Application Report
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Getting Started with Smart Amp Development

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ABSTRACT

PurePath™ Smart Amp provides powerful tools to make speaker characterization and tuning easy.

Smart Amp replaces traditional continuous power design principles and hardware based speaker protection methods with algorithms that allow significant increases in peak power output, loudness and sound quality relative to conventional amplifiers.

Smart Amp tools allow developers to understand how speakers are performing in the system and then make informed decisions to improve performance. The algorithms, characterization and tuning tools allow developers to overcome a wide variety of audio challenges.

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Trademarks

1 Supported Smart Amp Devices

This document supports the following Smart Amp devices.

1. TAS5766M
2. TAS5768M

2 What is Smart Amp?

Conventional hardware-based speaker protection matches the continuous power output of the audio amplifier with the speaker output rating and sometimes incorporates high pass filtering to prevent over-excursion. PurePath™ Smart Amp replaces hardware based speaker protection methods with predictive algorithms, speaker characterization tools and real-time signal monitoring to increase the peak output of the speaker without damage.

The first implementation step of Smart Amp based audio solutions is characterizing the speaker with TI's PurePath™ Console 3 and the PurePath™ Learning Board. These are powerful, easy-to-use tools designed specifically to simplify system level characterization, tuning and implementation. The characterization process creates a digital model of the speaker based on thermal, electro-mechanical and acoustic parameters.

The output of the characterization process is an initial set of coefficients that define the Safe Operating Area (SOA) which establishes the boundaries of maximum speaker diaphragm excursion and voice-coil temperature during operation. If the SOA is set correctly, the audio engineer need not worry about speaker damage during the audio tuning process – depending on how hard the system is pushed audio might sound more or less desirable, but speaker safety is ensured if configured properly.

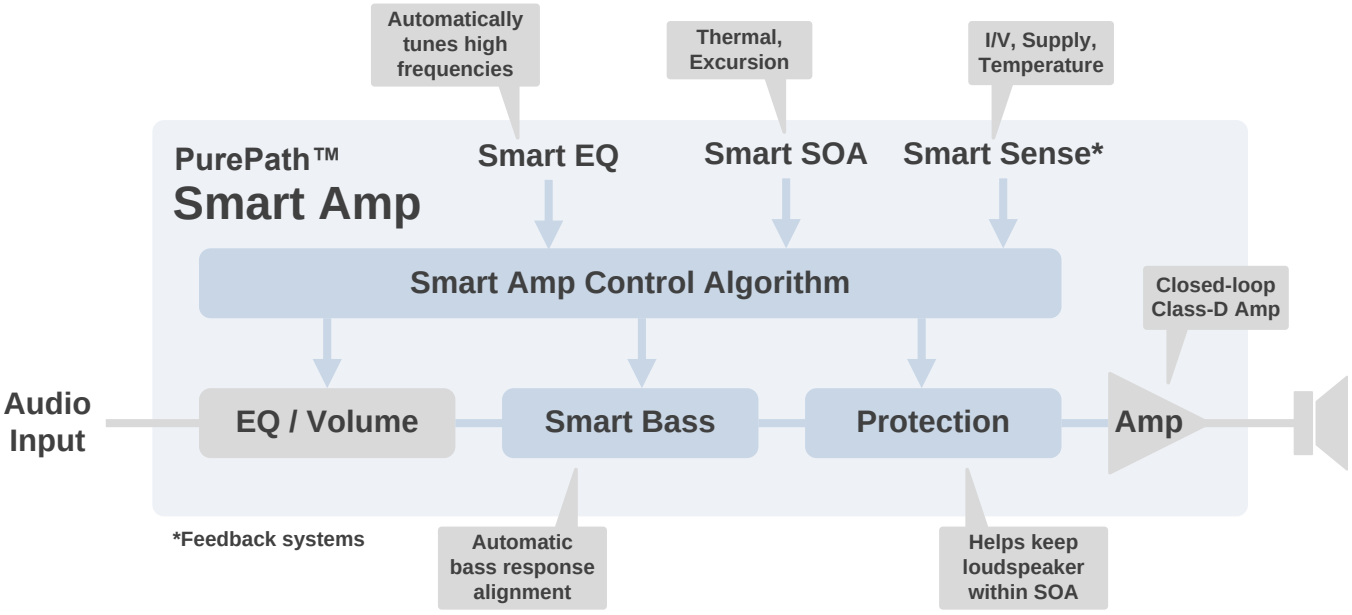

Figure 1. PurePath™ Smart Amp Block Diagram

PurePath™ Smart Amp technology enables significant sound quality and system reliability improvements while reducing component size and cost. The *PurePath™ Console 3* graphical user interface and Learning Board speaker characterization hardware provide simple configuration of advanced properties fully describing an audio system's acoustical, electrical, thermal and reliability capabilities and simplifying system level characterization, tuning and integration.

2.1 Smart Amp Features

2.1.1 Smart Base

Bass can easily be extended into any alignment automatically. As signal amplitude is increased in the bass region, Smart Bass automatically morphs the response to accommodate for larger excursion.

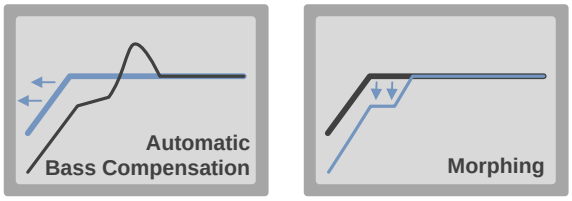

Figure 2. Smart Base

2.1.2 Smart SPL

High-frequency behavior of the loudspeaker diaphragm cannot be obtained electrically. Similarly, it is difficult to obtain accurate low-frequency acoustical measurements without an expensive anechoic chamber. Smart SPL automatically merges electrical and acoustical measurements to create a full picture of the SPL response.

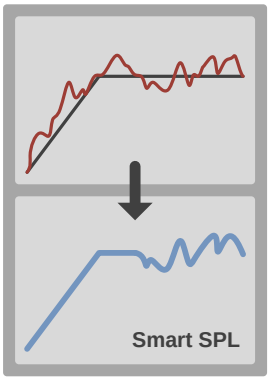

Figure 3. Smart SPL

2.1.3 Smart EQ

Automatically tunes high frequencies to deliver a flat response or match a target curve in seconds. And it does it very efficiently.

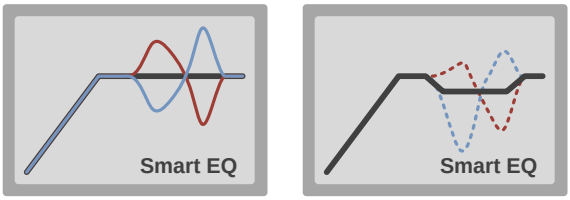

Figure 4. Smart EQ

2.1.4 Thermal and Excursion Protection

The Smart Amp algorithm understands the thermal and excursion limitations of the speaker. This allows to drive it at peak levels much louder than conventional amplifiers while keeping the voice coil temperature and excursion within the specified limits. This results in louder audio playback.

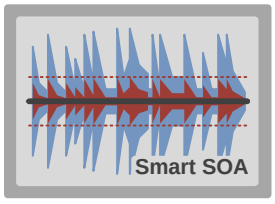

Figure 5. Smart SOA

3 Smart Amp Development Overview

The following steps summarize Smart Amp evaluation, planning, characterization, tuning and integration:

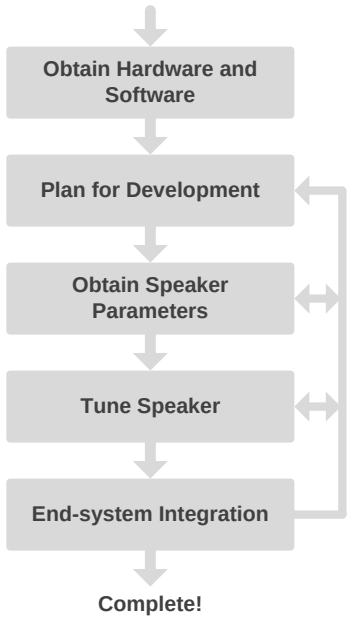

Figure 6. Smart Amp Development Overview

1. **Obtain Hardware and Software** - Speaker characterization and tuning are performed using the *PurePath™ Console 3 software*. The *TI Learning Board and the Smart Amp Target EVM* are needed in order to fully evaluate and develop with Smart Amp.
2. **Plan for Development** – Developing *Smart Amp* based systems for the first time can be different than working with conventional amplifiers. Information obtained during the speaker characterization process often leads to changes to the speaker or enclosure to maximize output and quality.
3. **Obtain Speaker Parameters** – The next step is to understand the characteristics of the speaker to be tested. Once a speaker is characterized, the ppc3 file obtained from this step will be used on the next step.
4. **Tune Speaker** – Once the speaker data is obtained, a speaker can be tuned using the *Learning Board* or the *Target EVM* by importing a ppc3 file.
5. **End-system Integration** – Smart Amp fundamentally shifts how audio systems are designed. Using the Smart Amp tool set, a designer gathers an in-depth understanding of speaker electro-mechanical, thermal and acoustic parameters. Based on these parameters, Smart Amp algorithms deliver high peak voltage and current to the speaker while protecting the speaker from excessive heat or movement. Increased voltage and current levels lead to changes in the system power design. For these reasons it is important to understand the power supply requirements early in the design.

4 What's Needed

Table 1 shows the hardware and software requirements organized by configuration type (e.g. 2.0, 2.1 or 4 channel). All the configurations require the Learning Board for characterization. The Target EVM is required to generate code to be implemented in the end-system.

Table 1. Table 1. Equipment and Software

	2 Channel Mid-Power Smart Amp	2.1 Channel Mid-Power mart Amp	4 Channel Mid-Power Smart Amp
Hardware Tools (4.1)			
PurePath™ Smart Amp Learning Board	x	x	x
PurePath™ Console Motherboard	x	x	x
Target EVM (4.1)			
2 Channel TAS5766M EVM (TSSOP)	x		
4 Channel TAS5766M EVM (QFN)		x	x
Miscellaneous Equipment (4.2)			
Weigh Scale	o	o	o
Adhesive Putty	o	o	o
Metric Ruler	o	o	o
24V Power Supply	x	x	x
Microphone	p	p	p
Software Tools (4.1)			
PurePath™ Console 3	x	x	x

4.1 Obtaining TI Hardware and Software

TI approval is required to order Smart Amp-related hardware and software. Click the button in the *Target EVM* web site to begin the approval process. Once approved, the user will receive an email confirming access to the mySecureSoftware web site and hardware ordering information.

The PurePath™ Console 3 software can be downloaded from the *PUREPATHCONSOLE Software Product* page in mySecureSoftware, as shown below. There is no need to download separate plugins – Smart Amp Apps will automatically be available within PurePath™ Console 3 once the user is given access to the proper Software Product (e.g. *TAS5766MSW-SA*, etc.).

The *Target Software Product*, as shown in Figure 7, contains hardware ordering information, documentation, videos, etc.

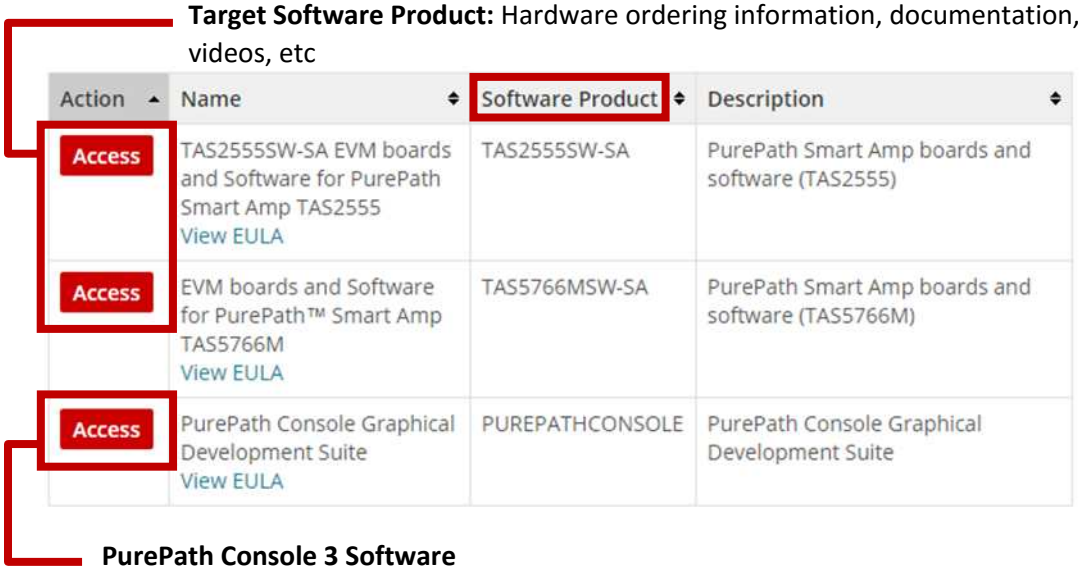

Figure 7. mySecureSoftware Page

Contact audio_software@ti.com for any issues related to software access

4.2 Miscellaneous Equipment

In order to perform a full characterization the following hardware is recommended. Some of these items are not needed if loudspeaker parameters are known.

Table 2. Miscellaneous Equipment

Equipment	Description
Weight Scale	20g in 1mg increments preferred. The Gemini-20 Portable Milligram Scale by American Weigh is recommended. Not required if the force factor Bl is provided by the speaker manufacturer.
Adhesive Putty	Similar to Blu Tack or *Removable Adhesive Putty* by Scotch. Not required if the force factor Bl is provided by the speaker manufacturer.
Metric Ruler	Size depends on loudspeaker diaphragm area (Sd). Also used to measure port area (Sp). Plastic is preferred to prevent the magnet from pulling the ruler. Not required if Sd and Sp parameters are known.
24V Power Supply	A lab power supply capable of providing peak power to the speakers. A 24V, 6A supply addresses most circumstances. An external AC/DC supply could be used as well, such as the *MENB1100A2403F01* by SL Power Electronics.

A microphone is required for *Smart SPL* and characterizing passive radiator systems. Table 3 is a list of microphones that have been tested for Smart Amp.

Table 3. Microphones Tested for Smart SPL and Passive Radiator Systems

Model	Manufacturer	Type
Mic: CME-1538-100LB	CUI, Inc.	Electret Condenser (requires external 1.8V bias)
Capsule: 4938 Preamp: Type 2670	Brüel & Kjær	¼" Diameter Pressure Field
Mic: EMM-6	Dayton Audio	½" Diameter Condenser (tested with Shure X2u USB Preamp)
Mic: iMM-6	Dayton Audio	Condenser (requires external 1.8V bias)

5 Support

Smart Amp is supported through the Audio Amplifiers Support Forum. Please include the words Smart Amp and the part number in the subject line. Contact your local TI sales representative for additional details.

Revision History

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

Changes from C Revision (July 2015) to D Revision **Page**

- Changed the Title From: PurePath™ Smart Amp Overview (TAS5766M/68M) to: Getting Started with Smart Amp Development 1

Revision History

Changes from B Revision (November 2014) to C Revision **Page**

- Complete re-write of the document. 1

Revision History

Changes from A Revision (July 2014) to B Revision **Page**

- Added *Section 1* with links to TAS5766M and TAS5768M 2
- Changed Figure 1 3
- *Section 4.1 Hardware Tools*: Added passive radiator information 7
- Deleted Appendix A 8

Revision History

Changes from Original (May 2014) to A Revision **Page**

- *Section 4.1 Obtaining TI Hardware and Software*: Added bullets and change wording in Smart Amp Device EVM bullet, Changed Smart Amp Learning Board bullet, and Added Adhesive Putty bullet 7
- *Section 4.2 Miscellaneous Equipment*: added a paragraph and changed bullets 8
- *Section 5 Documentation*, removed link and reworded second to last paragraph 8

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