Digital Resistor Sets Operating Power For Laser Driver

By James Horste
ED Online 14977

Derivation of Equations

Equation for Opamp Output Voltage

$$V_{OUT} = V_{REF} \cdot \left(-\frac{R_{DS1859}}{R_3} \right) + V_{MD} \cdot \left(1 + \frac{R_{DS1859}}{R_3} \right)$$

Rearrange Terms

$$V_{OUT} = V_{MD} + \frac{\left(V_{MD} - V_{REF} \right) \cdot R_{DS1859}}{R_3}$$

Substitute 0.2V for Reference Voltage - Modulation Voltage

$$V_{OUT} = V_{MD} - \frac{0.2V \cdot R_{DS1859}}{R_3}$$

Equation for Current through R2

$$I_{R2} = \frac{V_{OUT} - V_{MD}}{R_2}$$

Substitute in equation for OpAmp Output Voltage

$$I_{R2} = \frac{\left(V_{MD} - \frac{0.2V \cdot R_{DS1859}}{R_3} \right) - V_{MD}}{R_2}$$

Modulation voltage terms cancel out

$$I_{R2} = \frac{-0.2V \cdot R_{DS1859}}{R_3 \cdot R_2}$$

Equation for Current through R1

$$I_{R1} = \frac{V_{REF} - V_{MD}}{R_1}$$

Substitute 0.2V for Reference Voltage - Modulation Voltage

$$I_{R1} = \frac{0.2}{R_1}$$

Equation for Current through Photo Diode

$$I_{PD} = I_{R1} + I_{R2}$$

Substitute equations for R1 Current and R2 Current

$$I_{PD} = \frac{0.2}{R_1} - \frac{0.2V \cdot R_{DS1859}}{R_3 \cdot R_2} \qquad R_1 = 249 \quad R_2 = 1240 \quad R_3 = 10000$$

$I_{PD} = 787uA$ DS1859 Resistance = 1K $I_{PD} = -3.3uA$ DS1859 Resistance = 50K

Design Procedure

Select Desired Photodiode Min and Max current

$I_{PDmax} \equiv 800 \cdot 10^{-6}$ $I_{PDmin} \equiv 0$

$I_{PDdelta} := I_{PDmax} - I_{PDmin}$ $I_{PDdelta} = 8 \cdot 10^{-4}$

DS1859 Min and Max Values

$R_{DS1859max} \equiv 50000$ $R_{DS1859min} \equiv 1000$

$R_{DS1859delta} := R_{DS1859max} - R_{DS1859min}$ $R_{DS1859delta} = 4.9 \cdot 10^{4}$

OpAmp Output Voltage Range

$V_{OUTmax} \equiv 2.0$ $V_{OUTmin} \equiv 0$

$V_{OUTdelta} := V_{OUTmax} - V_{OUTmin}$ $V_{OUTdelta} = 2$

Modulation Voltage Min and Max

$V_{MDmin} \equiv 1$ $V_{MDmax} \equiv 2$

$V_{MDdelta} \equiv V_{MDmax} - V_{MDmin}$ $V_{MDdelta} = 1$

$$R_1 := \frac{0.2}{I_{PDmax}} \qquad R_1 = 250$$

$$R_3 := \frac{0.2 \cdot R_{DS1859delta}}{\langle V_{OUTdelta} - V_{MDdelta} \rangle} \qquad R_3 = 9.8 \cdot 10^{3}$$

$$R_2 := 0.2 \cdot \frac{R_{DS1859delta}}{\langle I_{PDdelta} R_3 \rangle} \qquad R_2 = 1.25 \cdot 10^{3}$$