

1 半导体二极管

$$I_D = I_S(e^{\frac{U_D}{U_T}} - 1), \quad U_T = 26\text{mv} \quad (1.1)$$

$$R_D = \frac{U_D}{I_D}, \quad \text{静态电阻} \quad (1.2)$$

$$r_d = \frac{U_T}{I_D}, \quad \text{动态电阻} \quad (1.3)$$

$$I_{Z\min} \leq I_Z \leq I_{ZM} \Leftrightarrow \frac{U_{I(\max)} - U_Z}{I_{O(\min)} + I_{ZM}} \leq R \leq \frac{U_{I(\min)} - U_Z}{I_{O(\max)} + I_{Z(\min)}} \quad (1.4)$$

2 晶体管

$$U_{opp} = \max\{2I_{CQ}R'_L, \quad 2(U_{CEQ} - U_{CES})\} \quad (2.1)$$

$$r_{be} = r_{bb'} + (1 + \beta) \frac{U_T}{I_{EQ}} \quad (2.2)$$

$$f_{Htr} \approx 0.35 \quad (2.3)$$

2.1 下限截止频率

$$\dot{A}_{uLs} = \frac{\dot{A}_{ums}}{(1 - j\frac{f_{L1}}{f})(1 - j\frac{f_{L2}}{f})} \quad (2.4)$$

$$C'_1 = \frac{C_1 C_E}{(1 + \beta_0)C_1 + C_E} \quad (2.5)$$

$$f_{L1} = \frac{1}{2\pi(R_s + r_{be})C'_1} \quad (2.6)$$

$$f_{L2} = \frac{1}{2\pi(R_C + R_L)C_2} \quad (2.7)$$

2.2 上限截止频率

$$\dot{A}_{uHs} = \frac{\dot{A}_{ums}}{(1 - j\frac{f}{f_{H1}})(1 - j\frac{f}{f_{H2}})} \quad (2.8)$$

$$f_{H1} = \frac{1}{2\pi R'_s C_i} \quad (2.9)$$

$$f_{H2} = \frac{1}{2\pi R'_L C_o} \quad (2.10)$$

$$C_M = C_{b'c}(1 - \dot{A}) \quad (2.11)$$

$$C'_{ce} = C_{b'c}\left(1 - \frac{1}{\dot{A}}\right) \quad (2.12)$$

$$r_{b'e} = (1 + \beta) \frac{U_T}{I_{EQ}} \quad (2.13)$$

$$R'_s = (R_s + r_{bb'}) // r_{b'e} \quad (2.14)$$

$$R'_L = R_C // R_L \quad (2.15)$$

$$C_i = C_M + C_{b'e} \quad (2.16)$$

$$C_o = C_{ce} + C'_{ce} \quad (2.17)$$

2.3 多级放大电路的频率响应

$$f_L \approx 1.1 \left(\sum_i f_{L_i}^2 \right)^{\frac{1}{2}} \quad (2.18)$$

$$f_H \approx 0.9 \left(\sum_i f_{H_i}^{-2} \right)^{-\frac{1}{2}} \quad (2.19)$$

3 场效应管

$$i_D = I_{DSS} \left(1 - \frac{u_{GS}}{u_{GS(of)}} \right)^2 \quad (3.1)$$

$$g_m = -\frac{2}{U_{GS(of)}} \sqrt{I_{DSS} I_{DQ}} \quad (3.2)$$

$$i_D = K(u_{GS} - U_{GS(th)})^2 \quad (3.3)$$

$$g_m = 2\sqrt{KI_{DQ}} \quad (3.4)$$

3.1 共源

$$\dot{A}_u = -g_m(r_{ds} // R_D // R_L) \quad (3.5)$$

$$R_i = R_G \quad (3.6)$$

$$R_o = r_{ds} // R_D \quad (3.7)$$

4 集成运算放大器

$$I_B = \frac{V_{EE} - U_{BE}}{R_B + 2(1 + \bar{\beta})R_E} \quad (4.1)$$

$$I_E \approx I_C \approx \frac{V_{EE} - U_{BE}}{2R_E} \quad (4.2)$$

$$U_{CEQ} \approx V_{CC} + V_{EE} - I_C(R_C + 2R_E) \quad (4.3)$$

$$K_{CMR} = \left| \frac{A_{ud}}{A_{uc}} \right| = \frac{\beta R_E}{R_E + r_{be}} \quad | \quad \infty \quad (4.4)$$

4.1 差模

$$A_{ud} = \pm \frac{\beta R_C}{2(R_B + r_{be})} \quad | \quad - \frac{\beta R_C (// \frac{R_L}{2})}{R_B + r_{be}} \quad (4.5)$$

$$R_{id} = 2(R_B + r_{be}) \quad (4.6)$$

$$R_{od} = R_C \quad | \quad 2R_C \quad (4.7)$$

4.2 共模

$$A_{uc} = \frac{\beta R_C (// R_L)}{R_B + r_{be} + 2(1 + \beta)R_E} \quad | \quad 0 \quad (4.8)$$

$$R_{ic} = R_B + r_{be} + 2(1 + \beta)R_E \quad (4.9)$$

4.3 含源电路

$$I_{C2} = \frac{V_{CC}}{R} \quad (4.10)$$

$$I_{C2} = \frac{V_{CC}}{R + R_{E1}} \frac{R_{E1}}{R_{E2}} \quad (4.11)$$

$$R_E = \frac{U_T}{I_{C2}} \ln \frac{I_R}{I_{C2}} \quad (4.12)$$

5 反馈电路

$$A_f = \frac{A}{1 + AF} \quad (5.1)$$

$$\frac{dA_f}{A_f} = \frac{dA}{A} \frac{1}{1 + AF} \quad (5.2)$$

$$f_{Hf} = f_H(1 + A_m F) \quad (5.3)$$

$$f_{Lf} = \frac{f_L}{(1 + A_m F)} \quad (5.4)$$

$$R_{if} = \frac{1}{1 + AF} R_i \quad (5.5)$$

$$R_{of} = (1 + AF) R_o \quad (5.6)$$

6 运算电路

$$u_O = -\frac{1}{RC} \int u_I dt \quad | \quad + u_O(t_1) \quad (6.1)$$

$$u_O = -RC \frac{du_I}{dt} \quad (6.2)$$

$$u_O \approx -U_T \ln\left(\frac{u_I}{I_S R}\right) \quad (6.3)$$

$$u_O \approx -I_S R e^{\frac{u_I}{U_T}} \quad (6.4)$$

7 功率放大电路

$$I_{C(AV)} = \frac{1}{\pi} \frac{U_{om}}{R_L} \quad (7.1)$$

$$P_V = \frac{2}{\pi} \frac{V_{CC} U_{om}}{R_L} \quad (7.2)$$

$$\eta = \frac{\pi U_{om}}{4 V_{CC}} \quad (7.3)$$

8 直流稳压电源

$$U_{O(AV)} = \frac{2\sqrt{2}}{\pi} U_2 = 0.9U_2 \quad (8.1)$$

$$\gamma = \frac{U_{or}}{U_{O(AV)}} \quad (8.2)$$

$$\gamma = \frac{U_{or}}{U_{O(AV)}} = \sqrt{\left(\frac{U_2}{U_{O(AV)}}\right)^2 - 1} = 0.483 \quad (8.3)$$

$$U_O = \frac{R_1 + R_P + R_2}{R_2 + \frac{1}{2}R_P} U_{REF} \quad (8.4)$$