Stage 2 Design

⇒ Designed with I_{BZ} = max, lowers gain A_{V2} to insert clipping stage before

$\beta = 160$, $R_E = 680\Omega$, $R_2 = 10K\Omega$

↳ 10.88 KΩ exact

$\boxed{I_{BZ} \cong 15\,\mu A}$

$I_C = \beta I_B = (160)(15\mu A)$

$\boxed{I_C = 2.4mA}$

$I_C \cong \boxed{I_E \cong 2.4mA}$

$V_C = 4.5V = 9V - 2.4mA(R_C + 680)$

$\left(\frac{-4.5V}{-2.4mA}\right) - 680 = \boxed{R_C = 1195\Omega}$ → Choose 1k or 1.5k

R_1:

$2.33Z = 9V\left(\frac{10,88K}{10.88K + R_1}\right)$

$\boxed{R_1 = 31110\Omega}$

↳ 33k

$I_E = V_E / R_E$

$2.4mA(680) = \boxed{V_E = 1.632\,V}$

$V_B = V_E + 0.7$

$\boxed{V_B = 2.332\,V}$

Simulated:

R_1	33K	I_B	12.6 μA
R_2	10 K	V_B	2 V
R_C	1K	I_C	1.92mA
R_E	680	V_C	7.08V

→ increase R_C / Decrease R_E (≥625)

↳ ~~1.5K~~ 2.2K

R_1	33K	I_B	12.9 μA
R_2	10K	V_B	1.99V
R_C	2.2K	I_C	1.92mA
R_E	680	V_C	4.78 V

Stage 2 DC param. | For Adding Clipping

$R_1 = 33k$, $R_2 = 10k$, $R_C = 2.2k$, $R_E = 680$

$\beta R_E \geq 10 R_2$

$(160)(680) \geq 10(10k) \rightarrow 108k \geq 100k$ ✓

$V_B = 9V\left(\frac{10k}{43k}\right) = \boxed{2.09V = V_B}$

$V_E = V_B - V_{BE} = 2.09 - 0.7 = \boxed{1.39V = V_E}$

$I_E = V_E / R_E = 1.39V / 680\Omega = \boxed{2.04mA = I_E}$

$I_E \cong I_C$, $\boxed{I_C \cong 2.04mA}$

$V_C = V_{CC} - I_C(R_C + R_E)$

$= 9 - 2.04mA(2.2k + 680)$

$\boxed{V_C = 2.09V}$

$I_B = \frac{I_C}{\beta} = \frac{2.04mA}{160} = 15\mu A$ ✓

$\boxed{I_B = 15\mu A}$

V_B	2.09V
V_C	2.09V
V_E	1.39V
I_B	15 μA
I_C	2.04mA
I_E	2.04mA

simulated

$V_B =$	1.99V
$V_C =$	1.92V
$V_E =$	1.31V
$I_B =$	12.9 μA
$I_C =$	1.92mA
$I_E =$	1.93mA

$A_{V,NL} = \frac{R_C}{-R_E}$

$= -\frac{2.2k}{680} \cong \boxed{-3.2 V/V} \leftarrow \boxed{A_{V0,2}} \rightarrow$

Simulated $\frac{V_o}{V_i} = \frac{18.112mV}{-5.906mV}$

$\boxed{= -3.1 V/V}$

Gain Parameters (modified)

Stage 1

$$r_e = \frac{26mV}{661\mu A} = 39.33\Omega$$

$$Z_i = R_1 \| R_2 \| \beta(r_e + R_E)$$

$$= 68K \| 10K \| 160(39.33+680$$

$$\boxed{Z_i = 8.1\ k\Omega}$$

$$\boxed{Z_o \cong R_C = 6.8K}$$

$$A_V = -\frac{R_C \| R_L}{R_E}$$

$$A_{V,1} = \frac{6.8K \| 7.18K}{-680}$$

$$\boxed{A_{V,1} = -5.14\ V/V}$$

Stage 2

$$r_e = \frac{26mV}{2.04mA} = 12.75\Omega$$

$$Z_i = R_1 \| R_2 \| \beta(r_e + R_E)$$

$$= 33K \| 10K \| 160(12.75+680)$$

$$\boxed{Z_i = 7.18K\Omega}$$

$$\boxed{Z_o \cong R_C = 2.2\ K\Omega}$$

$$A_{V2,NL} = -\frac{R_C}{R_E} = -\frac{2.2K}{680}$$

$$\boxed{A_{VO,2} = -3.24}$$

Total

$$A_{VT(NL)} = (A_{V,1}) \cdot (A_{V(NL),2})$$

$$A_{VT,NL} = (-5.14)(-3.24) = 16.65\ V/V$$

$$A_{VT,L} = \left(\frac{100K}{100K+2.2K}\right)16.65 = \boxed{16.29\ V/V}$$