Application Report
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Single-Ended Input Pop Reduction for TPA6203A1

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ABSTRACT

TPA6203A1, with high PSRR, improved RF-rectification immunity, and small PCB area makes it an ideal audio power amplifier for portable product application. These portable products may include handsets, CMMB, GPS, and PMP.

One phenomenon of TPA6203A1, in single-ended (SE) input configuration, is the undesirable audible pop when cycling in and out of shutdown quickly. This application report describes a method to reduce the audible pop, present lab results, and discusses tradeoffs to consider for the implementation.

1 Introduction

TPA6203A1 is a fully differential amplifier with integrated de-pop circuitry; however, in a SE input configuration, an audible pop can occur when TPA6203A1 is cycled in and out of shutdown quickly. This is especially true if the impedance of the audio input paths are not well matched and if there is insufficient time in shutdown to discharge the input capacitors. This application report explains the cause of pop and describes a method to reduce this pop and is applicable to similar TPA62xx devices, such as TPA6204A1 and TPA6205A1.

Figure 1 is a typical implementation of TPA6203A1 as a SE input amplifier in a portable application. The red arrow line is the discharge path for IN+ input, the blue one is for IN– input. In this case, the impedance of the audio input paths are not well matched since IN+ terminates to GND after C3 while IN– terminates into HPLCOM after C1. HPLCOM is in a high impedance state when TLV320DAC32 is in a standby state.

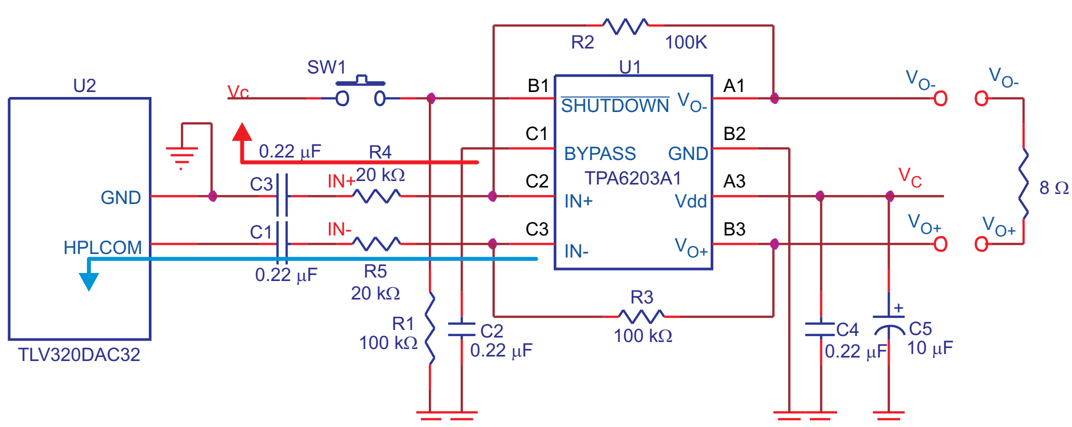

Figure 1. TPA6203A1 in SE Configuration

2 Cause of Pop in TPA6203A1 in SE Input Configuration

During TPA6203A1 normal operation, the input and output terminals are biased to Vdd/2. When shutdown is asserted, both input and output bias voltages begin to discharge from Vdd/2 to 0V. If IN+ and IN– input impedance paths are well matched, the discharge slope and time between IN+ and IN– input paths will be very similar and there will be no audible pop even when TPA6203A1 is cycled in and out of shutdown quickly. In real application, such as interfacing with the TLV320DAC32, the output impedance of TLV320DAC32 and tolerance of discrete components can result in impedance mismatch between two differential inputs. The different discharge slopes between IN+ and IN– paths can produce an audible pop. This pop can be reduced if there is sufficient time for both input capacitors to discharge completely.

Figure 2 is the voltages of IN+ and IN– when cycling in and out of shutdown with sufficient time (about 4 seconds) for both input capacitors to discharge completely. Trace1 is Shutdown, Trace 2 is Vo+, Trace 3 is Vin+, Trace 4 is VIN–. No transient signal or audible pop is observed.

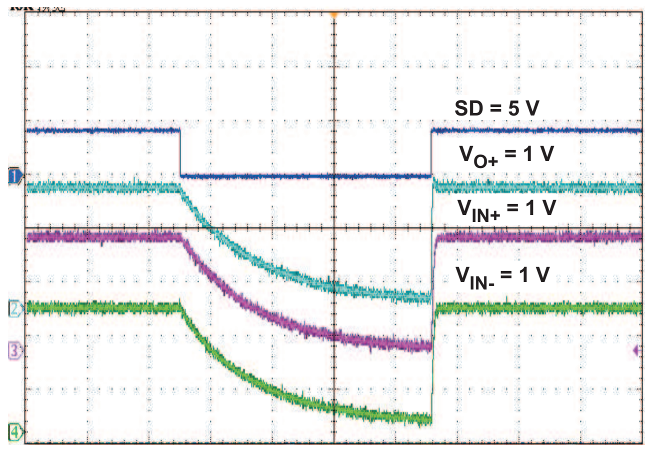

Figure 2. Four Seconds Discharge Time for Input and Output Bias Voltage

In most portable applications for example, the play, pause, or key button tones for music devices may be operated before the capacitor discharge time. An audible pop can occur, as shown in Figure 3, if there is insufficient time to completely discharge the capacitors (400ms discharge time), a transient signal is observed.

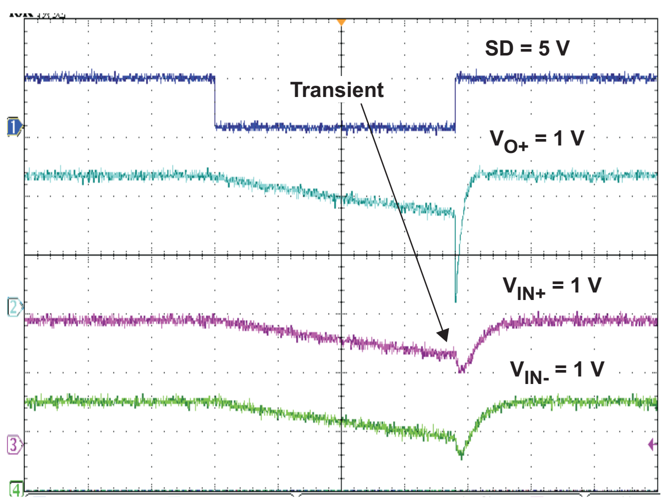

Figure 3. The Transient Signal Happened With Insufficient Discharge Time

Changing the Bypass capacitor has little effect reducing the pop as it has little effect in discharging Vin–. Figure 4 and Figure 5 are the captures with 0.22µF and 2.2µF Bypass capacitor respectively.

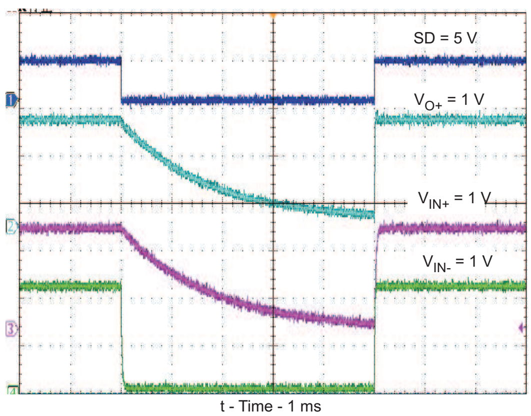

Figure 4. 0.22 µF Bypass Capacitor

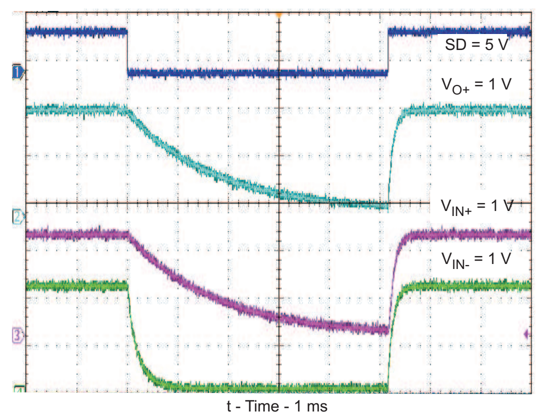

Figure 5. 2.2 µF Bypass Capacitor

3 Reducing the Pop

Adding resistors R6 and R7 shown in Figure 6 provides an additional path to discharge the input capacitors. This shortens the discharge time to about 100ms and reduces the audible pop. The red dotted line is the additional discharge path for IN+ and the blue dotted line is for IN–.

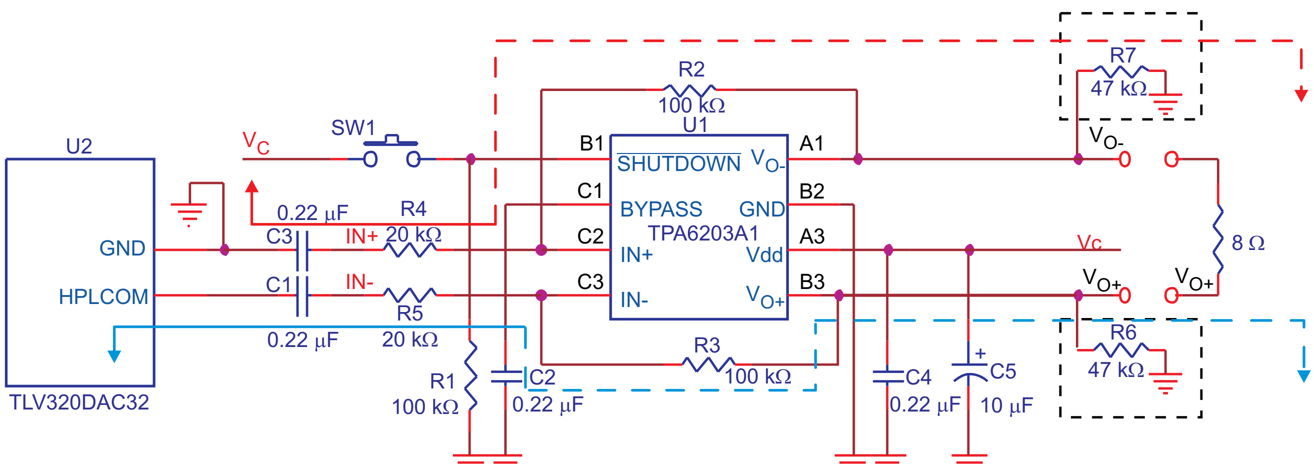

Figure 6. Additional Discharge Paths for Bias Voltage

Figure 7 is the oscilloscope capture of the discharge time with R6 and R7 connected. With a shutdown time as low as 130ms, no transient signal or audible pop are observed.

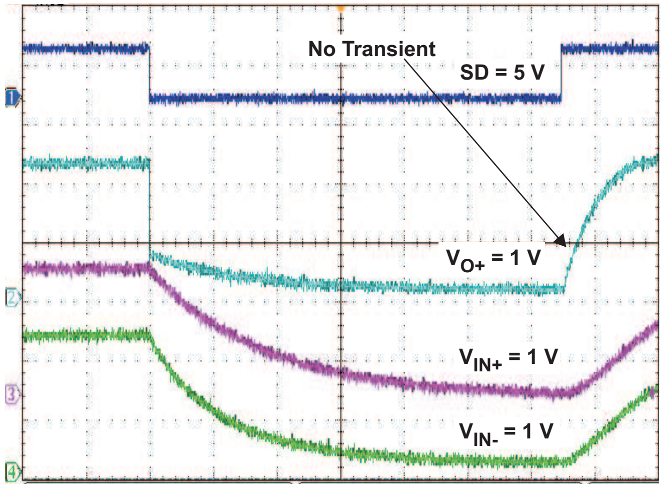

Figure 7. The Shortened Discharge Time

Figure 8 and Figure 9 compare the pop before and after implementing the solution.

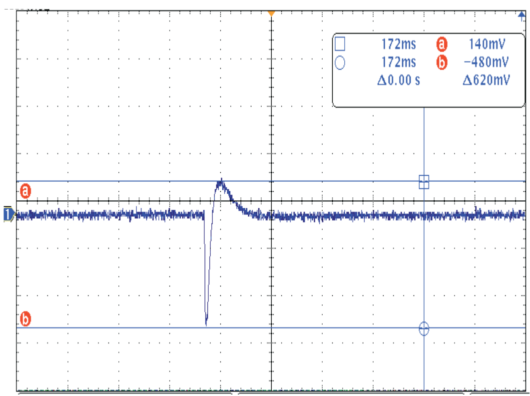

Figure 8. Pop Before the Solution

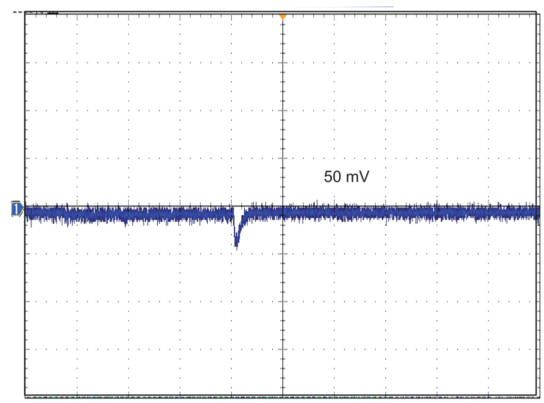

Figure 9. Pop After the Solution

4 Tradeoffs

One tradeoff of this solution is slightly higher quiescent current added in normal operation mode.

$$Iq = 2 \times (\text{output bias voltage} / R \tag{1}$$

The factor of 2 is due to two legs of BTL output.

For 4.2V power supply, the output bias voltage is 2.1V. Substituting it to Equation 1:

$$Iq = 2 \times (2.1V / 47K) = 89.4\mu A \tag{2}$$

The power dissipation added is

$$Pdiss = \text{Power supply} \times Iq = 4.2V \times 89.4\mu A = 375\mu W \tag{3}$$

This power dissipation is negligible compared to the maximum output power (1.25W) of TPA6203A1.

5 Audio Performance Test

The TPA6203A1 audible pop solution presented in this document does not degrade its overall performance. Figure 10 is THD+N vs output power and Figure 11 is THD+N vs Frequency. Trace 1(Green) is tested in the circuit before the solution and Trace 2(Yellow) is after the solution. The test conditions is as follow:

a. V_C = 4V, R_{LOAD} = 8 Ω, Gain = 5 V/V.

b. C_{bypass} = 0.22µF (C2 in Figure 6), input capacitor = 0.22µF (C1 and C3 in Figure 6).

c. Input signal frequency = 1kHz

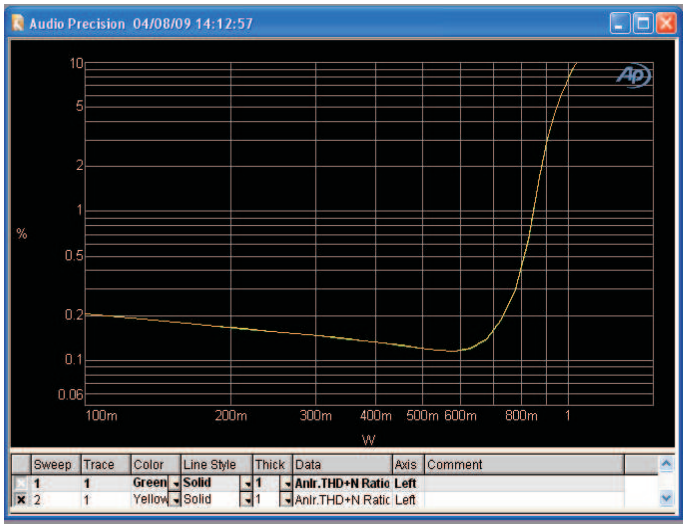

Figure 10. THD+N vs Output Power Sweep, R_{load} = 8Ω, Vdd = 4V, Input Frequency = 1kHz

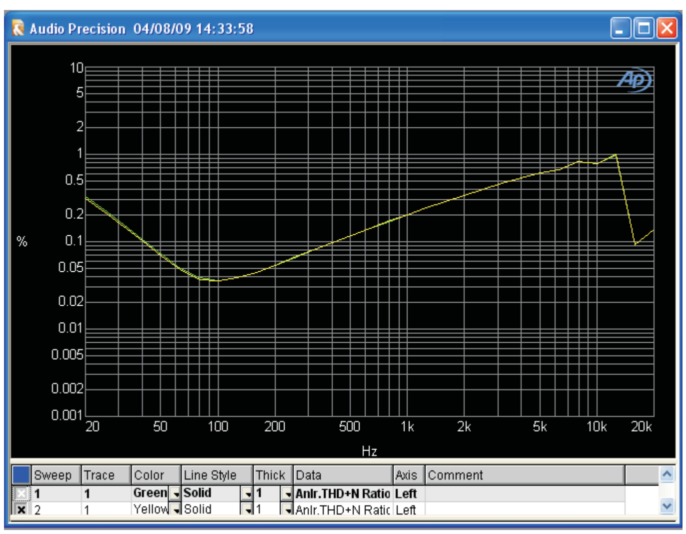

Figure 11. THD+N vs Frequency Sweep, R_{load} = 8Ω, Vdd = 4V, Output Power = 1 W

6 Conclusion

This Application Note presents the cause of audible pop in TPA6203A1 in a single-ended input configuration when cycled in and out of shutdown quickly. Adding two resistors at the output terminals reduces the discharge time and audible pop. The tradeoff of the solution is a slight increase in power dissipation.

7 References

1. TPA6203A1: 1.25W Mono Fully Differential Audio Power Amplifier data sheet (SLOS364F)
2. TPA6203A1EVM Board User Guide (SLOU123A)