Analysis of the Circuit in Figure A

1. Overview

The circuit in Figure A represents a high-speed operational amplifier-based amplifier with a push-pull output stage. The design ensures stability, high gain, and the ability to drive significant loads with minimal distortion.

2. Components and Their Functions

(A) Input Stage

- **R8 (1kΩ) & R13 (100kΩ):** Form a voltage divider to set the input bias.
- **D3 & D4 (1N5235, 6.8V Zener Diodes):** Provide voltage regulation and set the biasing for the transistors.
- **R7 & R12 (10kΩ each):** Provide biasing for Q5 and Q6.
- **Q5 (PN2222A, NPN) & Q6 (PN2907A, PNP):** Act as current sources for the input differential amplifier.
- **U1 (AD8610 Op-Amp):** High-speed precision operational amplifier used for voltage gain and error correction.

(B) Frequency Compensation

- **C1 (100pF) & C2 (22pF):** Stabilize high-frequency response and improve phase margin.
- **R6 (90kΩ):** Works with C2 for frequency compensation.

(C) Gain Setting & Feedback Network

- **R1 (4.99kΩ) & R2 (499Ω):** Set the gain of the amplifier. The gain is given by:

$$G=1+R1R2=1+4.99k\Omega*499\Omega\approx1.1Gohm$$

(D) Output Stage (Push-Pull Configuration)

- **Q1 - Q3 (ZDT751 Dual NPN Transistors) & Q2 - Q4 (ZDT651 Dual PNP Transistors):** Act as a push-pull class AB amplifier for delivering high current to the load.
- **R4 & R3 (39.2Ω each):** Provide emitter degeneration for better linearity.
- **R9 & R10 (10Ω each):** Improve stability and current sharing in the push-pull stage.
- **R14 (100Ω):** Ensures proper biasing at the output stage.

(E) Power Supply Decoupling

- **C3 & C2 (10µF each):** Provide decoupling to stabilize power supply rails (+24V and -24V).
- **R11 (10kΩ):** Works with D3 and D4 for proper biasing.

(F) Load Considerations

- **R_L (≥500Ω):** The circuit is designed to drive a load of at least 500Ω. If more power is required, a buffer stage may be needed.

3. Performance Analysis

- **Voltage Gain:** ~11 (set by R1 and R2)
- **Output Swing:** Close to ±24V but limited by transistor saturation.
- **Frequency Response:** Determined by C1, C2, and associated resistances.
- **Output Impedance:** Low, ensuring it can drive moderate loads with minimal distortion.

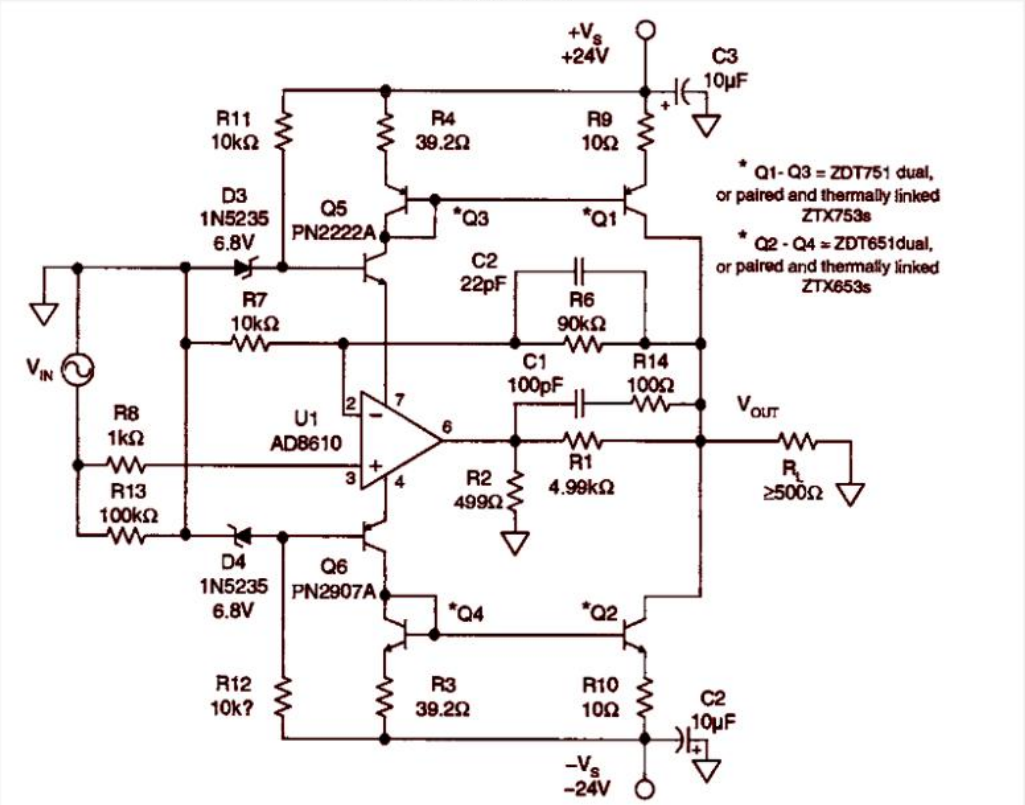
4. Enhancements for 20V Sine Wave Output

- **Increase supply voltage (if components allow) to ensure full 20V swing.**
- **Add a buffer stage (e.g., Class AB MOSFET amplifier) for higher current drive.**
- **Use a transformer at the output for voltage scaling and isolation if required.**

Conclusion

This circuit effectively amplifies the input signal with low distortion and stable operation. By adding a buffer stage, it can be adapted to drive higher power loads and achieve a 20V sine wave output.

FIGURE A


+Vs
+24V
C3
10µF
R11
10kΩ
R4
39.2Ω
R9
10Ω
* Q1- Q3 = ZDT751 dual, or paired and thermally linked ZTX753s
* Q2 - Q4 = ZDT651dual, or paired and thermally linked ZTX653s
D3
1N5235
6.8V
Q5
PN2222A
*Q3
*Q1
C2
22pF
R7
10kΩ
R6
90kΩ
VIN
C1
100pF
R14
100Ω
VOUT
R8
1kΩ
U1
AD8610
R1
4.99kΩ
RL
≥500Ω
R13
100kΩ
R2
499Ω
D4
1N5235
6.8V
Q6
PN2907A
*Q4
*Q2
R12
10k?
R3
39.2Ω
R10
10Ω
C2
10µF
–Vs
–24V