TAS5707EVM (TAS5709EVM) User's Guide

This manual describes the operation of the TAS5707EVM (TAS5709EVM) to evaluate the performance of the TAS5707 (TAS5709), integrated digital audio power amplifier. The main contents of this document are:

- Details on how to properly connect a TAS5707/09 Evaluation Module (EVM) and the details of the EVM
- Details on how to install and use the GUI to program the TAS5707/09
- Details on how to use the audio processing features like EQ and DRC
- Quick-Start Guide for the common modes in which TAS5707EVM (TAS5709EVM) can be used

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1 Overview

The TAS5707/09 evaluation module demonstrates the TAS5707/09 device from Texas Instruments. TAS5707 EVM is named "TAS5707EVM" and TAS5709 EVM is named as "TAS5709EVM". They both are same EVM except for the audio amplifier. The TAS5707 combines a high-performance PWM processor with a class-D audio power amplifier. This EVM can be configured with two bridge-tied loads (BTL) (2.0). For detailed information about the TAS5707/09 device, review the device data sheet (SLOS550). The Pulse Width Modulator (PWM) is based on TI's Equibit™ technology.TAS5709 has additional audio processing features like 3D, Bass Boost and 2-band DRC.

The EVM software with its graphic user interface (GUI) facilitates evaluation by providing access to the TAS5707/09 registers through a USB port. See the *Using the EVM Software* section for further details.

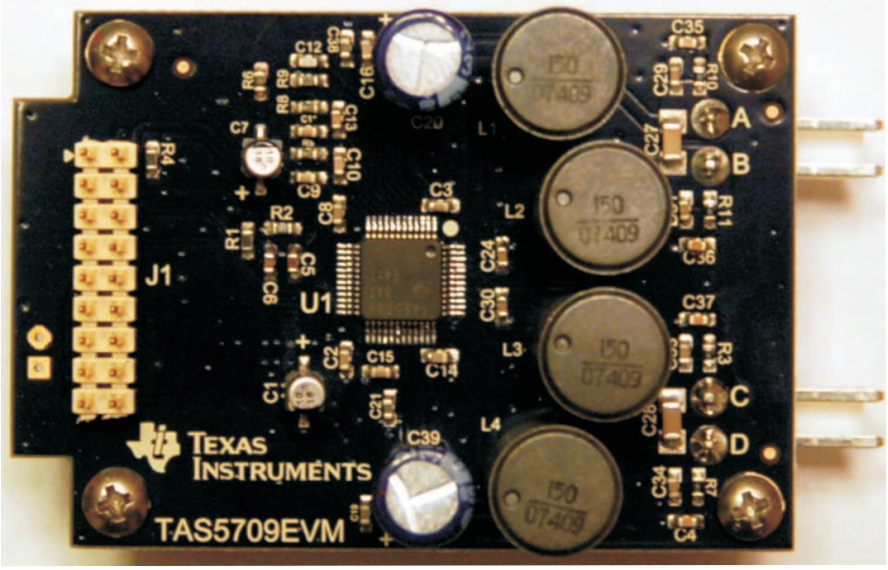


Figure 1. TAS5709EVM Printed-Circuit Board

The EVM together with other TI components on this board, is a complete 2.1-channel digital audio amplifier system. The MC57XXPSIA Controller board includes a USB interface, a digital input (SPDIF), analog inputs via the ADC, power inputs, and other features like a mute function and power down.

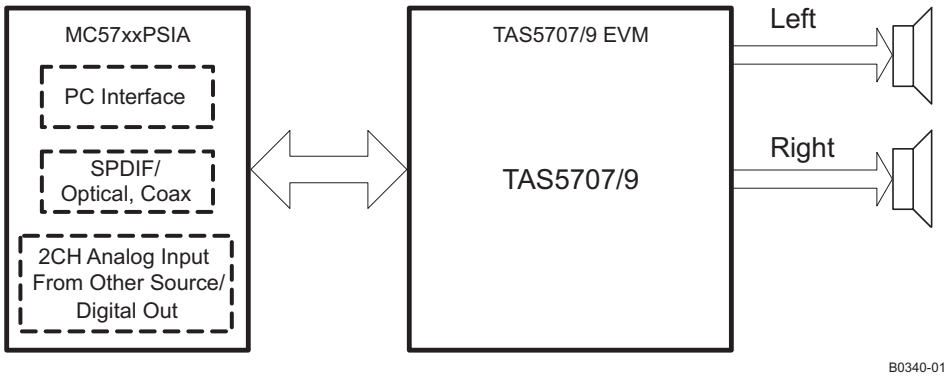


Figure 2. Complete System and EVM Signal Path Overview

1.1 TAS5707EVM (TAS5709EVM) and MC57xxPSIA Features

- Channel evaluation module design
- Self-contained protection systems and control pins
- USB interface
- Standard I^2S data input using optical or coaxial inputs
- Analog input through analog-to-digital converter
- Subwoofer connection—the PWM terminal provides the PWM signal and power to an external subwoofer board
- Double-sided, plated-through PCB, 1-oz copper, 2 mm
- Access to control signal gain and data format through EVM-software GUI

2 Installation

This section describes the EVM and software installation.

2.1 EVM Installation

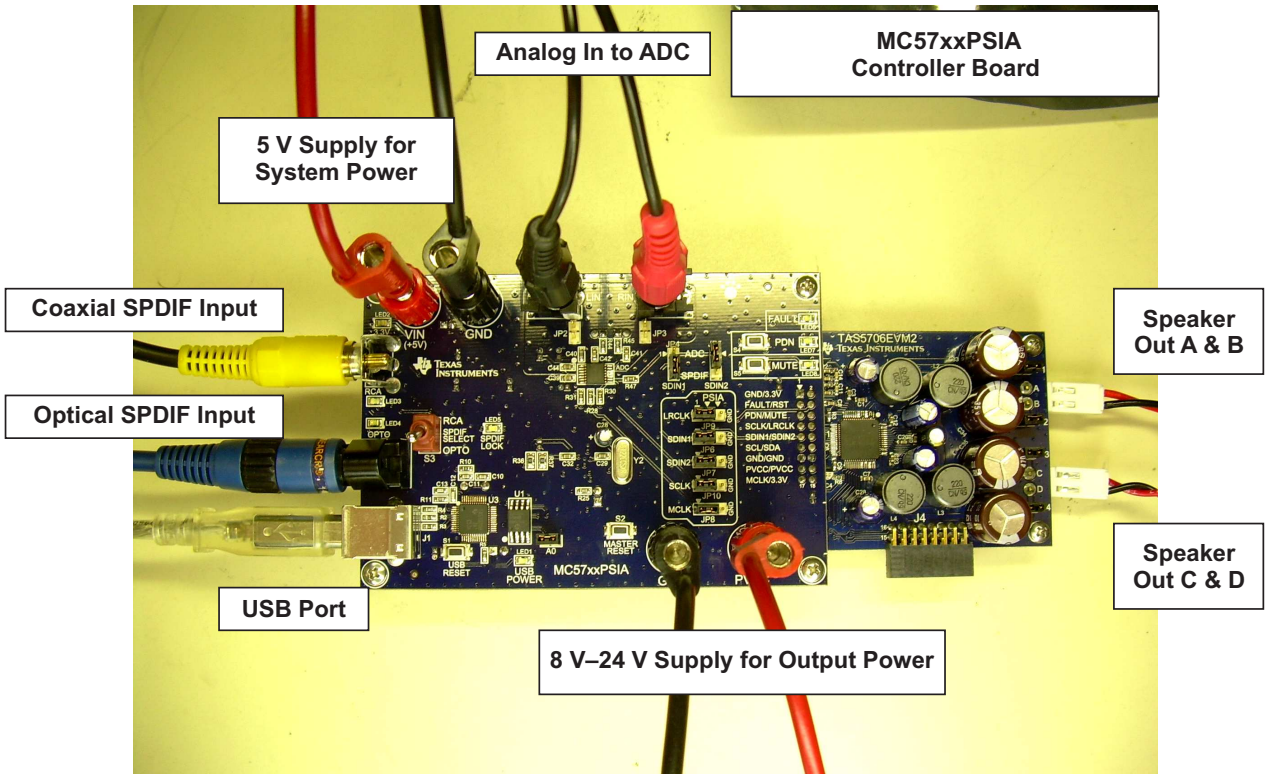


Figure 3. General Connection Picture

The following are the basic tools for the initial EVM power up.

- 5-V, 1-A power supply (VIN)
- 8–24-V, 4-A power supply (PVDD)
- Banana-style test leads for power supplies and speakers
- Optical or coaxial cable for SPDIF interface based on signal source
- USB cable
- EVM software
- Two 8-Ω speakers or loads

The following sections describe the TAS5707/09EVM board in regards to power supply (PSU) and system interfaces.

2.1.1 Connecting the TAS5707/09EVM to MC57xxPSIA

On the right side of the MC57xxPSIA is a terminal block and another on the left of the TAS5707/09EVM (labeled J1). Carefully place the MC57xxPSIA block above the TAS5707/09EVM block and gently push down.

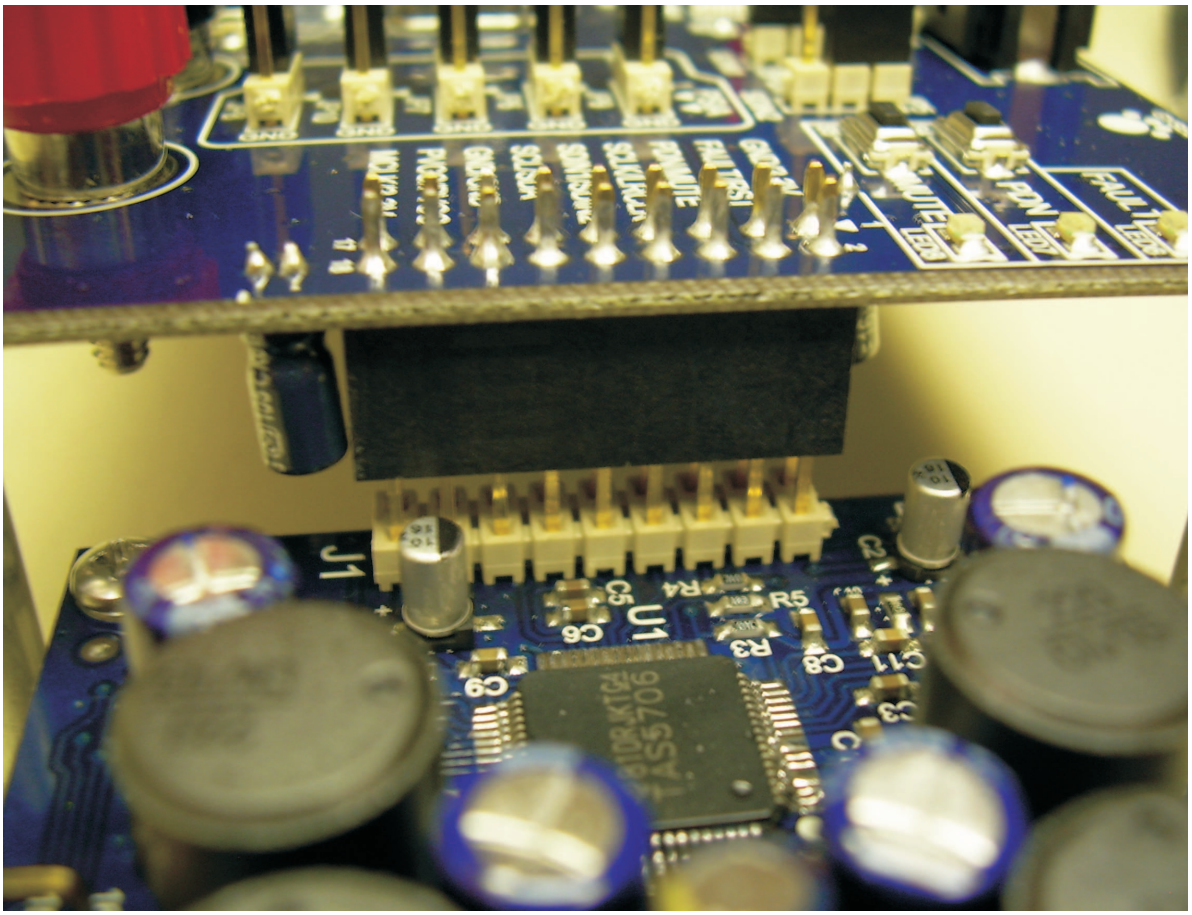


Figure 4. Connecting TAS5707/09EVM to MC57xxPSIA

2.1.2 PSU Interface

The TAS5707/09EVM is powered by two power supplies connected to the MC57xx controller board: a 5-V power supply (VIN), and a 8-V to 24-V (PVDD) power supply. The 3.3-V level is generated on the board by a voltage regulator from the 5-V supply.

Note: The power-supply cable length must be minimized. Increasing the length of the PSU cable increases the distortion of the amplifier at high output levels and low frequencies

The maximum output-stage supply voltage depends on the speaker load resistance. Check the recommended maximum supply voltage in the TAS5707/09 data sheet.

Table 1. Recommended Power Supplies

Description	Voltage Limitations (8-Ω Load)	Current Recommendations
System power supply	5 V	1 A
Output power stage supply	8–24 V	4 A[(1)]

(1) The rated current corresponds to two channels, full scale.

2.1.3 Loudspeaker Connectors

CAUTION

All speaker outputs are biased at Vcc/2 and must not be connected to ground (e.g., through an oscilloscope ground).

Loudspeaker connections vary by device setup. When connecting a speaker in BTL mode, connect the speaker's two terminals (A and B or C and D) across two outputs on the TAS5707/09EVM.

Speakers or loads can be connected to the outputs A-D with clip leads, or cables can be made with female connectors (JST VHR-2N) that can mate to male connectors on the EVM board.

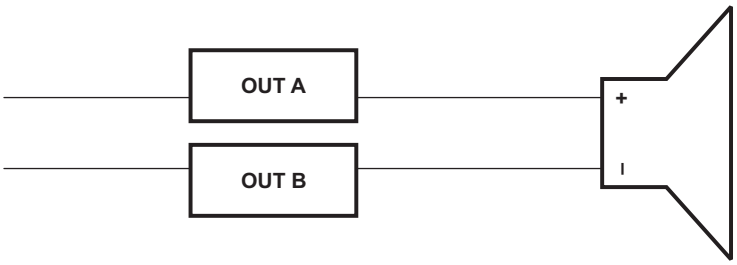


Figure 5. BTL Connection

2.1.4 USB Interface

The TAS5707/09 registers are accessed through I^2C™ bus lines SDA and SCL. The USB circuit and USB connector on the MC57xxPSIA board facilitates the connection between a host computer and the device. The EVM USB circuit is powered by the 5-V USB line of the host PC and is independent of the power supplies available on the board. The USB device that is used is a TAS1020B from Texas Instruments.

2.1.5 Digital Audio Interface SPDIF

The Digital Audio Interface SPDIF (RCA/OPTO) accepts digital audio data using the I^2S protocol. See the TAS5707/09 data sheet for more information.

The RCA connector and the OPTO connector are the two SPDIF interfaces on the MC57xxPSIA board. The switch S3 toggles between the OPTO and RCA connector to accommodate the signal source. When the RCA cable or optical cable is connected and the signal source is powered up, verify that the SPDIF lock indicator (blue LED5) illuminates, confirming that a viable signal is available to the device. Install a jumper on JP4 across the middle pin and the pin marked SPDIF to connect the digital source to SDIN1. Install a jumper on JP5 to connect the digital source to SDIN2.

For detailed information on how the data and clocks are provided to the TAS5707/09, see the schematic appearing at the end of this document and the DIR9001 device data sheet (SLES198).

2.1.6 ADC Interface

In the absence of a digital signal source, the PCM1808 ADC can be used to convert an analog audio signal to a digital signal to the TAS5707/09. The DIR9001 still provides clock signals to the ADC in this process. A 12-MHz crystal is installed on the MC57xxPSIA board. The ADC is an additional feature of this board to provide flexibility in sourcing an audio signal to the TAS5707/09. Review the PCM1808 data sheet (SLES177) for a detailed description of the ADC on this EVM. Install the jumper on JP4 across the middle pin and the pin marked ADC to select ADC as the source for SDIN1.

2.1.7 Board Power-Up General Guidelines

Connect the MC-57xx and the TAS5707/09EVM boards by locating pin 1 on each board, indicated by a small white triangle. The MC-57xx plugs down onto the TAS5707/09EVM board (i.e., the TAS5707/09EVM board fits underneath the MC57xxPSIA board). Pin 1 on each board must be connected to each other.

Install the EVM software on the PC before powering up the board. After connecting the loudspeakers or other loads, power supplies, and the data line, power up the 5-V power supply first; then power up the PVDD power supply. It is recommended initially to set the PVDD level to 10 V, then ramp it up to 20 V to verify cable connections.

2.2 Software Installation

Download the TAS570x GDE from the TI Web site. The TI Web site always has the latest release and any updates to versions of the GUI.

Execute the GUI install program, Setup.exe. Once the program is installed, the program group and shortcut icon is created in Start → Program → Texas Instruments Inc → TAS570X GDE. THE GUI come ups as shown in Figure 6.

Select the appropriate tab, in this case, select TAS5705 tab. It has two subwindows. One shows the Process Flow window. From the Process Flow window, each of the signal processing function tools can be selected by clicking on it. The Biquad GUI and the DRC GUI can be opened by using the right button of the mouse. This window also shows Input select, Mode select, Channel, and Master Volume. All functions are shown in the order that they are in the device.

The other subwindow, Properties window, has the properties where a user can update by selecting from the available options. The properties available depends on the device selected. From the main window, the user must set three properties before connecting to the EVM.

Select the device Enable/Disable auto bank switch function, and set the sample rate. The TAS570x automatically detects sample rates. This setting is simply to synchronize the GUI and the device.

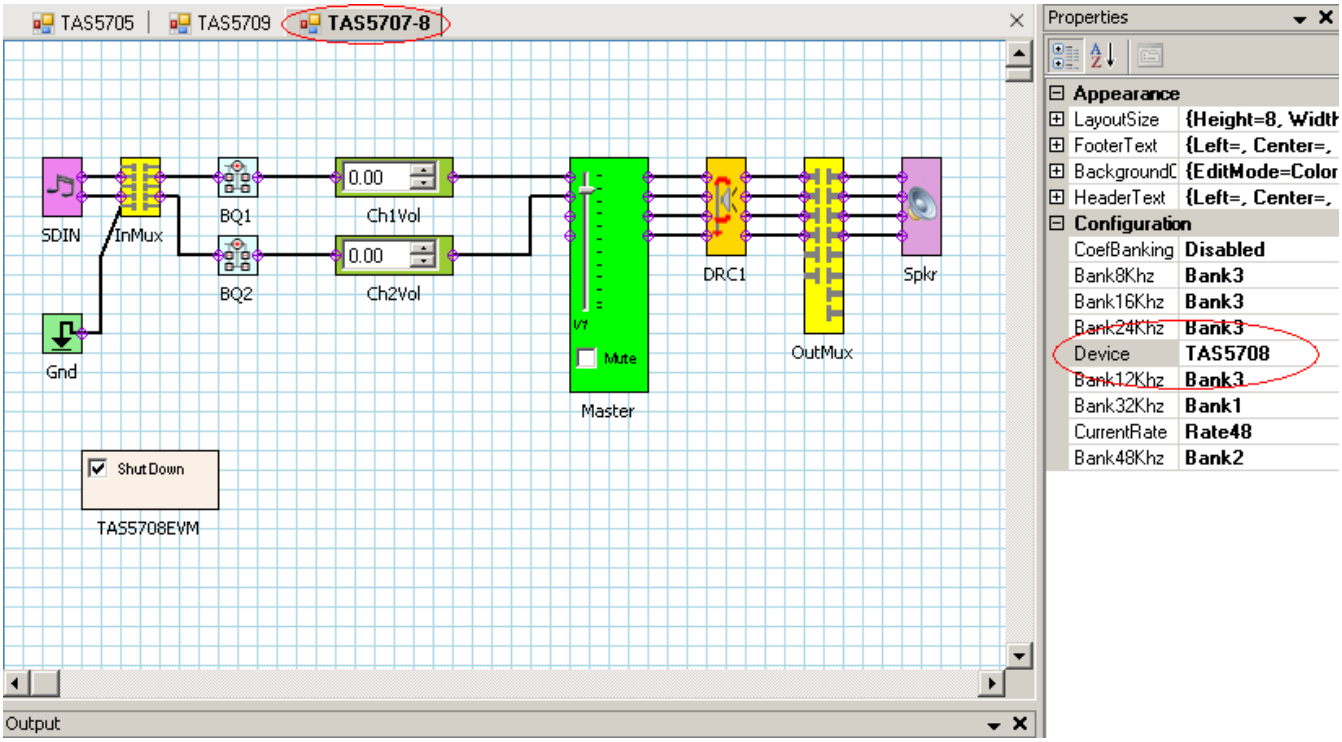


Figure 6. Process Flow for TAS5707 UG

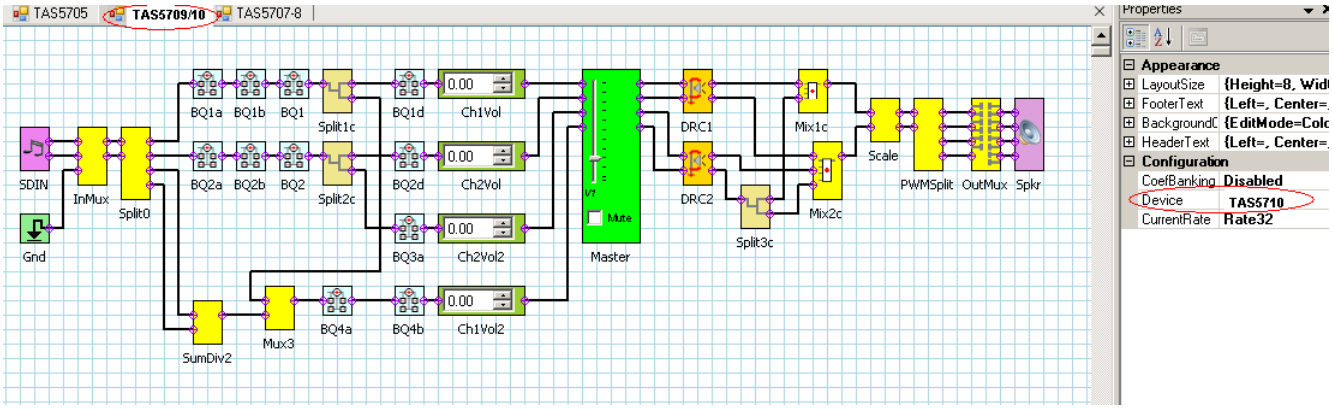


Figure 7. Process Flow for TAS5709 UG

3 Using the EVM Software

3.1 Connect the GUI to the EVM

Once the properties window selections have been made, go to the menu Target → Connect.

This sends the initialization commands to the device. Master volume is in mute. Select the master volume function. Type the required volume in the properties window. For TAS5707/09, type 0 dB. The difference is due the power stage gain in both devices. At this time, audio, if connected properly, plays through the device. Check All channel shutdown button. It must be un-checked. When the Connect command is issued, if an error appears indicating a USB problem, check the connections, and press the USB RESET button on the controller board. Then disconnect and re-connect from the Target menu.

3.2 I2C Memory Tool

This tool can be opened from GDE (Tools → I2C Memory Tool) or independent of GDE from Start → Program → Texas Instruments Inc → Memory Tool.

Select I2C as show in Figure 8.

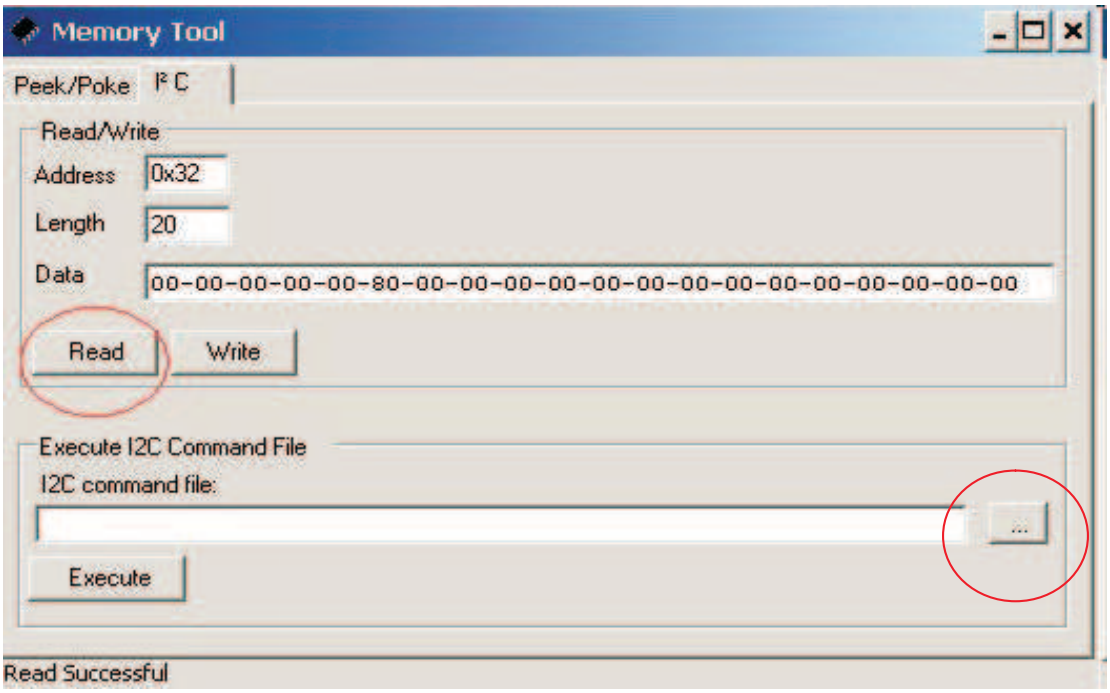


Figure 8. Memory Tool Window

I2C registers can be written or read using this tool. The I2C command file can be sent by selecting the command file and *Execute* command.

3.3 Volume Function

The Individual and Master volume can be selected, and the required volume value can be entered by typing on the property Window after selecting the function with the mouse (see Figure 9).

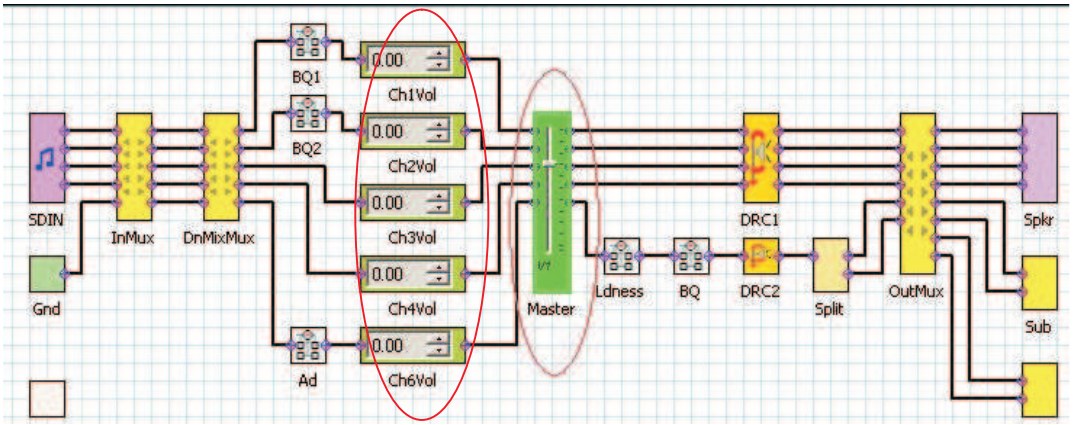


Figure 9. Volume Control

3.4 Biquad GUI

Using the right button of mouse, select Biquad GUI (Figure 10).

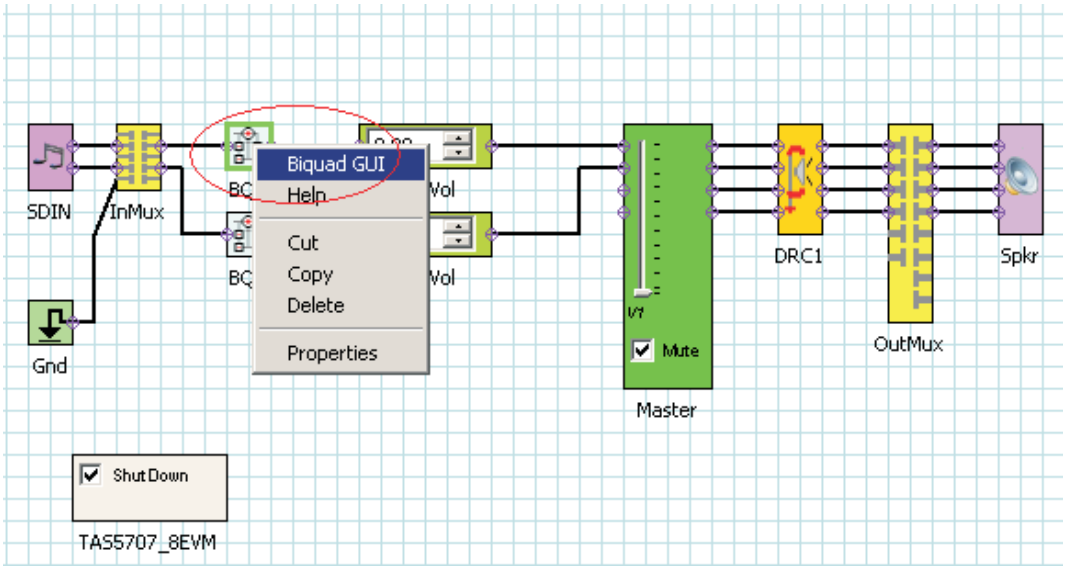


Figure 10. Selecting Biquad GUI

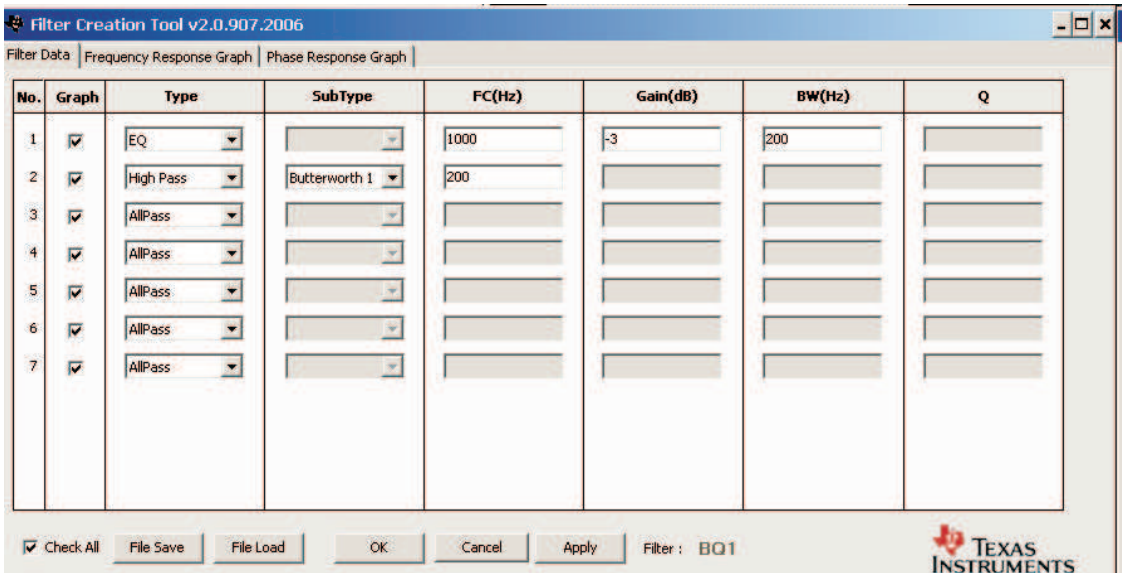


Figure 11. Filter Creation Tool Window

A check mark selects the Biquad. If not selected, the Biquad is in ALL PASS Mode.

The frequency response for the current settings can be viewed and adjusted in **Frequency Response Window** Tab (Figure 11). The Individual Biquad Gains must be within ±12 db.

Apply from the filter data window sends all the three banks of coefficients (providing auto bank is enabled).

3.5 DRC GUI

Clicking on the function selects DRC GUI (Figure 12). Click on the DRC function, and check to see if DRC is enabled in the property window.

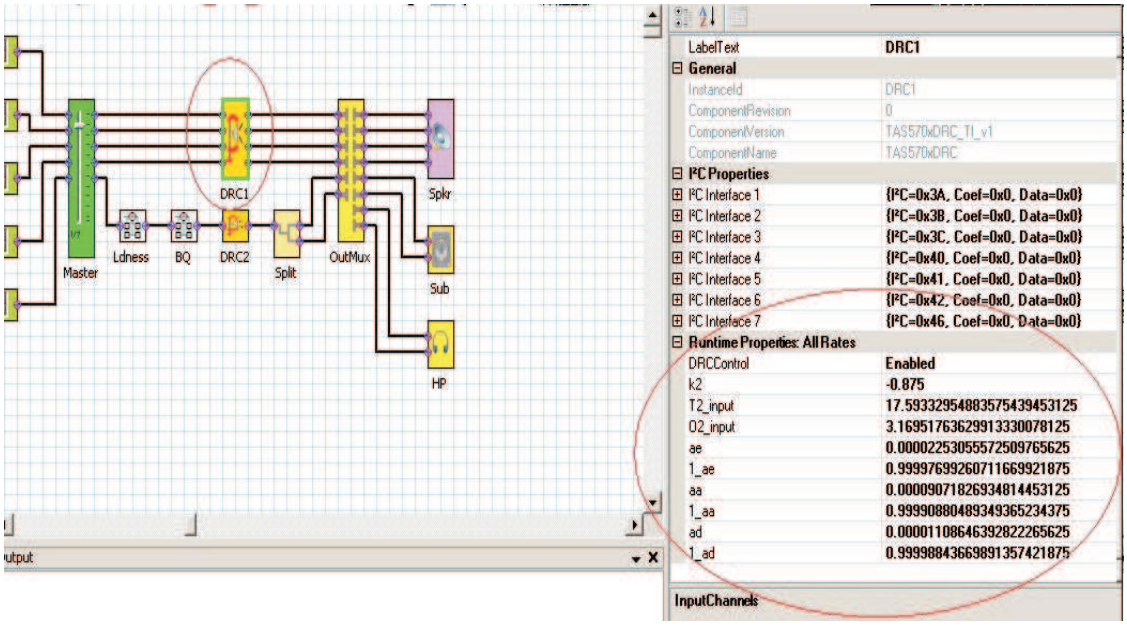


Figure 12. DRC Parameters

Next, using the right button of the mouse, select **Activate DRC GUI** (Figure 13).

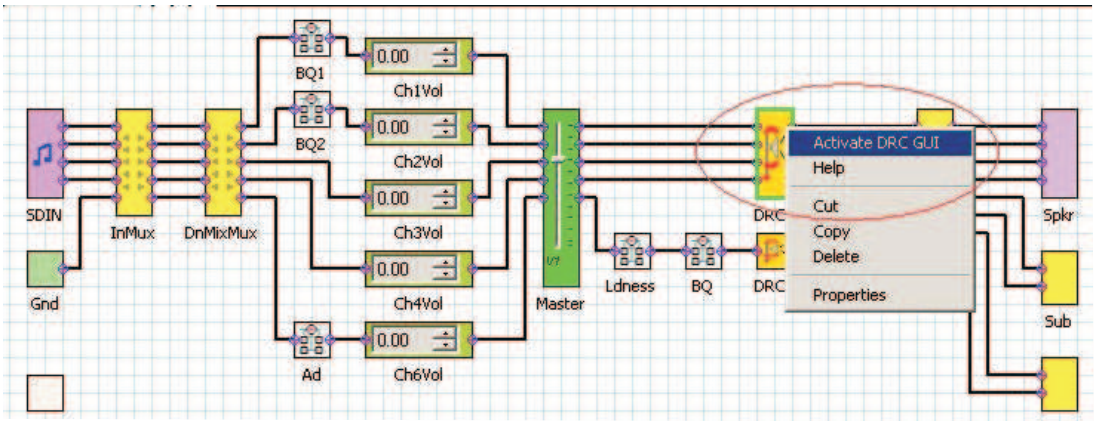


Figure 13. Activating the DRC GUI

Set the **compression ratio** to a value between 1 and 50.

The **offset** has a range at ±6 dB. *A value of 0* is illegal. If no offset is required, set the offset to 0. Offset is generally not required in a DRC application because is just provides a gain.

Threshold is selected with a value of 0 to –72 dB.

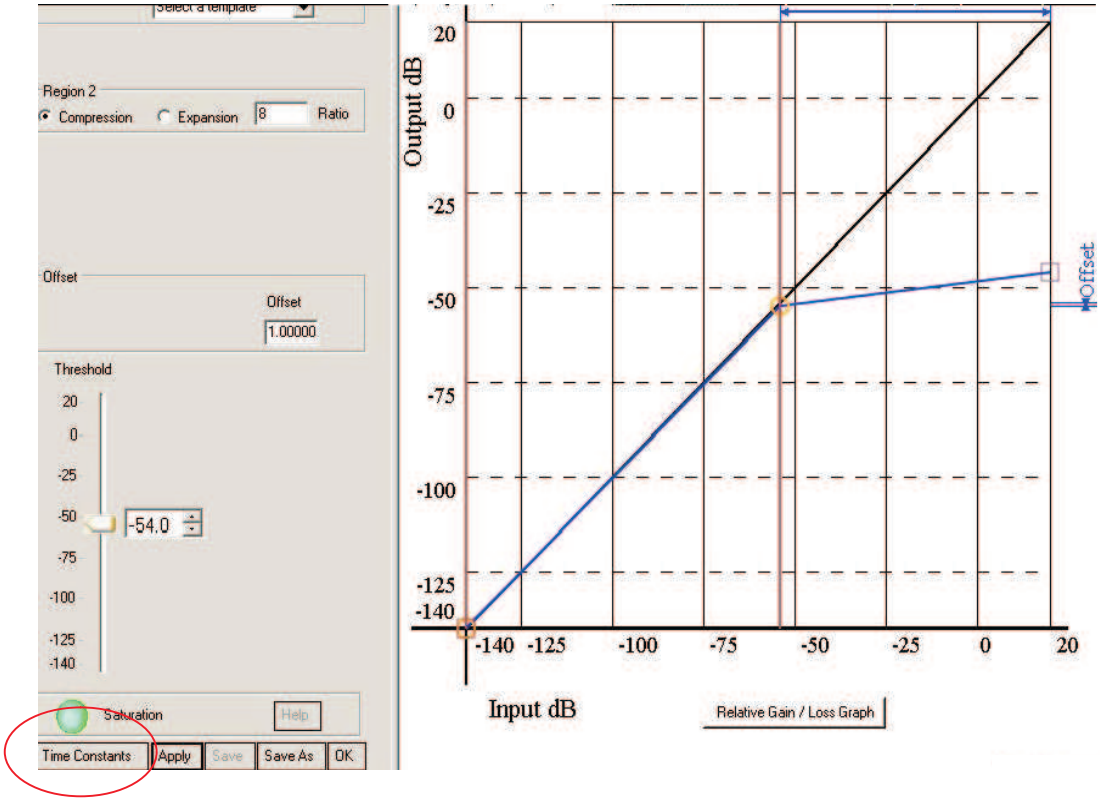


Figure 14. Time Constants Button

Time constants: Select the time constants to adjust the energy, attack, and decay filters (Figure 14).

3.5.1 MODULATION SCHEMES

Common Configurations:

1. 2 × BTL BD
2. 2 × BTL AD Mode

Note:

AD : AD Modulation-Outputs are 180° out of phase

BD : BD Modulation

BTL : Bridge-Tied Load

3.5.1.1 2 X BTL BD (BD mode)

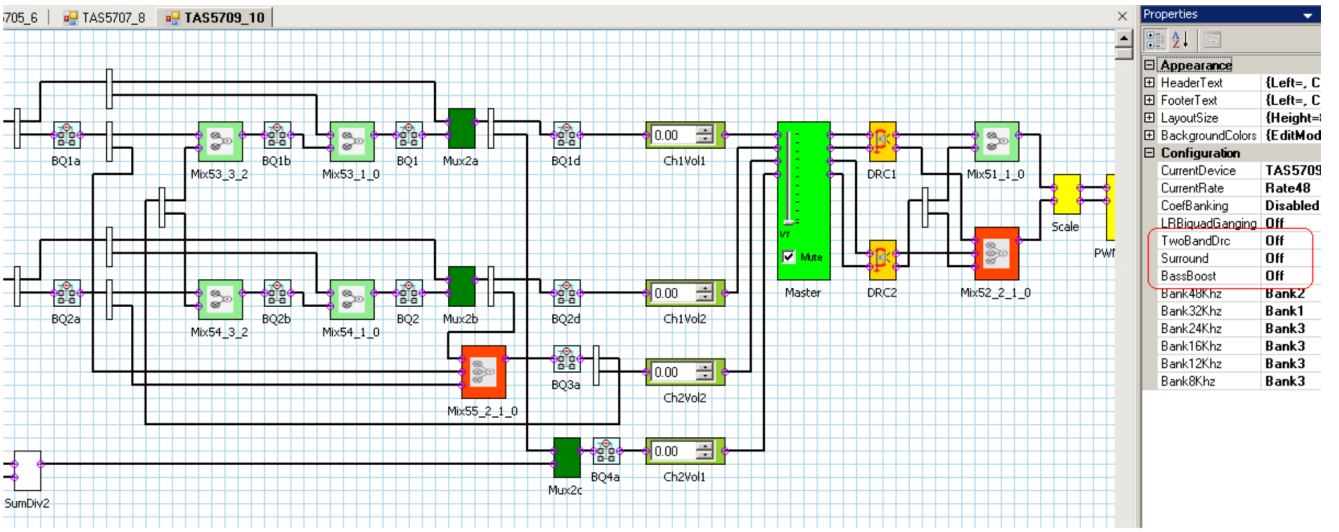
1. Set up the hardware.
2. Select the Input MUX from GDE. In the properties window, select BD Mode.
3. GDE: **Target > Connect**.
4. Finally uncheck the **shutdown** box to bring the device out of Shutdown mode, and adjust the **Master Volume** as desired.

3.5.1.2 2 X BTL AD(Default: AD mode)

1. Set up the hardware .
2. Select the Input MUX from GDE. In the properties window, select AD Mode
3. GDE: **Target > Connect**.
4. Finally uncheck the **shutdown** box to bring the device out of Shutdown mode, and adjust the **Master Volume** as desired.

4 Advanced Audio Processing Features in TAS5709

TAS5709 Process Structure as shown in GDE:



C001

TAS5709 process diagram has three audio processing functions in the main properties window:

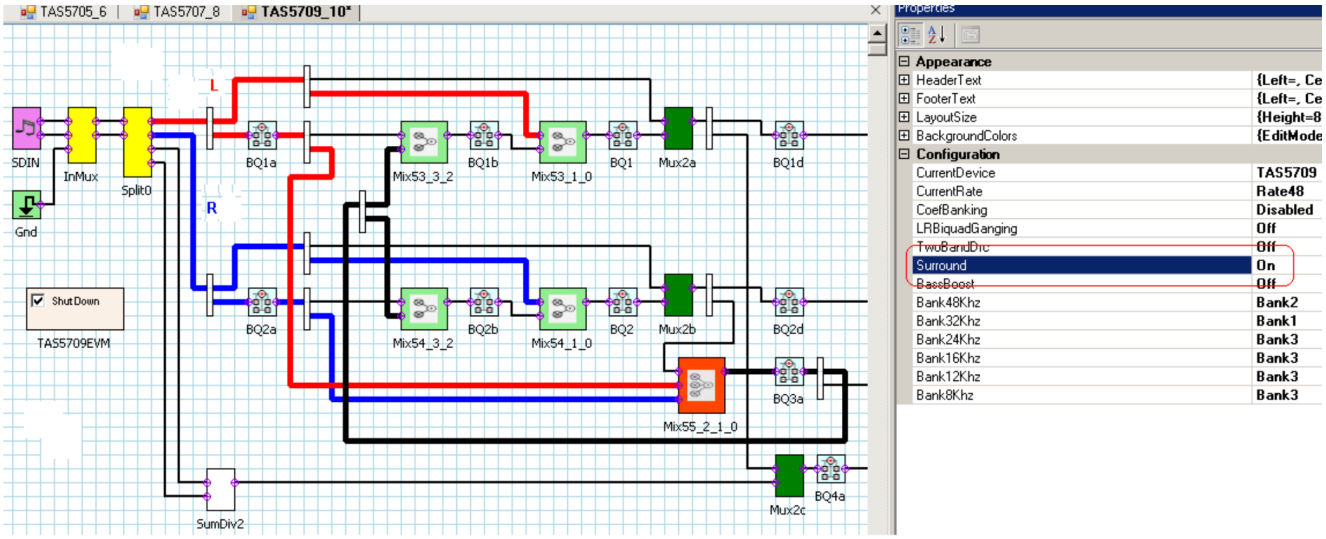
1. **Surround (3D): ON/OFF**

2. **Bass Boost (Pseudo Bass): ON/OFF**
3. **Two-Band DRC (2-band DRC): ON/OFF**

Each of these features are explained as follows:

1. **Surround (3D): ON/OFF**

   Turn it ON. Then L-R terms gets mixed with raw L and R after band-pass filtering. L-signal is RED, R-signal is BLUE and L-R-signal is BLACK.

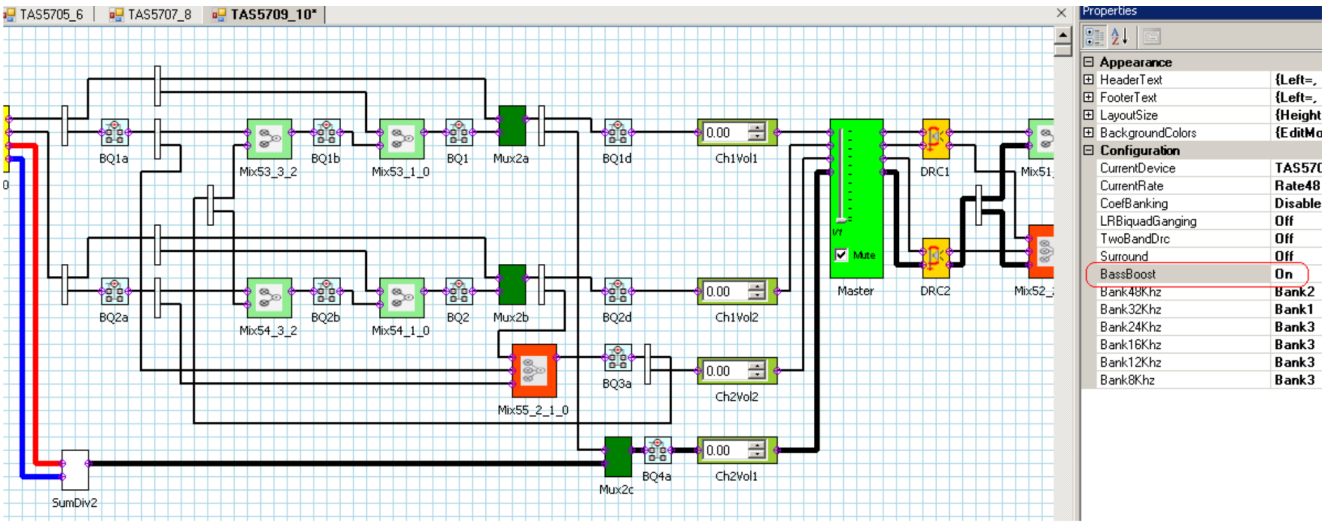


C002

   Biquads and mixers can be adjusted to fine-tune 3D.

2. **Bass Boost (Pseudo Bass): ON/OFF**

   (L+R)/2 signal is low-pass filtered to get the Bass signal and then applied a boost before mixing with L and R channels.

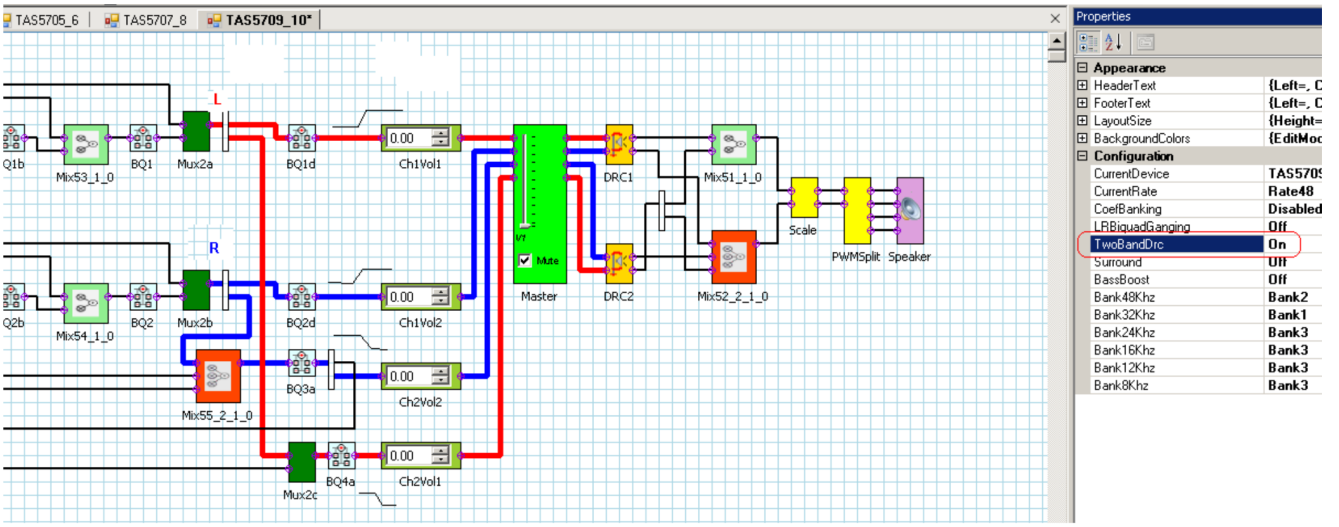


C003

3. **Two-Band DRC (2-band DRC): ON/OFF**

   L and R signals are split into two paths: one path with high-frequency components (high pass) and the other with low-frequency components (low pass).

   High frequency of both L and R has one DRC-ganged and low-frequency paths have another DRC-ganged. This allows both high- and low-frequency components to have different thresholds.



Both DRCs can be programmed separately.

5 Jumpers and Control Utilities on MC57xxPSIA board

5.1 RCA/OPTICAL Jumpers

Select the jumper to reflect the source whether it is RCA or OPTICAL.

5.2 Switches

Reset is an active-low function. Pressing the master reset switch (S2) resets the TAS5707/09 device; USB RESET (S1) resets the USB bus. Pressing PDNZ (S4) powers down the TAS5707/09, and pressing MUTE (S5) mutes (volume mute) the TAS5707/09.

5.3 LED Indicators

LED1 : USB Power connector installed at J1.

LED2 : 3.3V Power is valid.

LED3: RCA connection made

LED4: Optical connection made

LED5: SPDIF signal locked

LED6: FAULT (Not used with TAS5707/09EVM)

LED7: PDN switch (S4) is depressed.

LED8: MUTE switch (S5) is depressed.

6 Board Layouts, Bill of Materials, and Schematic

6.1 TAS5709EVM (TAS5707EVM) and MC57xxPSIA Board Layouts

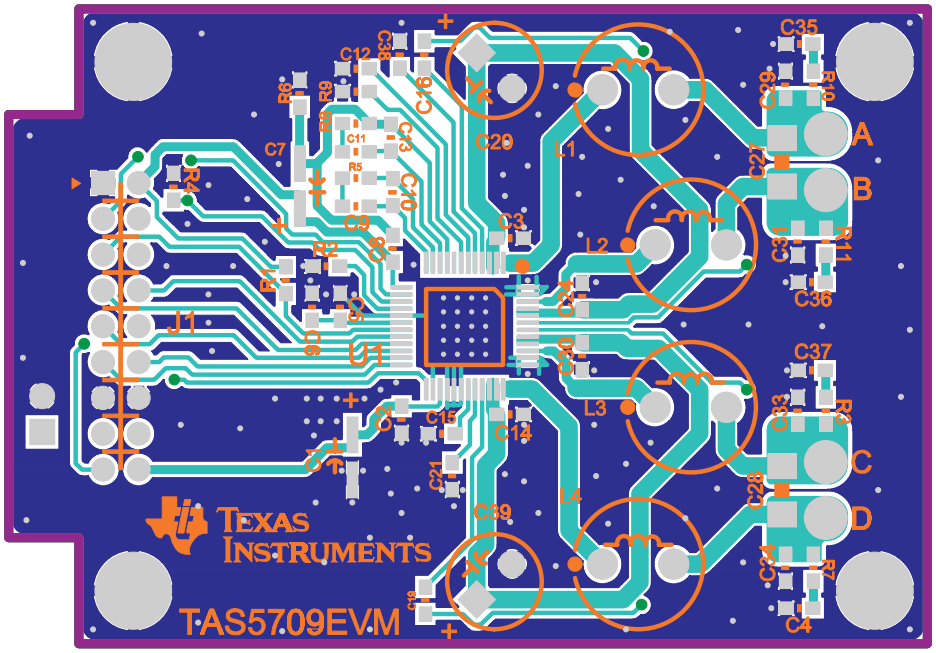


Figure 15. TAS5709EVM(TAS5707EVM) Top Composite Assembly

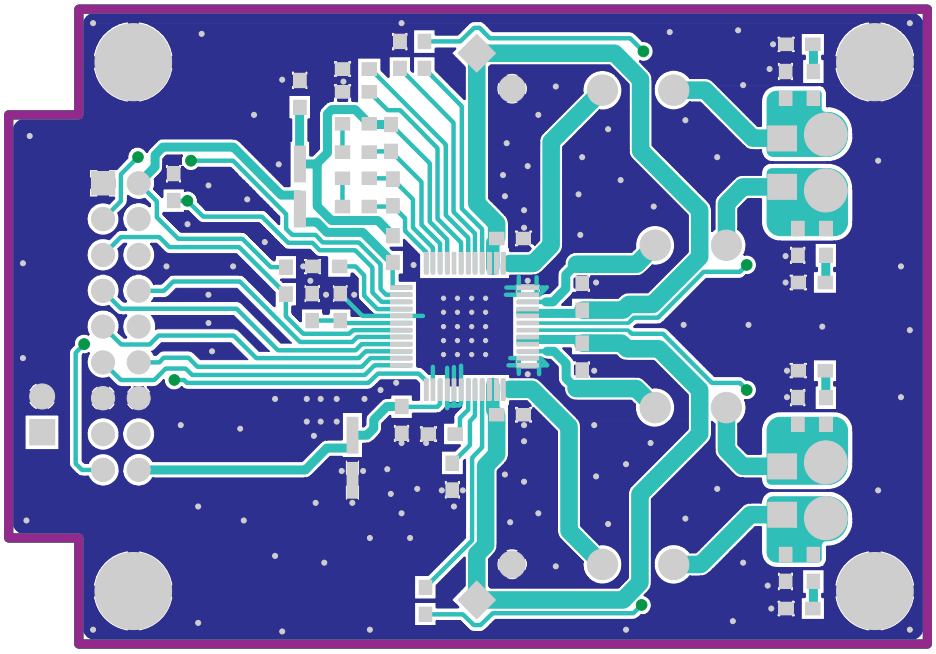


Figure 16. TAS5709EVM (TAS5707EVM) Top Copper Assembly

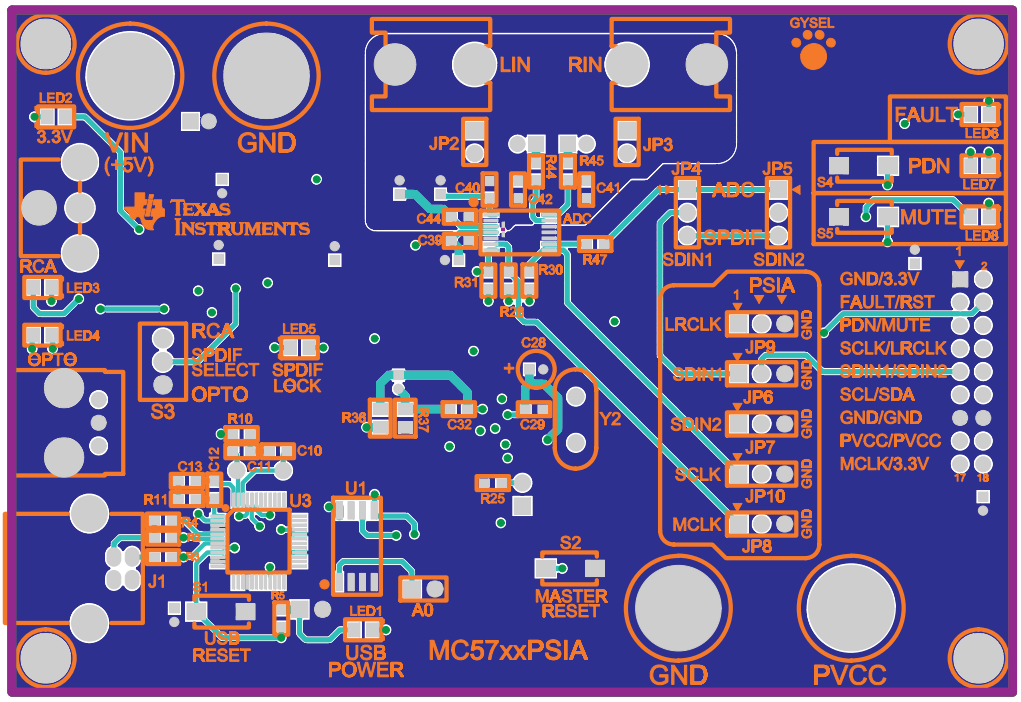


Figure 17. MC57xxPSIA Top Assembly

6.2 Bill of Materials

Table 2. Bill of Materials for TAS5709EVM

MANU Part No.	QTY	REF DES	Vendor Part No.	Description	Vendor	MANU
TI-SEMICONDUCTORS						
TAS5709PHP	1	U1	TAS5709PHP	15W DIGAMP PLUS EQ-DRC HTQFP48-PHP	Texas Instruments	Texas Instruments
CAPACITORS						
ECJ-1VB1H222K	1	C12	PCC1776CT	CAP 2200PFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1H472K	2	C10, C13	PCC1780CT	CAP 4700PFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1E103K	4	C4, C35–C37	PCC1763CT	CAP 0.01UFD 25V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1H333K	4	C16–C19	PCC2284CT	CAP 0.033UFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1C473K	2	C9, C11	PCC1758CT	CAP 0.047UFD 16V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1C104K	4	C2, C6, C8, C15	PCC1762CT	CAP 0.1UFD 16V CERM 0603 X7R	Digi-Key	Panasonic
GRM188R71H104KA93D	8	C3, C14, C24, C29– C31, C33, C34	490-1519-1	CAP 0.1UFD 50V CERM 0603 X7R	Digi-Key	Murata
C1206C684K5RACTU	2	C27, C28	399-3500-1	CAP 0.68UFD 50V CERM 1206 X7R ROHS	Digi-Key	Kemet
TMK107BJ105KA-T	2	C21, C38	587-1248-1	CAP 1.0UFD 25V CERM 0603 X5R ROHS	Digi-Key	Taiyo Yuden
C1608X5R0J475M	1	C5	445-1417-1	CAP 4.7UFD 6.3V CERM 0603 X5R	Digi-Key	TDK Corp.
ECE-V1CS100SR	2	C1, C7	PCE3061CT	CAP 10UFD 16V ALUM ELEC SMD VSA	Digi-Key	Panasonic
ECA-1VM101	1	C32	P10418TB	CAP 100UFD 35V RAD ALUM ELEC M	Digi-Key	Panasonic
ECA-1VM221BJ	2	C20, C39	P10419TB	CAP 220UFD 35V ALUM ELEC M-SERIES ROHS	Digi-Key	Panasonic
RESISTORS						
ERJ-3GEY0R00V	1	R6	P0.0GCT	RES 0.0 OHM 1/16W 5% SMD 0603	Digi-Key	Panasonic
9C06031A3R30JLHFT	4	R3, R7, R10, R11	311-3.3GCT	RES 3.3 OHM 1/16W 5% SMD 0603	Digi-Key	Yageo
ERJ-3GEYJ471V	2	R5, R8	P470GCT	RES 470 OHM 1/10W 5% SMD 0603	Digi-Key	Panasonic
9C06031A1002JLHFT	2	R1, R4	311-10KGCT	RES 10K OHM 1/16W 5% SMD 0603	Digi-Key	Panasonic
9C06031A1822FKHFT	1	R2	311-18.2KHCT	RES 18.2K OHM 1/10W 1% SMD 0603	Digi-Key	Yageo
ERJ-3EKF2212V	1	R9	P22.1KHCT	RES 22.1K OHM 1/16W 1% SMD 0603	Digi-Key	Panasonic
INDUCTORS						
A7503AY-150M	4	L1–L4	A7503AY-150M	INDUCTOR, SERIES 11RHBP, 15UH	Toko America	Toko America
HEADERS						
B2PS-VH	2	J2, J3	455-1255	Header, 2 Pin Male, PCB-RA, TIN, W/Lock	Digi-Key	JST
PBC09DAAN	1	J1	S2011E-09	HEADER, 2X9 PIN MALE, PCB STRAIGHT GOLD ROHS	Digi-Key	Sullins
STANDOFFS AND HARDWARE						
PMS 440 0025 PH	4	HW1-HW4	H342	4-40 Screw, Steel 0.250 IN	Digi-Key	Building Fasteners
2027	4	HW1-HW4	2027K	StandofF,4-40,0.5INx3/16IN, ALUM RND F-F	Digi-Key	Keystone Electronics
Component Count:	62					
COMPONENTS NOT ASSEMBLED						
C32						
COMPONENTS MISSING FROM SEQUENCE						
C22, C23, C25, C26						

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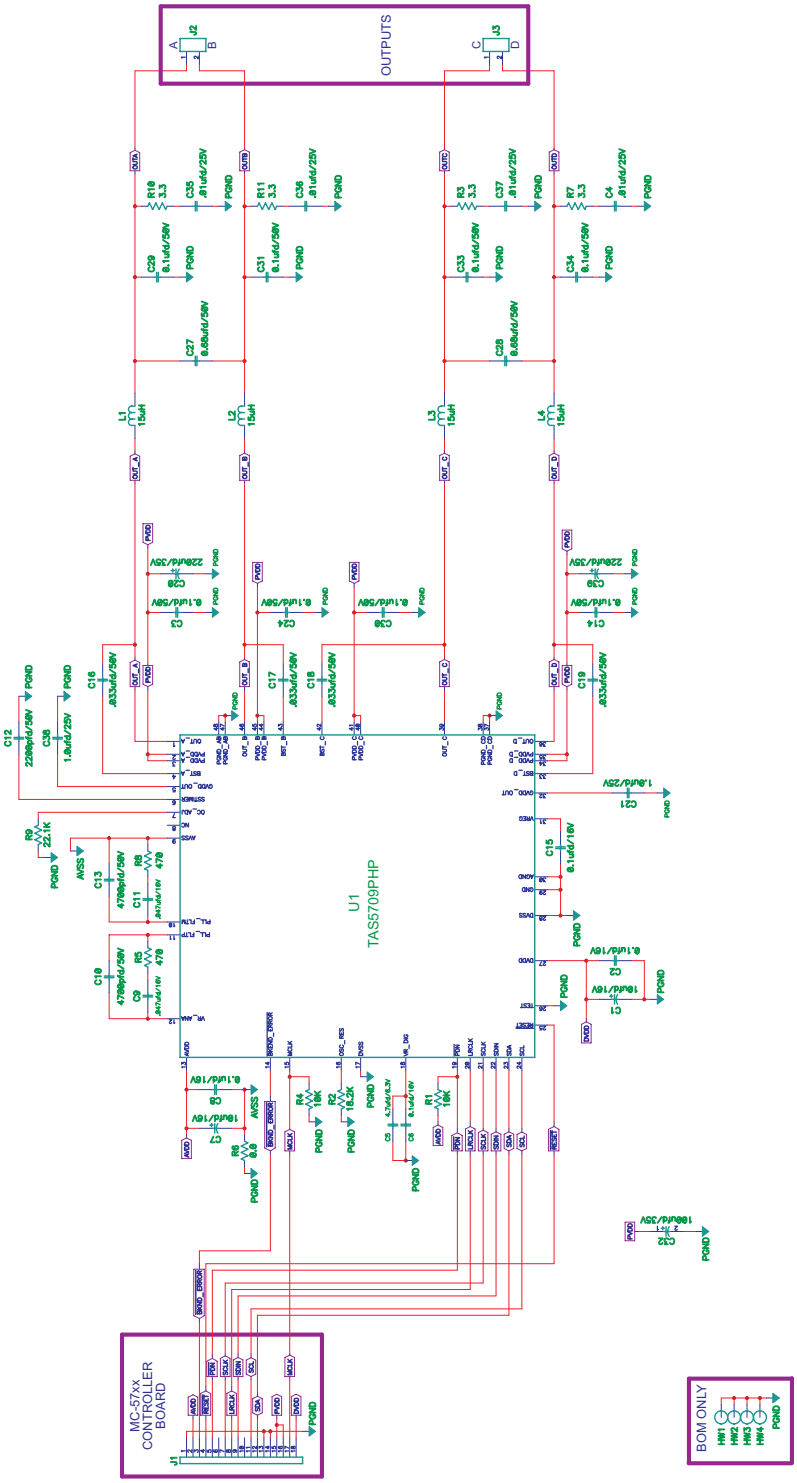
TAS5707PHP	1	U1	TAS5707PHP	15W DIGAMP PLUS EQ-DRC HTQFP48-PHP	Texas Instruments	Texas Instruments
CAPACITORS						
ECJ-1VB1H222K	1	C12	PCC1776CT	CAP 2200PFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1H472K	2	C10, C13	PCC1780CT	CAP 4700PFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1E103K	4	C4, C35–C37	PCC1763CT	CAP 0.01UFD 25V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1H333K	4	C16–C19	PCC2284CT	CAP 0.033UFD 50V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1C473K	2	C9, C11	PCC1758CT	CAP 0.047UFD 16V CERM 0603 X7R	Digi-Key	Panasonic
ECJ-1VB1C104K	4	C2, C6, C8, C15	PCC1762CT	CAP 0.1UFD 16V CERM 0603 X7R	Digi-Key	Panasonic
GRM188R71H104KA93D	8	C3, C14, C24, C29– C31, C33, C34	490-1519-1	CAP 0.1UFD 50V CERM 0603 X7R	Digi-Key	Murata
C1206C684K5RACTU	2	C27, C28	399-3500-1	CAP 0.68UFD 50V CERM 1206 X7R ROHS	Digi-Key	Kemet
TMK107BJ105KA-T	2	C21, C38	587-1248-1	CAP 1.0UFD 25V CERM 0603 X5R ROHS	Digi-Key	Taiyo Yuden
C1608X5R0J475M	1	C5	445-1417-1	CAP 4.7UFD 6.3V CERM 0603 X5R	Digi-Key	TDK Corp.
ECE-V1CS100SR	2	C1, C7	PCE3061CT	CAP 10UFD 16V ALUM ELEC SMD VSA	Digi-Key	Panasonic
ECA-1VM101	1	C32	P10418TB	CAP 100UFD 35V RAD ALUM ELEC M	Digi-Key	Panasonic
ECA-1VM221BJ	2	C20, C39	P10419TB	CAP 220UFD 35V ALUM ELEC M-SERIES ROHS	Digi-Key	Panasonic
RESISTORS						
ERJ-3GEY0R00V	1	R6	P0.0GCT	RES 0.0 OHM 1/16W 5% SMD 0603	Digi-Key	Panasonic
9C06031A3R30JLHFT	4	R3, R7, R10, R11	311-3.3GCT	RES 3.3 OHM 1/16W 5% SMD 0603	Digi-Key	Yageo
ERJ-3GEYJ471V	2	R5, R8	P470GCT	RES 470 OHM 1/10W 5% SMD 0603	Digi-Key	Panasonic
9C06031A1002JLHFT	2	R1, R4	311-10KGCT	RES 10K OHM 1/16W 5% SMD 0603	Digi-Key	Panasonic
9C06031A1822FKHFT	1	R2	311-18.2KHCT	RES 18.2K OHM 1/10W 1% SMD 0603	Digi-Key	Yageo
ERJ-3EKF2212V	1	R9	P22.1KHCT	RES 22.1K OHM 1/16W 1% SMD 0603	Digi-Key	Panasonic
INDUCTORS						
A7503AY-150M	4	L1–L4	A7503AY-150M	INDUCTOR, SERIES 11RHBP, 15UH	Toko America	Toko America
HEADERS						
B2PS-VH	2	J2, J3	455-1255	Header, 2 Pin Male, PCB-RA, TIN, W/Lock	Digi-Key	JST
PBC09DAAN	1	J1	S2011E-09	HEADER, 2X9 PIN MALE, PCB STRAIGHT GOLD ROHS	Digi-Key	Sullins
STANDOFFS AND HARDWARE						
PMS 440 0025 PH	4	HW1-HW4	H342	4-40 Screw, Steel 0.250 IN	Digi-Key	Building Fasteners
2027	4	HW1-HW4	2027K	StandofF,4-40,0.5INx3/16IN, ALUM RND F-F	Digi-Key	Keystone Electronics
Component Count:	62					
COMPONENTS NOT ASSEMBLED						
C32						
COMPONENTS MISSING FROM SEQUENCE						
C22, C23, C25, C26						

6.3 Schematics

The schematic for TAS5709EVM (TAS5707EVM) follows. The schematics for MC57xxPSIA appear on the following pages.



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It is important to operate this EVM within the input voltage range of -0.5 V to 4.1 V and the output voltage range of 1 Vrms.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 85°C. The EVM is designed to operate properly with certain components above 85°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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