A Comparison Between the GS551 and the LD549

APPLICATION NOTE

INTRODUCTION

The GS551 is a high power class B output stage. This two stage amplifier consists of an inverting amplifier and a unity gain phase splitter which drives a class B output block. Gain in the first stage is set by two resistors, typically a 10 kΩ input resistor and a 100 kΩ volume control (up to 20 dB), while the second stage has a fixed gain of 28 dB, for a total adjustable gain of up to 48 dB. As the circuit is internally compensated, no external capacitor across the receiver is required, reducing the total parts count. The GS551 requires relatively small external capacitor values (0.047 µF) and is not plagued by long startup times compared to other Class B output stages. This output stage is capable of driving low impedance receivers (down to 68 Ω) at high output sound pressure levels. In this application note, comparisons will be made between the GS551 and the LD549 to point out the advantages of the GS551 over the LD549.

COMPARISON

Designed for low parts count, the GS551 as an output stage requires two small valued capacitors (0.047 µF), a coupling capacitor, a 10 kΩ resistor, and a 100 kΩ volume control. On the other hand, the LD549 requires two 6.8 µF decoupling capacitors, a coupling capacitor, and a receiver capacitor for stability, resulting in a parts count totalling four capacitors and a volume control. The decoupling capacitors in the GS551 are tied to a virtual ground instead of the supply or ground. Thus, unlike the LD549, where the 6.8 µF capacitors need to be charged up to an appropriate DC potential during turn on, start up times for the GS551 are negligible. Also, the effective low pass RC filter effect of these capacitors was made smaller, allowing the GS551 to pass more low frequency components of the input signal. The GS551 provides two ground pins which allows "Star" grounding in order to reduce second order harmonic distortion associated with ground line resistance. Typical quiescent current consumption for the GS551 is 460 µA, which is lower than that of the LD549 at 500 µA.

With maximum volume control settings, the GS551 has higher gain at 48 dB compared to 40 dB for the LD549. Electrical and acoustic measurements of the GS551 and LD549 were performed using the LC506 as a preamplifier. Figures 1 and 2 depict the corresponding circuits used to evaluate the GS551 and LD549 respectively.

ACOUSTIC MEASUREMENTS.

Figures 3 and 4 show the ANSI 60 and 90 dBSPL acoustic response curves of the GS551 and LD549 taken with a 25 dB preamp gain. The output stage gain is adjusted such that the circuit conforms to the ANSI reference test position setting. These acoustic measurements were taken with a Knowles CI 2960 (400 Ω) receiver. Figure 5 compares the 60 dBSPL and 90 dBSPL response curves of the GS551 and LD549. Note that the acoustic response curves are similar, although the GS551 is capable of higher low frequency output. The GS551 and LD549 have similar distortion characteristics at equal acoustic outputs. Figure 6 is an acoustic THD versus frequency measurement at 70 dBSPL in for both output stages. Note that at the lower frequencies the GS551 has more output which probably reflects the higher distortion numbers.

A significant advantage of the GS551 over the LD549 is its ability to drive more output current into a load. This may be easily demonstrated by substituting the CI 2060 for a lower impedance receiver (CI 2970 at 112 Ω and CI 2955 at 68 Ω). Figures 7 and 8 show the 60 dBSPL and 90 dBSPL response curves of the GS551 and LD549 using the low impedance receivers. Since the GS551 is capable of driving more current, as the impedance is reduced, higher output sound pressure levels are achieved. Figure 9 shows the electrical response curve of the GS551 and the LD549, which also reflect the higher low frequency output of the GS551.

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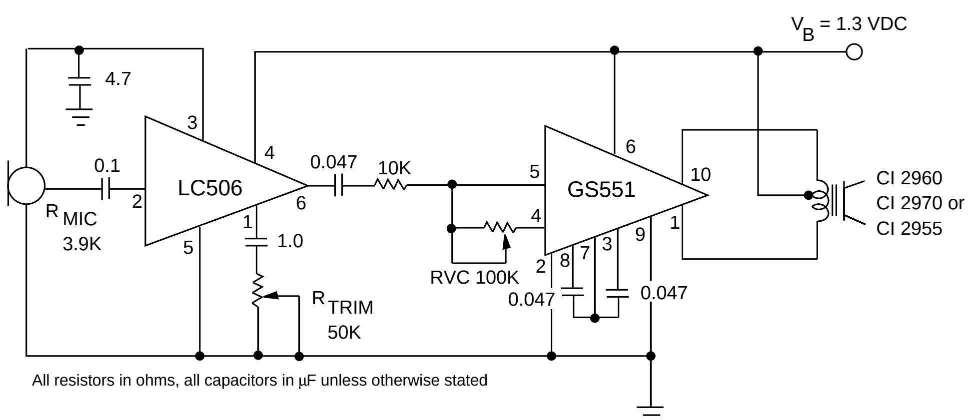

Fig. 1 LC506 and GS551 Hearing Aid Circuit

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GENNUM CORPORATION P.O. Box 489, Stn A, Burlington, Ontario, Canada L7R 3Y3 tel. (905) 632-2996 fax: (905) 632-5946
Japan Branch: A-302, Miyamae Village, 2–10–42, Miyamae, Suginami–ku, Tokyo 168, Japan tel. (03) 3334-7700 fax (03) 3247-8839

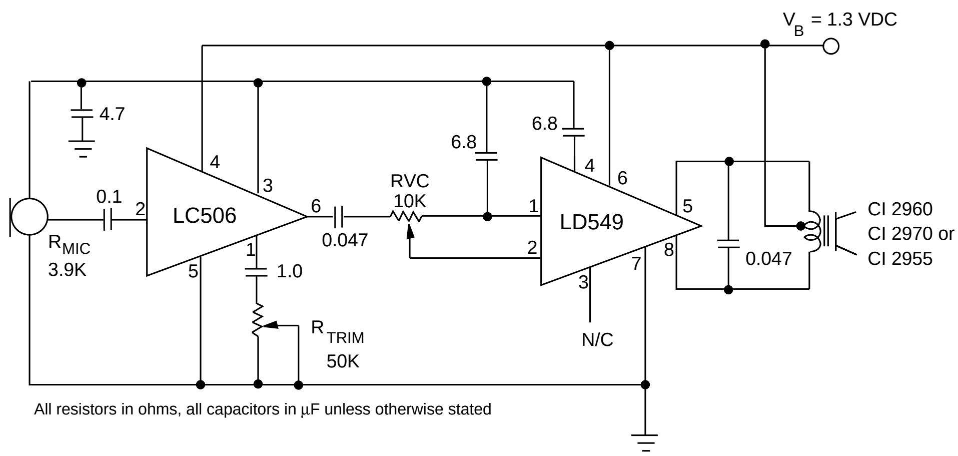

Fig. 2 LC506 and LD549 Hearing Aid Circuit

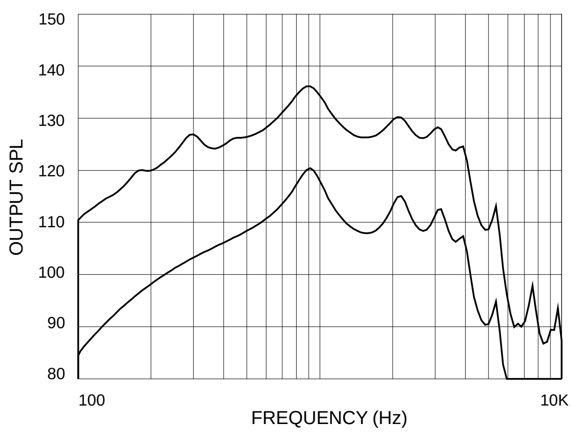

Fig. 3 GS551 ANSI 60 and 90 SPL Acoustic Response Curves, CI 2960 Receiver

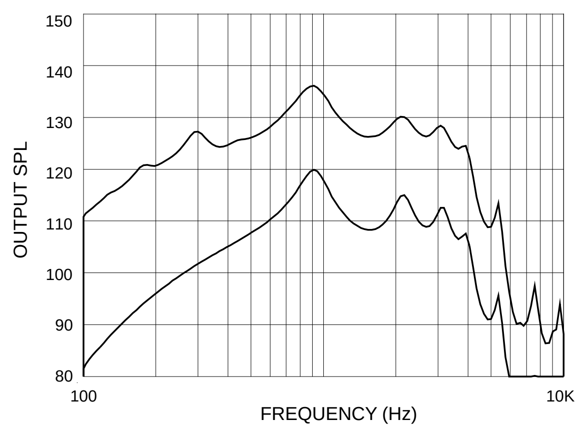

Fig. 4 LD549 ANSI 60 and 90 SPL Acoustic Response Curves, CI 2960 Receiver

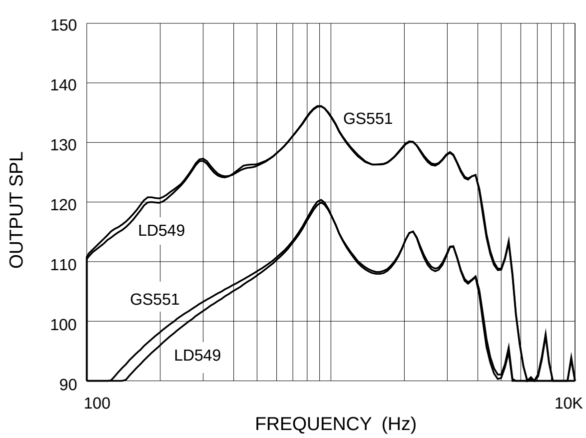

Fig. 5 Acoustic Response Curves of the GS551 vs LD549, CI 2960 Receiver

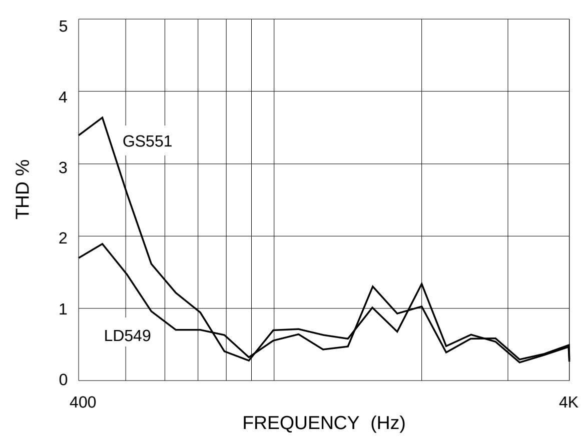

Fig. 6 THD vs Frequency Characteristics of the GS551 and LD549, CI 2960 Receiver

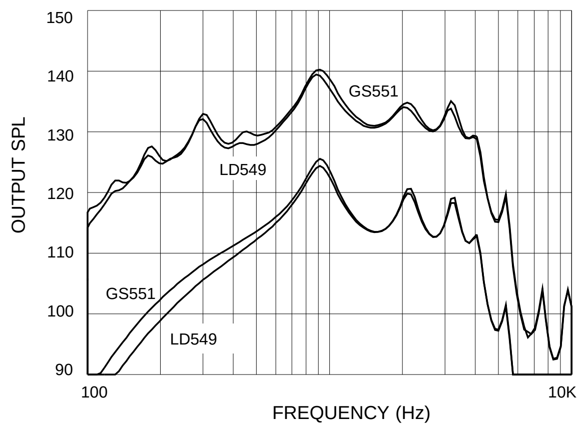

Fig. 7 Acoustic Response Curves of the GS551 and LD549 with CI 2970, 112 Ω Receiver

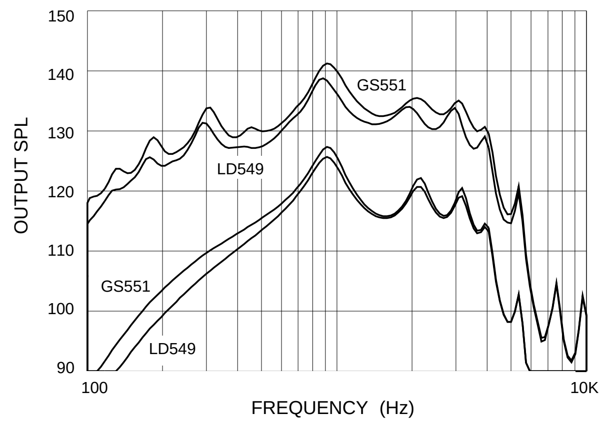

Fig. 8 Acoustic Response Curves of the GS551 and LD549 with CI 2955, 68 Ω Receiver

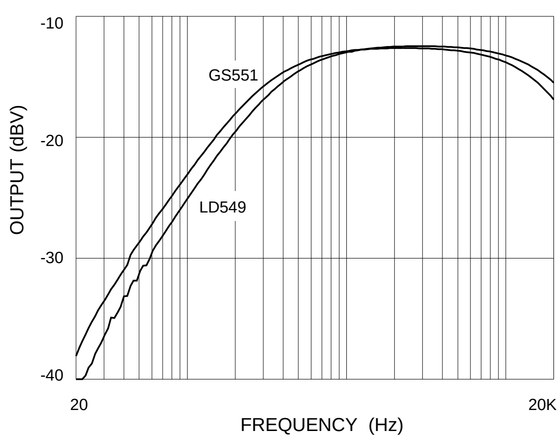

Fig. 9 Electrical Response Curves of the GS551 and LD549 at -74 dBV_{IN} and 390 Ω Load

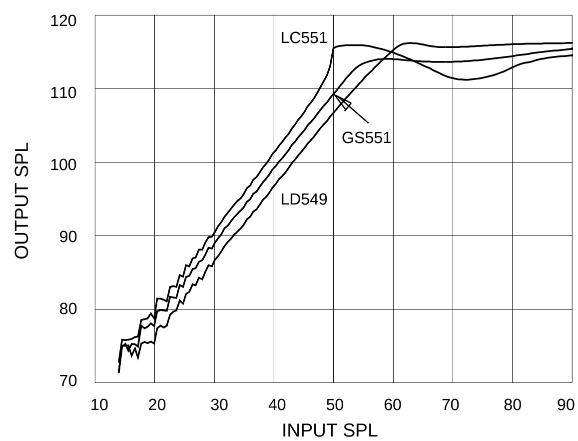

Fig. 10 Acoustic I/O Characteristics of the GS551, LC551 and LD549 with RMPO = 1 K CMPO = 10 μF at 1 kHz and CI 2960 Receiver

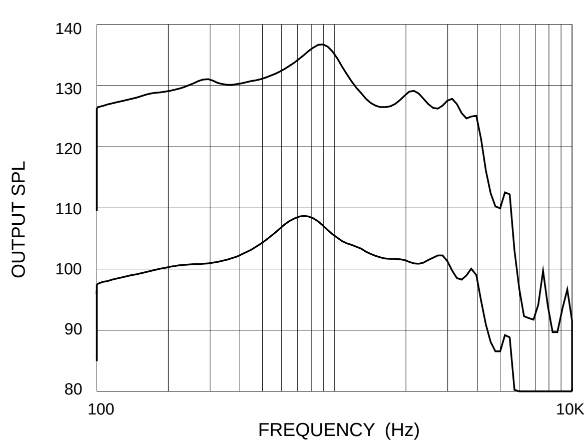

Fig. 11 MPO Range of the GS551 with R_{MPO} = 5 kΩ, C_{MPO} = 2.2 μF, 90 SPL_{IN}, CI 2960 Receiver

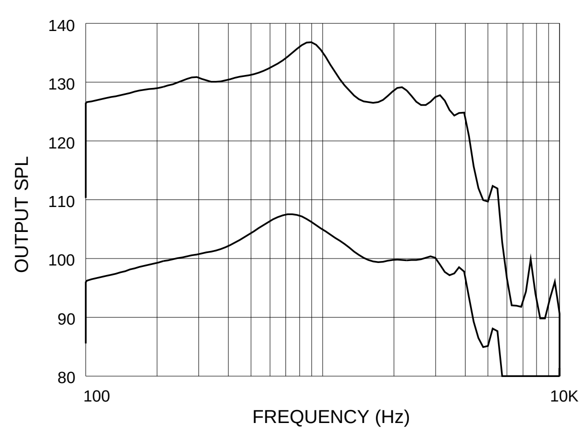

Fig. 12 MPO Range of the LD549 with R_{MPO} = 5 kΩ, C_{MPO} = 2.2 μF, 90 SPL_{IN}, CI 2960 Receiver

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It is important to consider that although the GS551 can drive the 68 Ω receivers as shown in the previous measurements, the low impedance receivers will demand fairly high current output especially in the low frequencies. These receivers typically have AC impedances of around 20 Ω at frequencies below 500 Hz. The voltage drive output stage will attempt to supply enough current to maintain the output voltage. Therefore, reducing load impedance will tend to increase current consumption.

MPO

The GS551 has several advantages over its predecessor the LC551. The GS551 is not prone to gain expansion, an increase in gain which occurs at amplifier saturation. Also, gain droop, which is the gain reduction during saturation, in the GS551 is not as severe as that in the LC551. Figure 10 shows the I / O characteristics of the GS551, LC551, and LD549. The LC551 gain expansion and gain droop are dependent on the MPO resistor, the MPO decoupling capacitor and the receiver impedance. Thus in the LC551, restrictions must be made on the MPO resistance to keep the gain expansion coefficient low. Due to the smaller MPO resistance, there is only a limited MPO range allowable in the LC551 (typically 10 dB). Since there is also a limited MPO decoupling capacitor range in order to prevent a large gain droop, higher distortion may be seen near the limiting MPO threshold. Since neither the GS551 nor the LD549 experience the gain expansion phenomenon, larger MPO resistors may be used resulting in greater MPO control (>25 dB). Larger MPO capacitors may also be used in the GS551 for lower distortion at the limiting MPO threshold. Note that using very large MPO capacitors may cause some gain droop in the GS551. Figures 11 and 12 show MPO range for the GS551 and LD549, respectively, with R_{MPO} = 5 kΩ and C_{MPO} = 2.2 μF.

CONCLUSION

The GS551 Class B output stage is capable of higher drive current than the LD549. This results in higher output sound pressure levels when using the lower impedance receivers. Although the LC551 is its predecessor, GS551 avoids several pitfalls of the LC551. The GS551 does not have gain expansion effects and therefore allows the use of a larger range of MPO resistance resulting in more MPO range control. Also, the gain droop is not as evident and thus larger MPO capacitors are possible, reducing the limiting level distortion. Although both GS551 and LD549 have similar parts count, the GS551 uses much smaller capacitance values. Also, the GS551 is capable of more low frequency output. The acoustic measurements show the GS551 to be superior to the LD549 in the demanding high power applications.