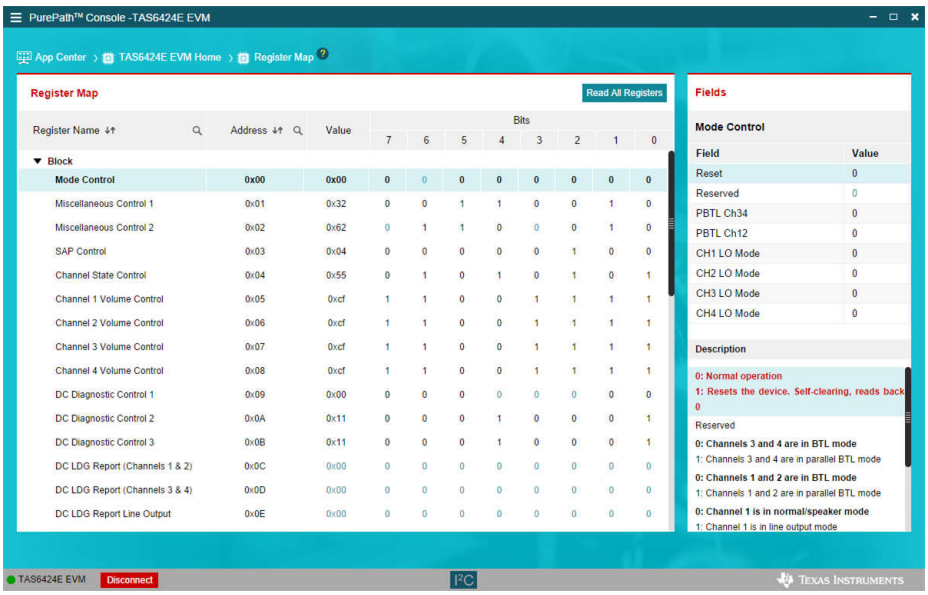

Figure 2-17. Register Map Window - Expanding

Double click on any bit and the bit changes state. This state is executed at the end of the click.

2.5.4 I2C Window

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

When this window is first opened, the round button is green. To record I2C commands, click on this button and the button turns red. The recording can be saved by clicking the save icon.

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

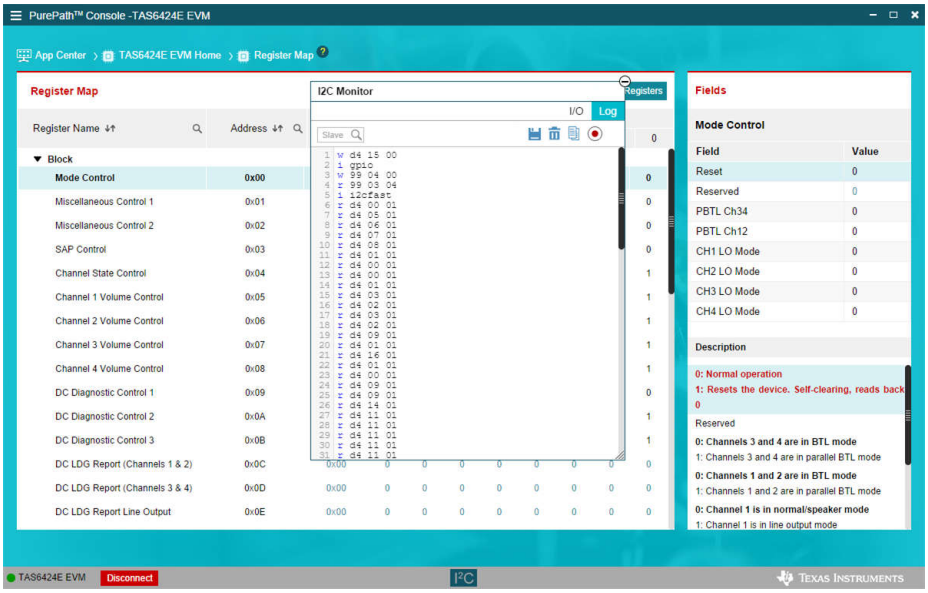

Figure 2-18. I2C Window – I2C Logging

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

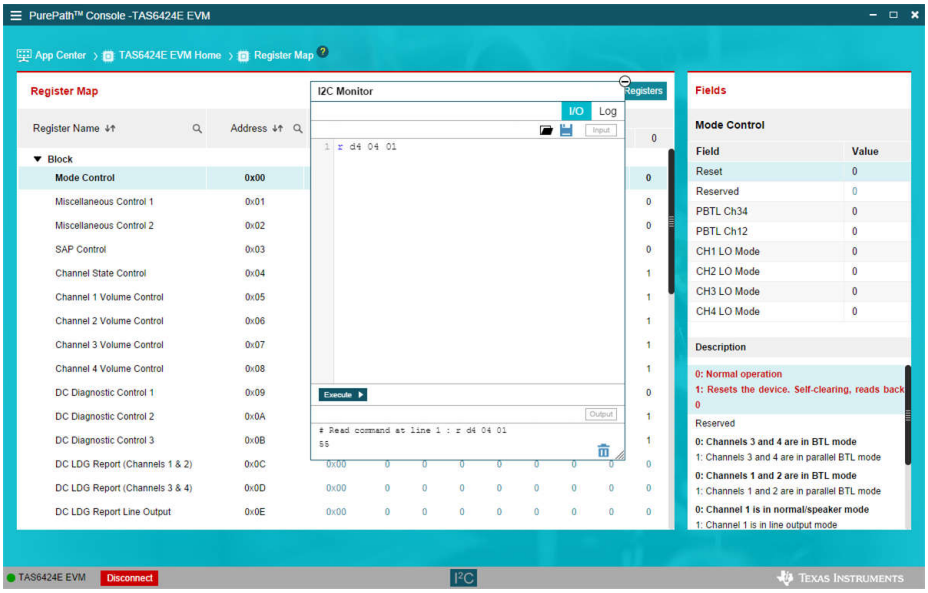

Figure 2-19. I2C Window – Sending I2C Commands

3 Schematic, Board Layouts, and Bill of Materials

3.1 TAS6424R-Q1 EVM Schematic

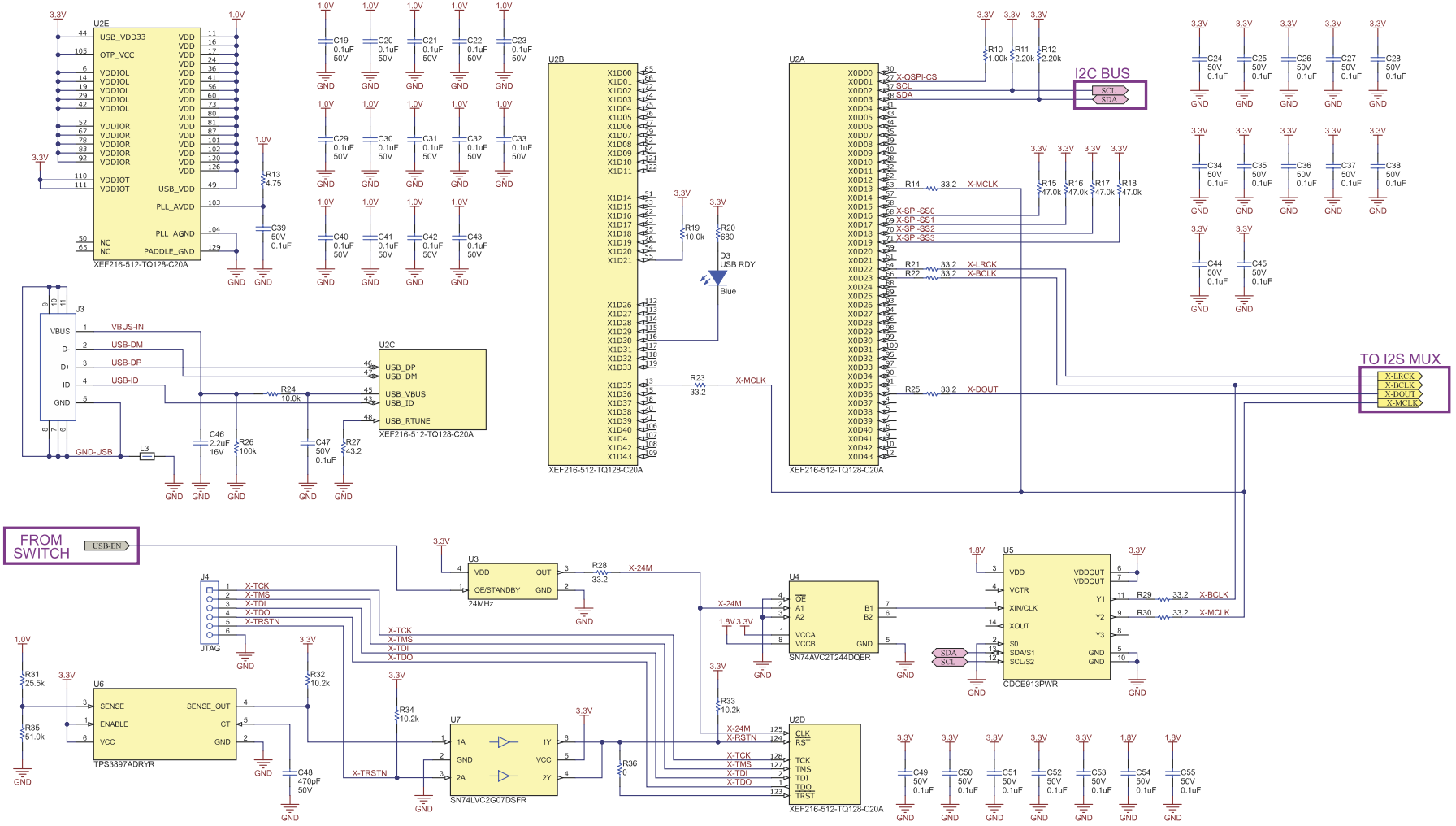

Figure 3-1. Schematic (Page 1)

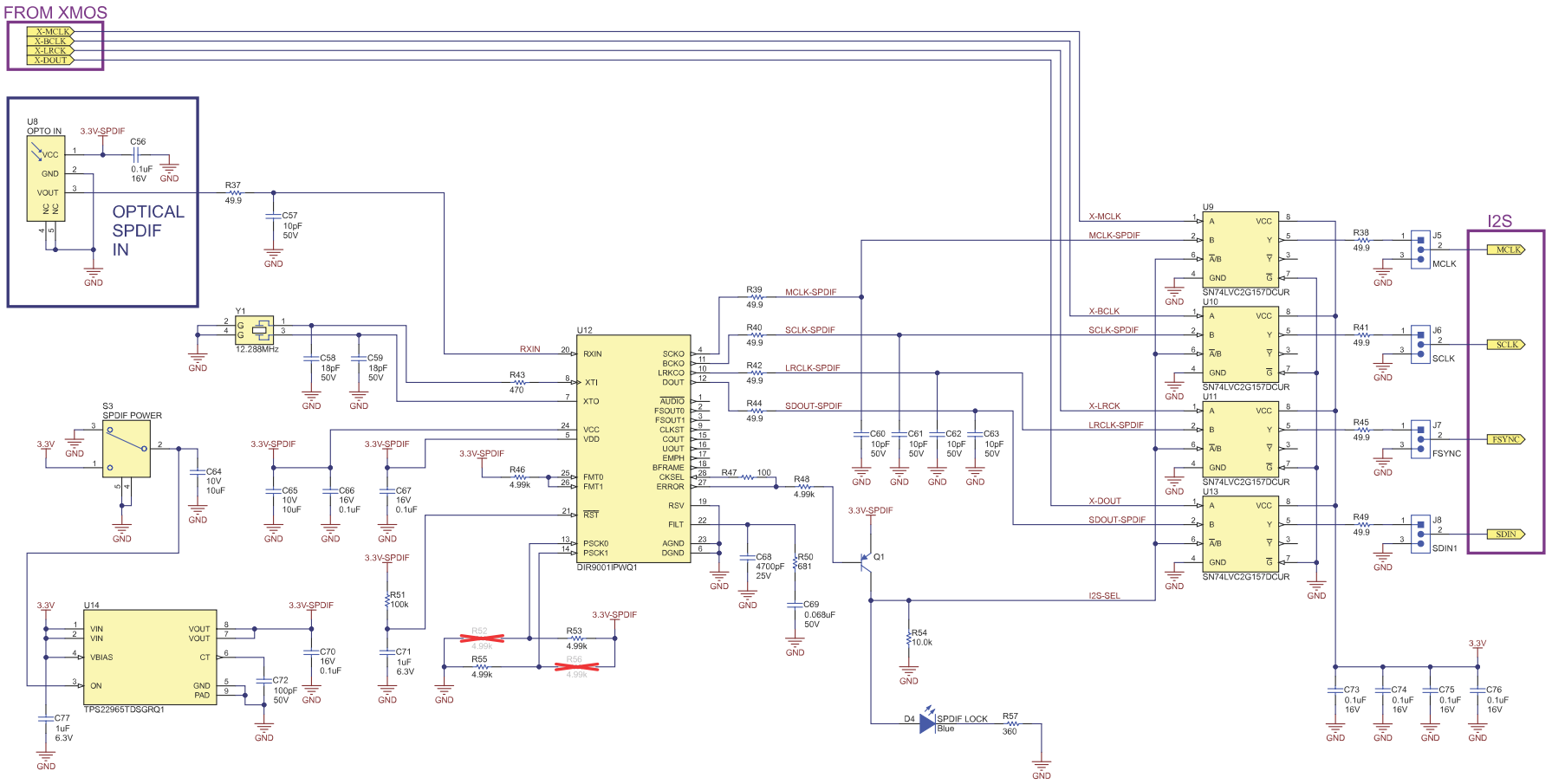

Figure 3-2. Schematic (Page 2)

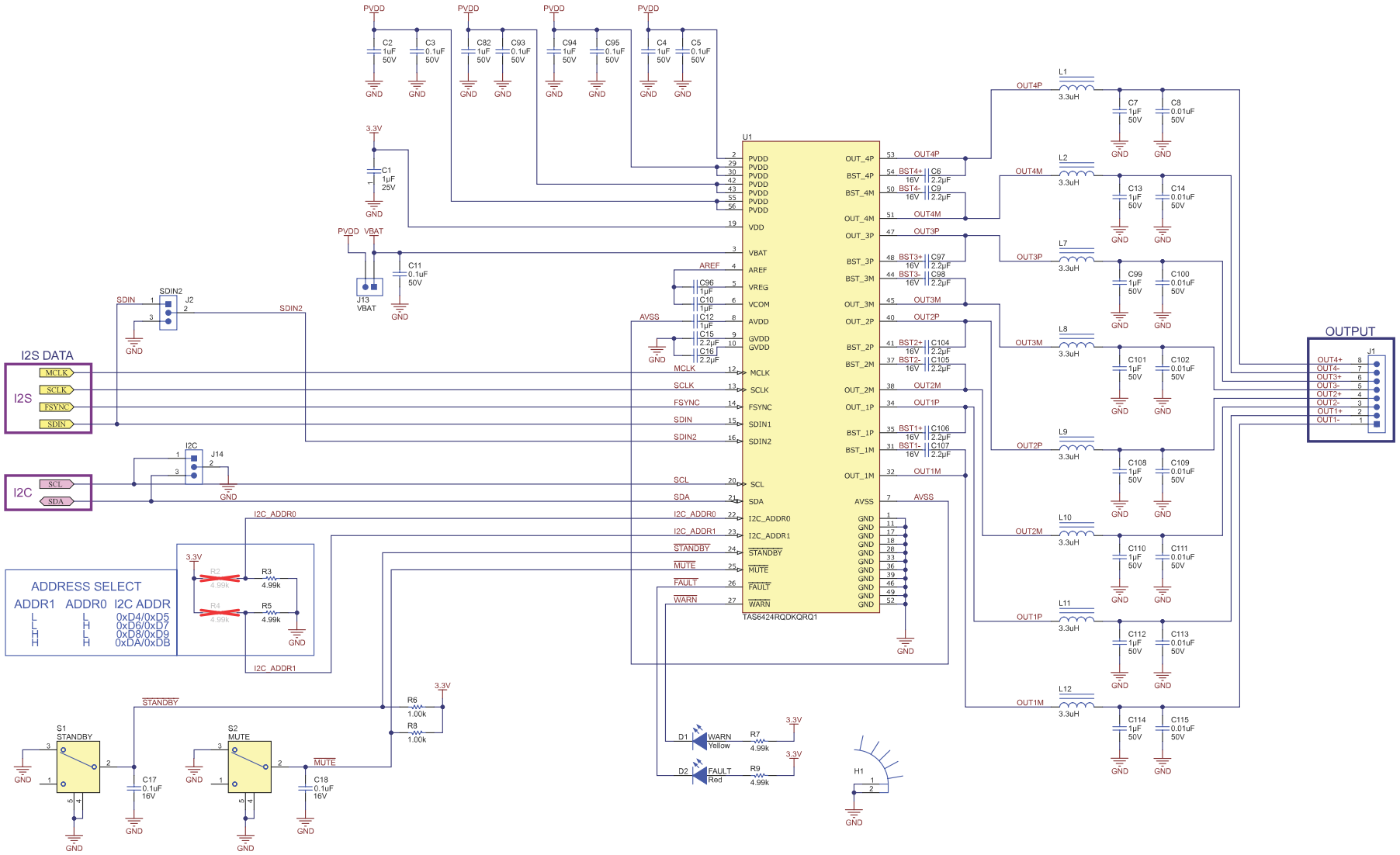

Figure 3-3. Schematic (Page 3)

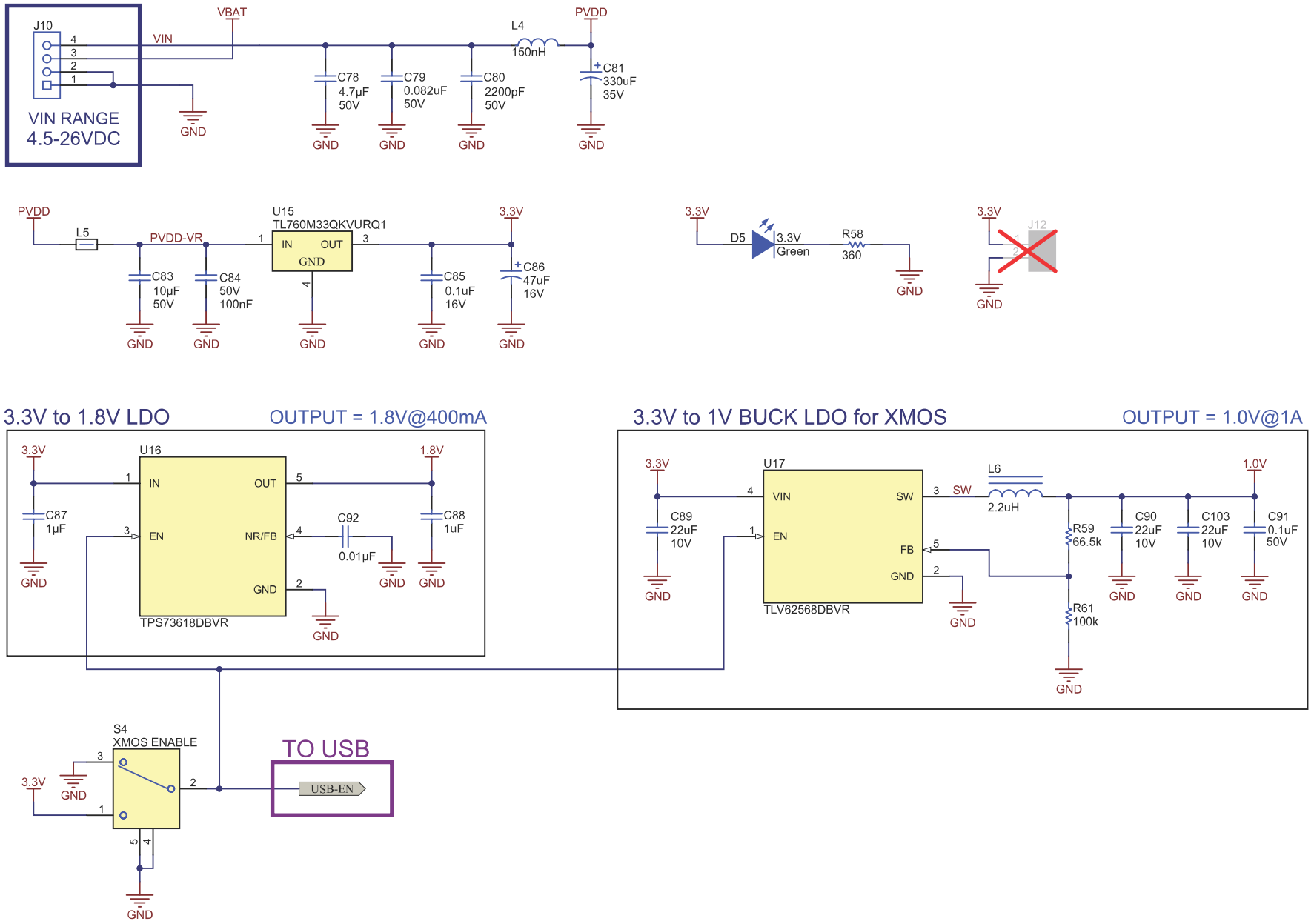

Figure 3-4. Schematic (Page 4)

3.2 TAS6424R-Q1 EVM Layouts

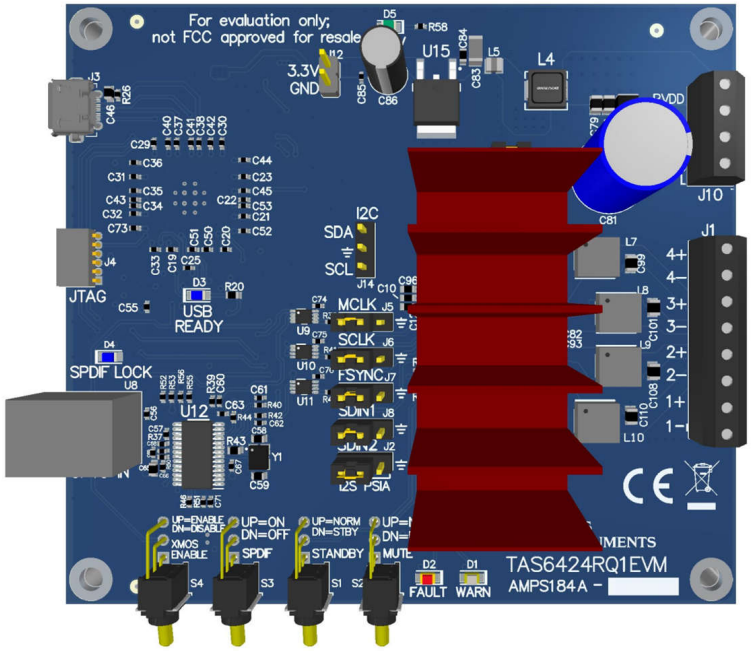

Figure 3-5. TAS6424R-Q1 EVM Top

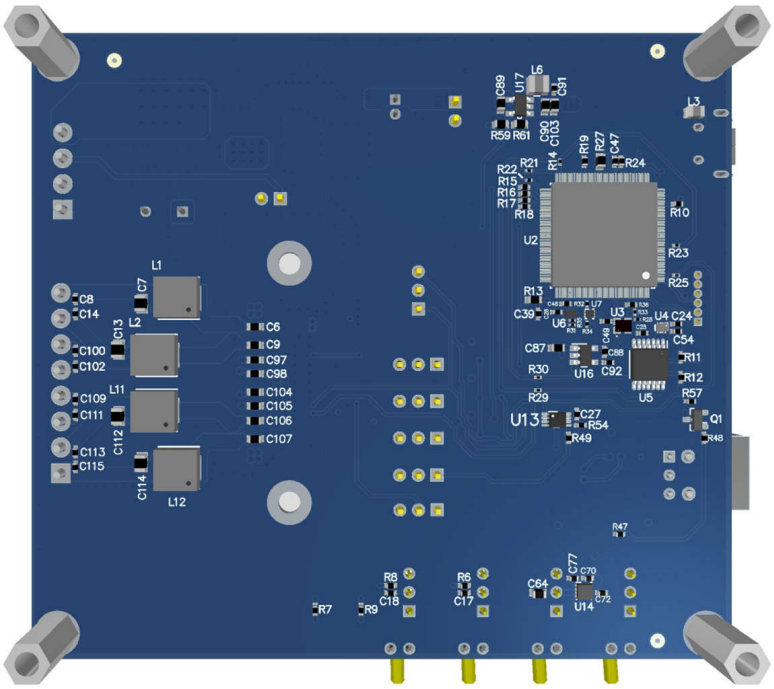

Figure 3-6. TAS6424R-Q1 EVM Bottom

3.3 Bill of Materials

Table 3-1 presents the bill of materials for TAS6424EQ1EVM.

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
PCB1	1		Printed Circuit Board		AMPS142	Any		
C1, C10, C12, C96	4	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, 0603	0603	C0603C105K3RACTU	Kemet		
C2, C4, C82, C94	4	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0603	0603	UMK107AB7105KA-T	Taiyo Yuden		
C3, C5, C11, C93, C95	5	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	0603	C0603C104K5RACTU	Kemet		
C6, C9, C15, C16, C97, C98, C104, C105, C106, C107	10	2.2uF	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X7R, 0603	0603	EMK107BB7225KA-T	Taiyo Yuden		
C7, C13, C99, C101, C108, C110, C112, C114	8	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, 0805	0805	C0805C105K5RACTU	Kemet		
C8, C14, C100, C102, C109, C111, C113, C115	8	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, C0G/NP0, 0402	0402	GCM155R71H103KA55D	MuRata		
C17, C18, C56, C66, C67, C70, C73, C74, C75, C76, C85	11	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	C0402C104K4RACAUTO	Kemet		
C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C47, C49, C50, C51, C52, C53, C54, C55, C91	36	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0402	0402	C1005X7R1H104K050BB	TDK		
C46	1	2.2uF	CAP, CERM, 2.2 uF, 16 V,+/- 10%, X7R, 0603	0603	EMK107BB7225MA-T	Taiyo Yuden		
C48	1	470 pF	CAP, CERM, 470 pF, 50 V,+/- 5%, C0G, AEC-Q200 Grade 1, 0402	0402	GRT1555C1H471JA02D	MuRata		
C57, C60, C61, C62, C63	5	10 pF	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	885012005055	Wurth Elektronik		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
C58, C59	2	18 pF	CAP, CERM, 18 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	C0603C180J5GACTU	Kemet		
C64, C65	2	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X5R, 0603	0603	C1608X5R1A106M080AC	TDK		
C68	1	4700 pF	CAP, CERM, 4700 pF, 25 V,+/- 10%, X7R, 0402	0402	CC0402KRX7R8BB472	Yageo		
C69	1	0.068uF	CAP, CERM, 0.068 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H683K050BB	TDK		
C71, C77, C88	3	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X5R, 0402	0402	GRM152R60J105ME15D	MuRata		
C72	1	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	CGA2B2C0G1H101J050BA	TDK		
C78	1	4.7uF	CAP, CERM, 4.7 µF, 50 V,+/- 10%, X7R, AEC-Q200 Grade 1, 1210	1210	C1210C475K5RACAUTO	Kemet		
C79	1	0.082uF	CAP, CERM, 0.082 uF, 50 V, +/- 10%, X7R, 0805	0805	08055C823KAT2A	AVX		
C80	1	2200 pF	CAP, CERM, 2200 pF, 50 V, +/- 5%, C0G/NP0, 0805	0805	08055A222JAT2A	AVX		
C81	1	330uF	CAP, AL, 330 uF, 35 V, +/- 20%, AEC-Q200 Grade 1, TH	D10xL20mm	UBT1V331MPD1TD	Nichicon		
C83	1	10uF	CAP, CERM, 10 µF, 50 V,+/- 10%, X5R, 1206	1206	UMK316BBJ106KL-T	Taiyo Yuden		
C84	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 5%, X7R, 0603	0603	C0603C104J5RACTU	Kemet		
C86	1	47uF	CAP, AL, 47 uF, 16 V, +/- 20%, 0.8 ohm, AEC-Q200 Grade 2, TH	D5xL11mm	EEU-FC1C470	Panasonic		
C87	1	1uF	CAP, CERM, 1 µF, 16 V,+/- 20%, X7R, 0603	0603	CL10B105MO8NNWC	Samsung		
C89, C90, C103	3	22uF	CAP, CERM, 22 uF, 10 V, +/- 20%, X5R, 0603	0603	C1608X5R1A226M080AC	TDK		
C92	1	0.01uF	CAP, CERM, 0.01 µF, 6.3 V,+/- 10%, X7R, 0402	0402	0402B103K6R3CT	Walsin		
D1	1	Yellow	LED, Yellow , SMD	0805 LED	LTST-C170KSKT	Lite-On		
D2	1	Red	LED, Red, SMD	Red 0805 LED	LTST-C170KRKT	Lite-On		
D3, D4	2	Blue	LED, Blue, SMD	LED_0805	LTST-C170TBKT	Lite-On		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
D5	1	Green	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On		
H1	1		Heat Sink for DKQ Packages, 41.4x20 mm	Heat Sink for DKQ Packages, 41.4x20 mm	HS-DKQ56_20X41.4X32.77	Any		
H2, H3, H4, H5	4		MACHINE SCREW PAN PHILLIPS M3	M3 Screw	RM3X8MM 2701	APM HEXSEAL		
H6, H7, H8, H9	4		Standoff, Hex, 12 mm, M3, Aluminum	Aluminum M3 12 mm Hex Standoff	24434	Keystone		
H10	1		Arctic Silver 5 Thermal Paste		ARCTIC SILVER 5	ARTIC SILVER, INC.		
J1	1		Terminal Block, 3.5mm, 8-Pos, TH	Terminal Block, 3.5mm, 8-Pos, TH	ED555/8DS	On-Shore Technology		
J2, J5, J6, J7, J8, J14	6		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J3	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	5.6x2.5x8.2 mm	475890001	Molex		
J4	1		Receptacle, 50mil, 6x1, Gold, R/A, TH	6x1 Receptacle	LPPB061NGCN-RC	Sullins Connector Solutions		
J10	1		Terminal Block, 3.5mm Pitch, 4x1, TH	14x8.2x6.5 mm	ED555/4DS	On-Shore Technology		
J13	1		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
L1, L2, L7, L8, L9, L10, L11, L12	8	3.3uH	Inductor, 3.3 uH, 4.5 A, 0.038 ohm, AEC-Q200 Grade 0, SMD	5.45x5.25x3.0mm	VCMT053T-3R3MN5	Cyntec		
L3	1	30 ohm	Ferrite Bead, 30 ohm @ 100 MHz, 6 A, 0805	0805	MPZ2012S300AT000	TDK		
L4	1	1.5uH	Inductor, 1.5 uH, 5.5 A, 0.017 ohm, AEC-Q200 Grade 0, SMD	5.45x5.25x3.0mm	VCMT053T-1R5MN5	Cyntec		
L5	1	180 ohm	Ferrite Bead, 180 ohm @ 100 MHz, 3.4 A, 0806	0806	NFZ2MSM181SN10L	MuRata		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
L6	1	2.2uH	Inductor, Multilayer, Ferrite, 2.2 uH, 1.3 A, 0.08 ohm, SMD	SMD, Body 2.5x2mm, Height 1.2mm	LQM2HPN2R2MG0L	MuRata		
Q1	1	40 V	Transistor, PNP, 40 V, 0.2 A, SOT-23	SOT-23	MMBT3906-7-F	Diodes Inc.		
R3, R5, R7, R9, R46, R48, R53, R55	8	4.99k	RES, 4.99 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K99FKED	Vishay-Dale		
R6, R8	2	1.00k	RES, 1.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K00FKED	Vishay-Dale		
R10	1	1.00k	RES, 1.00 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1001X	Panasonic		
R11, R12	2	2.20k	RES, 2.20 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF2201X	Panasonic		
R13	1	4.75	RES, 4.75, 1%, 0.1 W, 0603	0603	RC0603FR-074R75L	Yageo		
R14, R21, R22, R23, R25, R28, R29, R30	8	33.2	RES, 33.2, 1%, 0.05 W, 0201	0201	RC0201FR-0733R2L	Yageo America		
R15, R16, R17, R18	4	47.0k	RES, 47.0 k, 1%, 0.0625 W, 0402	0402	RC0402FR-0747KL	Yageo America		
R19, R24	2	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America		
R20	1	680	RES, 680, 1%, 0.1 W, 0603	0603	RC0603FR-07680RL	Yageo		
R26	1	100k	RES, 100 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1003X	Panasonic		
R27	1	43.2	RES, 43.2, 1%, 0.1 W, 0603	0603	RC0603FR-0743R2L	Yageo		
R31	1	25.5k	RES, 25.5 k, 1%, 0.05 W, 0201	0201	RC0201FR-0725K5L	Yageo America		
R32, R33, R34	3	10.2k	RES, 10.2 k, 1%, 0.05 W, 0201	0201	RC0201FR-0710K2L	Yageo America		
R35	1	51.0k	RES, 51.0 k, 1%, 0.05 W, 0201	0201	RC0201FR-0751KL	Yageo America		
R36	1	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic		
R37, R38, R39, R40, R41, R42, R44, R45, R49	9	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale		
R43	1	470	RES, 470, 1%, 0.1 W, 0603	0603	RC0603FR-07470RL	Yageo		
R47	1	100	RES, 100, 1%, 0.1 W, 0402	0402	ERJ-2RKF1000X	Panasonic		
R50	1	681	RES, 681, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402681RFKED	Vishay-Dale		
R51	1	100k	RES, 100 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KFKED	Vishay-Dale		
R54	1	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
R57, R58	2	360	RES, 360, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402360RJNED	Vishay-Dale		
R59	1	66.5k	RES, 66.5 k, 1%, 0.1 W, 0603	0603	RC0603FR-0766K5L	Yageo		
R61	1	100k	RES, 100 k, 1%, 0.1 W, 0603	0603	RC0603FR-07100KL	Yageo		
S1, S2, S3, S4	4		Switch, SPDT, On-On, 1 Pos, 0.4A, 28 VDC, TH	5.6x5.4mm	FT1D-4M-Z	Copal Electronics		
SH1, SH2, SH3, SH4, SH5, SH6	6	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA	3M
U1	1		45-W, 2-MHz Digital Input 4-Channel Automotive Class-D Audio Amplifier with Load Dump Protection and I 2C Diagnostics	HSSOP56	TAS6424RQDKQRQ1	Texas Instruments		
U2	1		IC MCU 512KB RAM, 128TQFP	TQFP-128	XEF216-512-TQ128-C20A	XMOS semiconductor		
U3	1		OSC, 24 MHz, 2.25 - 3.63 V, SMD	2x1.6mm	ASTMLPA-24.000MHZ-EJ-E-T	Abracon Corporation		
U4	1		Dual-Bit Dual-Supply Bus Transceiver, DQE0008A, LARGE T&R	DQE0008A	SN74AVC2T244DQER	Texas Instruments		
U5	1		Programmable 1-PLL VCXO Clock Synthesizer with 2.5-V or 3.3-V LVCMOS Outputs, PW0014A (TSSOP-14)	PW0014A	CDCE913PWR	Texas Instruments	CDCE913PW	Texas Instruments
U6	1		Single-Channel Ultra-Small Adjustable Supervisory Circuit With Active-High Open-Drain Output, DRY0006A (USON-6)	DRY0006A	TPS3897ADRYR	Texas Instruments		
U7	1		Enhanced Product Dual Buffer/ Driver with Open-Drain Output, DCK0006A (SOT-SC70-6)	DSF0006A	SN74LVC2G07DSFR	Texas Instruments		
U8	1		Photolink- Fiber Optic Receiver, TH	13.5x10x9.7 mm	PLR135/T10	Everlight		
U9, U10, U11, U13	4		Single 2-Line to 1-Line Data Selector/Multiplexer, DCU0008A, LARGE T&R	DCU0008A	SN74LVC2G157DCUR	Texas Instruments	SN74LVC2G157DCUT	Texas Instruments
U12	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		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
U14	1		5.5 V, 4 A, 16 mΩ Automotive Load Switch With Adjustable Rise Time and Optional Quick Output Discharge, DSG0008B (WSON-8)	DSG0008B	TPS22965TDSGRQ1	Texas Instruments	TPS22965TDSGTQ1	Texas Instruments
U15	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		
U16	1		Single Output LDO, 400 mA, Adj.(1.2 to 5.5V), Cap free, Low Noise, Reverse Current Protection, DBV0005A (SOT-23-5)	DBV0005A	TPS73618DBVR	Texas Instruments		
U17	1		1-A High Efficiency Step-Down Converter in SOT23-5 Package, DBV005A, DBV0005A (SOT-5)	DBV0005A	TLV62568DBVR	Texas Instruments	TLV62568DBVT	Texas Instruments
Y1	1		Crystal, 12.288 MHz, 18 pF, SMD	Crystal, 2.5x1x3.2mm	ABM8G-12.288MHZ-18-D2Y-T	Abracon Corporation		
J12	0		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
R2, R4, R52, R56	0	4.99k	RES, 4.99 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K99FKED	Vishay-Dale		

4 Revision History

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

Changes from Revision * (April 2023) to Revision A (September 2023)	Page
• Initial public release	1

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

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

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

NOTE:

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

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

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

Concernant les EVMs avec antennes détachables

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

3.3 *Japan*

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

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

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

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

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

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

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

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

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

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

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

3.4 *European Union*

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

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

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:*

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