APPENDIX D

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1 Cherry-hooper impedance

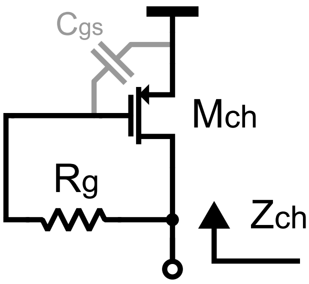

Figure 0.1. Cherry-hooper circuit.

$$\frac{V_x - V_g}{R_D} = V_g \cdot C_{gs}s$$
$$\frac{V_x}{R_D} = V_g \left(\frac{1}{R_D} + C_{gs}s\right)$$
$$V_g = \frac{V_x}{R_D} \cdot \frac{R_D}{1 + R_D C_{gs}s}$$
$$V_g = \frac{V_x}{1 + R_D C_{gs}s}$$

$$I_x = \frac{V_x - V_g}{R_g} + g_m V_g$$
$$I_x = \frac{V_x}{R_g} + \left(g_m - \frac{1}{R_g}\right) \cdot \frac{V_x}{1 + R_g C_{gs}s}$$
$$\frac{I_x}{V_x} = \frac{(1 + R_g C_{gs}s) + R_g \left(g_m - \frac{1}{R_g}\right)}{R_g(1 + R_g C_{gs}s)}$$
$$\frac{I_x}{V_x} = \frac{R_g g_m + R_g C_{gs}s}{R_g(1 + R_g C_{gs}s)}$$
$$\frac{V_x}{I_x} = \frac{1 + R_g C_{gs}s}{g_m + C_{gs}s}$$

$$Z_{ch} = \frac{1}{g_m} \cdot \frac{1 + R_g C_{gs}s}{1 + \frac{C_{gs}s}{g_m}} \tag{1}$$

2 Cross-coupled pair impedance

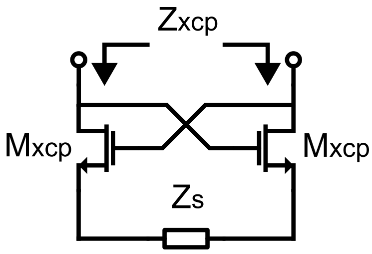

Figure 0.2. Cross-coupled pair circuit.

$$I_x = -g_m V_1$$
$$V_1 = -\frac{I_x}{g_m}$$
$$I_x = -g_m(V_x - V_2)$$
$$V_2 = V_x + \frac{I_x}{g_m}$$

$$I_x = \frac{V_x - V_2}{Z_s}$$
$$I_x = \frac{-I_x}{g_m Z_s} - \frac{V_x}{Z_s} - \frac{I_x}{g_m Z_s}$$
$$-\frac{V_x}{Z_s} = I_x\left[1 + \frac{2}{g_m Z_s}\right]$$
$$\frac{V_x}{I_x} = -\frac{2}{g_m} - Z_s$$

if $Z_s = \frac{1}{Cs}$

$$Z_{xcp} = -\frac{2}{g_m} - \frac{1}{sC} \tag{2}$$

3 Cross-coupled pair impedance

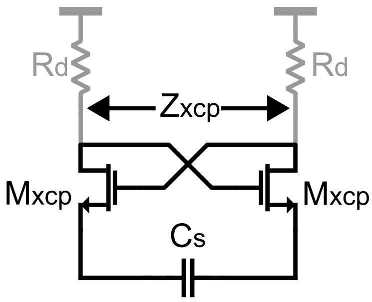

Figure 0.3. Cross-coupled pair with equivalent resistors.

$$Z_{xcp} = \frac{R_d\left[-\frac{2}{g_m} - \frac{1}{sC}\right]}{R_d - \frac{Z}{g_m} - \frac{1}{sC}}$$

$$Z_{xcp} = \frac{-2Cs - g_m}{g_m Cs - \frac{2Cs}{R_d} - \frac{g_m}{R_d}}$$

$$Z_{xcp} = \frac{g_m\left[1 + \frac{2C}{g_m}s\right]}{\frac{g_m}{R_d} + sC\left[\frac{2}{R_d} - g_m\right]}$$

$$Z_{xcp} = \frac{g_m\left[1 + \frac{2C}{g_m}s\right]}{\frac{g_m}{R_d}\left[1 + \frac{sC}{g_m}\left(2 - g_m R_d\right)\right]}$$

$$Z_{xcp} = R_d \cdot \frac{1 + \frac{2C}{g_m}s}{1 + \frac{sC}{g_m}\left(2 - g_m R_d\right)} \quad (3)$$