Circuit Challenge 7

The Situation
You are an integrated circuit designer. A last-minute change in the system configuration for your customer's PCB now requires that your die have a 0.2Ω sense resistor placed between two particular bonding pads. Unfortunately, the prototype design has just completed wafer fabrication. The die will be probed at the wafer level, diced & assembled, tested again in the final package, and samples will then be sent to your customer. The customer will not want to re-configure his PCB to account for the missing sense resistor. Nor can he afford to wait for a re-layout of your IC.

The Challenge
The bonding pads in question are adjacent to each other. Fortunately, they were configured for double bonds in such a way that you have an option to add a wire from one of the bonding pads to an unused pin, and a wire from the other bonding pad to the same pin. You consult with your packaging engineer and determine that in the aggregate the two additional bond wires will provide about 190 mils in length (accounting for looping, etc.). Assuming the sense resistor tolerance could have been +/- 25%, and knowing you have only 1-mil-diameter gold wire to work with, can this wire bonding adjustment serve to provide a suitable sense resistor? Make your decision, then compare with the analysis found by scrolling down.

Analysis for Challenge 7

First, the resistance of a length of wire is given by

$$R = \rho l/A$$

where ρ is the resistivity, l is the length, and A is the cross-sectional area.

The resistivity of gold is approximately 2.2×10^{-8} Ω•meter. So, for the wire in question we write

$$R = (2.2\times10^{-8}\ \Omega\bullet\text{meter})(190\text{mils})/[\pi(0.5\text{mil})^2]$$

This gives

$$R = 5.3\times10^{-6}\ \Omega\bullet\text{meter/mil}$$

There are 25.4 microns per mil, and 10^6 microns per meter. Thus,

$$R = (5.3\times10^{-6}\ \Omega\bullet\text{meter/mil})(1\text{mil}/25.4\text{micron})(10^6\text{micron/meter})$$

$$R \sim 0.21\ \Omega$$

This works! It is well within the specified window of $0.15\Omega \leq R_{Sense} \leq 0.25\Omega$.