



BY BONNIE BAKER

Just use a 100Ω resistor

So there I was, a new hire for a leading-edge analog-electronics company. As it was my first job, I was wide-eyed and excited—confronting new problems left and right. One problem I ran into involved the stability of an amplifier circuit. In this application, a buffer-amplifier circuit, with a capacitive load, sang like a bird. Because I had a huge community of experts around me, I ran around and asked for advice. The

words of wisdom that came down to me were, “Oh, put a 100Ω load resistor between the amplifier output and the load capacitor.” When I asked why, the engineer said, “Just do it. Trust me; it will work.”

So, I built a new circuit as suggested, and, lo and behold, the circuit still oscillated. This new circuit was still singing, but it was producing a new

frequency. I returned to the engineer who gave me the first bit of great advice. His recommendation: “Change the 100Ω resistor to a 500Ω resistor,” still with no explanation. It solved my problem, but, given my work load, I did not return to his suggestion for several years. Now, it has come back to haunt me. I need to know what is really going on!

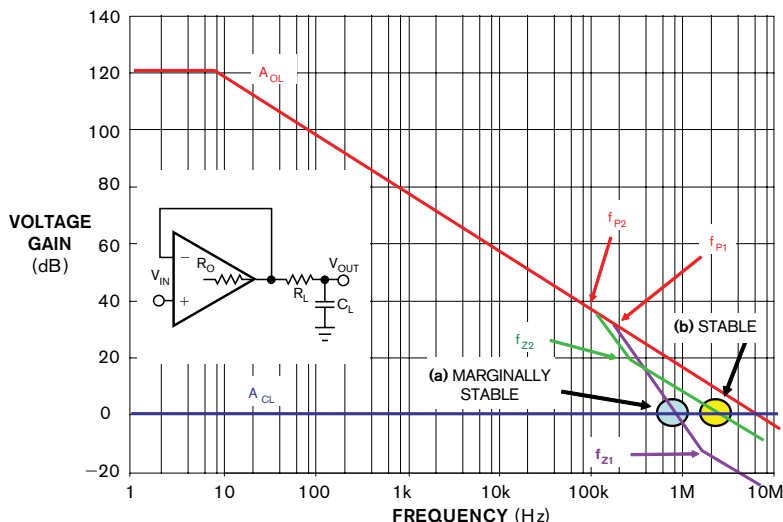


Figure 1 A buffer-amplifier circuit with a capacitive load can be marginally stable (a) or very stable (b). Keep the rate of closure between the open-loop-gain, A_{OL} , and the closed-loop-gain, A_{CL} , slope at 20 dB/decade.

What I did not understand then but understand now is that a capacitor and a resistor that hang on the output of an amplifier change the amplifier's open-loop-gain curve. The combination of the load capacitor, C_L ; the load resistor, R_L ; and the amplifier's open-loop resistance, R_O , introduces a pole to the open-loop-gain curve, and C_L and R_L then introduce a zero to the open-loop-gain curve (**Figure 1**). Creating this pole and zero does not disrupt the amplifier's stability as long as they cancel each other out before the open-loop-gain curve crosses the closed-loop-gain curve. If the open-loop-gain and closed-loop-gain curves cross with a 40-dB/decade closure rate, the amplifier circuit will be marginally unstable or, worse yet, will oscillate.

You can find the pole and zero locations in this circuit in the following equations:

$$f_p = \frac{1}{2\pi(R_O + R_L)C_L}$$

$$f_z = \frac{1}{2\pi R_L C_L}$$

What have I learned from this situation? It pays to understand why an engineer's rule of thumb works. If you comprehend the general guidelines, you will be OK. If you are not on top of the explanation, however, it will come back to bite you. **EDN**

REFERENCES

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