OVERVIEW

This document comprises usage precautions, external component descriptions, and frequently asked questions (FAQ) for using the SM6451 electronic audio volume control IC with high-performance audio characteristics.

HIGH PERFORMANCE USAGE

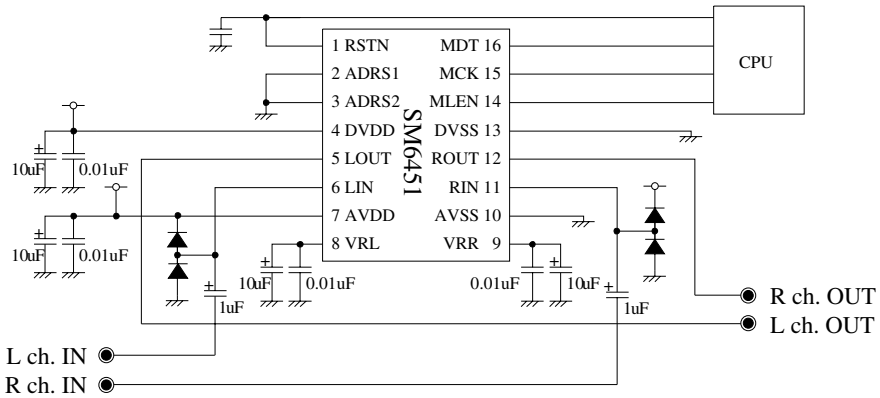

Figure 1. Typical application circuit 1

Digital and Analog Separation

Digital noise mixing with the analog signals can cause a deterioration in audio characteristics.

- Physically separate the digital supply (DVDD, DVSS) and the analog supply (AVDD, AVSS) PCB wiring as far as possible.
- Connect decoupling capacitors of approximately 10µF between the supply pins DVDD to DVSS and AVDD to AVSS.
- Connect bypass capacitors of approximately 0.01µF between the supply pins to prevent incorrect operation due to digital signal mixing.

Reference Voltage (VRL, VRR)

- Connect decoupling capacitors between VRL to AVSS and VRR to AVSS, just as for the supply pins.
- Connect bypass capacitors of approximately 0.01µF between the supply pins to prevent noise caused by mixing with digital signals during data transfer.

Input Coupling Capacitors

The SM6451 uses an internal reference voltage of $V_{DD}/2$ (analog ground). Connect coupling capacitors to LIN and RIN inputs, which are self biased, to block the analog input signal DC offset voltage. The capacitor results in a low-frequency cutoff given by:

$$fc = \frac{1}{2\pi RC}[\mathrm{Hz}]$$

where R is the internal resistance of 50kΩ (typ). For example, the circuit in figure 1 has a cutoff given by:

$$fc = \frac{1}{2\pi RC} = \frac{1}{2\pi \times 50k\Omega \times 1\mu F} = 3.18[\mathrm{Hz}]$$

Input Signal Amplitude

The SM6451 employs input reference amplitudes of 1.2Vrms (SM6451A) and 0.8Vrms (SM6451B). Accordingly, the signal amplitude at the input should match the input reference amplitude, as shown in figure 2.

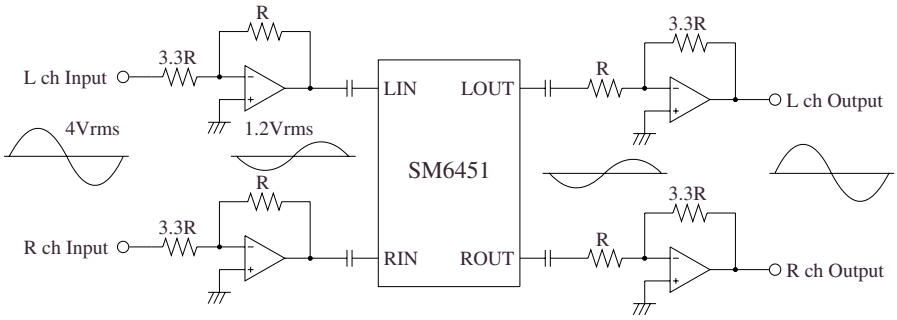

Figure 2. 4Vrms input example

Input Protection Diodes

All inputs have built-in protection circuits to protect the device against electrostatic breakdown. However, if there is a possibility that the input signal may exceed the supply voltage, connect external input protection diodes as shown in figure 3. Take care when selecting diodes as these can greatly affect device characteristics.

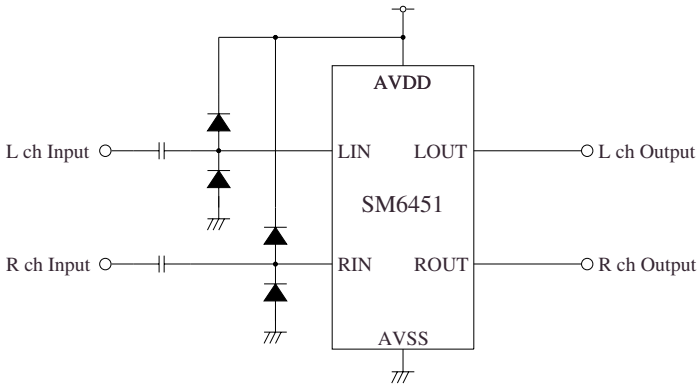

Figure 3. Input protection diodes

SIMPLIFYING CIRCUIT STRUCTURE

The circuit structure can have a direct affect on the analog characteristics, and this should be kept in mind when considering simplifying the circuit.

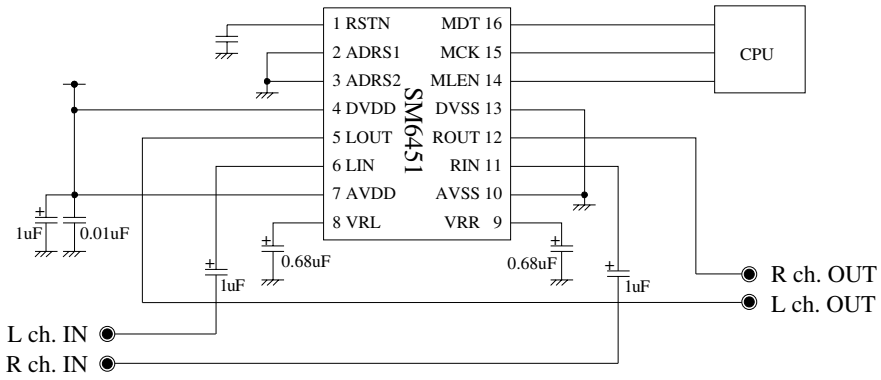

Figure 4. Typical application circuit 2

Common Digital and Analog Supplies

There is no inherent operating problem with using a common supply for both the digital and analog circuits.

Decoupling Capacitors

Decoupling capacitors can have capacitance as low as 1μF.

VRL and VRR

Decoupling capacitors can be as low as 0.33 to 0.68μF. The bypass capacitors can be eliminated, although noise may be generated during digital signal data transfers between device and microcontroller.

Input Signal Amplitude, Input Protection Diodes

If the signal amplitude is less than the supply voltage, there is no need to match the amplitude to the input reference amplitude. Also, the LIN and RIN input protection diodes are not necessary.

FREQUENTLY ASKED QUESTIONS (FAQ)

Q: Are output op-amps built-in?
A: The SM6451 has built-in op-amps for both inputs and outputs.

Q: What is the phase relationship between inputs and outputs?
A: The output signals are in-phase with the input signals.

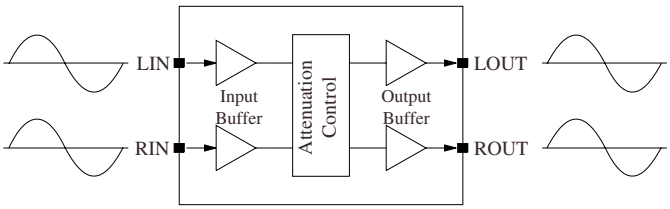

Figure 5. SM6451 input/output block

Q: Is the current consumption higher than devices by other manufacturers?
A: The SM6451 has built-in input/output op-amps, so the rated current consumption is higher than devices without built-in op-amps from other manufacturers.

Q: What is the total IC current consumption?
A: During normal operation, the current consumption is the sum of the digital circuit I_{DDD1} and the analog circuit I_{DDA} currents. When transferring data from the CPU, the digital circuit current (during data transfer) is I_{DDD2}.

Q: What is the device state after system reset?
A: The attenuation level is set to mute.

Q: Is a system reset required when power is applied?
A: A reset is required to reset internal attenuation decoder data. After power is applied, RSTN should be held LOW for a minimum of 100ns and then be set HIGH.

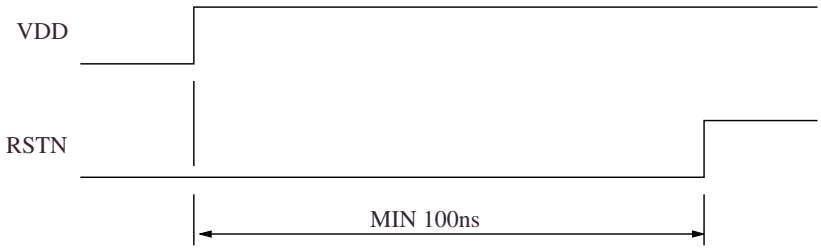

Figure 6. Reset timing

Q: What is the affect of the state of the microcontroller interface and chip address select pins?
A: RSTN, ADRS1, and ADRS2 inputs all have pull-up resistors built-in.
If a single SM6451 device is being used, it is recommended that the chip address select pins be tied HIGH (connected to DVDD or left open circuit) to reduce current consumption. When set to LOW, the current consumed is only the input current per pin I_{IL} which is 230µA (SM6451A) and 70µA (SM6451B).

Q: What are the limits on microcontroller interface data transfer speed?
A: There is no lower limit on transfer speed.
At high speed, the MDT data setup time (t_{MDS} = 50ns min) and hold time (t_{MDH} = 50ns min) place an upper limit on the clock speed of approximately 10MHz.

Q: Are the so-called A curve, B curve, and C curve characteristics not possible?
A: The SM6451 can control the attenuation level in 1dB steps (min). The attenuation step width can be changed by data, allowing A, B, and C curves to be closely approximated.

Q: Can input amplitudes other than the input reference amplitude be used?
A: The analog characteristics change with input amplitude, but operation is still possible for small input amplitudes. However, when the input amplitude is large, the signal waveform is clipped close to the supply voltage, and this condition becomes worse with larger amplitudes. Note that if the signal amplitude exceeds the supply voltage, input protection diodes become necessary.

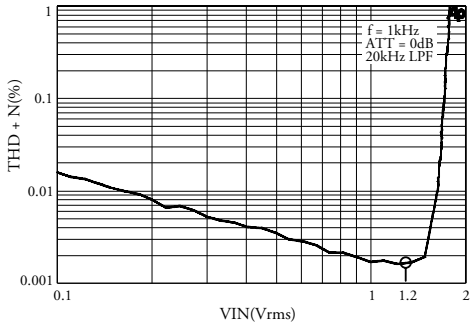

Figure 7. THD+N vs. input amplitude (SM6451A)

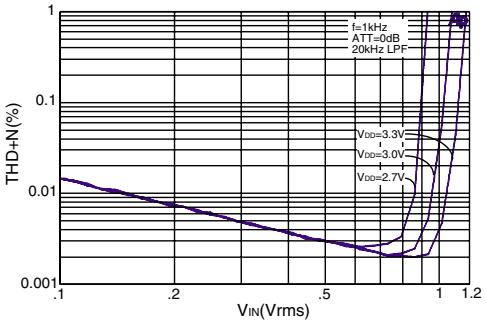

Figure 8. THD+N vs. input amplitude (SM6451B)

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