LM4935 I2C/SPI INTERFACE SOFTWARE MANUAL v1.4

National Semiconductor Audio

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INTRODUCTION:

The LM4935 Software provides easy read/write access to the data registers of the LM4935 audio subsystem through an I2C/SPI control interface. This manual will provide instruction on how to use this software with the LM4935 Demoboard and associating USB interface card. Furthermore, examples will be provided on using the software to program the headphone and high efficiency loudspeaker outputs, setting the PLL, and other features of the LM4935 audio subsystem.

INSTALLATION:

The LM4935 software is built on a new Microsoft® .NET Framework. It may require that *Microsoft® .NET Framework Software Development Kit (SDK) version 1.1* be installed in your computer, which is downloadable through the Microsoft® website[1]. The LM4935 software setup file will automatically install *Microsoft® .NET Framework Software Development Kit (SDK) version 1.1* if your PC requires it. An internet connection is not required since *Microsoft® .NET Framework Software Development Kit (SDK) version 1.1* is already included in the LM4935 software package. Installation of the SDK may take a few minutes. Once that is completed the rest of the installation process is fast.

The following steps should be followed:

Step 1: Uninstall any previous version, if any, from Control Panel/Add Remove Program/ LM4935 I2C SPI interface.

Step 2: Unzip the LM4935 software.

Step 3: Run the Setup.exe file.

Step 4: The LM4935.exe file will be installed to your desktop as well as the folder you specified during the installation process.

Step 5: Please make sure that the LM4935 Demoboard and USB Interface Card are properly connected to your PC and that proper power is applied to the LM4935 Demoboard. Please refer to the LM4935 Evaluation Package Instructions for details on how to accomplish this.

Step 6: Run the LM4935.exe file. The LM4935 software will run properly ONLY if Step 5 is completed.

OVERVIEW:

The LM4935 Software is divided up into three main sections: Menu Bar, Tabs Control, and Status Register and Bar. (please refer to Figure 1)

1) The Menu Bar contains File, Control, Settings and Help Options:

File: Exits program
Control: Switches between **I2C** and **SPI** mode. Switching between I2C and SPI will initialize all of the data registers back to their default settings of zero.
Settings: Sets the USB interface board's regulated output voltage to **3V** or **3.8V**. The **Disable Polling** option can be activated to disable continuous polling on the I2C/SPI interface bus. Continuous polling is desirable whenever constant feedback from the Status Register or the SAR is required. Enabling the **Disable Polling** option increases the efficiency of the LM4935 software program. Note: If **Disable Polling** is activated the Status Register can still be read in by clicking the **Read** button located in the Status Register section.
Help: Contains the **About** box, which can be used to check Version number of the software.

2) Tabs Controls are further divided up to following:

Basic: Contains the main functionality of the LM4935 chip.
Interface: Contains I2S and PCM options.
AGC: Contains Automatic Gain Control settings.
PLL: Contains PLL control settings.
SAR: Provides SAR options and triggering capability.
Advanced: Provides read/write access to any register using brute force.

3) The Status Register and Bar provide feedback on the communication status between the USB interface card/LM4935 Demoboard to the LM4935 software. The Status Bar has useful messages that provide feedback on the communication status of the I2C/SPI control interface.

Status Messages (please refer to Figure 1):
1) If there is a proper connection between the PC and the LM4935 Demoboard/USB interface card, the message 'USB Connected' will appear. If there is no proper connection than 'USB I/O error' will appear.
2) For I2C mode, an 'All ACK' message indicates a successful I2C read/write, an 'I2C ACK missing' message indicates. For SPI mode the message 'SPI Mode' appears.

3) Shows two hex numbers. The first number shows the data register address (0x3h) and the second number shows the data byte (0x00h). (Figure1)

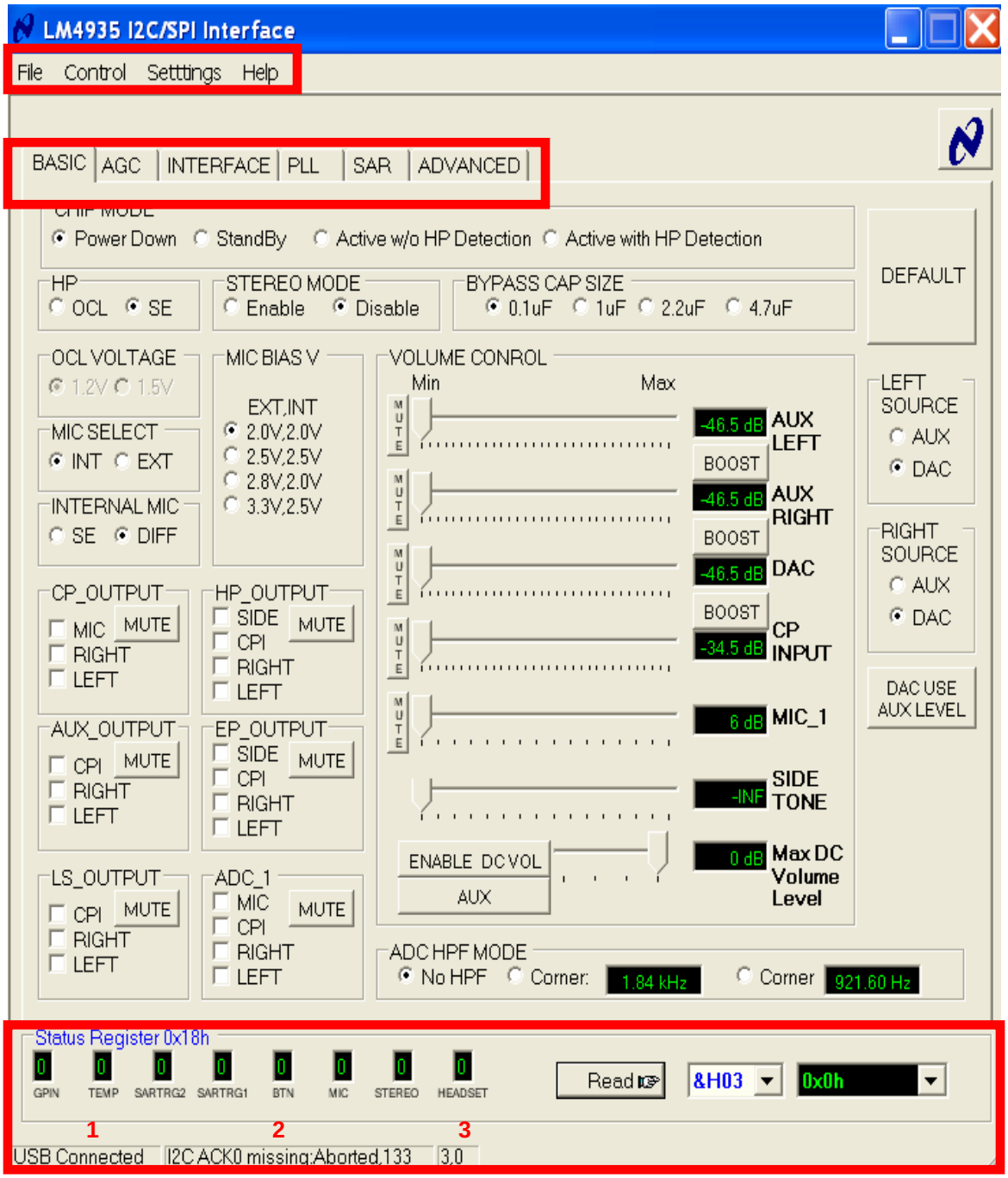


Figure 1: A main View of LM4935 Software (BASIC tab).

DEFAULT BUTTON:

Pressing this button will reset the software back to its default state and will initialize all of the data registers back to their default setting of zero.

BASIC TAB:

i) BASIC OPERATIONS:

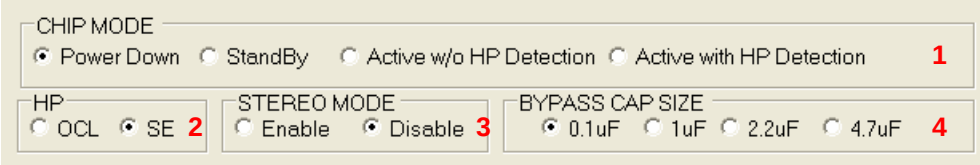


Figure 2: Basic operations

Register (BASIC 0x00h)
1) The LM4935 can be placed in one of four modes which dictate its basic operation.
2) The headphone amplifier can be set to **OCL** or **SE** Mode. Please make sure that the position of the OCL/SE switch (Y3) on the demoboard corresponds to the HP setting on the software.
3) Enabling the **Stereo** Mode (bit 6 of register 0x00h) reduces the gain of the Left and Right signal by 6dB to allow enough headroom for them to be summed. This may be useful when summing both the Left and Right audio signal to a mono output like the earpiece or loudspeaker.
4) Programs the turn-on time of the LM4935 to accommodate the size of the bypass capacitor, C_{20}.

ii) OUTPUT OPERATIONS:

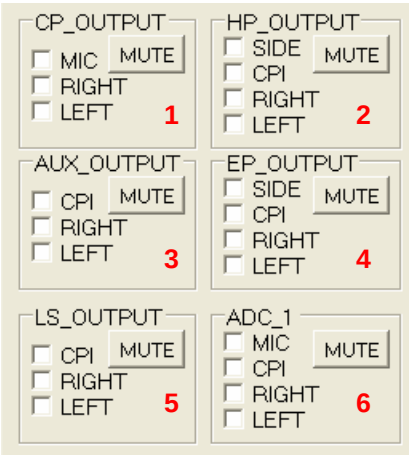


Figure 3: LM4935 outputs

1) CP_OUTPUT: (Register 0x12h). The Microphone, Left, and/or Right inputs can be mixed to the Cell Phone Output by checking the corresponding box(es). Enabling the mute will mute all the inputs.

2) HP_OUTPUT: (Register 0x15h). The Sidetone, Cell Phone, Left, and/or Right inputs can be mixed to the stereo Headphone Output by checking the corresponding box(es). Enabling the mute will mute all the inputs.

3) AUX_OUTPUT: (Register 0x13h). The Cell Phone, Left, and/or Right inputs can be mixed to the Auxiliary Output by checking the corresponding box(es). Enabling the mute will mute all the inputs.

4) EP_OUTPUT: (Register 0x16h). The Sidetone, Cell Phone, Left, and/or Right inputs can be mixed to the Earpiece Output by checking the corresponding box(es). Enabling the mute will mute all the inputs.

5) LS_OUTPUT: (Register 0x14h). The Cell Phone, Left, and/or Right inputs can be mixed to the Loudspeaker Output by checking the corresponding box(es). Enabling the mute will mute all the inputs.

6) ADC_1: (Register 0x06h). The Microphone, Cell Phone, Left, and/or Right inputs can be mixed to the input of the ADC by checking the corresponding box(es). Enabling the mute will mute all the inputs.

iii) VOLUME CONTROL AND GAIN OPERATIONS:

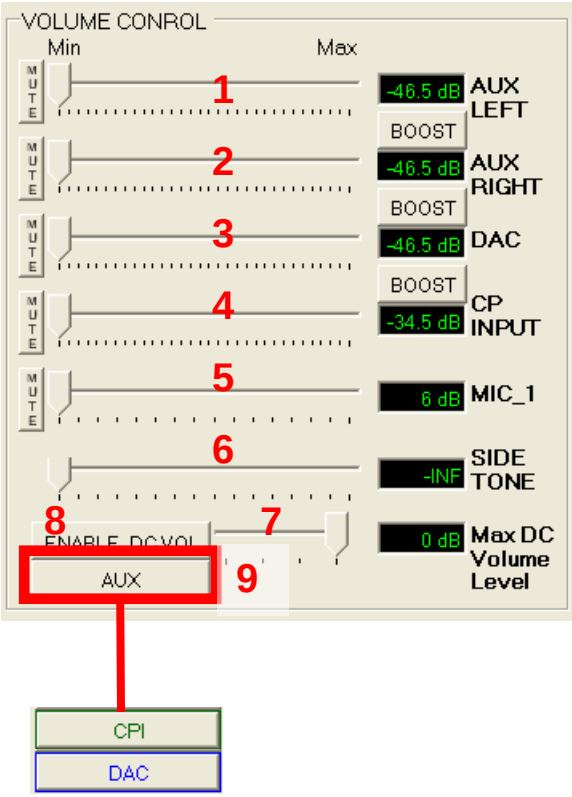


Figure 4:

1) AUX LEFT (0x0Fh). Controls the volume of the AUX Left analog input. Activating **BOOST** increases the gain by 12dB. Enabling **MUTE** will mute the AUX Left analog input.
2) AUX RIGHT (0x10h). Controls the volume of the AUX Right analog input. Activating **BOOST** increases the gain by 12dB. Enabling **MUTE** will mute the AUX Right analog input.
3) DAC (0x11h). Controls the level of the DAC Output. Activating **BOOST** increases the gain by 12dB. Enabling **MUTE** will mute the output of the DAC.
4) CP_INPUT (0x0Eh) Controls the volume of the Cell Phone analog input. Enabling **MUTE** will mute the Cell Phone analog input.
5) MIC_1 (0x0Bh) Controls the volume of the Cell Phone analog input. Enabling **MUTE** will mute the Cell Phone input.

6) SIDETONE (0x0Dh) Controls the analog sidetone volume.

7) Max DC Volume Level (0x21h) This sets the maximum attainable level of the DC Volume Control.

8) ENABLE DCVOL (0x21h) This enables the DC Volume control of the LM4935.

9) You can select which volume control (AUX/DAC or CPI) is altered by the DC Volume Control. Click on the AUX button once to get CPI, click twice to get DAC.

iii) AUX/DAC INPUT SOURCES

Figure 5:

1) If AUX is selected then AUX input is passed to the mixer, the default is for the DAC output to be passed to the mixer.

2) If DAC USE AUX LEVEL is enabled then the gain of the DAC inputs is controlled by the AUX_LEFT and AUX_RIGHT registers, allowing a stereo balance to be applied.

Figure 6:

3) ADC_1 HPF_MODE (0x06h). Sets the high pass filter of the ADC. The corner frequencies are computed as followed:

Corner 1 = ((sample rate of ADC) * 3 / 80)

Corner 2 = (Corner 1) / 2

*Please refer to more info on the datasheet ADC_1 (0x06)

PLL TAB:

This tab programs the settings of the Phase Lock Loop (PLL).

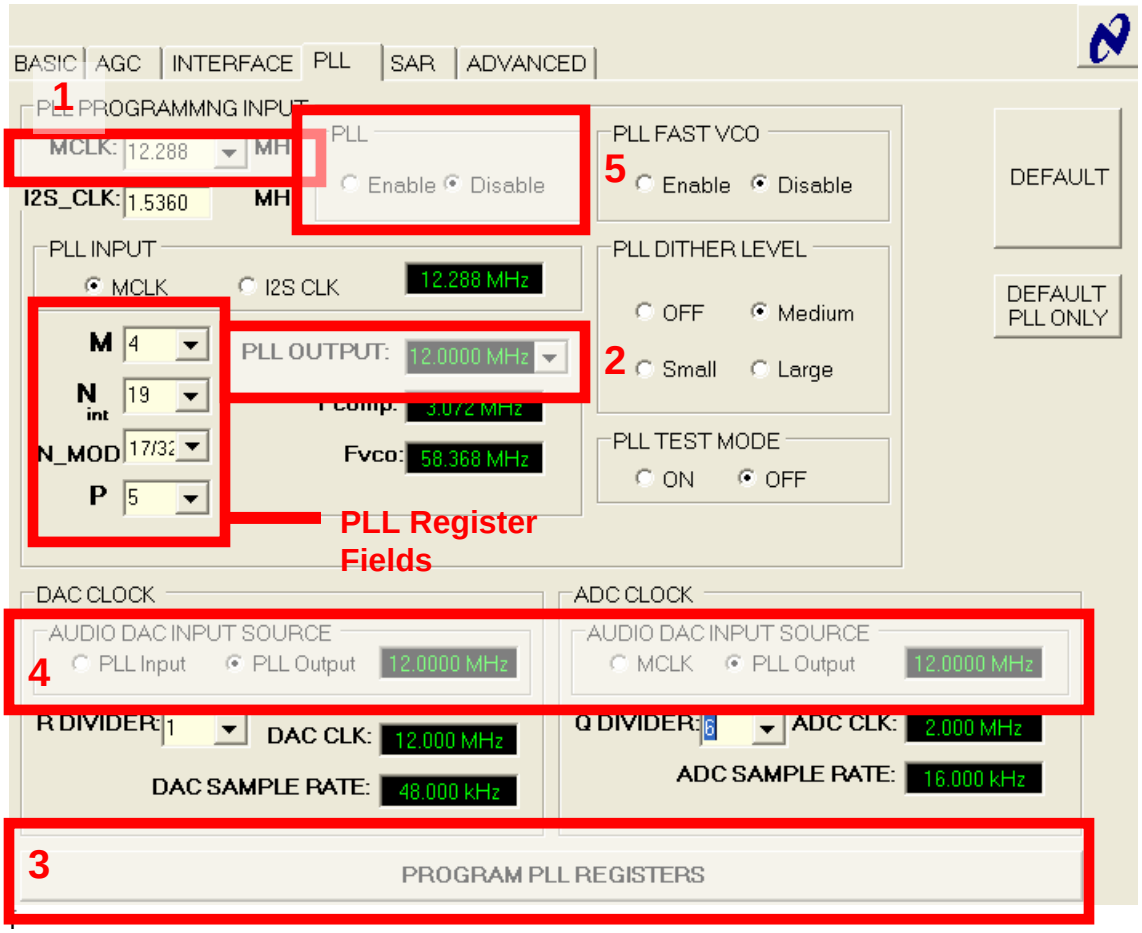
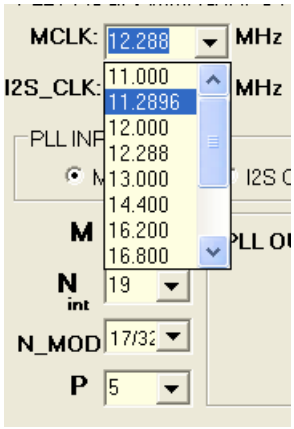


Figure 7: PLL TAB

i) MCLK Drop Down Menu Mode



1)In the drop down combo box of MCLK (which is based on common system clock values) the user can select from a list of pre-programmed MCLK inputs. Based on the value of MCLK that is chosen from the drop down menu, the LM4935 software will automatically update the M, N, N_MOD and P values according to the MCLK input value and the frequency of the PLL OUTPUT will be calculated in real time. The LM4935 runs optimally with a PLL OUTPUT of 12 MHz or 11.025 MHz.

2)In the PLL_OUTPUT drop down combo box, a 12 MHz (Fs = 48kHz) or 11.0250 MHz (Fs = 44.1kHz) target value can be selected and again the M, N, N_MOD and P values will be calculated based on the value chosen in the PLL OUTPUT and MCLK drop down combo boxes.

3)The **Program PLL Registers** button should be clicked after the correct PLL register fields have been set.

Figure 8: MCLK Dropdown

4)The audio DAC and ADC input sources must be set for PLL OUTPUT if the PLL is to be used.

5)The PLL must then be enabled.

ii) User Defined MCLK or I2S CLK Mode

The user can also choose their own MCLK or I2S CLK value by simply entering that value into the corresponding input field. The M, N, N_MOD and P values are not automatically updated as they were when using the MCLK Drop Down Menu Mode. The M, N, N_MOD and P should be adjusted manually by the user to achieve a PLL OUTPUT calculated value of 12 MHz (Fs = 48kHz) or 11.0250 MHz (Fs = 44.1kHz). The only time that the M, N, N_MOD and P values are automatically calculated is when MCLK is chosen from the pre-programmed list of values on the drop down menu for MCLK.

SAR TAB:

This Tab programs the SAR ADC and its triggers.

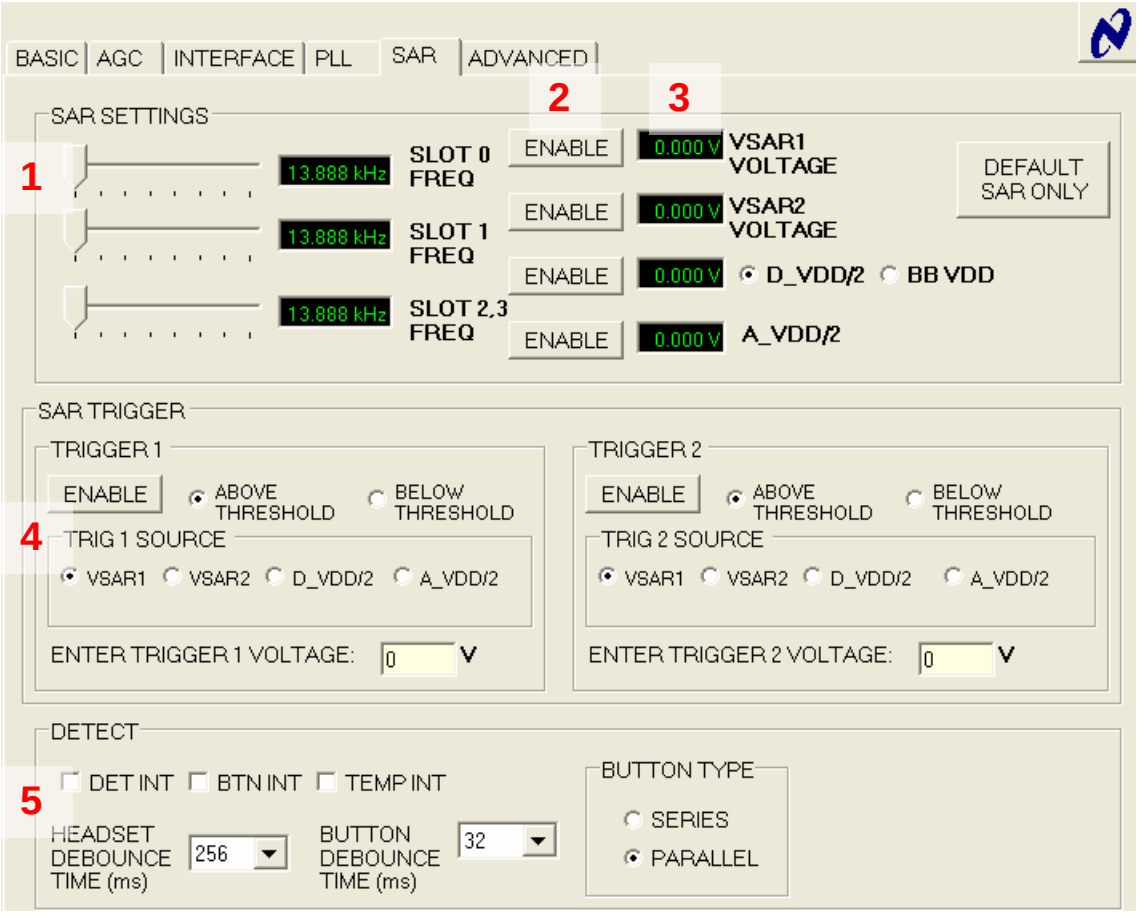


Figure 9: SAR TAB

1) The sample rate for each SAR channel can be adjusted through these slider controls.

2) The **ENABLE** buttons activate the corresponding SAR channel.

3) The output of the 4 SAR data registers are converted into voltage by the LM4935 software. The maximum voltage that can be displayed is 2.5V since the SAR data resolution is only 8 bits per channel.

4) The SAR Trigger option is used for triggering the IRQ pin based specific condition. Users specify their own Trigger 1 and Trigger 2 Voltage. The maximum trigger voltage is 2.5V. Once the trigger condition is met then SARTRIG1 and/or SARTRIG2 is set on the Status Register if Trigger 1 and/or Trigger 2 is enabled.

5) DETECT (0x17h) is programmed through the bottom portion of SAR TAB. Please refer to datasheet for more information.

INTERFACE TAB:

The Interface Tab controls the I2S / PCM interfaces and the GPIO pins. Please refer to GPIO Configuration Register (0x1Ah) and Audio Interface Configuration Register (0x19h) in datasheet for further detail.

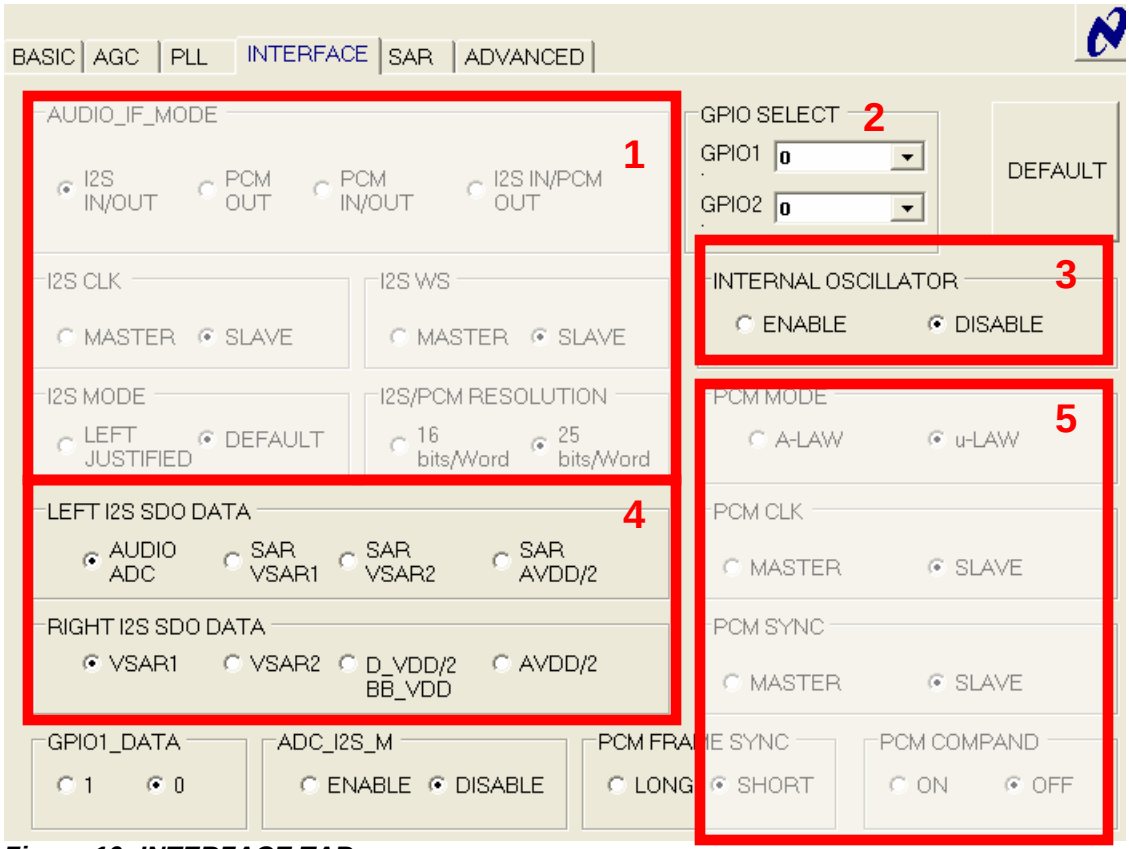


Figure 10: INTERFACE TAB

1) The I2S/PCM audio data interface can be adjusted through these settings.

2) GPIO SELECT can be used to configure the GPIO pins of the LM4935. GPIO1 can be programmed as either READABLE, LS_AMP_ENABLE, GPIO_DATA or ZERO and GPIO2 could programmed as either SPI_SDO or SAR_SDO. Please refer to GPIO configuration register (0x1A) in datasheet for further detail. Both GPIO1 and GPIO2 pull down menus have to be set in order to properly program the GPIOs.

3) The Internal On-Chip Oscillator can be enabled or disabled through these settings. The Internal On-Chip Oscillator should be enabled in applications where the LM4935 uses its analog audio inputs only.

4) The LEFT and/or RIGHT words of I2S SDO DATA can be configured to read back data from the SAR or ADC.

5) The PCM audio data interface can be adjusted through these settings.

AGC TAB:

The Automatic Gain Control is programmed in this tab.

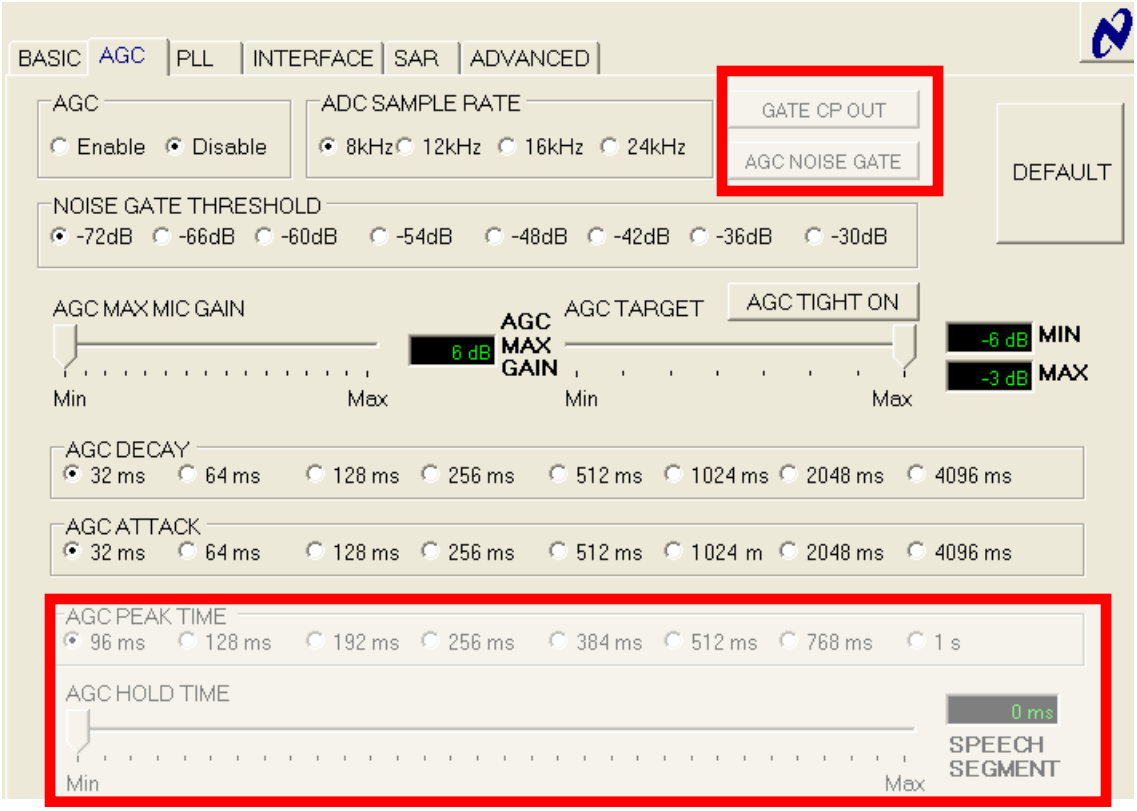
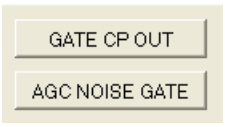
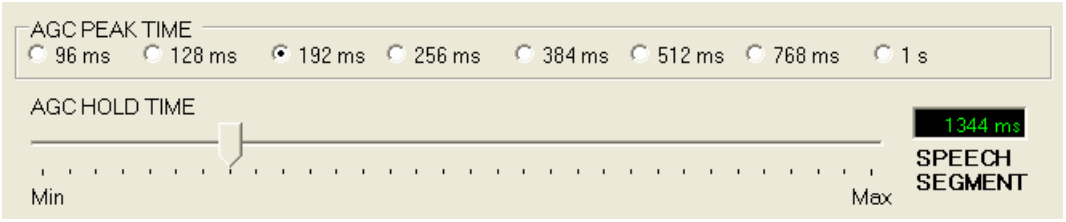


Figure 11: AGC TAB:



GATE CP OUT: If enabled and AGC noise is enabled, the MIC to CPO path will be gated if the signal is determined to be noise.
AGC NOISE GATE: If enabled, signals below the noise gate threshold are muted; the noise gate is only activated after a set period of signal absence.



AGC PEAK TIME AND AGC HOLD TIME options are provided by LM4935 Software.
SPEECH SEGMENT is calculated by:

(AGC PEAK TIME) x (AGC HOLD TIME) = SPEECH SEGMENT

Others AGC Options are following:

1) AGC Enable or Disable

2) AGC MAX MIC GAIN

3) AGC TARGET with AGC TIGHT button

4) ADC SAMPLE RATE

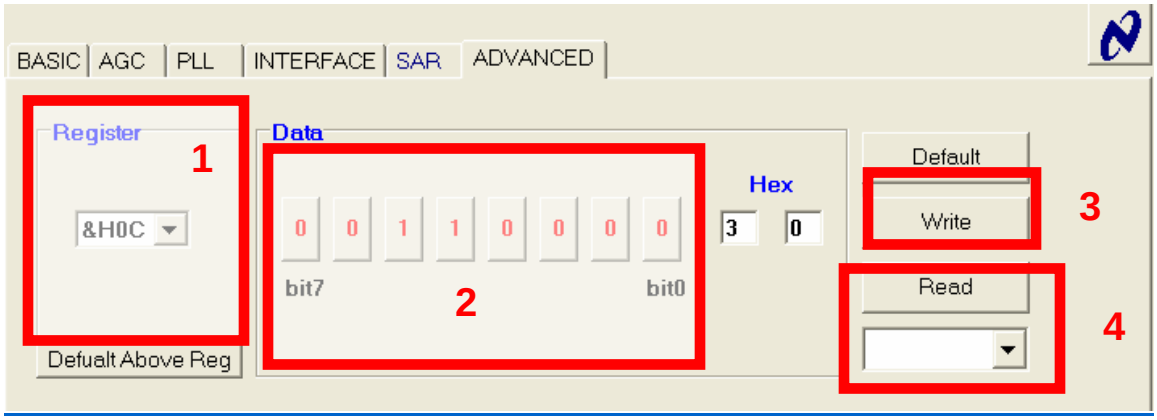
5) AGC DECAY

6) AGC ATTACK

Please refer to the AGC_1 (0x08h), AGC_2 (0x09h), AGC_3 (0x0Ah) register pages in the datasheet for further detail.

ADVANCED TAB:

This tab allows the user to directly program a specific data register of their choosing. This tab is useful for system debug.



1) This drop down menu allows the user to select a specific data register to read/write to.

2) This row of 8 buttons sets the bit7 to bit0 data of the specified register. Each button press will trigger an I2C/SPI write.

3) This will write the current data field to the specified register.

4) Pressing the Read button will read the contents of the specified data register into the text box below the button.

COMMON CONFIGURATIONS:

The following examples will provide a simple walk through to run LM4935 software. Proper connection between the LM4935 Demoboard/USB Interface Card and PC is required. The LM4935 Demoboard must be properly powered on.

Setting up the Headphone and High Efficiency Loudspeaker Mode (Analog Input):

a) A stereo input source should be connected to the AUX_LEFT and AUX_RIGHT inputs of the LM4935 demoboard.
b) A Loudspeaker and a headset should be connected the LM4935 demoboard.

i) Using Analog AUX inputs and Internal on chip oscillator

Hit the default Button on the BASIC Tab.

1) From the INTERFACE TAB Enable the Internal Oscillator.

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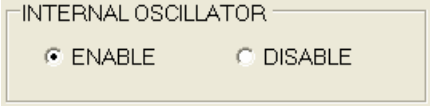
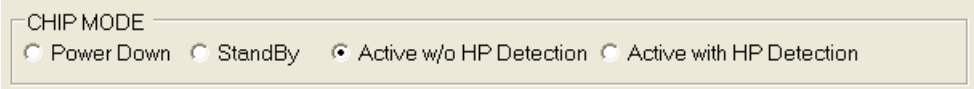
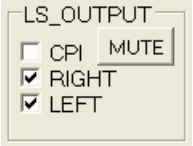
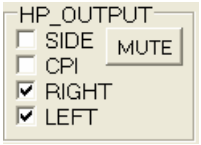


2) Bring Part to Active w/o HP Detect on BASIC TAB



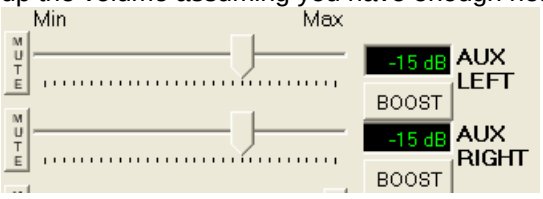
3) Check RIGHT AND LEFT on LS_OUTPUT and HP_OUTPUT on BASIC TAB





4) Since DAC is bypassed in Analog inputs use LEFT AND RIGHT SOURCE TO AUX MODE ON BASIC TAB,

5) Turn up the volume level for AUX LEFT AND RIGHT on BASIC TAB, you can hit boost for gain up the volume assuming you have enough headroom.



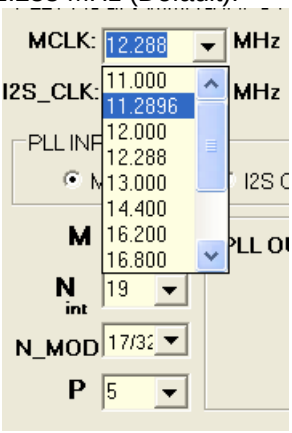
ii) Using the S/PDIF Input and MCLK from the S/PDIF Receiver

a) S11 of the LM4935 Demoboard should be closed.
b) Switch Y2 of the Demoboard should be placed in the 'int I2S' position.
c) An S/PDIF input signal should be connected to either the Optical or Coax input of the LM4935 Demoboard.
d) Switch S12 on the LM4935 Demoboard should correspond to the S/PDIF input being used.
e) S18 should be placed in the 'S/PDIF Receiver Master' position.
f) At this point the S13 'S/PDIF Receiver RESET' button should be pressed.
g) Loudspeaker and a headset should be connected the LM4935 Demoboard.

Hit the default Button on the BASIC Tab.

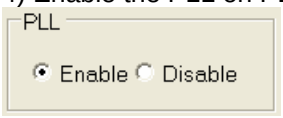
1) Click on PLL TAB

2) If using CD audio source, use 11.2896 MHz for MCLK. If running audio from a DVD then use 12.288 MHz (Default).

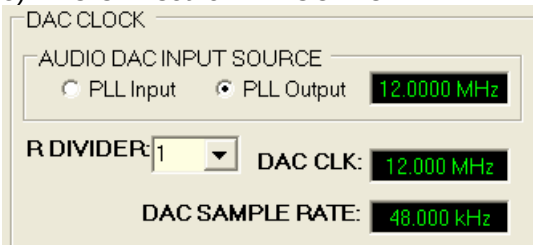


3) Program the PLL by hit the 'Program PLL REGISTERS' button.

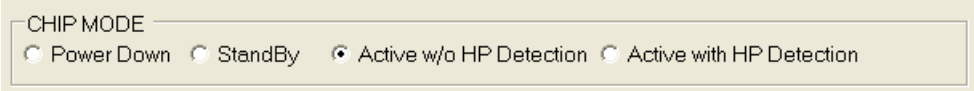
4) Enable the PLL on PLL TAB.



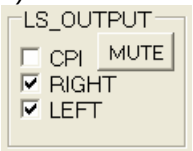
5) DAC CLK set for PLL OUTPUT

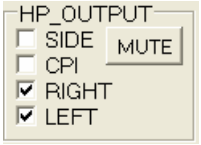


6) Bring Part to Active w/o HP Detect on BASIC TAB

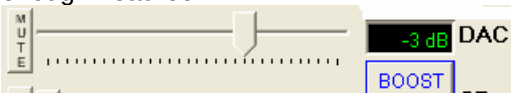


7) Check RIGHT and LEFT on LS_OUTPUT and HP_OUTPUT on BASIC TAB





8) Turn up the DAC Volume; you can enable BOOST for increased gain assuming that there is enough headroom.



References:

1) Microsoft framework .net 1.1 Direct download link
http://www.microsoft.com/downloads/details.aspx?FamilyId=9B3A2CA6-3647-4070-9F41-A333C6B9181D&displaylang=en

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