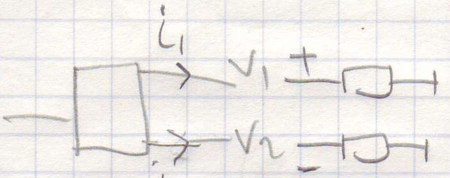
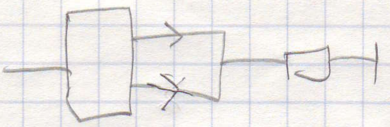
CMRR



i_2 is negative for diff. mode

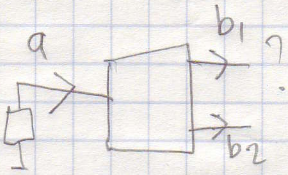
$V_{dm} = V_1 - V_2$

i_{dm} = av of i_1 and i_2 $= \frac{i_1 - i_2}{2}$



V_{cm} = av of V_1 and V_2 $= \frac{V_1 + V_2}{2}$

$i_{cm} = i_1 - i_2 \longrightarrow$ not +?



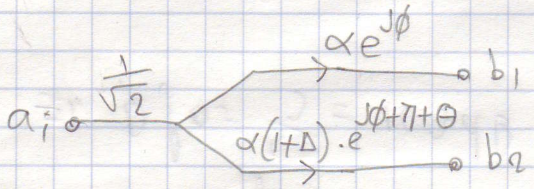
$CMRR = \left|\frac{b_{dm}}{b_{cm}}\right| =$

$\boxed{\text{can be shown}}$ $b_{dm} = \frac{1}{\sqrt{2}}(b_1 - b_2)$

$b_{cm} = \frac{1}{\sqrt{2}}(b_1 + b_2)$

voltage waves: $b_n = \frac{V_n^-}{\sqrt{2 Z_{on}}}$

imbalanced 3dB 180° splitter: error = Δ and θ



α - balanced loss

$$b_{dm} = \frac{a_i}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}(b_1 - b_2) = \frac{1}{2}\left(\alpha a_i e^{j\phi} - \alpha a_i e^{j\phi+\pi+\theta} - \alpha \cdot a_i \cdot \Delta \cdot e^{j\phi+\pi+\theta}\right).$$

$$= \frac{\alpha a_i e^{j\phi}}{2} \cdot \underbrace{\left(1 - e^{j\pi+\theta} - \Delta \cdot e^{j\pi+\theta}\right)}_{1 + e^{j\theta} + \Delta e^{j\theta} = 1 \pm (1+\Delta) e^{j\theta}} =$$

π means $\times -1$

$\boxed{\text{\& for common mode (no } \pi)}$ $\longrightarrow$ $1 - e^{j\theta} - \Delta e^{j\theta} = 1 - (1+\Delta) e^{j\theta}$

$\boxed{\text{if } \theta << 1 \Rightarrow e^{j\theta} \approx 1 + j\theta}$ $\Rightarrow$ $\cancel{b_{dm} = \frac{\alpha a_i e^{j\theta}}{2} \cdot \left(1 - (1+j\theta) - \Delta(1+j\theta)\right)/2}$

$\cancel{-j\theta - \Delta - j\theta}$