

APPLICATION NOTE 3673

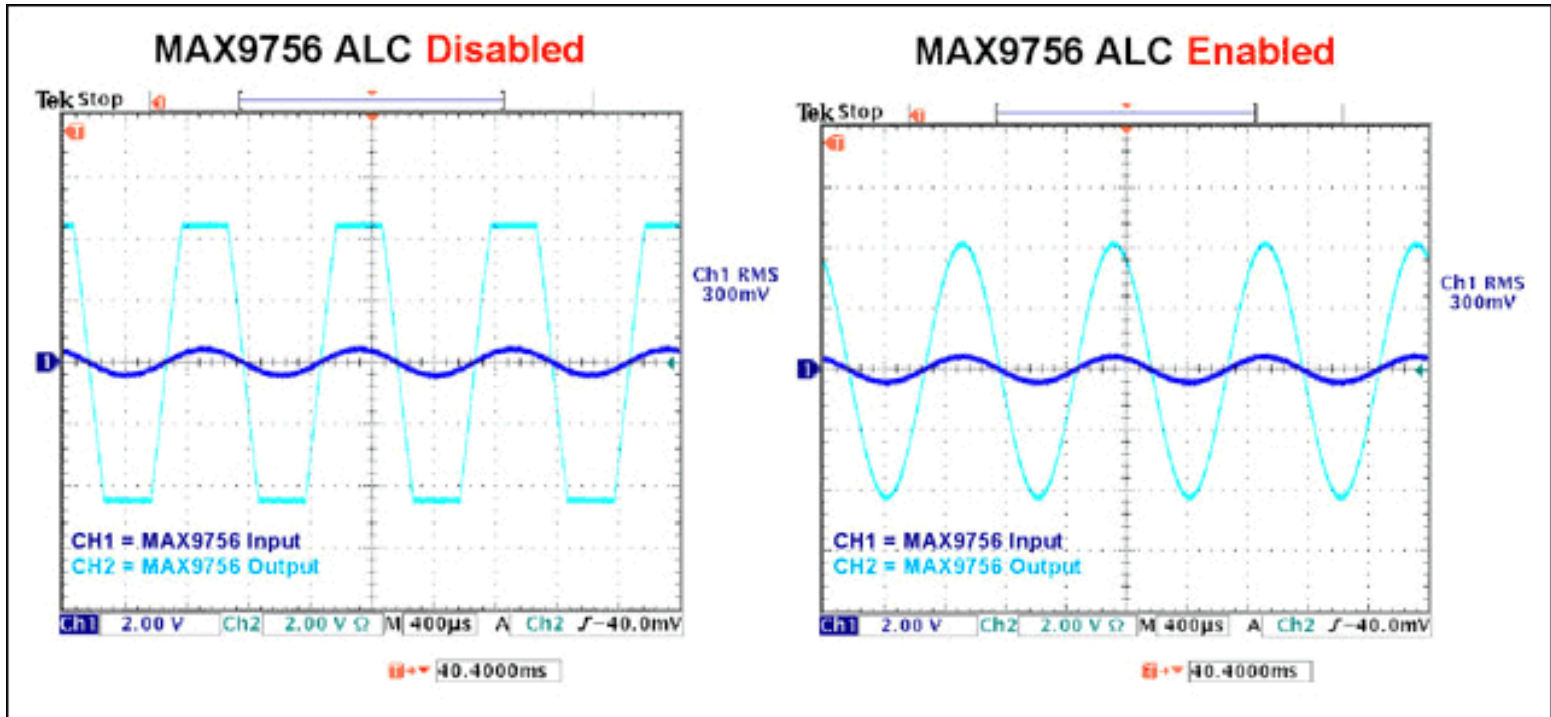
An Overview of Automatic Level Control

Abstract: Automatic Level Control (ALC) is a technology that automatically controls output power to the speaker. ALC prevents loudspeaker overload and optimizes dynamic range. This application note presents ALC technology and demonstrates its use in the MAX9756/MAX9757/MAX9758 stereo speaker amplifiers.

Maxim's Automatic Level Control (ALC) offers two key benefits (**Figures 1 and 2**).

1. It protects the loudspeaker by limiting the amplifier output power.
2. It boosts low-level signals without distorting the high-level signals.

ALC is implemented in the [MAX9756](#), [MAX9757](#), and [MAX9758](#) 2.3W stereo speaker amplifiers and DirectDrive headphone amplifiers.



Figures 1 and 2. The MAX9756's automatic level control (ALC) function protects the speakers without adding distortion.

ALC vs. Output Limiting

ALC differs from traditional output limiting. An output-limiter function limits the output swing at a predetermined level so that the transducer is protected from overvoltage peaks. Clipping (distortion) is added at the output signal as a result (**Figure 3**). An ALC function, however, reduces the gain so that the transducer is protected. No distortion is added (**Figure 4**).

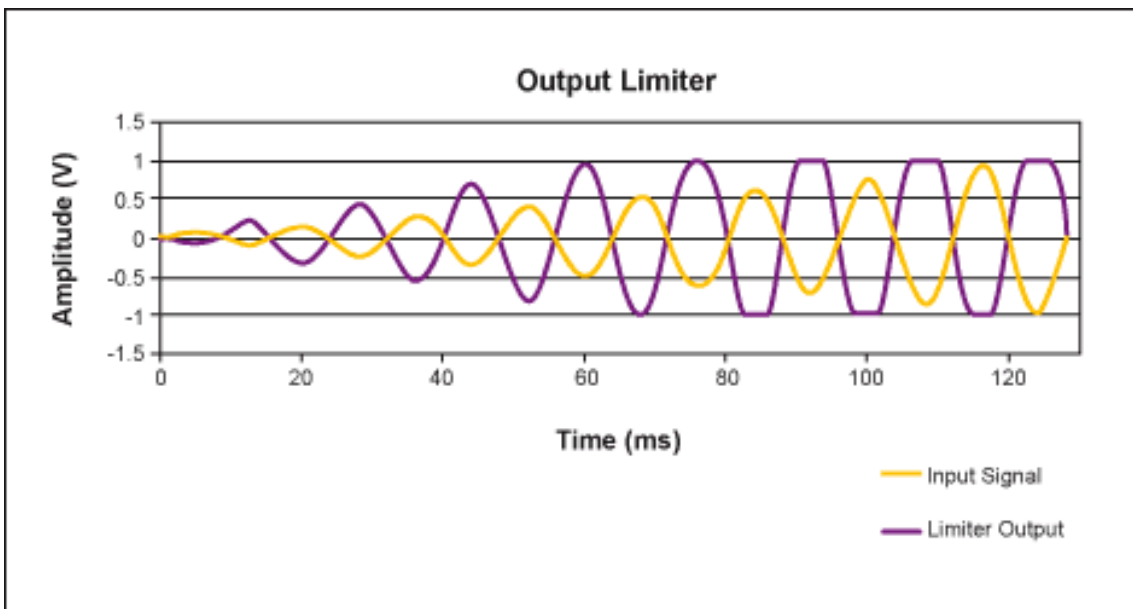


Figure 3. The output limiter clips the output signal in overvoltage conditions and, thus, produces audible distortion.

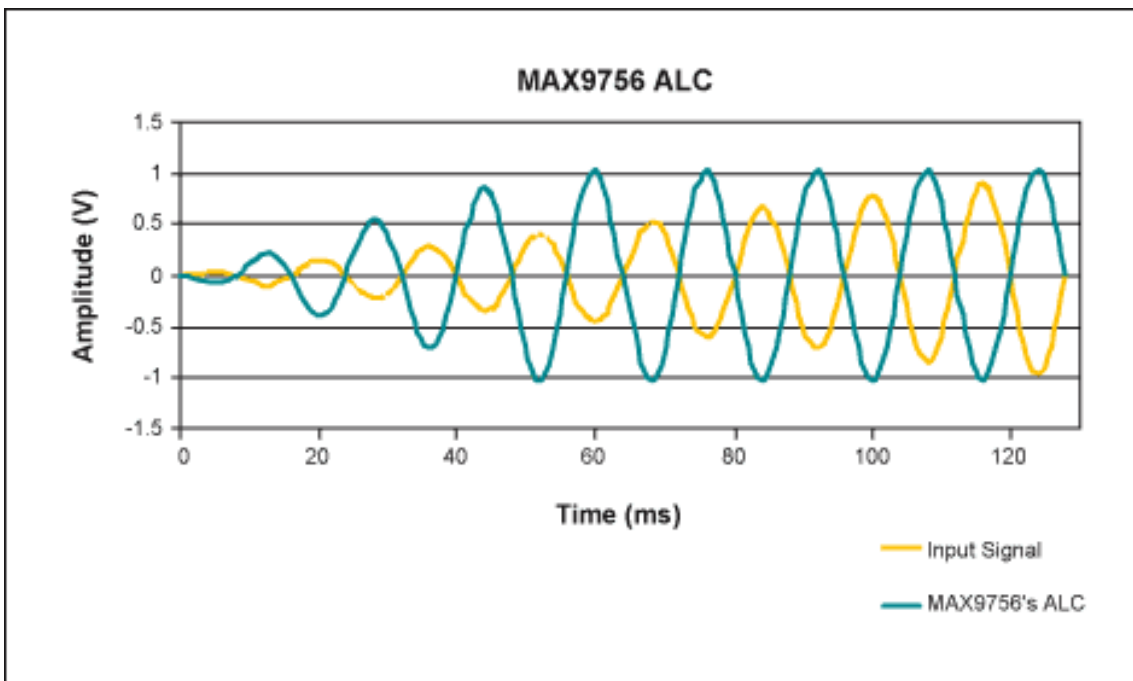


Figure 4. The MAX9756's ALC reduces the amplifier gain in overvoltage conditions so that no distortion is added to the output signal.

How Does ALC Work?

There are three key timing specifications in Maxim's ALC technology (**Figures 5 and 6**): Attack Time, Hold Time, and Release Time.

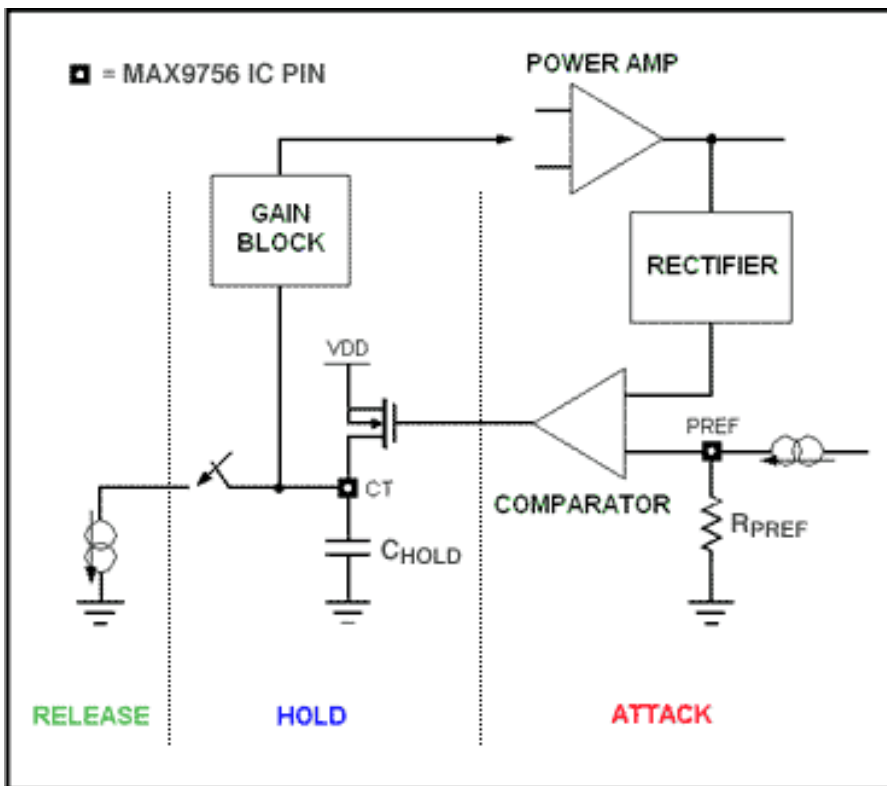


Figure 5. Key timing specifications of the ALC function.

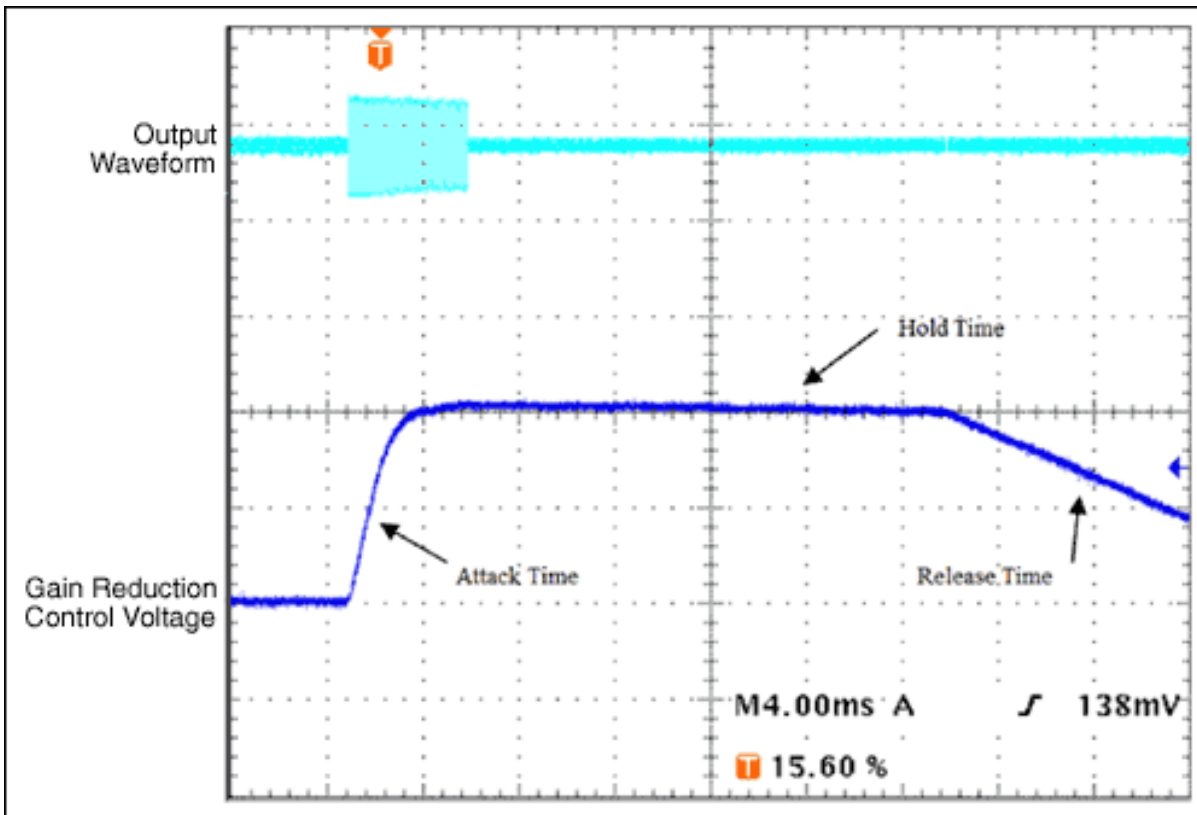


Figure 6. Data plotted for the three key timing specifications of the ALC function. Data were generated on the MAX9756.

ATTACK TIME

This is the time it takes to reduce the gain after the output signal has exceeded the threshold level. The time constant of the attack is given by **15,000 X C_{CT} seconds**, where C_{CT} is the external timing capacitor. The selection of the time constant is application specific. For example, in applications where transient signals such as snare drum beats (music) or gun shots (DVD) must be reduced quickly, shorter attack times should be selected. For other applications with longer attack times, the ALC will ignore short-duration peaks and will only reduce the gain when loudness increases noticeably.

HOLD TIME

This is the delay after the signal falls below the threshold level, but before the release phase is initiated. The hold time is not adjustable; it is internally set to 50ms. The hold time prevents gain 'pumping,' where ALC action can be heard responding to low-frequency material. The hold time is cancelled by any signal exceeding the set threshold level, at which point the attack is reinitiated.

RELEASE TIME

This is the time it takes for the gain to return to its normal level after the input signal fell below the threshold level and the hold time expired. Release time is further defined as release from a 6dB gain compression to 10% of the nominal gain setting, after the input signal has fallen below the P_{REF} (pin 29) threshold and the 50ms hold time has expired. The release time is determined by an attack-/release-time ratio that can be selected by setting the logic state of DR (pin 25) (**Table 1**). Release time is adjustable between 95ms and 10s.

Table 1. Attack/Release Ratio Is Set with a Logic Level at Pin DR

DR	ATTACK/RELEASE RATIO
VDD	1:200
VBIAS	1:633
GND	1:2000

Output Power Threshold

An external resistor connected from P_{REF} to ground sets the threshold at which the speaker output is clamped (**Figure 7**). Equation 1 sets the resistor value at P_{REF} for a desired maximum output power and a selected speaker impedance.

$$R_{\text{PREF}} = 180\text{k}\Omega \left(\left(\sqrt{\frac{P_{\text{OUT}}}{1.166}} \right) \times \left(\sqrt{\frac{R_{\text{L}}}{8}} \right) \right)$$

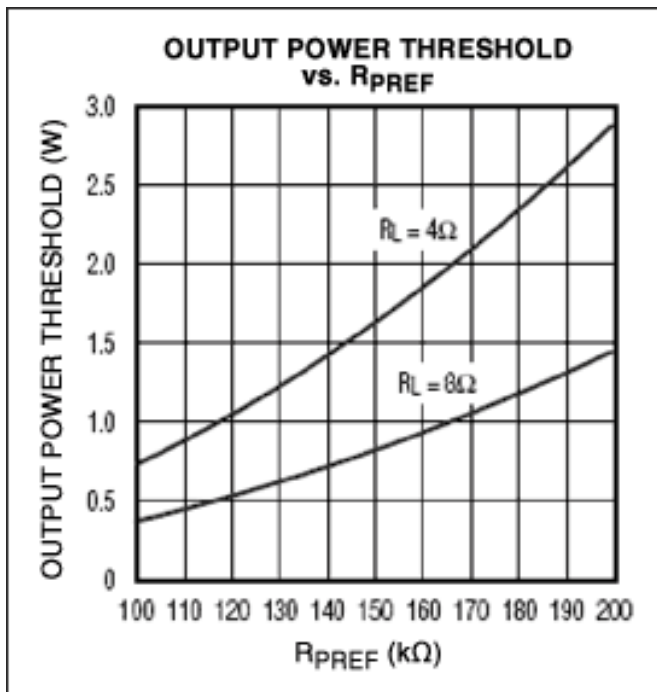


Figure 7. The output power threshold is set by an external resistor.

Maxim Application Recommendation

For notebook applications in which music CDs and DVDs are the main audio source, an attack time of 495ms and a release time of 990ms are recommended with an output power threshold of 1.2W with an R_L = 8Ω (**Figure 8**).

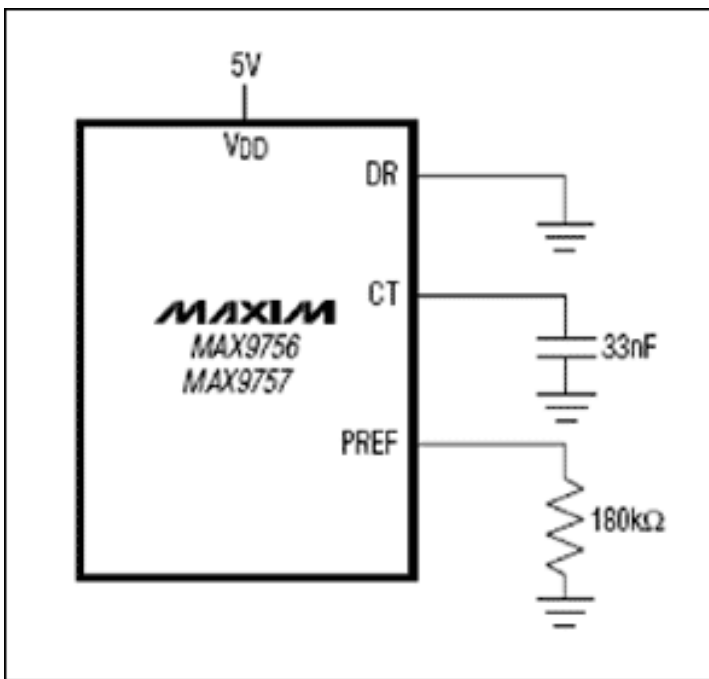


Figure 8. Recommended ALC values for a notebook application.

Application Note 3673: www.maxim-ic.com/an3673

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