Application Note
TAS2563 PDM Microphone Interface and Echo Reference

TEXAS INSTRUMENTS

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ABSTRACT

The TAS2563 device features the pulse-density modulation (PDM) microphone interface. This allows the smart amplifier to be used in two-way audio applications with up to two digital microphones. In most two-way audio applications, echo cancellation algorithms are implemented to avoid the audio played on the speaker to be coupled on the microphone recording. The TAS2563 also features echo reference feedback data, helping to significantly eliminate the speaker echo from the microphone recording. This document explains how to configure TAS2563 for using these features and shows an example of how data is received back at the host controller.

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1 PDM Microphone

The TAS2563 supports PDM microphone inputs. Two PDM microphone inputs simplify the audio signal chain for two-way audio systems, interfacing digital microphones with the host processor.
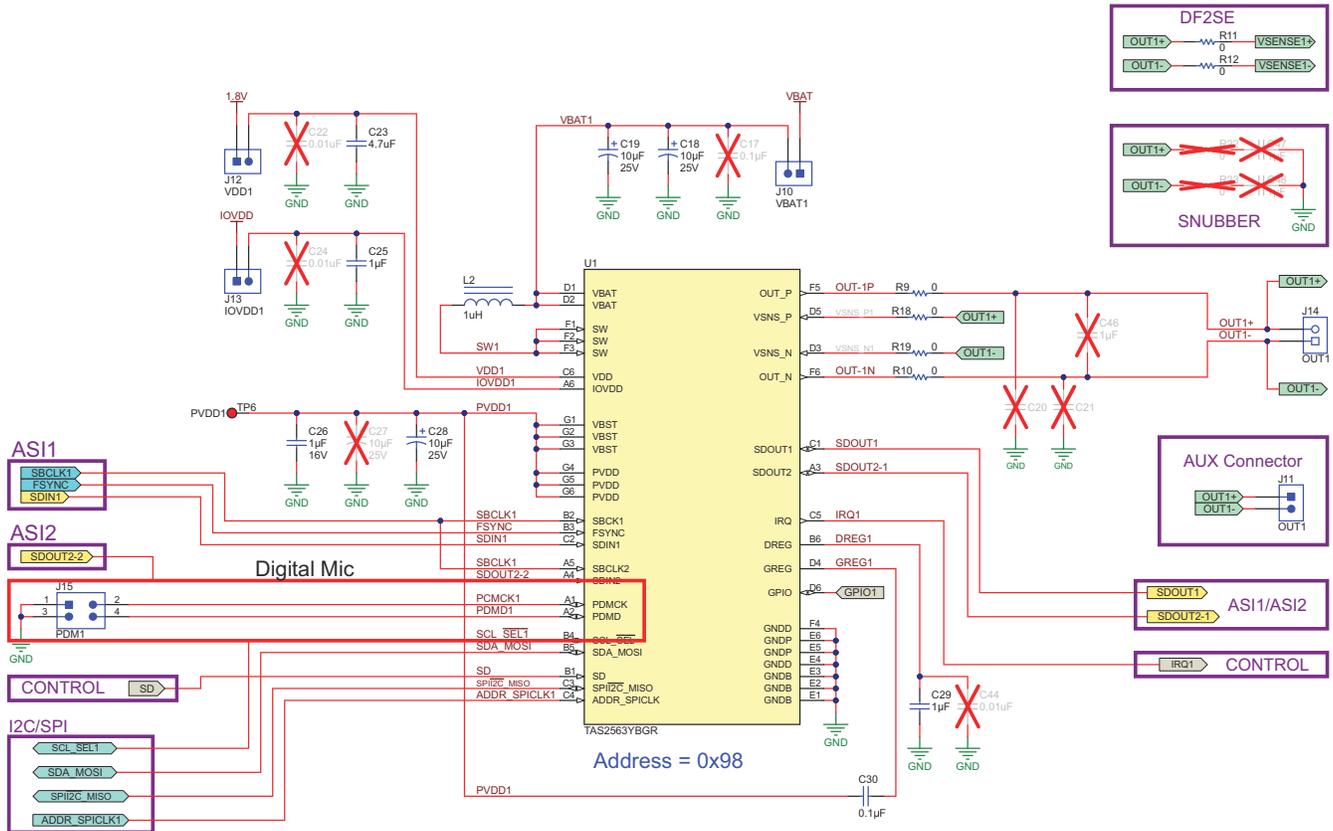

Figure 1-1. PDM Connection Schematic

1.1 PDM Microphone Hardware Connections

Besides the power supply, the PDM microphone usually needs two signals to work. The two signals are PDM CLK and PDM data. The PDM data can be available at the rising edge or falling edge of PDM CLK. Obtain this data from the *PDM Timing Diagram* (illustrated in Figure 1-2) in the *TAS2563 6.1-W Boosted Class-D Audio Amplifier With Integrated DSP and IV Sense* data sheet.
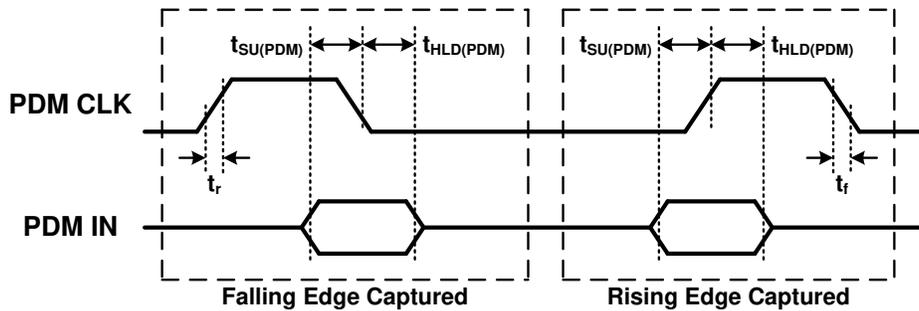
Figure 1-2. PDM Timing Diagram

The two PDM microphones can be connected together. One PDM microphone works at the CLK raising edge and the other one works at the CLK failing edge. The chipset reads the data both at the raising edge and failing edge but splits them. So, the chipset gets signals of the two PDM microphones.

For example, the PDM microphone has 5 pins, shown in Table 1-1. The *SELECT pin* can be set high or low to determine which signal edge makes the microphone data available.

Table 1-1. PDM Microphone Connections

Pin #	Pin Name	Type	Description
1	DATA	Digital O	PDM Output
2	SELECT	Digital I	Lo/Hi (L/R) Select Connect to VDD or GND
3	GROUND	Power	Ground
4	CLOCK	Digital I	Clock Input
5	VDD	Power	Power Supply

On the TAS2X63EVM, the two microphones are connected together, but the select pins are set to low or high in different levels. The two microphones work independently in the system.
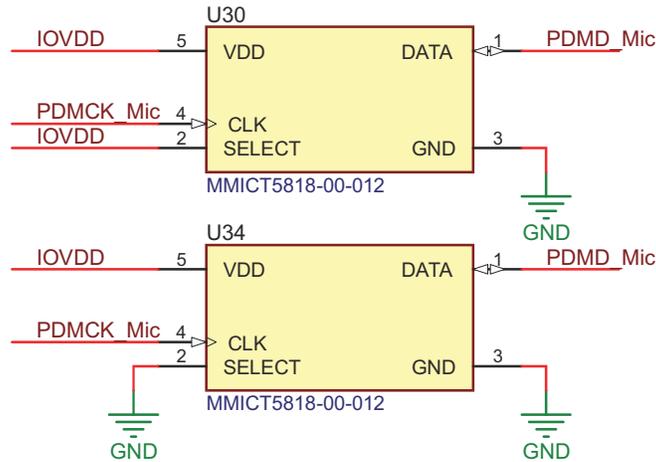

Figure 1-3. PDM Hardware Connections

1.2 PDM Input Function Modes

The TAS2563 provides one PDM input. Figure 1-4 illustrates the double data rate nature of the PDM input. It has two interleaved PDM channels, one sampled by the rising edge and the other by the falling edge of the clock.
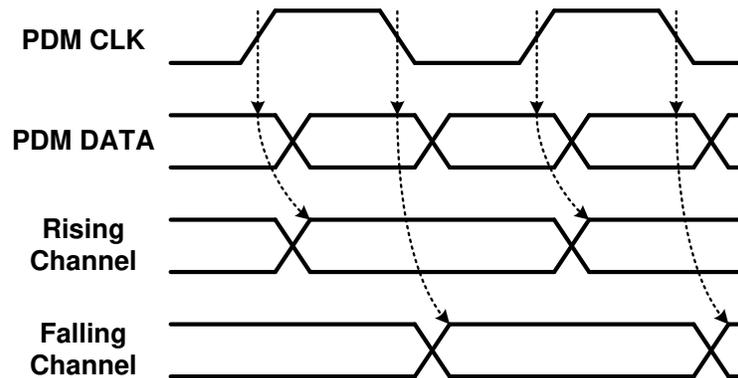

Figure 1-4. PDM Channel Sampling

The PDM inputs are sampled by the PDMCLK pin, which can be configured as either a PDM clock input or a PDM clock output. The PDM_MIC_EDGE and PDM_MIC_SLV register bits select the sample clock edge and output or input mode PDM clock signal. In output mode the PDMCLK pin can disable the clocks (and drive logic 0) by setting the PDM_GATE_PAD0 register bit low. When configured as a clock input, the PDM clock input does not require a specific phase relationship to the system clock (SBCLK in TDM | I2S Mode), but must be from the same source as the audio sample rate. This is equivalent to 64 | 32 |16 (about 3 MHz) or 128 | 64 | 32 (about 6 MHz) times a single | double | quadruple speed sample rate. The PDM rate is set by the PDM_RATE_PAD0. When PDMCLK pin is configured as a clock output, the TAS2563 outputs a 50% duty cycle clock of frequency that is set by the PDM_RATE_PAD0 and register bit (64 | 32 | 16 or 128 | 64 | 32 times a single | double | quadruple speed sample rate).

The data from the PDM microphone will have digital gain up to 30 dB. The two microphones can have independent gains.

2 Echo Reference

The TAS2563 supports echo reference feedback. This data stream is a loopback of the digital audio that the amplifier is playing, just before it is processed by the digital-to-audio converter (DAC). It includes all effects produced by the smart amp features such as EQ, DRC, speaker protection algorithm, and so forth.

This feature allows the user to do noise cancellation or echo correction algorithms. Figure 2-1 presents the block diagram.
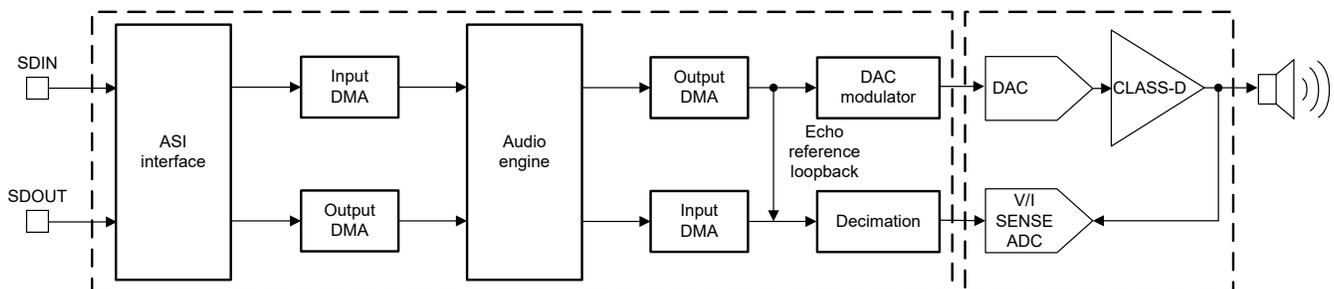

Figure 2-1. Echo Reference Loopback

3 SDOUT Data Arrangement

The data slots for the transmitter (SDOUT) stream are always allocated in 8-bit slots, regardless of the data and word length configuration for receiver, or playback data stream.

The PurePath™ Console 3 (PPC3) GUI is the best way to configure the device, as the tool automatically sets the required register values depending on the user selections. However, if the user needs to configure each data slot manually, the following aspects must be considered.

3.1 Data Slot

Each SDOUT data slot has a length of 8 bits, consider this when setting the value of registers 5–0 on each register from 0x0B to 0x10. Each of these registers controls a different type of data, which can be different depending on the output data configuration; Section 4 of this document shows an example of how this data can change.

3.2 Data Enable

Similarly, each of these registers can set bit 6 to enable or disable the data output. This means different data types can share the same slot configuration, as long as only one of them is enabled at a time.

3.3 Data Length

The bits 7–6 on register 0x08 (IVMON_LEN) set the length of the data specifically for I sense, V sense, PDM, echo reference, estimated excursion, estimated temperature, audio in and audio out. Only three of these can be output at the same time, and all of these will have the same data length based on IVMON_LEN settings. As previously mentioned in this application note, the data length is independent of slot allocation, which is always based on 8-bit slots. This means the user has to consider a higher count of slots depending on data length.

4 Practical Configurations Using PPC3

The PurePath™ Console 3 (PPC3) software is the best way to properly configure TI smart amplifiers, due to its complexity in register settings and internal processing features. This section considers the TAS2563 in a QFN package and the PDM use-case.

4.1 Tuning and Audio Processing

When creating a new PPC3 tuning file, first go to the tuning and audio processing panel. The reason for this is that either PDM or *smart amp only* configuration must be selected. This use-case covers the PDM mode.
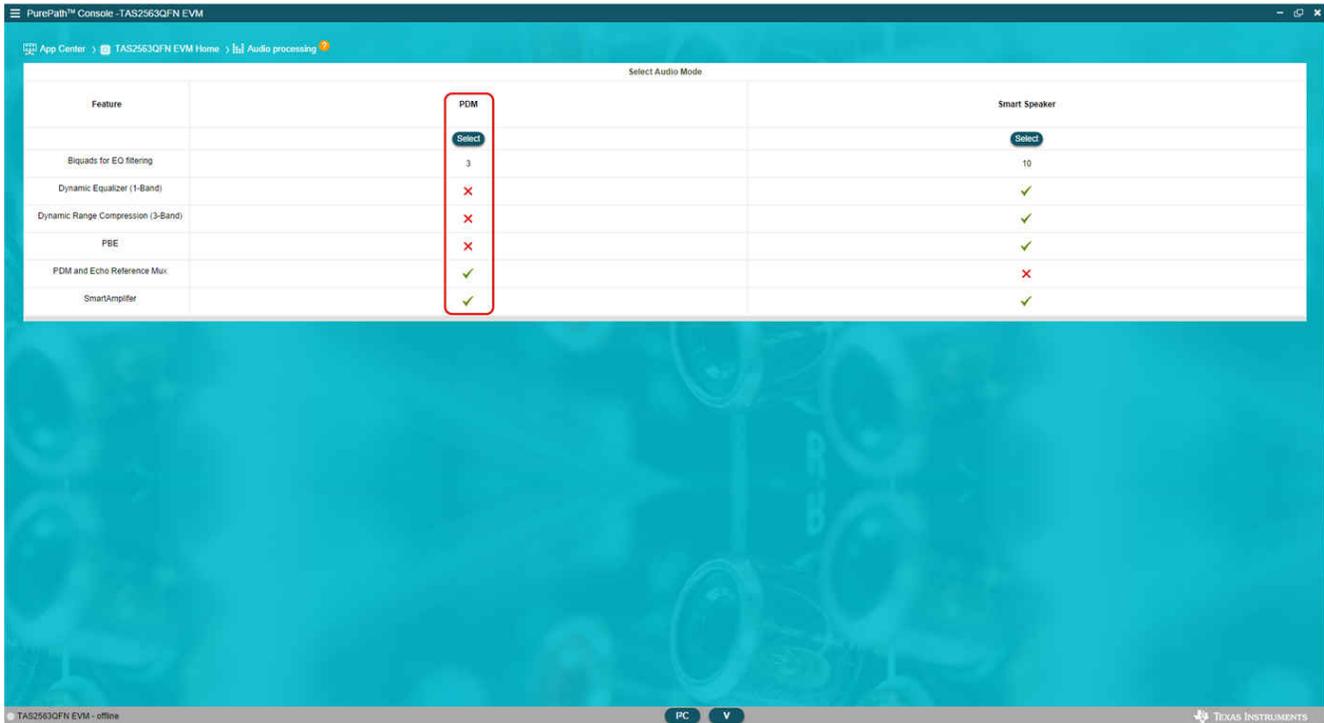
Figure 4-1. Audio Modes

Once PDM is selected, the smart amp panel can be used to access the PDM microphone gain settings.
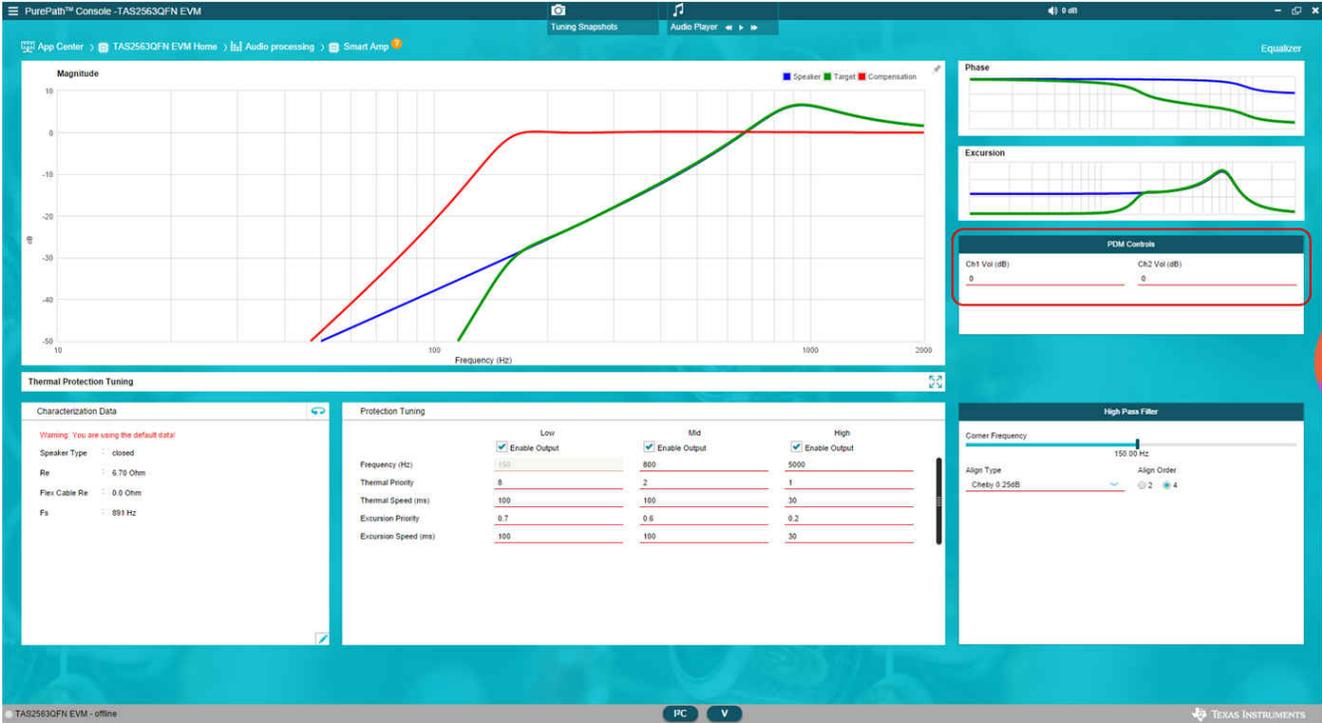
Figure 4-2. PDM Microphone Gain

In addition, the output data selection is available in two different options:

1. At Device Control -> TDM Transmitter -> Configure Slots device control panel -> transmitter -> configure slots. Here the device can be configured as part of debugging on the EVM. Different types of data can be included and the gear icon on the top right corner allows the user to select the data length.
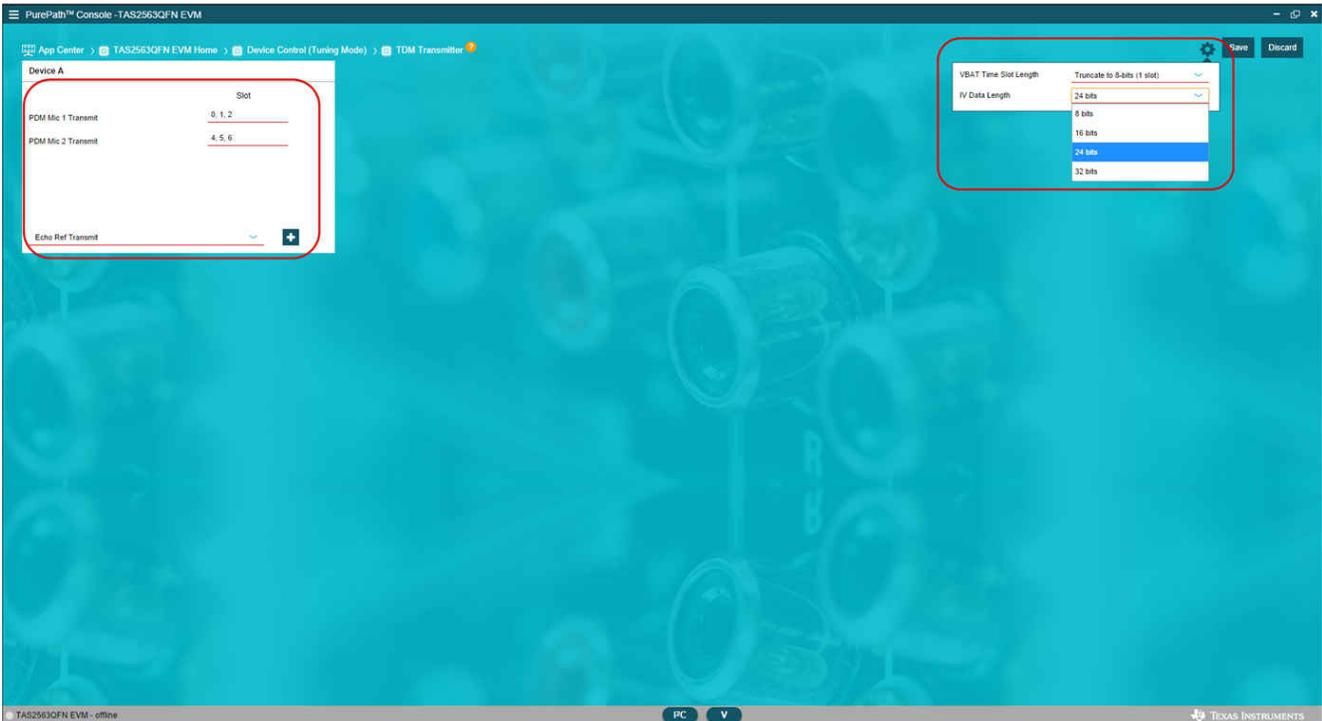
Figure 4-3. SDOUT Data Configuration - Device Control

2. This can also be configured at the end-system integration, as part of the snapshot selection configuration. Use the gear icon on the top right corner to access the different output data options.
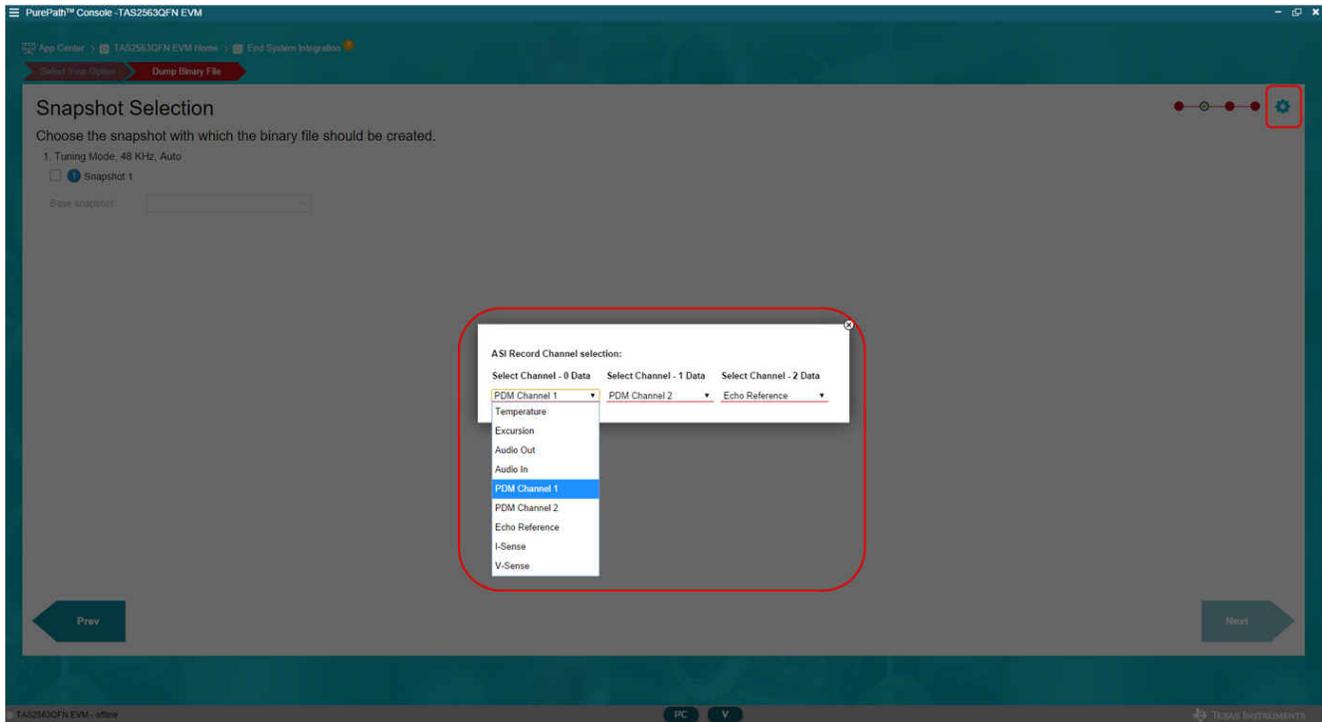
Figure 4-4. SDOUT Data Configuration - End System Integration

5 References

- Texas Instruments, *[FAQ] TAS2563: PDM Interface* E2E™ forum
- Texas Instruments, *TAS2x63EVM Evaluation Module* user's guide
- Texas Instruments, *TAS2563YBGEVM-DC Evaluation Module* user's guide
- Texas Instruments, *TAS2563 Device Features and Controls Overview* application note
- Texas Instruments, *Overview and training series for smart amps and PurePath™ Console 3 (PPC3)* video series

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