

Design Guide: TIDA-060026

Scalable 2.1 Channel Audio Amplifier Reference Design



Description

This 2.1 channel audio amplifier reference design incorporates the TAS5825M digital stereo amplifier for left and right channel audio and the TAS5720M digital mono amplifier for the subwoofer channel. This design operates from a single audio host interface and is scalable to 5.1, 7.1, and 9.1 channel configurations, ideal for soundbar applications.

Resources

TIDA-060026	Design Folder
TAS5825M	Product Folder
TAS5720M	Product Folder
PurePath™ Console Motherboard	Tool Folder
PurePath™ Console Software (PPC3)	Tool Folder

Features

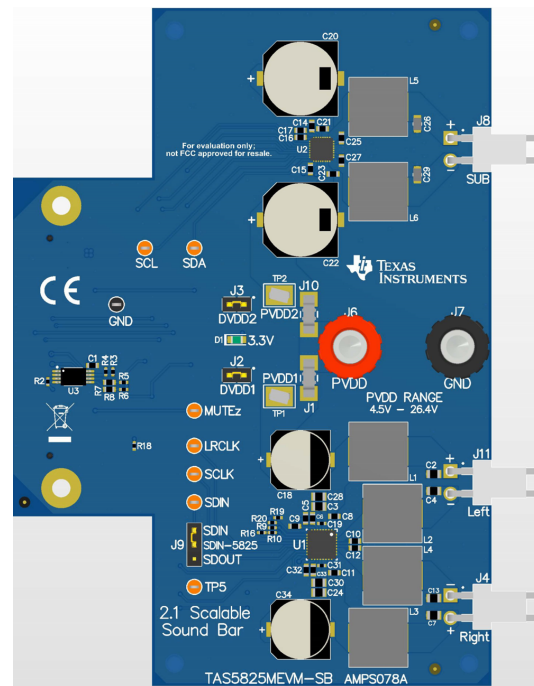
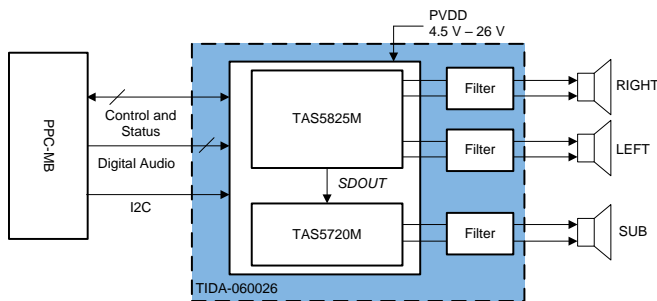
- PVDD tracking and thermal fold-back protection
- Smart Amp technology
- Modular, scalable multi-channel solution based on digital audio TDM
- Integrated self-protection (OCE, CB3C, OTW, OTE, UVLO, OVLO)
- Integrated audio DSP with enhanced 96 kHz processing supporting several advanced audio process flows
- Operates in TDM mode (as well as I2S) for speaker scalability

Applications

- [Soundbar](#)
- [Smart Speaker](#)
- [TVs](#)
- [Notebook/PC Speaker](#)
- [Wireless Speaker](#)
- [Smart Display](#)



ASK Our E2E™ Experts



An IMPORTANT NOTICE at the end of this TI reference design addresses authorized use, intellectual property matters and other important disclaimers and information.

1 System Description

Soundbars and wireless speakers, such as smart speakers and smart displays, often are released as part of a family of models that range in size and sound levels. Audio designers are often challenged to create new audio solutions for each model, in both hardware and software. This reference design illustrates how to start with a 2.1 channel system that can be easily scaled to more speakers on the same channel (such as in the case of Smart Speakers) or more channels (such as in the case of new emerging multi-channel Dolby Atmos soundbar systems). As the number of channels expands, the need remains to minimize the number of audio data output ports from the host SoC audio source. This design illustrates both the use of TDM mode and the main amplifier's SDOOUT port as means to scale the number of channels from a singular I2S port from the main audio source. The design uses high-quality, low-THD digital amplifiers that integrate mini DSPs for a number of process options including equalization, audio look-ahead, digital output for acoustic echo cancellation and a variety of speaker and amplifier protection functions.

1.1 Key System Specifications

Table 1. Key System Specifications

PARAMETER	SPECIFICATIONS
Power Supply	4.5 V to 26.5 V DC
Digital Interface	I ² S and I ² C
THD+N vs Frequency	Section 3.2.2
THD+N vs Power	Section 3.2.2

2 System Overview

2.1 Block Diagram

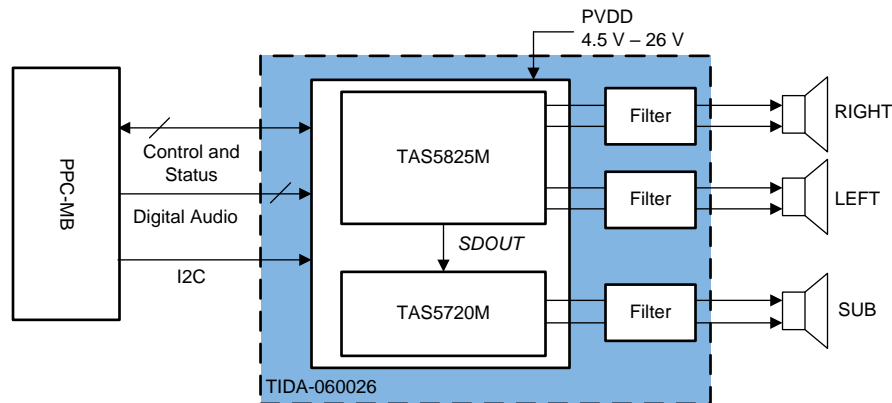


Figure 1. TIDA-060026 Block Diagram

2.2 Design Considerations

2.2.1 TAS5825M Layout

- Avoid placing other heat producing components or structures near the amplifier.
- If possible, use a higher layer count PCB to provide more heat sinking capability for the TAS5825M device and to prevent traces and copper signal and power planes from breaking up the contiguous copper on the top and bottom layer.
- Place the TAS5825M device away from the edge of the PCB when possible to ensure that the heat can travel away from the device on all four sides.
- Avoid cutting off the flow of heat from the TAS5825M device to the surrounding areas with traces or via strings. Instead, route traces perpendicular to the device and line up vias in columns which are perpendicular to the device.
- Unless the area between two pads of a passive component is large enough to allow copper to flow in between the two pads, orient it so that the narrow end of the passive component is facing the TAS5782M device.
- Because the ground pins are the best conductors of heat in the package, maintain a contiguous ground plane from the ground pins to the PCB area surrounding the device for as many of the ground pins as possible.
- Keep the thermal pad, which connects electrically and thermally to the PowerPAD™ of the TAS5825M device, be made no smaller than what is specified in the package addendum.

2.3 Highlighted Products

2.3.1 TAS5825M

The TAS5825M is a stereo high-performance closedloop Class-D with integrated audio processor with up to 192-kHz architecture. The powerful audio DSP core supports several advanced audio process flows. With 48-kHz or 96- kHz architecture, an integrated SRC (Sample rate convertor) detects the input sample rate change. Then auto converts to the target sample rate which DSP is running to avoid any audio artifacts. These process flows support: 2x15 BQs, 3-Band DRC, Fullband AGL (Automatic Gain Limiter), Smart Amplifier Algorithm (Thermal and Excursion Protection), Bass enhancement, Spatializer, THD manager, PVDD Tracking and Thermal Foldback. The 192-kHz process flow offers Full-band AGL and Thermal Foldback .

2.3.2 TAS5720M

The TAS5720x device is a high-efficiency mono Class-D audio power amplifier optimized for high transient power capability to use the dynamic power headroom of small loudspeakers. The device is capable of delivering more than 15 W continuously into a 4-Ω speaker. The digital time division multiplexed (TDM) interface enables up to eight devices to share the same bus.

2.4 System Design Theory

This 2.1 Soundbar audio system uses the TAS5825M as the left and right channels and the TAS5720M for the subwoofer. The TAS5825M is able to act as the central systems processor for both the stereo left and right speakers and for the mono subwoofer speaker by sending the audio signal through the TAS5825M's SDOUT pin to the TAS5720M's SDIN pin. The TAS5825M DSP can transmit a post-processed audio signal to the TAS5720M allowing for the signal to benefit from bass enhancement, smart amplifier algorithm, etc.

This design also allows for the 2.1 system to be expanded to a 5.1 system with the inclusion of another TIDA-060026 board with the I2C, 3.3-V, PVDD, and GND connected between the boards. This also can be expanded further to be a 7.1 and 9.1 system with the inclusion of the TAS5825MEVM as shown in Figure 4.

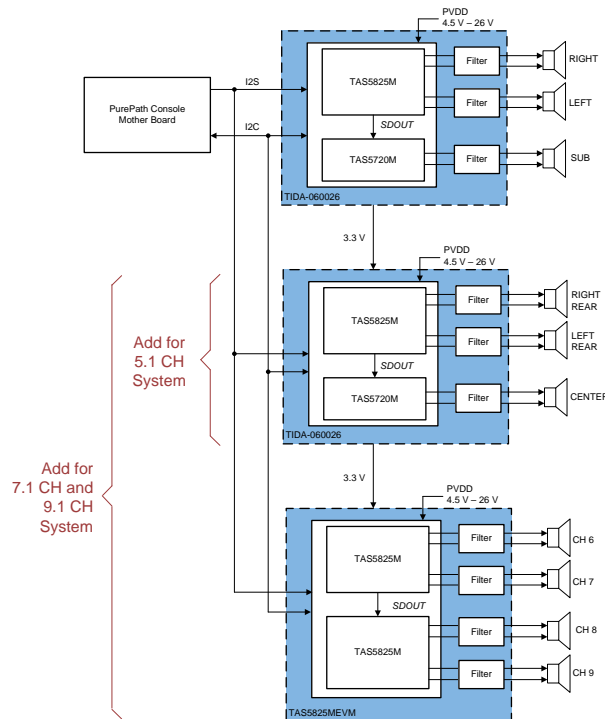


Figure 4. 5.1, 7.1, and 9.1 Channel Expansion Diagram

3 Hardware, Software, Testing Requirements, and Test Results

3.1 Required Hardware and Software

3.1.1 Hardware

- TIDA-060026 Board
- PurePath Console Motherboard
- USB-A to USB-B micro cord
- 4.5-V to 26.4-V 6-A DC power supply
- Speakers rated at or above the expected output power
- Computer
- Audio Precision System (optional)

3.1.2 Software

- PurePath Console 3 (PPC3)—available from [MySecureSoftware](#)
- I²C Master App—downloaded within PPC3
- Audio player
- Audio Precision (optional)

3.2 Testing and Results

3.2.1 Test Setup

- Check that the jumpers are in the following states as shown in [Table 2](#):

Table 2. Jumper States

Jumper	Setting
J2	In
J3	In
J9	2 to 3

- Set the power supplies to 12-V and current to 6-A. Do not power up.
- Connect the power supply to TIDA-060026, with the positive terminal in **J6** and the negative terminal in **J7**.
- Connect the SUB speaker to **J8**.
- Connect the Left speaker to **J11**.
- Connect the Right speaker to **J4**.
- Connect the PurePath Motherboard console to **J5**.
- Turn on the power supplies.
- Connect the USB cable to the PurePath Motherboard console.
- Verify that the computer has set the PurePath Motherboard as the default playback device by opening the sound dialog from the windows control panel (see [Figure 5](#))

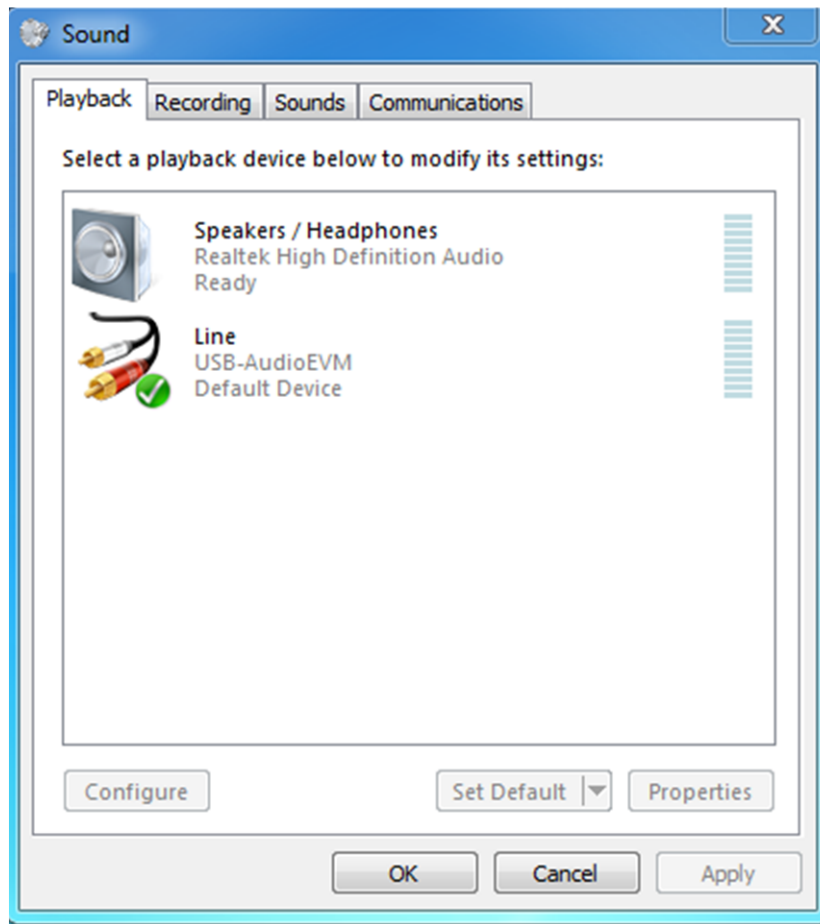


Figure 5. Playback Device Settings

- Start up PPC3 software.
- Log in and download the I2C Master App if it is not downloaded already.
- Launch the I2C Master App. In the bottom lefthand corner there should be a button that says Connect, shown in [Figure 6](#). Press the connect button and now the button should be red and say Disconnect.

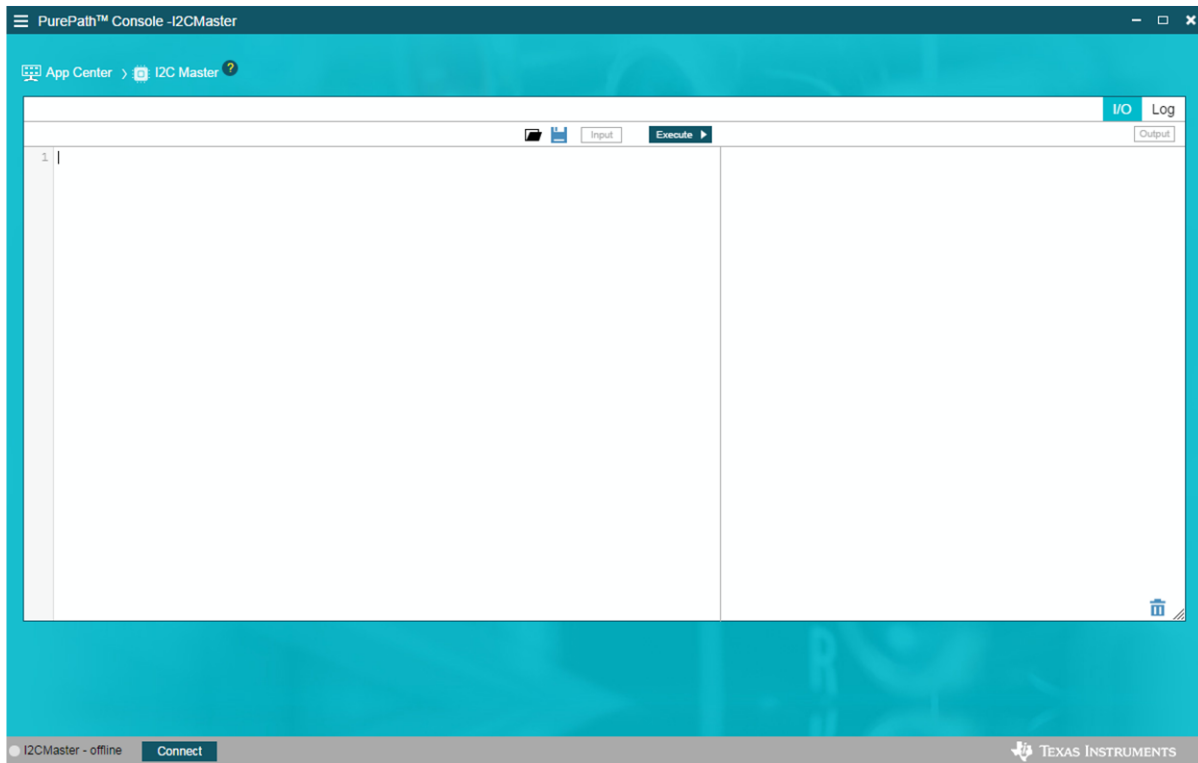
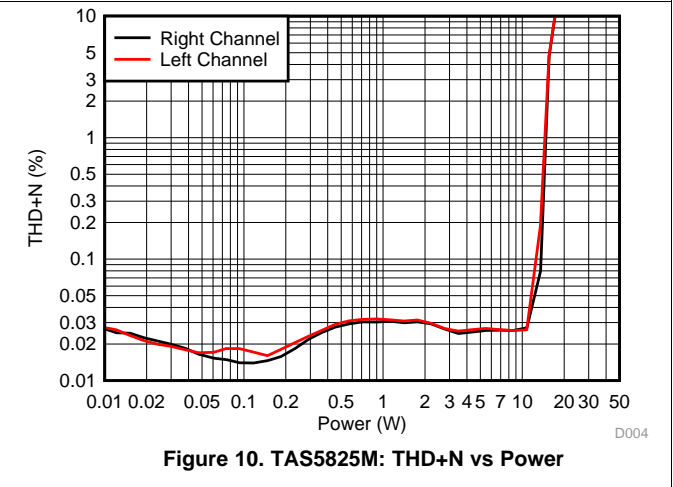
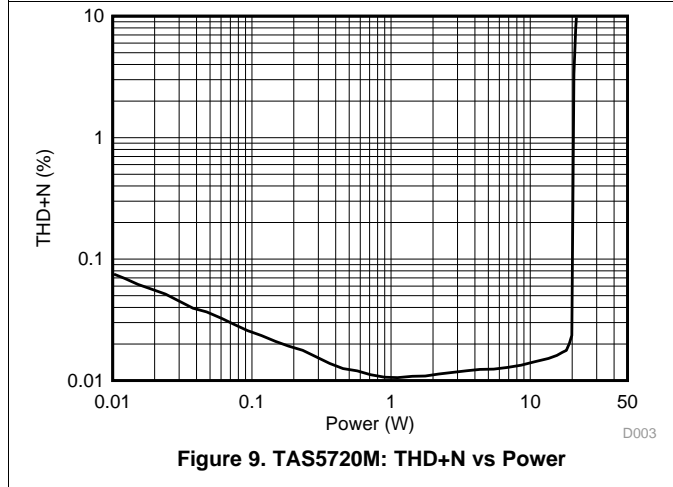
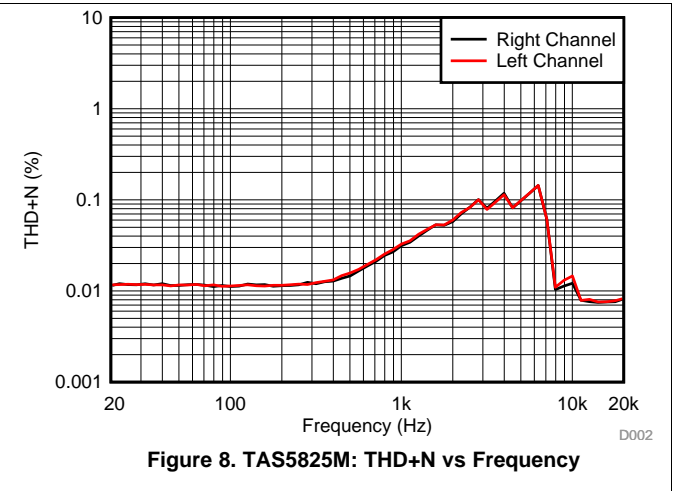
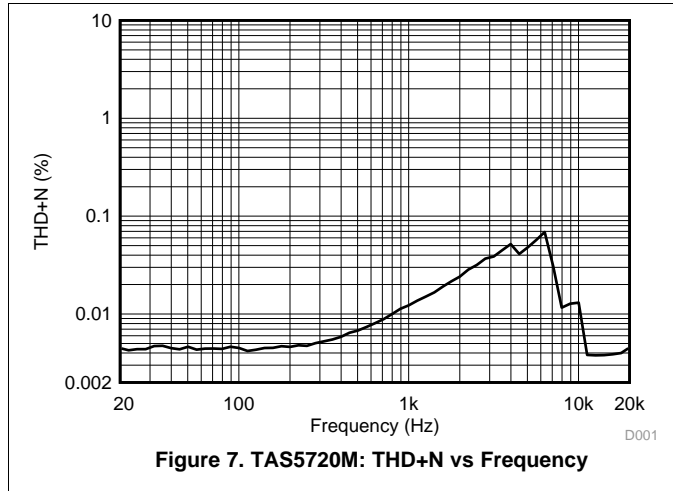


Figure 6. I2C Master Interface

- Open up the code .txt file provided on the website and copy and paste the code into the I2C Master app.
- Shown in [Figure 6](#), click the Excute button. All lines should say successfully written.
- Proceed to play audio through the audio player.

3.2.2 Test Results

Measurements were done at free-air room 25°C, with the Analog Analyzer filter set to 20-kHz brickwall filter. PVDD was set to 12-V with the load being 4-Ω.



4 Design Files

4.1 Schematics

To download the schematics, see the design files at [TIDA-060026](#).

4.2 Bill of Materials

To download the bill of materials (BOM), see the design files at [TIDA-060026](#).

4.3 PCB Layout Recommendations

4.3.1 Layout Prints

To download the layer plots, see the design files at [TIDA-060026](#).

4.4 Altium Project

To download the Altium Designer® project files, see the design files at [TIDA-060026](#).

4.5 Gerber Files

To download the Gerber files, see the design files at [TIDA-060026](#).

4.6 Assembly Drawings

To download the assembly drawings, see the design files at [TIDA-060026](#).

5 Software Files

To download the software files, see the design files at [TIDA-060026](#).

6 Related Documentation

1. [TAS5825M Process Flows](#)

6.1 Trademarks

E2E is a trademark of Texas Instruments.

Altium Designer is a registered trademark of Altium LLC or its affiliated companies.

All other trademarks are the property of their respective owners.

6.2 Third-Party Products Disclaimer

TI'S PUBLICATION OF INFORMATION REGARDING THIRD-PARTY PRODUCTS OR SERVICES DOES NOT CONSTITUTE AN ENDORSEMENT REGARDING THE SUITABILITY OF SUCH PRODUCTS OR SERVICES OR A WARRANTY, REPRESENTATION OR ENDORSEMENT OF SUCH PRODUCTS OR SERVICES, EITHER ALONE OR IN COMBINATION WITH ANY TI PRODUCT OR SERVICE.

7 About the Author

Robert Clifton is an applications engineer at Texas Instruments. Robert obtained his bachelor's degree from Texas Tech University in electrical engineering.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated