Design a passive network interface circuit between the DAC38J84 and TRF3704 modulator. Figure 1 shows the equivalent circuit of the network. The following constraints are given:

$Vdd := 5.0$ Pull up supply

$Vm := 1.7$ Common mode voltage of the modulator

$Vd := 0.25$ Desired DAC operating point

$Id := 10 \cdot mAmp$ Average DAC current at max gain

$It := 20 \cdot mAmp$ Max DAC current at max gain

$ZL := 25$ DAC load impedance

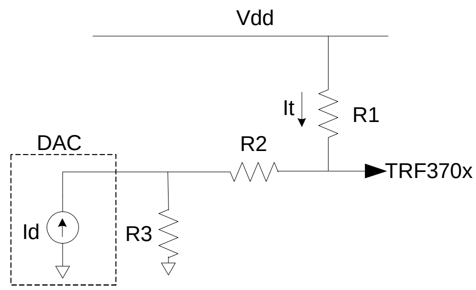

Figure 1

Solve network equations given It and Id:

$$Vdd - It \cdot (R1 + R2) = (Id + It) \cdot R3$$

Rearrange equation to solve for It as a function of Id:

$$\frac{Vdd - Id \cdot R3}{R1 + R2 + R3} = It$$

Solve for resistor values:

Guess $R1 := 2700$

$R2 := 1000$

$R3 := 25$

$TOL := 0.01$ $CTOL := 0.01$

Given

$$It = \frac{Vdd - Id \cdot (R3)}{R1 + R2 + R3}$$

$Vdd - It \cdot R1 = Vm$ This sets Vcomm for modulator

$Vdd - It \cdot (R1 + R2) = Vd$ Sets Vd to be AVdd (3.3V) +/- 0.1 V

$pll(R3, R1 + R2) = ZL$ This sets DAC load to ensure desired output swing

$R1 < 2210$

$R := Find(R1, R2, R3, It)$

$R1 := R_0$ $R1 = 2.21 \times 10^3$

$R2 := R_1$ $R2 = 971.061$

$R3 := R_2$ $R3 = 25.198$

$Itt := R_3$ $Itt = 1.493 \times 10^{-3}$

Substitute realizable values =======>

$R1 := 2.21 \cdot k$

$R2 := 953$

$R3 := 25.0$

Verify Solution:

$$It(I_d) := \frac{Vdd - I_d \cdot (R3)}{R1 + R2 + R3}$$

$Vd(I_d) := Vdd - It(I_d) \cdot (R1 + R2)$ $\quad Vd(Id) = 0.289$ Verify DAC operating point

$Vm(I_d) := Vdd - It(I_d) \cdot R1$ $\quad Vm(Id) = 1.727$ Verify modulator common mode voltage

$Vdmax := Vd(2 \cdot Id)$ $\quad Vdmax = 0.539$

$Vdmin := Vd(0)$ $\quad Vdmin = 0.039$

$\Delta := Vdmax - Vdmin$ $\quad \Delta = 0.5$ Verify DAC output swing

$Z_L := pll(R3, R1 + R2)$ $\quad Z_L = 25$ Verify DAC Load

$IL := A\left(\Delta, \Delta \cdot \frac{R1}{R1 + R2}\right)$ $\quad IL = 3.164$ Insertion loss of the network

Results: This approach uses one supply and minimizes the insertion loss while providing no more than 1 Vpp swing on the DAC. Substitute actual values

$R1 := 2.21 \cdot k$

$R2 := 953$

$R3 := 25.0$

Network parameters when using actual values:

$$It(I_d) := \frac{Vdd - I_d \cdot (R3)}{R1 + R2 + R3}$$

$Vd(I_d) := Vdd - It(I_d) \cdot (R1 + R2)$ $\quad Vd(Id) = 0.287$ DAC operating point

$Vm(I_d) := Vdd - It(I_d) \cdot R1$ $\quad Vm(Id) = 1.707$ Modulator common mode voltage

$Vdmin := Vd(2 \cdot Id)$ $\quad Vdmin = 0.535$

$Vdmax := Vd(0)$ $\quad Vdmax = 0.039$

$\Delta := Vdmax - Vdmin$ $\quad \Delta = -0.496$ DAC output swing

$Z_L := pll(R3, R1 + R2)$ $\quad Z_L = 24.804$ DAC Load

$IL := A\left(\Delta, \Delta \cdot \frac{R1}{R1 + R2}\right)$ $\quad IL = 3.114$ Insertion loss of the network

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