



SEMICONDUCTORS

INTRODUCTION

Delco Radio's DTG-110B, H.K. Nu-Base Power transistor has been introduced to answer the need for a reliable, high voltage, high power audio transistor. This design memorandum demonstrates an exploitation of this capability in practical class AB push-pull output circuits.

**100 WATT
AUDIO POWER
AMPLIFIER DESIGN**

CIRCUIT DESCRIPTION

The circuit shown represents a basic design which will deliver up to 100 watts RMS to an 8 ohm load. It is a practical, functional approach intended to achieve maximum utilization of a minimum number of circuit components.

The general form of the suggested circuit is that of a 2 stage driver, transformer coupled to a half-bridge push-pull output circuit which is direct coupled to a nominal 8 ohm load. This arrangement was chosen in lieu of the direct coupled quasi-complementary symmetry approach because it allows more design latitude in achieving high sensitivity and high feedback with the fewest number of active components. In addition, it allows for a more thermally stable bias circuit for the output power transistors. The use of the driver transformer presented no limitations on the design because a wide band transformer could be easily fabricated with proper winding techniques on common core material.

The output circuit is of the standard half-bridge configuration which drives the load directly from a balanced ± 50 volt supply. Because of this balanced supply, there is only a negligible d.c. component across the load caused by bias tolerances. This d.c. component and the a.c. ripple accompanying it are easily nulled out by small bias pots as desired. The bias network itself is a stable voltage divider which presents a fixed voltage to the base of each power transistor to allow an idling current determined by the inherent transconductance characteristics of the devices. The modest 0.47 ohm emitter degeneration enhances this stiff voltage bias to provide a thermally stable circuit and offers a small amount of local a.c. feedback. The output circuit of this design uses the transformer secondary resistance as part of the bias network since that resistance can often be held to a tighter tolerance than a separate resistor. This arrangement minimizes the total drive voltage required from the transformer secondary such that the emitter diode of the power transistor is not avalanched too far.

It should be noted that this shunt bias network is practicable only when the output transistors are driven from a low impedance source (as reflected through the transformer) so as to minimize the effects of the shunt negative voltage feedback loop thereby developed, viz., degradation of input impedance and increase in required drive power. Extensive testing has indicated that this voltage drive optimizes the basic linearity of the amplifier throughout the audio bandwidth and extends the frequency response of the output circuit. The low source impedance provides a constant drive voltage to the power devices as their input impedance changes with load and/or frequency. It thus allows a low distortion gain through the exceptionally linear transconductance characteristic.

The driver section of this basic amplifier consists of 2 common emitter stages, direct coupled and feedback biased for maximum circuit simplicity and stability. The d.c. feedback bias is derived from the emitter of Q2 and applied back to the input of Q1. The arrangement provides excellent thermal stability and compensates for d.c. parameter variations between the two transistors. About 16 db of negative a.c. feedback is

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derived from the collector of Q2 to reduce the output impedance of the driver section thereby providing the desired low impedance (voltage) source to drive the output transistors.

The driver transformer is a split primary design using common silicon steel core material. The split primary construction gives a coupling coefficient between primary and secondary which provides flat response in the audio spectrum and rolls off in a frequency range most beneficial to the total gain-phase behavior of the composite amplifier. The magnetization characteristics of the silicon steel allow direct current to be used in the primary without adversely affecting the transformer behavior. This favors maximum driver circuit efficiency. The transformer is constructed with a 1 mil air gap between the E and I member for optimum signal linearity, especially at the high induction levels related to low frequency operation. The 6:1:1 turns ratio was chosen so that a large drive voltage swing from a low current, signal device would drive the DTG-110B's to full output. The 2N3405 was found to be very satisfactory for the requirement.

This particular combination of 2 drivers and 2 output devices provides exceptional sensitivity for the rated output even with the 45 db of total negative feedback used in the design. This was achieved by properly staggering the frequency response characteristics of the silicon planar drivers Q1 and Q2, the driver transformer and the DTG-110B's.

The power supply is a basic capacitor filtered design which provides sufficient regulation for full continuous output. A simple feedback regulator provides

the desired driver bias supply at very low ripple content for optimum noise and power supply feedback rejection.

PERFORMANCE

The amplifier delivers up to 100 watts RMS continuous output on an 8 ohm load from an input of 0.1 volt into 10 K. The input may be stepped down by an additional input resistance for a sensitivity of 1.0 volt into 100 K if desired.

An amplifier built from the circuit design shown generated the following performance data: (Similar amplifiers may differ according to parts tolerances but should approach these test figures.)

- Output Power:* 100 watts RMS into 8 ohms.
- Bandwidth:* flat ± 1 db from 20 Hz to 20 KHz at up to full output.
- Total Harmonic Distortion:* less than 0.25% at 1 KHz up to full output.
- Intermodulation Distortion:* less than 1.0% at up to full output (60 Hz & 6 KHz mixed 4: 1/ IHFM).
- Sensitivity:* 0.1 volt RMS into 10 K or 1.0 volt RMS into 100 K.
- Signal to Noise Ratio:* 80 db below rated output (thermal noise).
- Output Impedance:* less than 0.5 ohm.
- Rise Time:* 10 μ Sec to full output.

The principal shortcoming of the amplifier, its harmonic content at high frequencies, is attributed to transit time in the power devices. The quoted figures

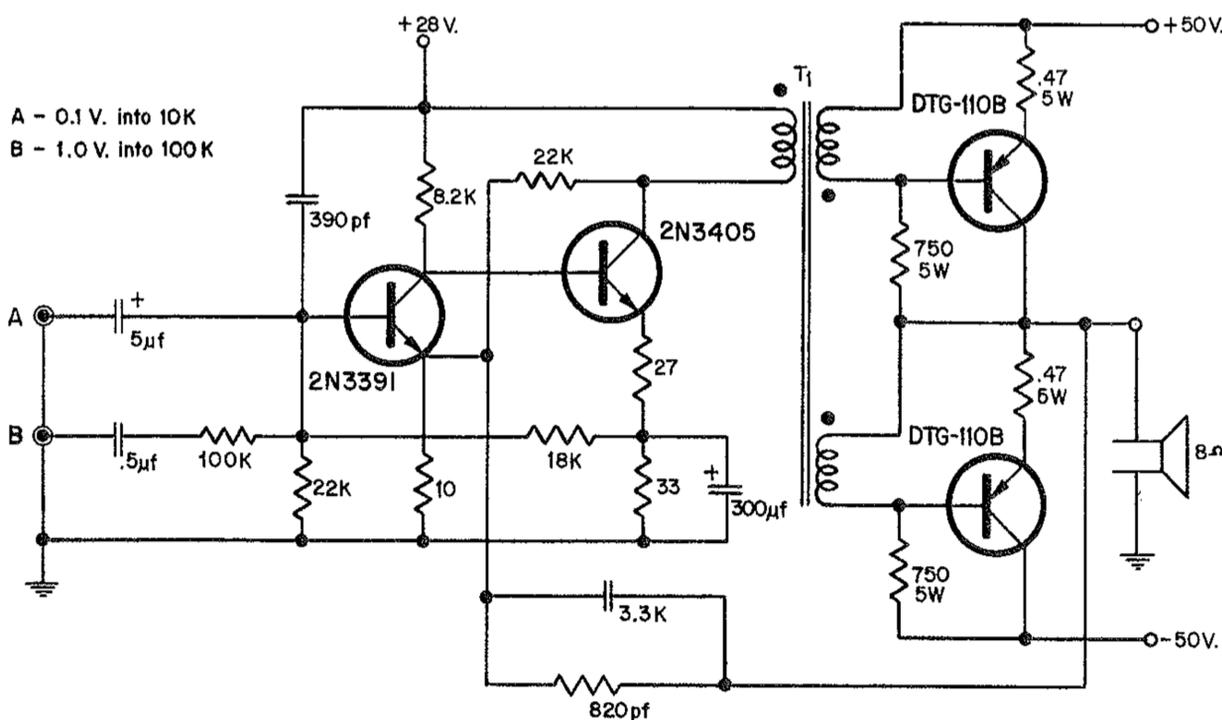


FIGURE 1
AUDIO POWER AMPLIFIER

T-1 DRIVER TRANSFORMER*

RATINGS
 $I_{pri} = 50$ mA DC
 $L_{pri} = 4$ h at 10 mA DC

SPECIFICATIONS
 Core: EI-75, fabricated with laminations of M-19 grade silicon steel. Use 1 mil air gap.
 Winding: Design is split primary sandwiching bifilar secondaries.
 Details: On nylon bobbin, wind 600 turns of #30 enameled wire. Next, simultaneously wind 2 wires of #27 enameled wire for 200 turns (each). Finally, resume winding the primary for another 600 turns. Bring ends of wire out as desired, observing starts for proper connections as shown in circuit schematic.

Test measurements:
 $R_{pri} \approx 45$ ohms
 $R_{sec} \approx 3.3$ ohms
 $N = 6:1:1$

*Triad Transformer Corp. P/N assigned: No. TY-160X.



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100 WATT AUDIO AMPLIFIER
BASIC PERFORMANCE CHARACTERISTICS

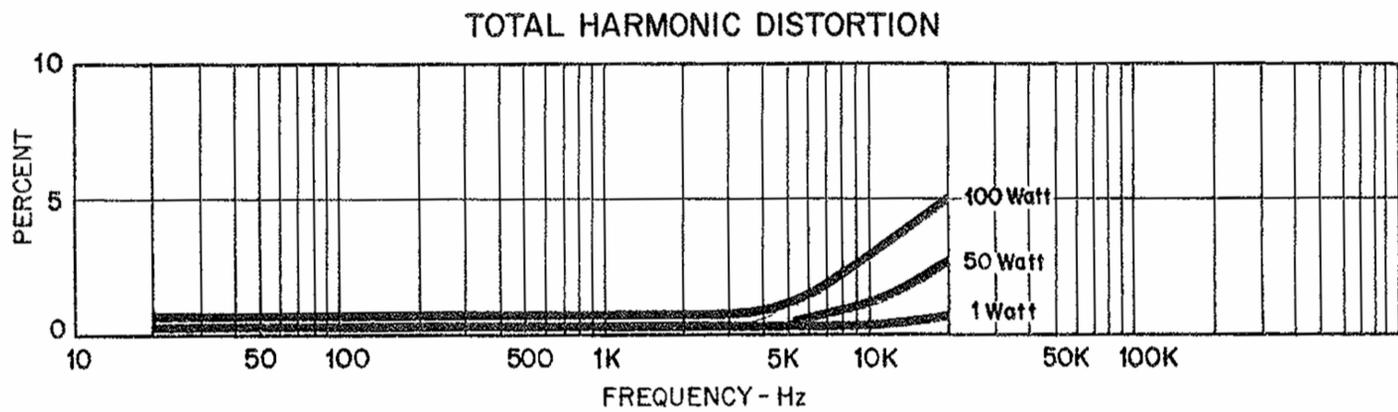
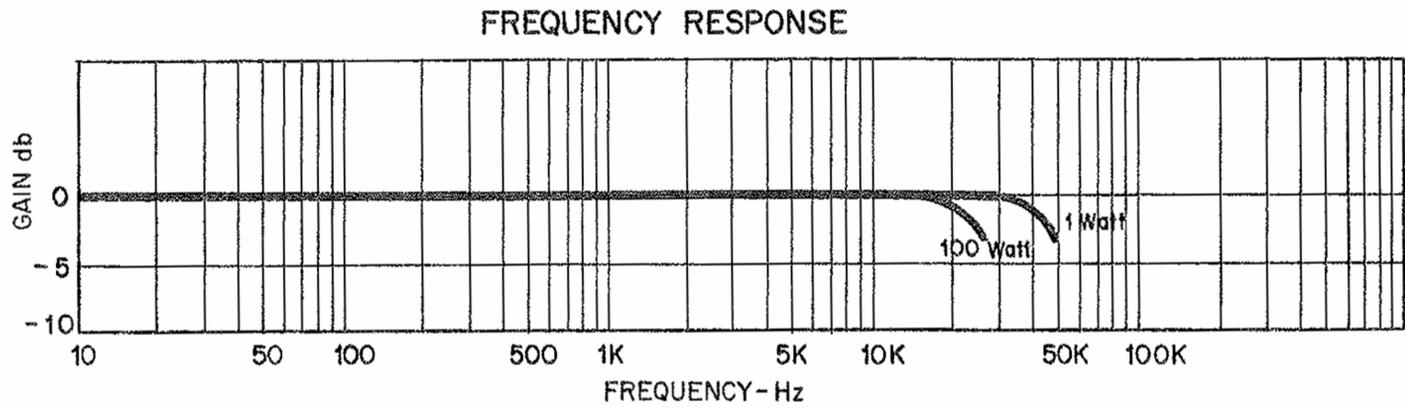


FIGURE 3

100 WATT AUDIO AMPLIFIER
LINEARITY AND CLIPPING CHARACTERISTICS

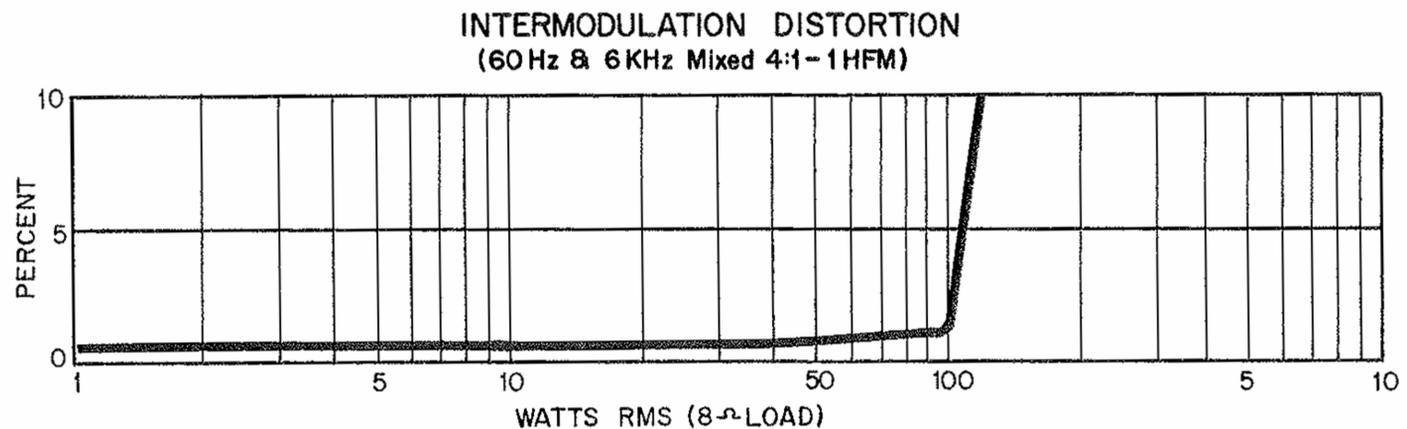
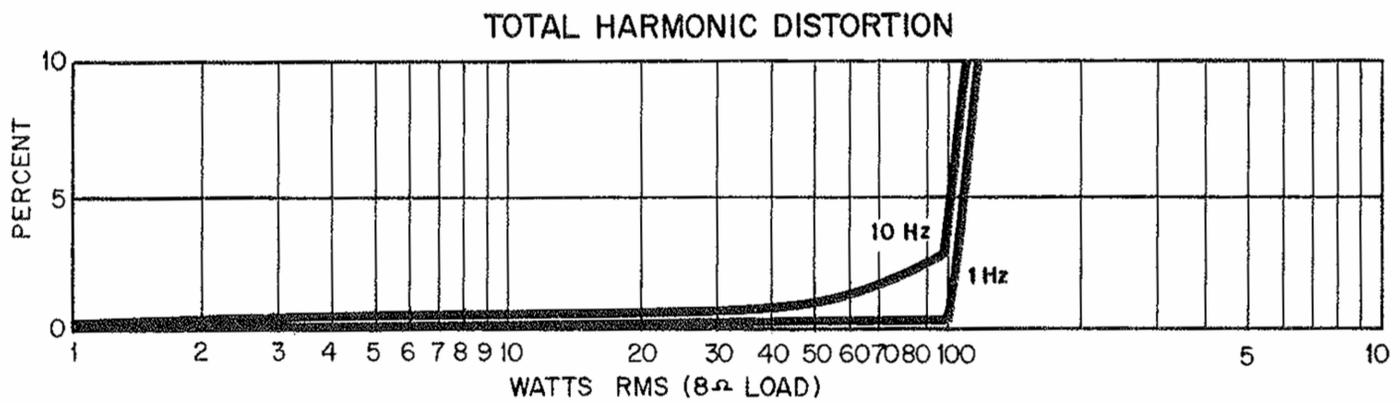


FIGURE 4