TI Designs
LED Audio DevPack

TI Designs

TI Designs provide the foundation that you need including methodology, testing and design files to quickly evaluate and customize the system. TI Designs help *you* accelerate your time to market.

Design Resources

TIDC-DEVPACK-LED-AUDIO	Tool Folder Containing Design Files
CC2650	CC2650
CC2640	CC2640
CC2630	CC2630
CC2620	CC2620
SensorTag	SensorTag
Debug DevPack	Debug DevPack

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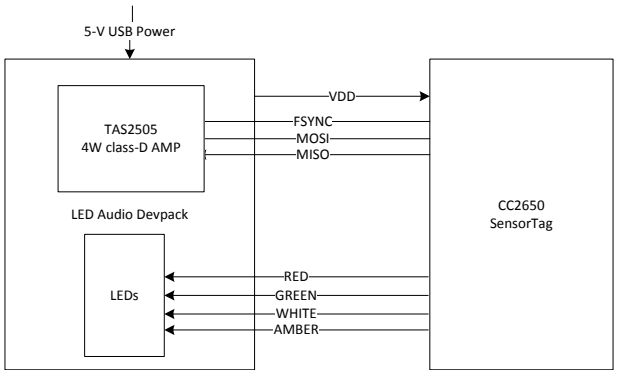
Design Features

- Offers Quick Prototyping of LED Lighting Applications
- Offers *Bluetooth* Smart™-Controlled Using Smart Phone Applications
- Connects to ZigBee™ Lighting Applications
- Offers 4 Multi-colored Osram LEDs (Red, Green, Amber and White)

Featured Applications

- Home Automation
- Industrial Lighting
- Wireless Audio



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1 Key System Specifications

- 4 high-power multi-color LEDs
- 4 W, Class-D Audio Amplifier with speaker and headphone outputs (software support available soon)
- Micro-USB power supply
- I2S audio interface

2 System Description

Use the SensorTag for lighting applications with the LED Audio DevPack. Plug it into the SensorTag DevPack expansion header and expand your design with four high-power LEDs from Osram. The LED Audio DevPack makes it easy to create LED lighting applications controlled from a mobile phone with the *Bluetooth*® Smart SensorTag or connect to ZigBee™ lighting system using ZigBee.

An additional SensorTag outer rubber sleeve is included for cutting an opening in the rubber to fit the LEDs or a lens. The DevPack includes mounting holes for the F12237_OSLO-CLUSTER-W lens from Ledil (not included).

The LED Audio DevPack is powered from a micro-USB connector. At full intensity, the LEDs can draw up to 2-A current, which requires a high-power USB power supply.

2.1 CC2650/CC2640/CC2630/CC2620

The LED Audio DevPack demonstrates the use of *Bluetooth* Smart/ZigBee/6LoWPAN for lighting and audio applications with the CC2650. The CC26xx family includes the following wireless MCUs targeting different wireless applications:

- CC2650, multi-protocol support for *Bluetooth* Smart, ZigBee and 6LoWPAN, and ZigBee RF4CE
- CC2640, *Bluetooth* Smart
- CC2630, IEEE802.15.4-compliant standards including ZigBee and 6LoWPAN
- CC2620, ZigBee RF4CE

The CC26xx family are cost-effective, ultra-low power, 2.4-GHz RF devices. Very low active RF and MCU current and low-power mode current consumption provides excellent battery life and operate on small coin-cell batteries and in energy-harvesting applications.

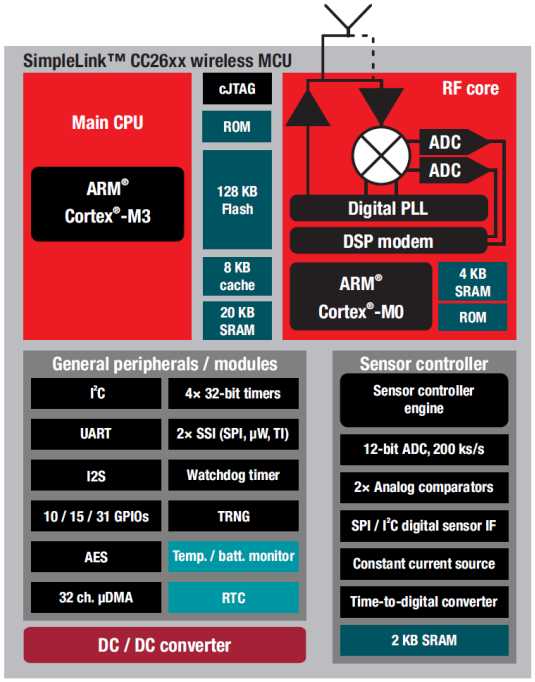

Figure 1. CC2650 Functional Block Diagram

3 Block Diagram

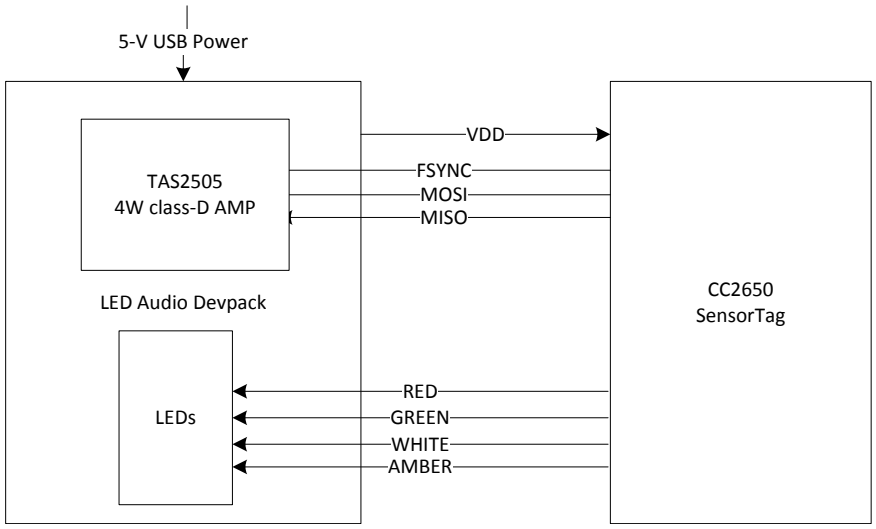

Figure 2. Block Diagram

4 Highlighted Products

The Reference Design features the following devices:

- CC260
  - See Section 2.1

5 System Design Theory

5.1 CC2650 SensorTag with the LED Audio DevPack

The SensorTag with the LED Audio DevPack is a complete development kit, where no embedded software knowledge is required to test and get started. Plug the LED Audio DevPack into the SensorTag DevPack connector, then connect the SensorTag to your smart phone using *Bluetooth* Smart. Download the LED Audio DevPack software from the application and control the display directly from the phone.

Get started in no time with your own applications using the supporting iOS® and Android® application examples, or use the SensorTag as a starting point when developing your own product.

5.2 Embedded Software Development

The SensorTag DevPacks includes open hardware and software reference designs for low cost and low power IoT nodes. Use the SensorTag with the Debug DevPack for the lowest cost hardware development platform. The SensorTag application can easily be ported between different radio standards to let you quickly evaluate which wireless technology is best for your application. The source code examples using the DevPacks are included with the BLE-stack (www.ti.com/ble-stack).

5.3 Hardware Development

Use the SensorTag hardware as the development platform for your IoT project. The open hardware demonstrates use of 10 low-power sensors and the LED Audio DevPack, to develop and test your own sensors and LED lighting applications.

6 Getting Started

The LED Audio DevPack must be used with the SensorTag kit. Plug the LED Audio DevPack into the SensorTag DevPack connector. The DevPack can be used with or without the plastic enclosure. The box also includes an additional rubber sleeve for cutting an opening for the LEDs.

6.1 Download the LED Audio DevPack Firmware

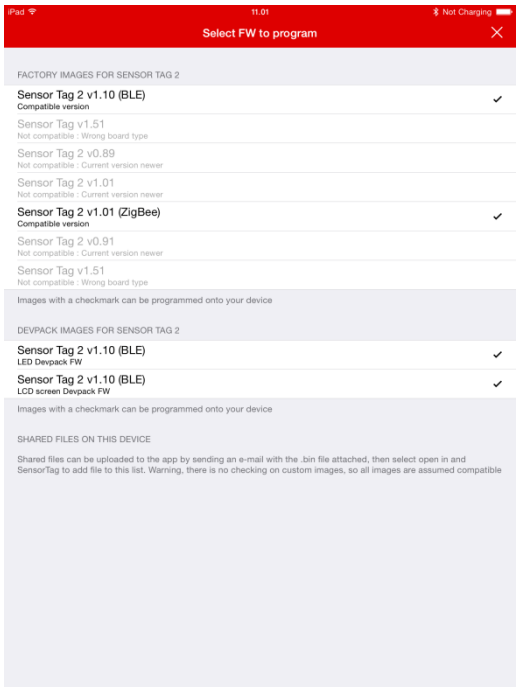

Figure 3. LED Audio Firmware Download

6.2 Plug the LED Audio DevPack into the SensorTag

Plug the LED Audio DevPack into the SensorTag, and insert the microUSB power supply.

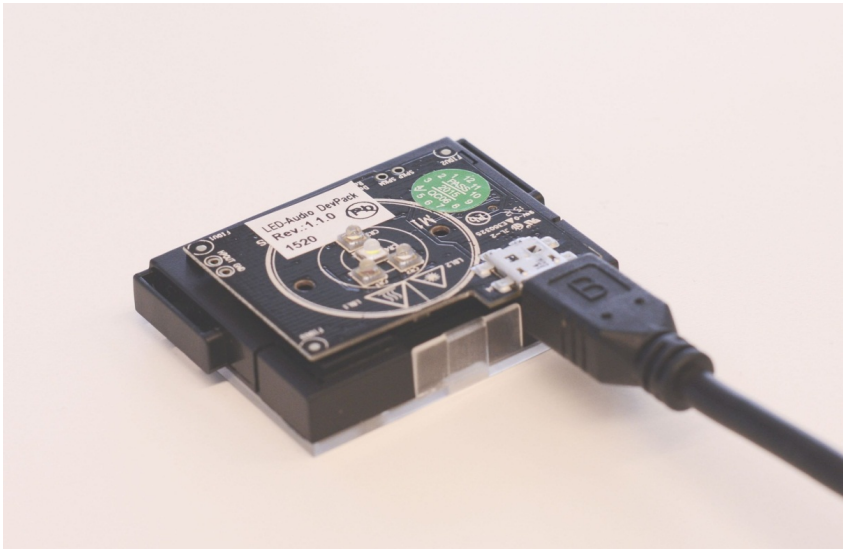

Figure 4. LED Audio DevPack with USB Power

For SensorTag hardware earlier than revision 1.2, the battery must be inserted while powering the LED Audio DevPack from the USB power supply. For SensorTag hardware revision 1.3 and later, the SensorTag does not require that the battery is inserted.

6.3 Control the LEDs from the Smartphone App

Control the LEDs from the smart phone application, using the color wheel to select the color and the slider to control light intensity.

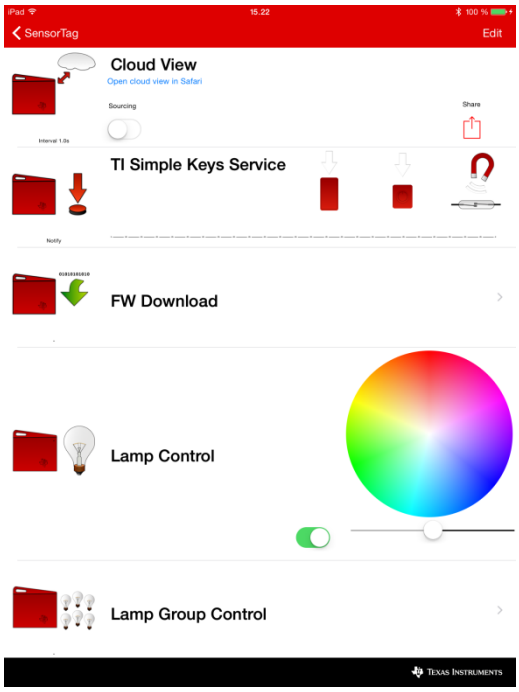

Figure 5. LED Control Services

6.4 Cut Open the Rubber Sleeve and Fit on a Lens

The DevPack includes mounting holes for the F12237_OSLO-CLUSTER-W lens from Ledil (not included). To use the rubber sleeve with the LEDs and lens, cut an opening for the LEDs and the USB cable.

Figure 6. Cutting the Sleeve to Fit a Lens

Figure 7. LED Audio DevPack with Lens and USB Power

6.5 Solder Wires to a Speaker on the Solder Points

Audio firmware support.

7 Getting Started Firmware

The SensorTag LED Audio DevPack *Bluetooth* Smart firmware is included in the *Bluetooth* low energy Stack examples (BLE-STACK-2): http://www.ti.com/tool/ble-stack

8 Design Files

8.1 Schematics

To download the schematics for each board, see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

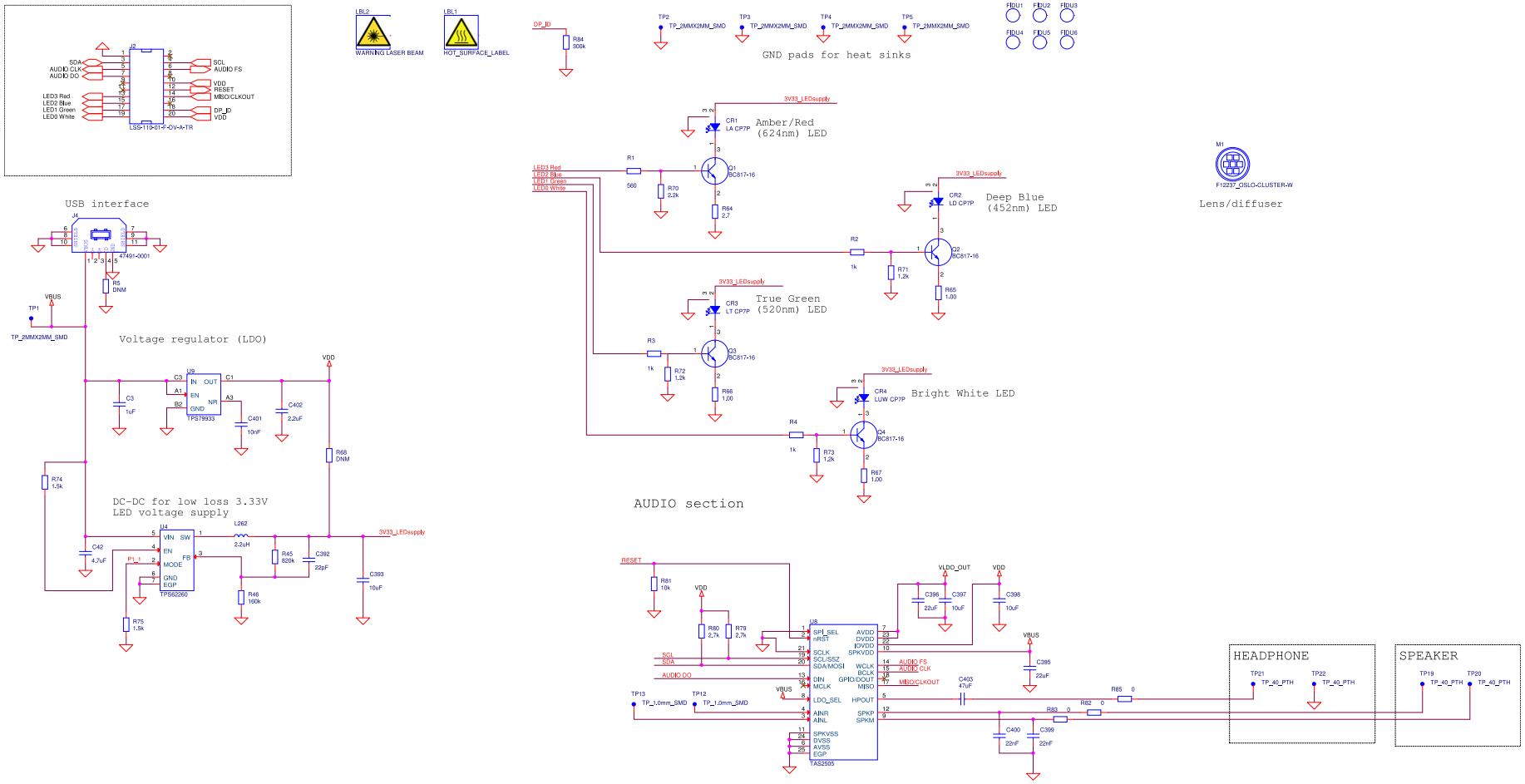

Figure 8. LED Audio DevPack Schematic

8.2 Bill of Materials

To download the bill of materials (BOM), see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

Table 1. BOM

Designator	Quantity	Value	Description	Part Number	Manufacturer
C3	1	1 µF	CAPACITORS, CERAMIC, 1 µF, 15%, X5R, 10 V, 0603, SMD	ISE4002	MURATA
C42	1	4.7 µF	CAPACITOR, CERAMIC X5R, 4.7 µF, 6.3 V, –10%/10%, –55°C/85°C, 0603, SMD	C1005X5R0J105M	MURATA
C392	1	22 pF	CAPACITOR, CERAMIC C0G/NP0, 22 pF, 50 V, –5%/5%, –55°C/125°C, 0402, SMD	GRM155R71A104KA01D	MURATA
C393	1	10 µF	CAPACITOR, CERAMIC X5R, 10 µF, 6.3 V, –20%/20%, –55°C/85°C, 0603, SMD	GRM1555C1H221JA01D	MURATA
C395, C396	2	22 µF	CAPACITOR, CERAMIC X5R, 22 µF, 4 V, –20%/20%, –55°C/85°C, 0603, SMD	JMK105BJ225MV-F	MURATA
C397, C398	2	10 µF	CAPACITOR, CERAMIC X5R, 10 µF, 6.3 V, –20%/20%, –55°C/85°C, 0402, SMD	GRM1555C1H1R0CA01D	TDK
C399, C400	2	22 nF	CAPACITOR, CERAMIC X7R, 22 µF, 50 V, –10%/10%, –55°C/125°C, 0402, SMD	GRM1555C1HR40BA01D	KEMET
C401	1	10 nF	CAPACITOR, CERAMIC X7R, 10 µF, 50 V, –10%/10%, –55°C/125°C, 0603, SMD	GRM1555C1H180JA01D	AVX
C402	1	2.2 µF	CAPACITOR, CERAMIC X5R, 2.2 µF, 10 V, –10%/10%, –55°C/85°C, 0603, SMD	GRM1555C1H150JA01D	MURATA
C403	1	47 µF	CAPACITOR, CERAMIC, X5R, 47 µF, 6.3 V, –20%/20%, –55°C/85°C, 0805, SMD	GRM1555C1H120JA01D	SAMSUNG ELECTRO-MECHANICS
CR1	1	LA CP7P	OPTO, LED, 2.6 V, 0.35 A, SMD	GRM1555C1H102JA01D	OSRAM OPTO SEMICONDUCTORS
CR2	1	LD CP7P	OPTO, LED, 3.7 V, 0.35 A, SMD	C0805C475K8PACTU	OSRAM OPTO SEMICONDUCTORS
CR3	1	LT CP7P	OPTO, LED, 3.5 V, 0.35 A, SMD	06036D104KAT2A	OSRAM OPTO SEMICONDUCTORS
CR4	1	LUW CP7P	OPTO, LED, 3.75 V, 0.35 A, SMD	GRM188R71H103KA01D	OSRAM OPTO SEMICONDUCTORS
FIDU1, FIDU2, FIDU3, FIDU4, FIDU5, FIDU6	6	FIDU_1.27 mm	FIDUCIAL MARK, ROUND 1.27 mm	GRM188R61A105MA61D	
J2	1	LSS-110-01-F-DV-A-TR	CONNECTOR, HEADER, HI-SPEED SOCKET, FEMALE, STRAIGHT, 2 ROWS, 20 PINS, PITCH 0.635 mm, SMD	CLG05P008F12	SAMTEC
J4	1	47491-0001	CONNECTOR, MICRO-USB, 1 ROW, 5 PINS, PITCH 0.65 mm, SMD	1SS315TPH3F	MOLEX
L262	1	2.2 µH	INDUCTOR, CHIP, 2.2 µH, -20%/+20%, 1 A, –55°C/125°C, 1008, SMD	SML-P12YTT86	MURATA
LBL1	1	HOT_SURFACE_LABEL	LABEL, HOT SURFACE LABEL	TPD1E10B06DPYR	
LBL2	1	WARNING LASER BEAM	NON COMPONENT, LABEL, WARNING LASER BEAM	BLM15HG102SN1D	
M1	1	F12237_OSLO-CLUSTER-W	MECHANIC, LENS ARRAY, NOT APPLY	FTSH-105-01-F-DH	LEDiL
Q1, Q2, Q3, Q4	4	BC817-16	TRANSISTOR, BIPOLAR NPN, 45 V, 0.5 A, 0.25 W, SOT23-3, SMD	PEC02SAAN	NXP
R1	1	500	RESISTOR, THICK FILM, 560, –1%/1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	PEC03SAAN	VISHAY
R2, R3, R4	3	1 k	RESISTOR, THICK FILM, 1k, –1%/1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	ED555/2DS	VISHAY
R5	1	DNM	RESISTOR, DO NOT MOUNT, 0402, SMD	CRCW040256K2FKED	
R45	1	820k	RESISTOR, THICK FILM, 820k, -1%/1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	5000	Manufacturer selection
R46	1	160k	RESISTOR, THICK FILM, 160k, -1%/1%, 0.063 W, 50 V, –55°C/125°C, 0402, SMD	CC2541RHA	VISHAY
R64	1	2.7	RESISTOR, THICK FILM, 2R7, 0.25 W, 200 V, -/+1%, -/+100 ppm/°, –55°C/125°C, 1206, SMD	Q22FA1280009200	VISHAY
R65, R66, R67	3	1.00	RESISTOR, THICK FILM, 1R00, 0.25 W, 200 V, -/+1%, -/+200 ppm/°, –55°C/125°C, 1206, SMD	CBC-PV-01N	VISHAY
R68	1	DNM	RESISTOR, DO NOT MOUNT, 0402, SMD	N/A	
R70	1	2.2 k	RESISTOR, THICK FILM, 2.2 k, -1%/+1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	C1005X5R0J105M	VISHAY
R71, R72, R73	3	1.2 k	RESISTOR, THICK FILM, 1.2 k, -1%/+1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	GRM155R71A104KA01D	VISHAY

Table 1. BOM (continued)

Designator	Quantity	Value	Description	Part Number	Manufacturer
R74, R75	2	1.5 k	RESISTOR, THICK FILM, 1.5 k, -1%/+1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	GRM1555C1H221JA01D	KOA SPEER
R79, R80	2	2.7 k	RESISTOR, THICK FILM, 2.7 k, -1%/+1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	JMK105BJ225MV-F	VISHAY
R81	1	10 k	RESISTOR, THICK FILM, 10 k, –1%/1%, 0.063 W, 50 V, -55°C/155°C, 0402, SMD	GRM1555C1H1R0CA01D	VISHAY
R82, R83, R85	3	0	RESISTOR, THICK FILM, 0, 0/+0.008R, 0.25 W, 75 V, –55°C/155°C, 0603, SMD	GRM1555C1HR40BA01D	VISHAY
R84	1	300 k	RESISTOR, THICK FILM, 300k, -1%/1%, 0.063 W, 50 V, –55°C/155°C, 0402, SMD	GRM1555C1H180JA01D	VISHAY
TP1, TP2, TP3, TP4, TP5	5	TP_2MMX2MM_SMD	NON COMPONENT, TESTPOINT, 2 MM × 2 MM, SMD	GRM1555C1H150JA01D	
TP12, TP13	2	TP_1.0mm_SMD	TESTPOINT 40-mil/1-mm SMD	GRM1555C1H120JA01D	
TP19, TP20, TP21, TP22	4	TP_40_PTH	NON COMPONENT, TESTPOINT 1.0-MM HOLE, PTH		
U4	1	TPS62260	IC, ANALOG, STEPDOWN CONVERTER, VIN:2 V TO 6 V, VOUT: ADJ, SON6, SMD	GRM1555C1H221JA01D	TEXAS INSTRUMENTS
U8	1	TAS2505	IC, DIGITAL AUDIO VIDEO, 1.5 V TO 1.95 V, QFN24, SMD	JMK105BJ225MV-F	TEXAS INSTRUMENTS
U9	1	TPS79933	IC, ANALOG, LOW DROPOUT LINEAR REGULATOR, VIN:2.7 V TO 6.5 V, VOUT:3.3 V, DSBGA5, SMD	GRM1555C1H1R0CA01D	TEXAS INSTRUMENTS

8.3 PCB Layout Recommendations

The layout of this DevPack only uses digital signals at a relatively low data rate. No special considerations are required for the layout of this design.

8.3.1 Layout Prints

To download the Layout Prints for each board, see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

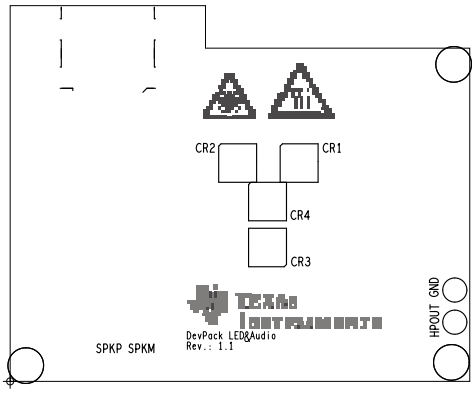

Figure 9. Top Silkscreen

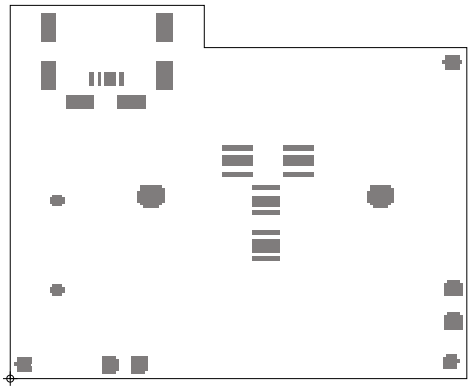

Figure 10. Top Solder Mask

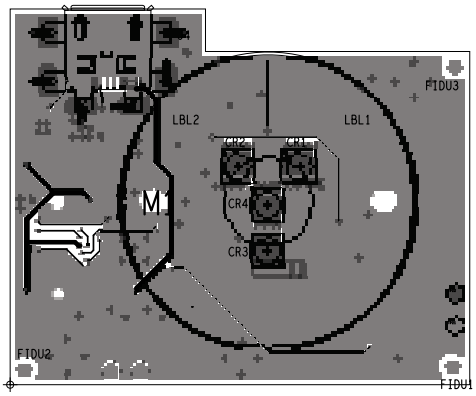

Figure 11. Top Layer

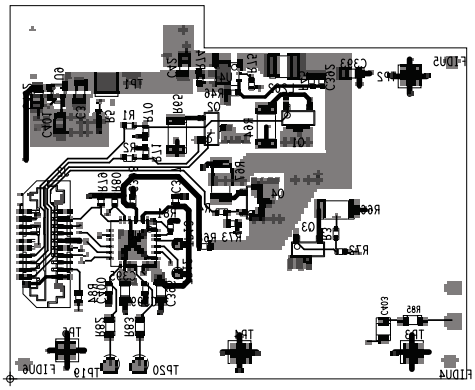

Figure 12. Bottom Layer

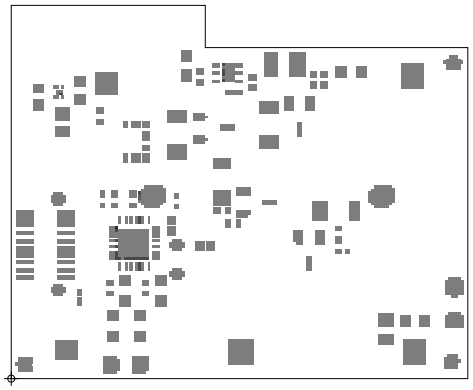

Figure 13. Bottom Solder Mask

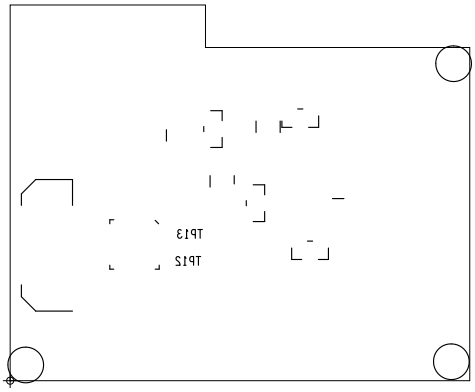

Figure 14. Bottom Silkscreen

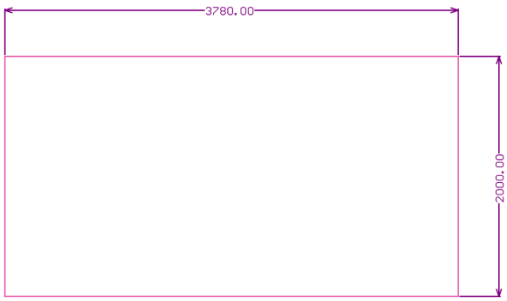

Figure 15. Mechanical Dimensions

8.4 Cadence Project

To download the Cadence project files for each board, see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

8.5 Gerber Files

To download the Gerber files, see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

8.6 Assembly Drawings

To download the Assembly Drawings for each board, see the design files at http://www.ti.com/tool/TIDC-DEVPACK-LED-AUDIO.

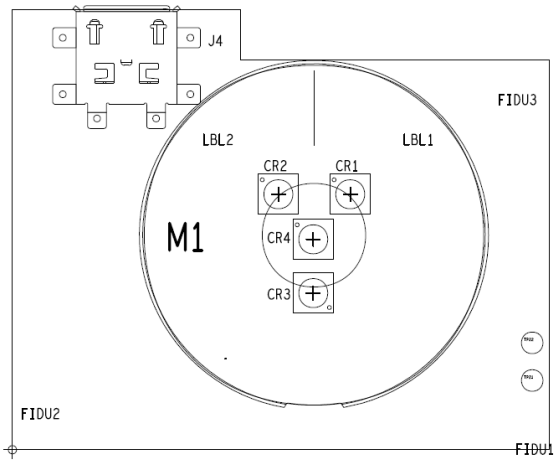

Figure 16. LED Audio DevPack Assembly Top

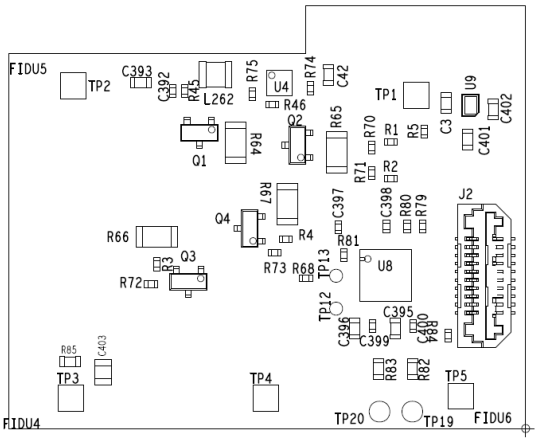

Figure 17. LED Audio DevPack Assembly Top

8.7 Software Files

See Section 7 for information regarding available software.

9 References

1. *Simplelink SensorTag*, www.ti.com/sensortag
2. *TI Technical Reference Manual, CC2650,* (SWCU117)
3. *TI Datasheet, CC2650*, (SWRS158)
4. *TI Datasheet, CC2640*, (SWRS176)
5. *TI Datasheet, CC2630*, (SWRS177)
6. *TI Datasheet, CC2620*, (SWRS156)
7. *TI Application Note, CC2640 Bluetooth low energy Software Developer's Guide*, (SWRU393)

10 About the Author

JARLE BOE is a system applications manager at TI. He is in charge of application-specific designs such as the SensorTag for *Bluetooth* Smart, ZigBee, and 6LoWPAN wireless applications. Jarle brings 18 years of experience from software and hardware engineering, applications, and marketing projects.

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