$$\frac{D(s)}{I_{FB}(s)} = -G_{PWM}\frac{1}{1+s/\omega_{p_2}} \tag{8.34}$$

If we now combine expressions given by (8.33) and (8.34), we obtain the complete chain from the compensator input to the duty ratio output:

$$\frac{D(s)}{V_{out}(s)} = -G_0\frac{(1+\omega_{z_2}/s)(1+s/\omega_{z_1})(1+s/\omega_{z_3})}{(1+s/\omega_{p_1})(1+s/\omega_{p_2})(1+s/\omega_{p_3})} \tag{8.35}$$

In (8.35), we have

$$G_0 = \frac{\text{CTR}}{R_{LED}}G_{PWM} \tag{8.36}$$

P.455

$$\omega_{z_1} = \frac{1}{R_s C_{V_{cc}}} \tag{8.37}$$

$$\omega_{z_2} = \frac{1}{R_1 C_1} \tag{8.38}$$

$$\omega_{z_3} = \frac{1}{sC_3(R_{LED}+R_3)} \tag{8.39}$$

P.455

$$\omega_{p_1} = \frac{1}{(R_d+R_s)C_{V_{cc}}} \tag{8.40}$$

$$\omega_{p_2} = 44 \text{ krad/s} \tag{8.41}$$

→ 7kHz

$$\omega_{p_3} = \frac{1}{sR_3C_3} \tag{8.42}$$

The resistor setting the mid-band gain is the LED series resistor. We first start by extracting the magnitude of the compensator gain, $G(s)$, as derived in (8.35):

$$|G(f_c)| = \frac{\text{CTR}}{R_{LED}}G_{PWM}\frac{\sqrt{1+(f_{z_2}/f_c)^2}}{\sqrt{1+(f_c/f_{p_1})^2}}\frac{\sqrt{1+(f_c/f_{z_1})^2}}{\sqrt{1+(f_c/f_{p_2})^2}}\frac{\sqrt{1+(f_c/f_{z_3})^2}}{\sqrt{1+(f_c/f_{p_3})^2}} \tag{8.43}$$

From which we can extract the value of the LED resistor:

$$R_{LED} = \frac{\text{CTR}}{G}G_{PWM}\frac{\sqrt{1+\left(\frac{f_{z_2}}{f_c}\right)^2}}{\sqrt{1+\left(\frac{f_c}{f_{p_1}}\right)^2}}\frac{\sqrt{1+\left(\frac{f_c}{f_{z_1}}\right)^2}}{\sqrt{1+\left(\frac{f_c}{f_{p_2}}\right)^2}}\frac{\sqrt{1+\left(\frac{f_c}{f_{z_3}}\right)^2}}{\sqrt{1+\left(\frac{f_c}{f_{p_3}}\right)^2}} \tag{8.44}$$

The definitions to obtain C_3 and R_3 are rather simple to derive. Extract R_3 from (8.42):

$$R_3 = \frac{1}{2\pi f_{p_3}C_3} \tag{8.45}$$