connects *before* the secondary *LC* filter. This is done to avoid offering gain at high frequency when the *LC* network starts to resonate. This configuration is typical of flyback converters featuring high-frequency noise reduction via an *LC* filter. Make sure the resonant frequency of this filter is placed at least 10 times above the selected crossover frequency to avoid any interaction.

As it is placed, C_{zero} capacitor looks as if it introduces an origin pole. However, if we derive the transfer function of this complete feedback chain, we get the following results:

$$V_{FB}(s) = \left(V_{out}(s)\frac{1}{sR_{upper}C_{zero}} + V_{out}(s)\right)\frac{R_{pullup}}{R_{LED}}\text{CTR} \tag{3-56}$$

Rearranging the equation gives

$$\frac{V_{FB}(s)}{V_{out}(s)} = -\left(\frac{1}{sR_{upper}C_{zero}} + 1\right)\frac{R_{pullup}}{R_{LED}}\text{CTR} = -\left(\frac{sR_{upper}C_{zero} + 1}{sR_{upper}C_{zero}}\right)\frac{R_{pullup}}{R_{LED}}\text{CTR} \tag{3-57}$$

Equation (3-57) reveals the presence of an origin pole, f_{po} (as suspected . . .) plus a zero, f_z, introduced by the fast lane configuration. Unfortunately, if we want a type 2 amplifier, which is the most common type, we need a pole f_p somewhere. How can we obtain it? Simply by placing a capacitor from the output node to ground (Fig. 3-38a and b). If we update Eq. (3-57) with the presence of this pole, we obtain the final equation ruling the TL431 network as presented by Fig. 3-35b:

$$G(s) = \frac{V_{FB}(s)}{V_{out}(s)} = -\left(\frac{sR_{upper}C_{zero} + 1}{sR_{upper}C_{zero}}\right)\left(\frac{1}{1 + sR_{pullup}C_{pole}}\right)\frac{R_{pullup}}{R_{LED}}\text{CTR} \tag{3-58}$$

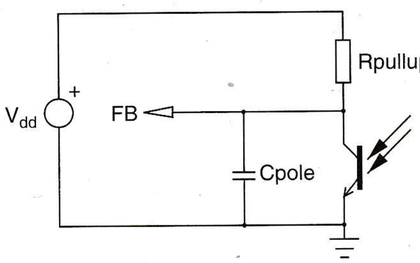
As usual, we can evaluate poles and the zero positions through the following definitions:

$$f_{po} = \frac{1}{2\pi R_{upper}C_{zero}} \tag{3-59}$$

$$f_z = \frac{1}{2\pi R_{upper}C_{zero}} \tag{3-60a}$$

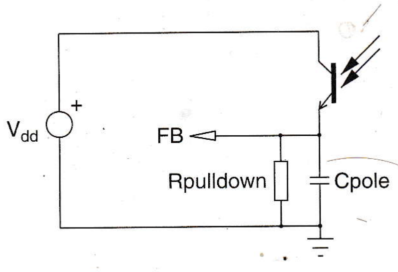
$$f_p = \frac{1}{2\pi R_{pullup}C_{pole}} \tag{3-60b}$$

$$G = \frac{R_{pullup}}{R_{LED}}\text{CTR} \tag{3-61}$$



a

FIGURE 3-38a A simple capacitor placed between the feedback pin and ground introduces a pole.



b

FIGURE 3-38b The same applies to a common collector configuration.