

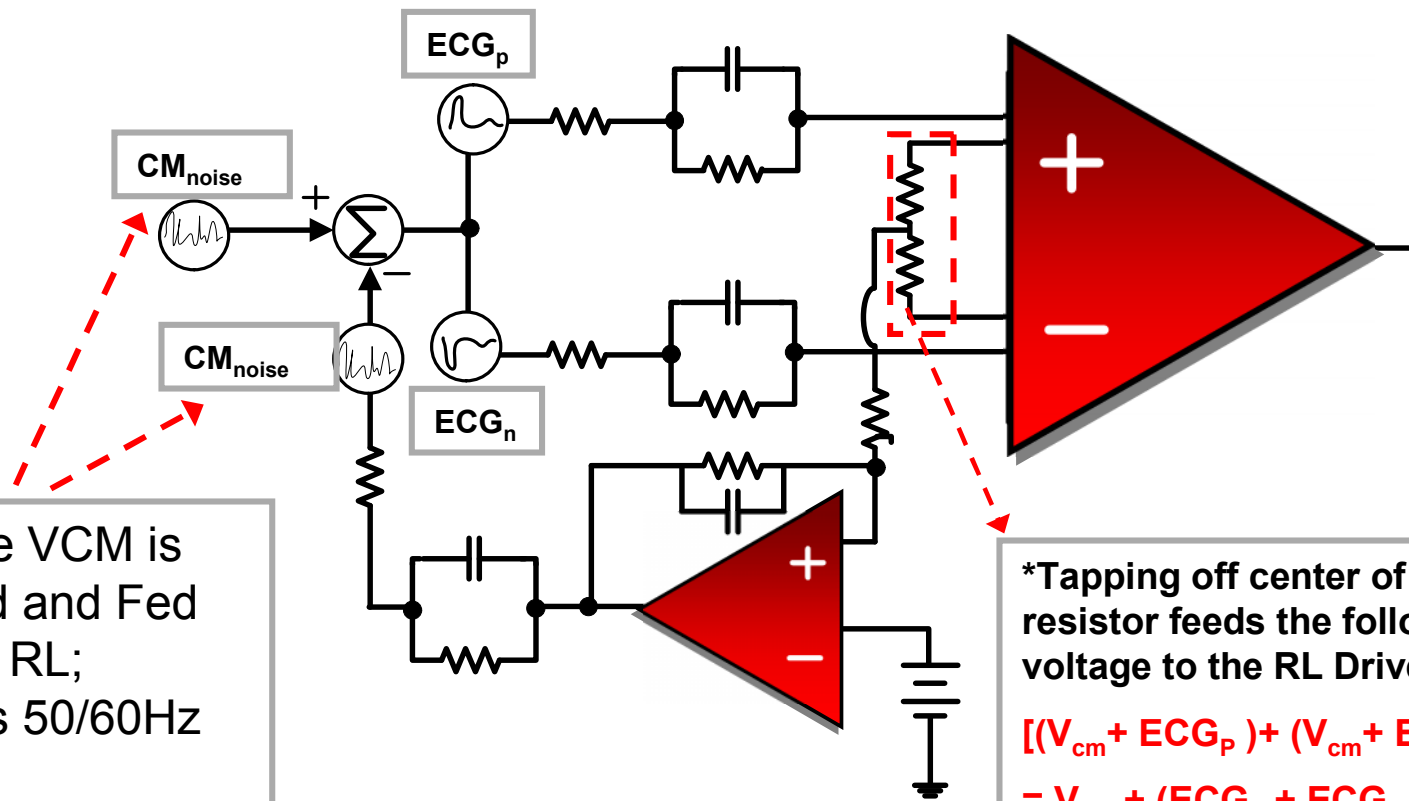


The Right Leg Drive Amplifier



The RL Drive Amplifier

The RL Drive Amplifier Serves 2 Purposes: (1) Common Mode Bias (2) Noise Cancellation



Average VCM is Inverted and Fed Back to RL; Cancels 50/60Hz noise

*Tapping off center of split gain resistor feeds the following voltage to the RL Drive Circuit

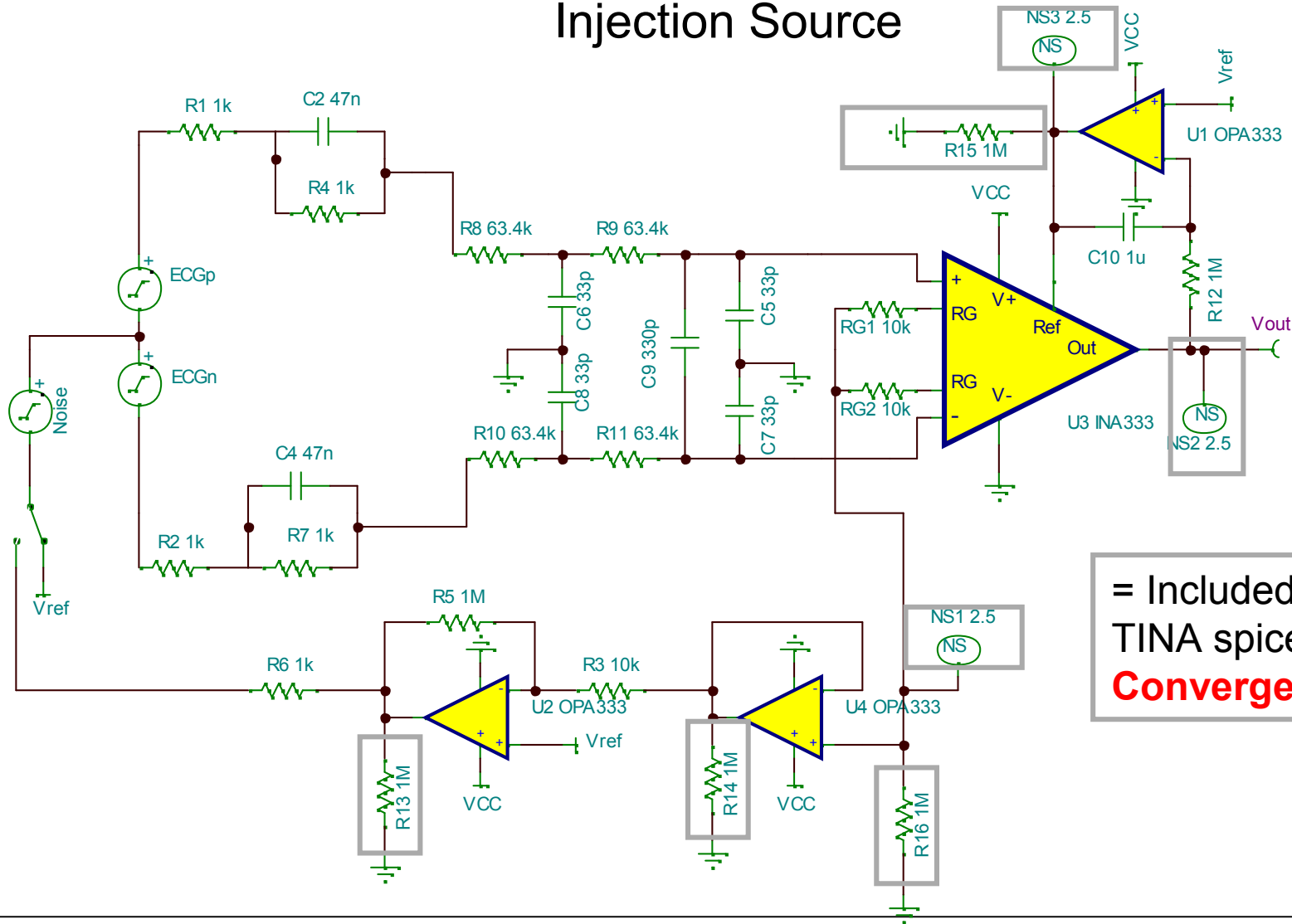
$$\frac{[(V_{cm} + ECG_p) + (V_{cm} + ECG_n)]}{2}$$

$$= V_{cm} + (ECG_p + ECG_n)/2$$



The INA Front End

Simulation Circuit for Response to 50/60 Hz CM Noise Injection Source

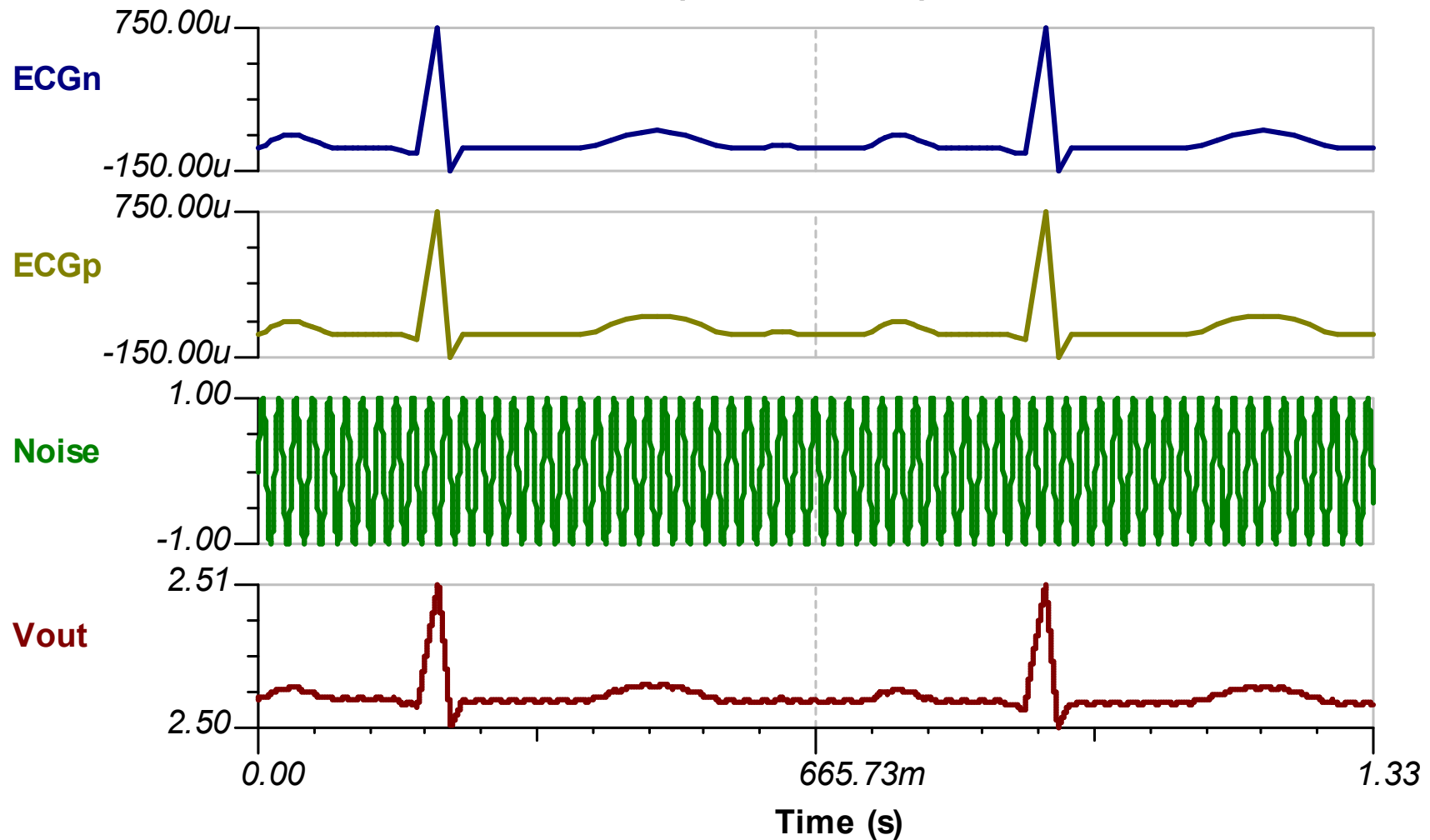


= Included for
TINA spice
Convergence



The INA Front End

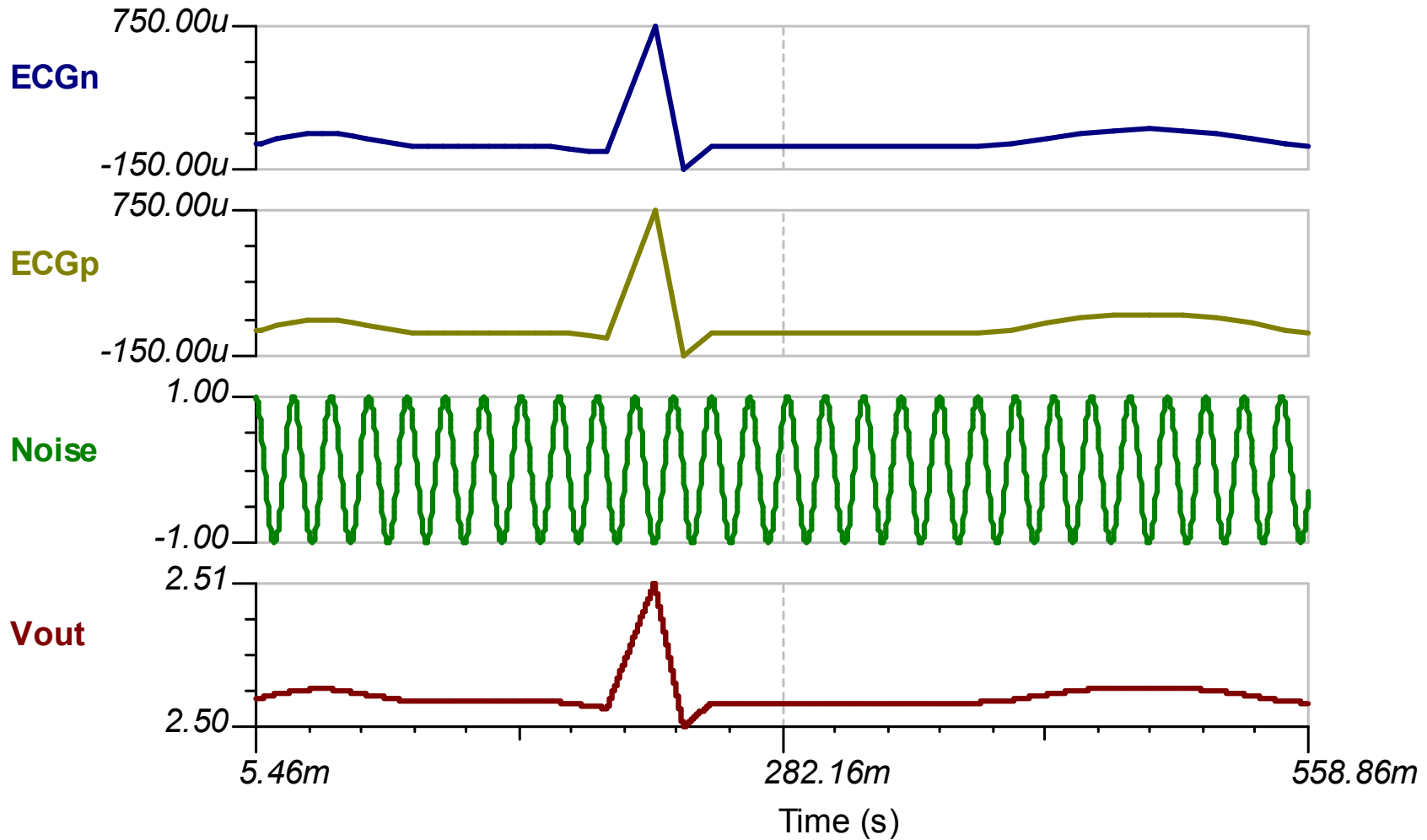
TINA Simulation with NO RL Drive; CM Noise is Coupled to Output





The INA Front End

TINA Simulation with RL Drive; Output Noise is Reduced



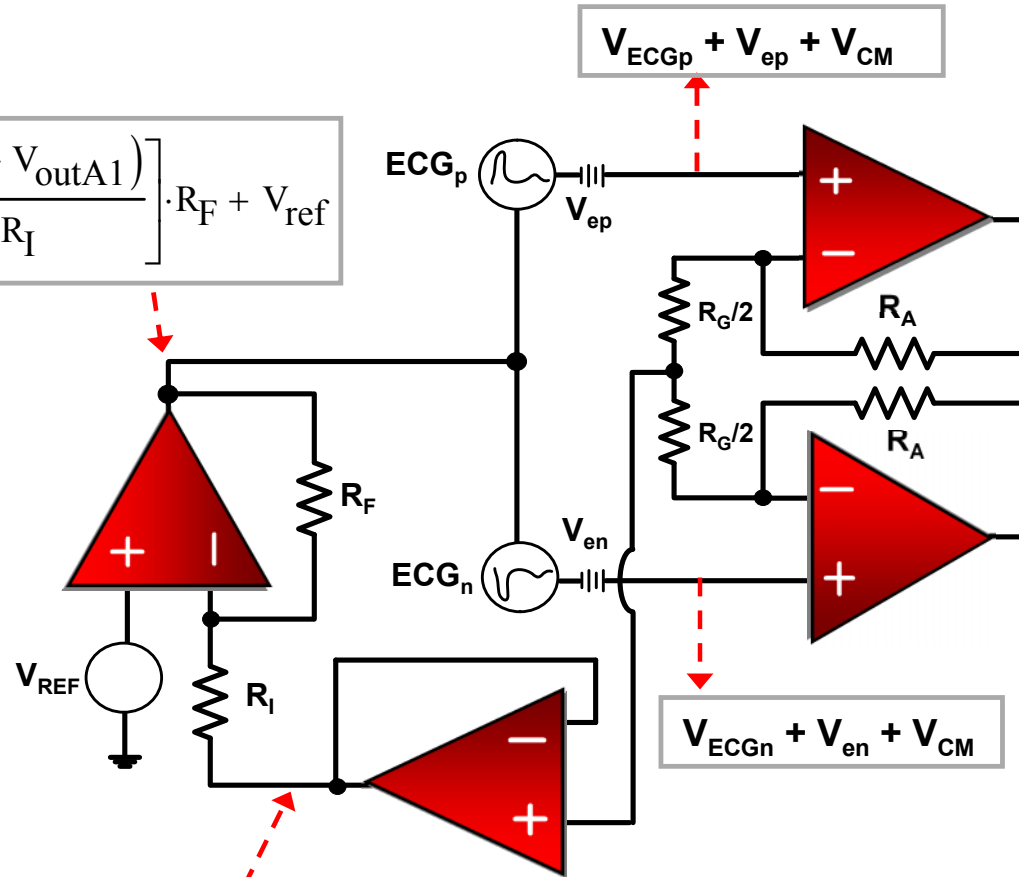


The INA Front End

Determining MAX Gain for the RLD Amplifier

$$V_{RL} = \left[\frac{(V_{ref} - V_{outA1})}{R_I} \right] \cdot R_F + V_{ref}$$

More Gain = Better CMRR
Gain *Limited* By Electrode Offset (MAX = ±300mV), $V_{OS_{A1}}$, and $V_{OS_{RLD}}$



$$V_{outA1} = \left[\frac{(V_{cm} + V_{ECGp} + V_{ep}) - (V_{cm} + V_{ECGn} + V_{en})}{R_G} \right] \cdot \left(\frac{R_G}{2} \right) + V_{OS_{A1}}$$

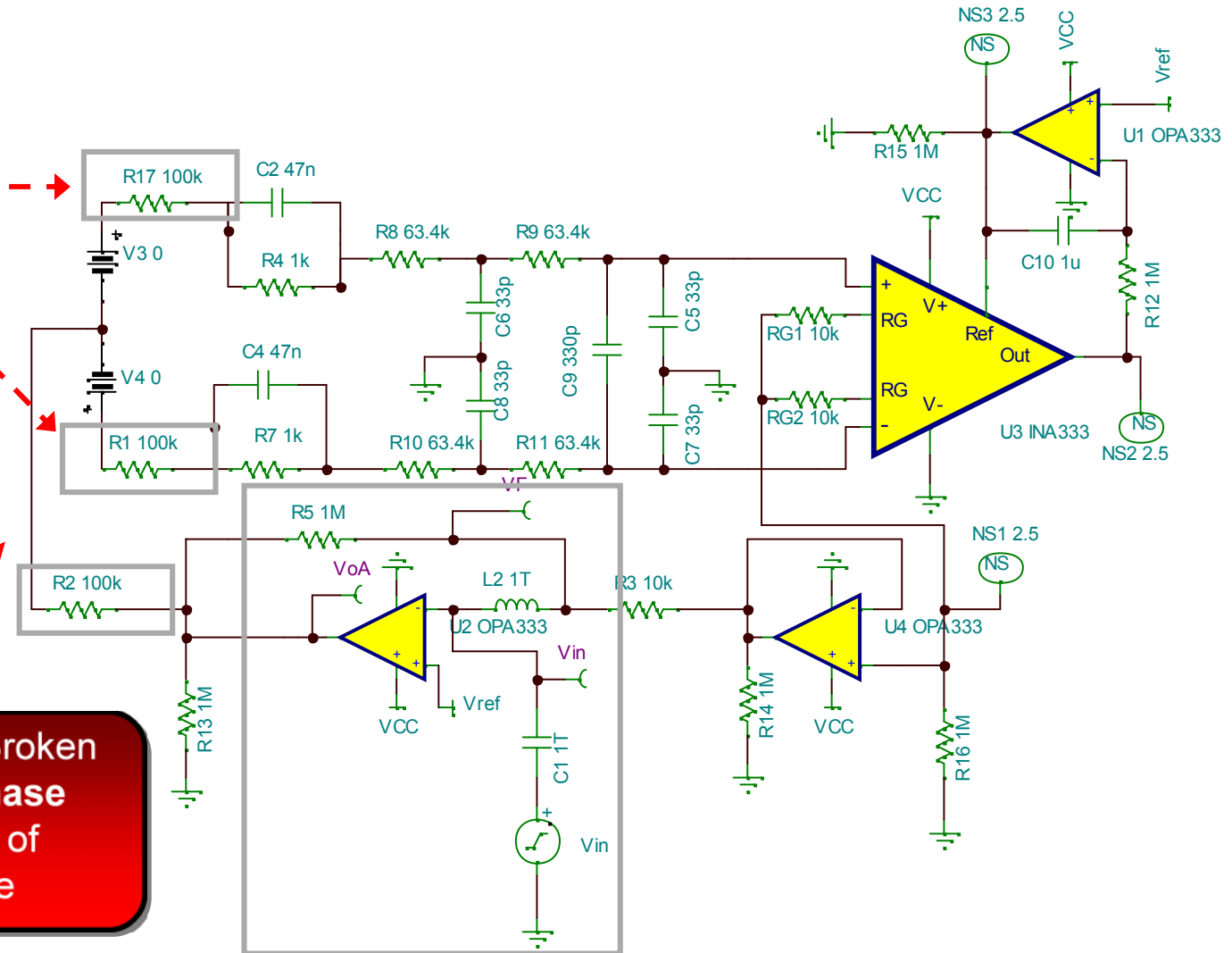


The INA Front End

RL Drive Stability Simulation Circuit

Electrode Resistance Varies With Contact and Moisture, Presents Problems for RLD Stability

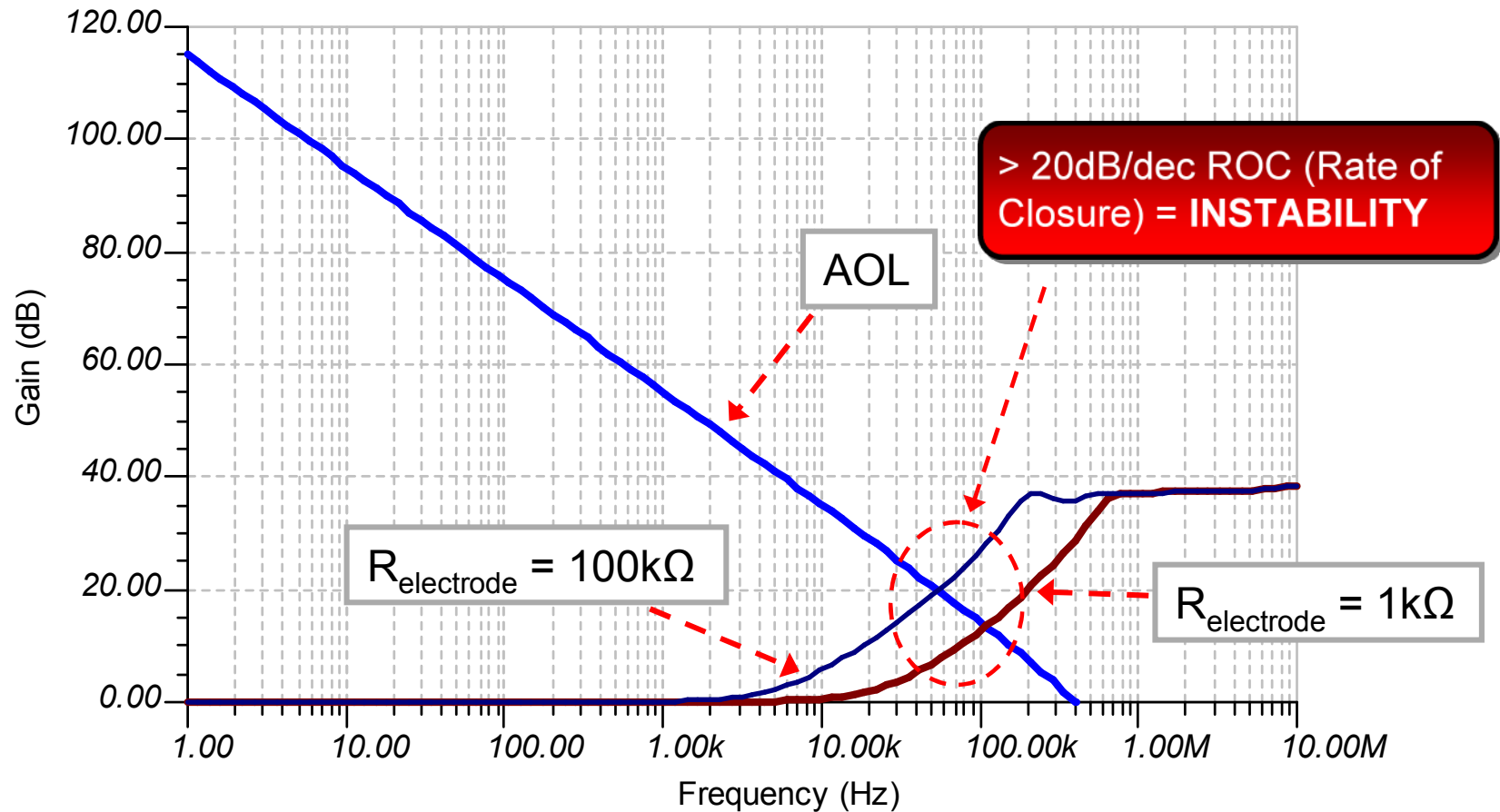
Local RLD Loop is Broken to Ensure Proper Phase Margin Over Range of Electrode Resistance





The INA Front End

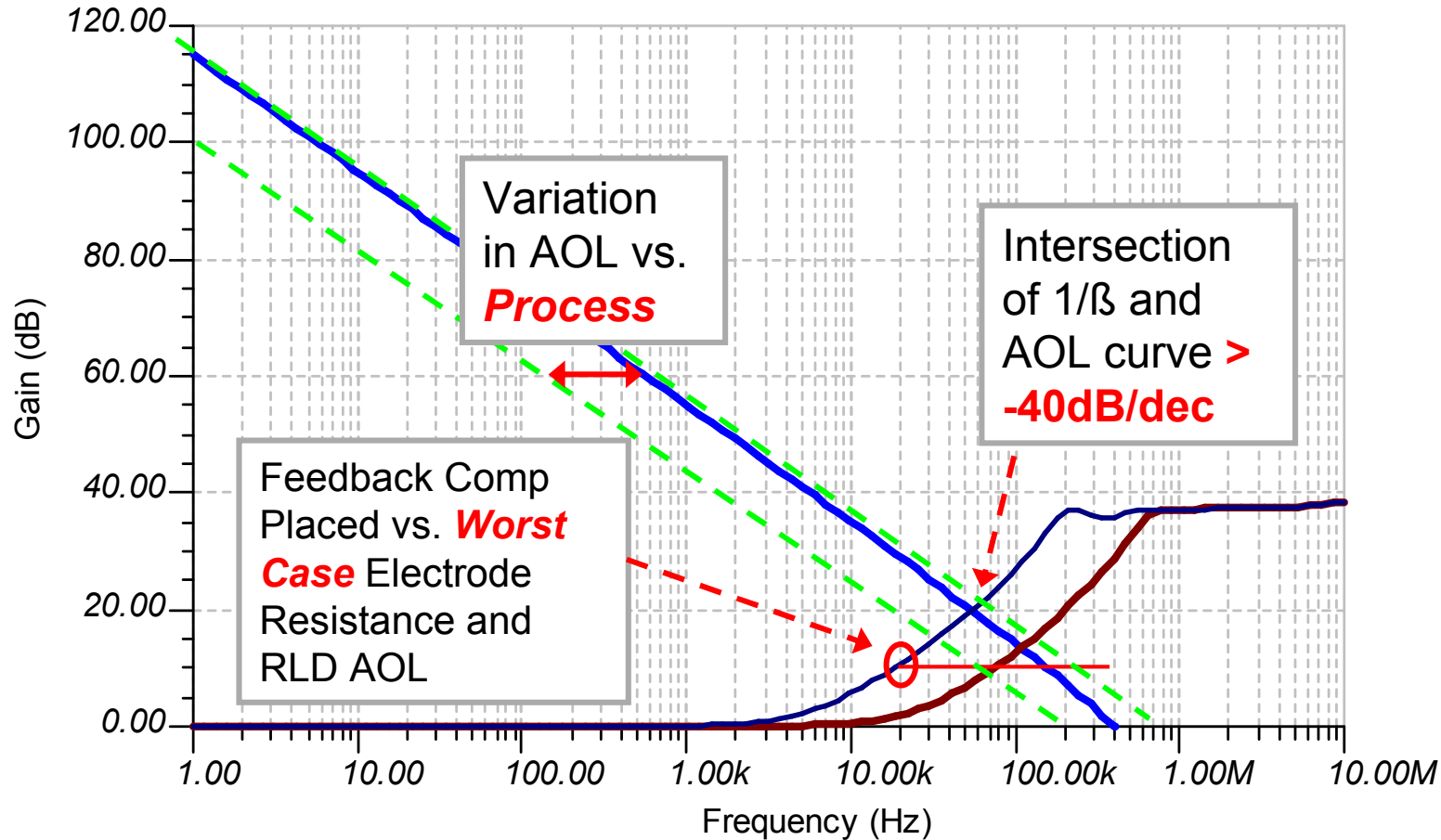
RL Drive Simulation Showing 1/Beta Variation With Electrode Resistance





The INA Front End

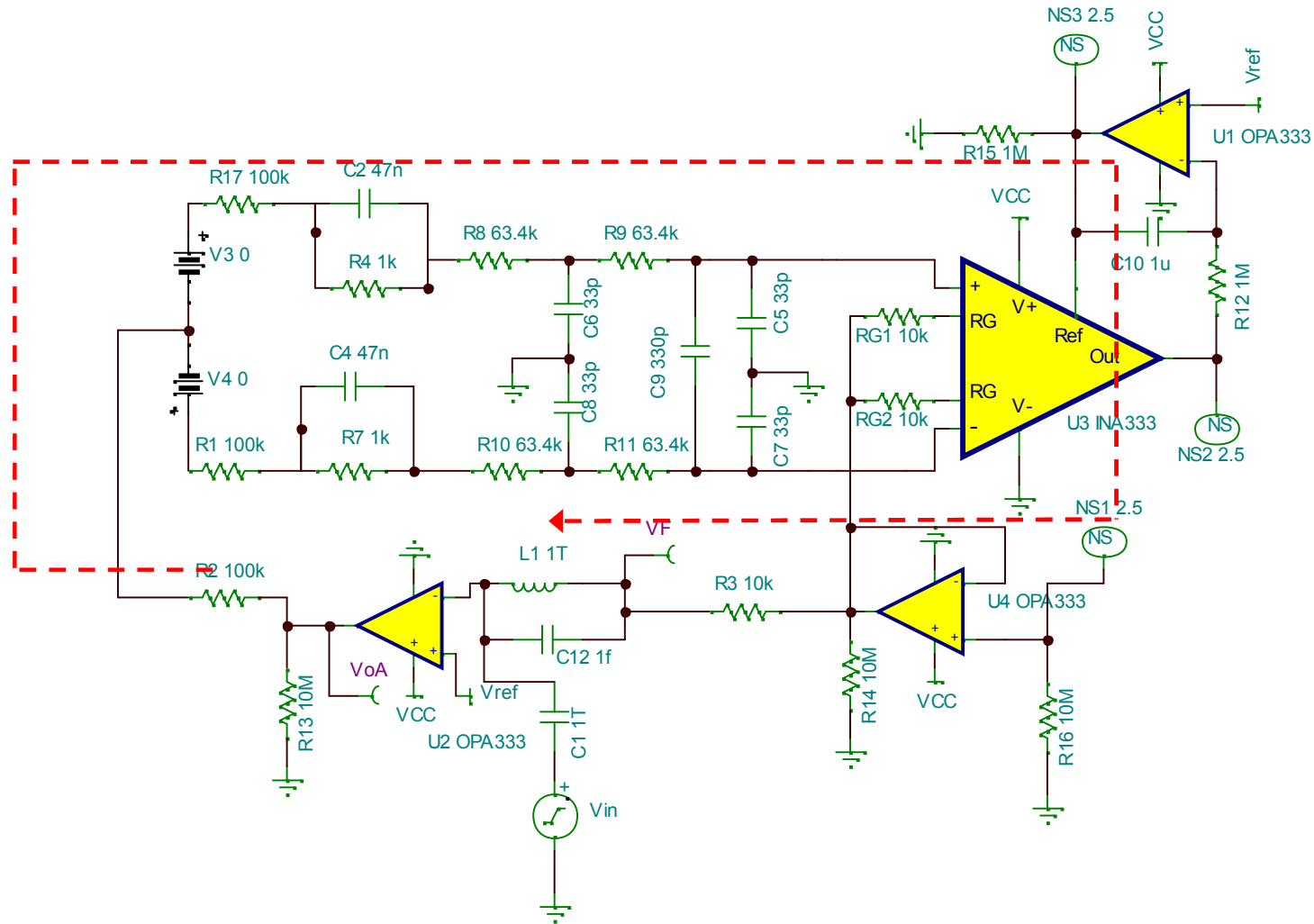
Using RLD Simulation to Compensate for $1/\beta$ Variation With Electrode Resistance





The INA Front End

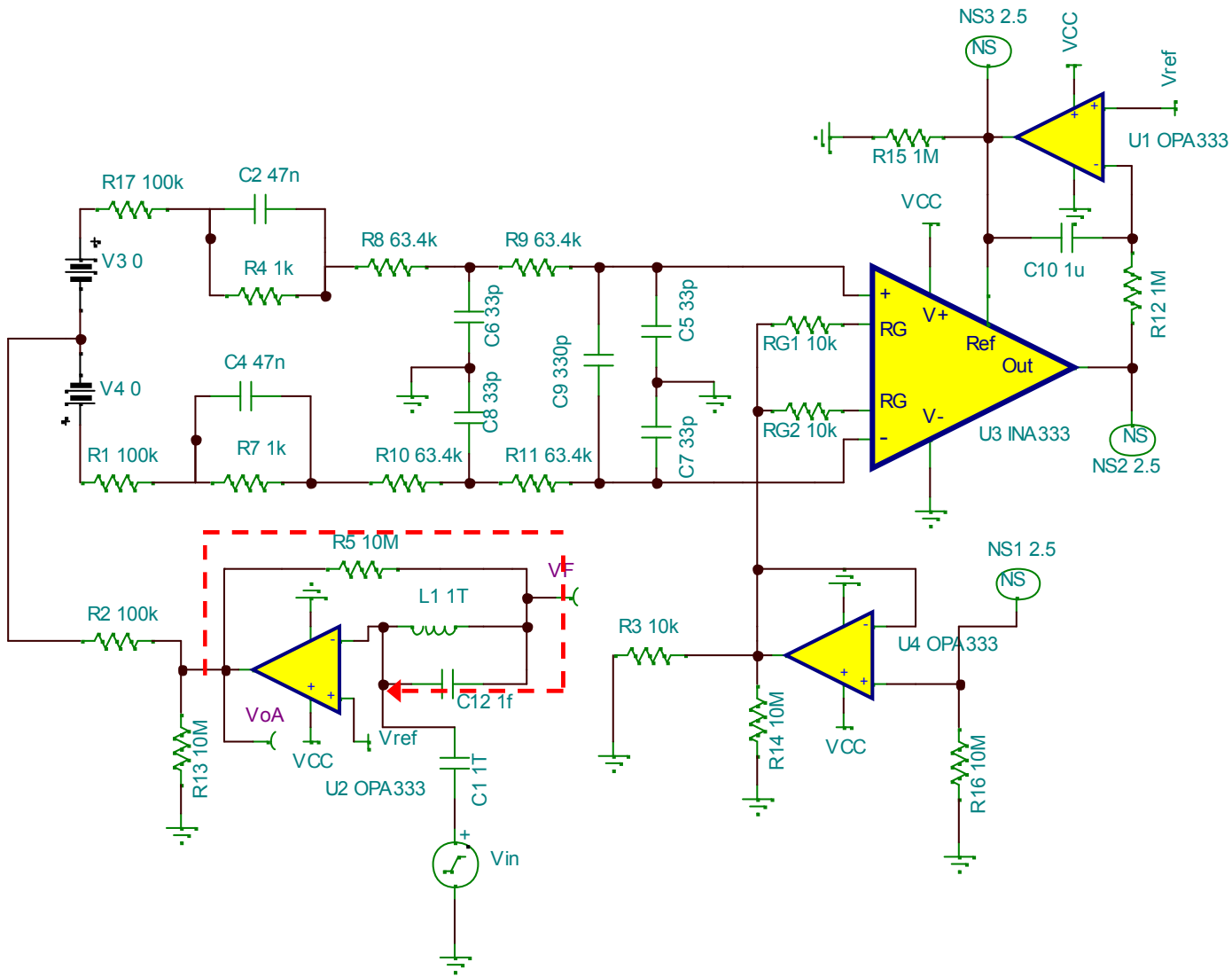
RL Drive Stability Simulation Circuit of Feedback #1





The INA Front End

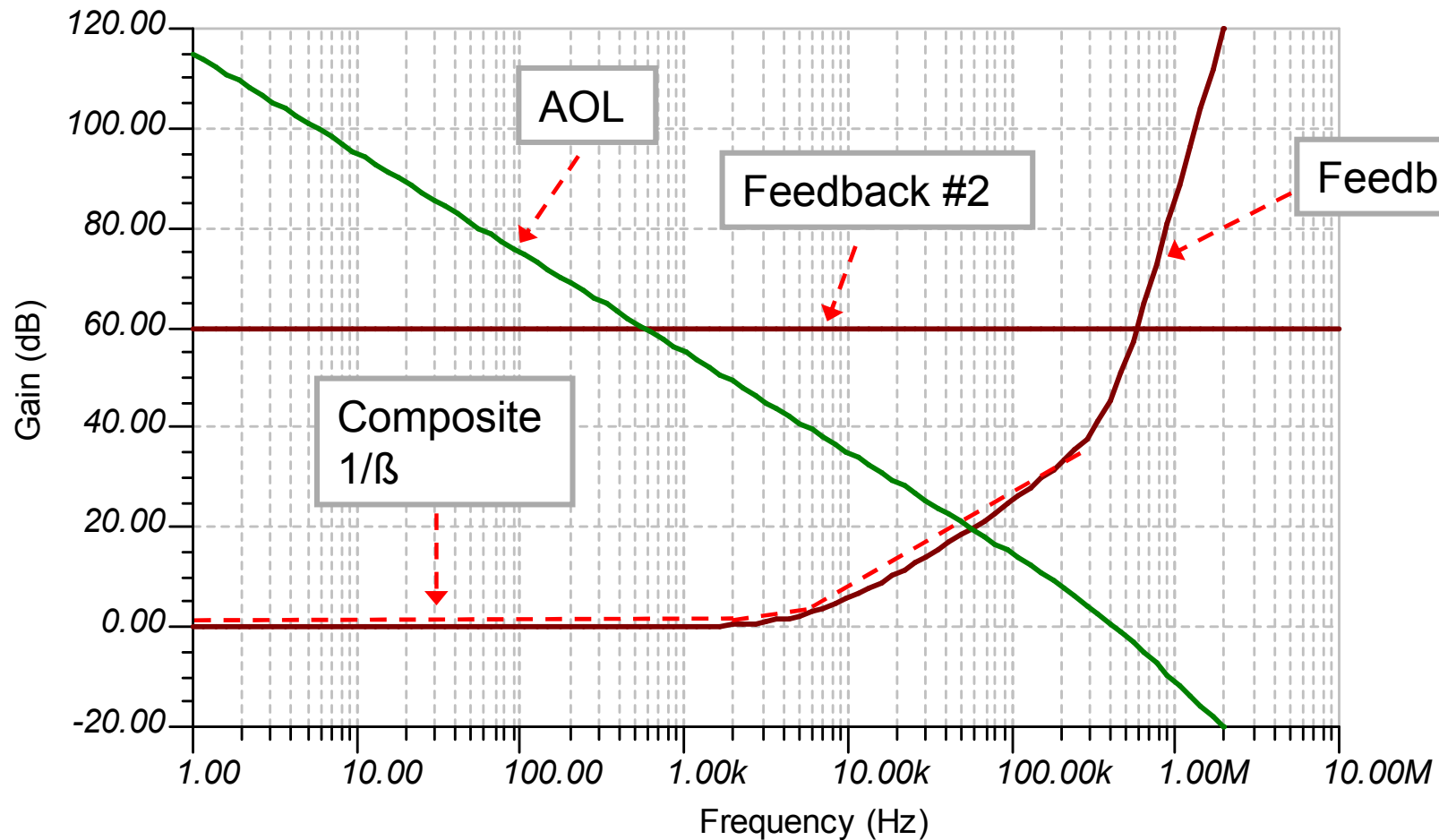
RL Drive Stability Simulation Circuit of Feedback #2





The INA Front End

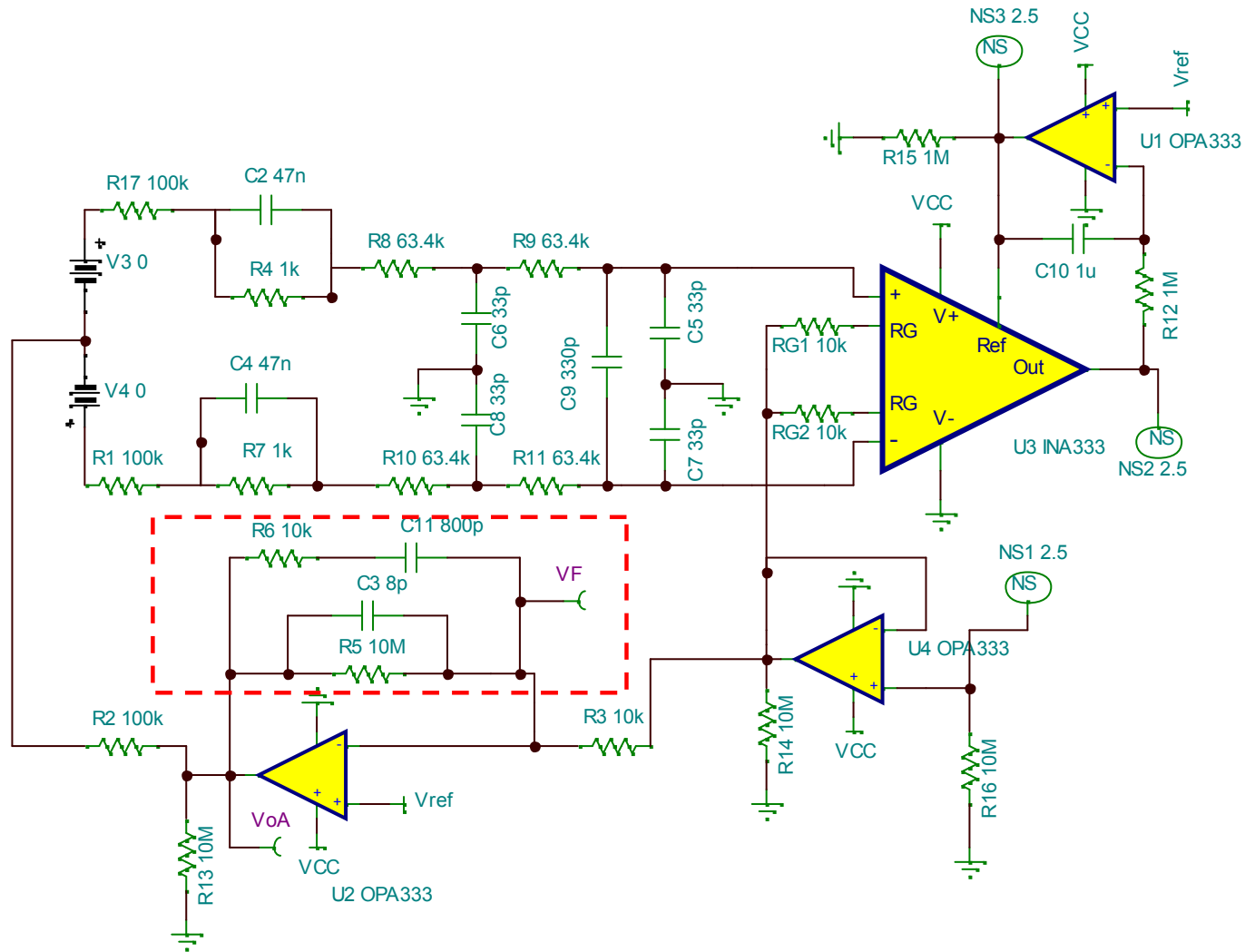
RL Drive Stability Simulation of Separate Feedback Paths





The INA Front End

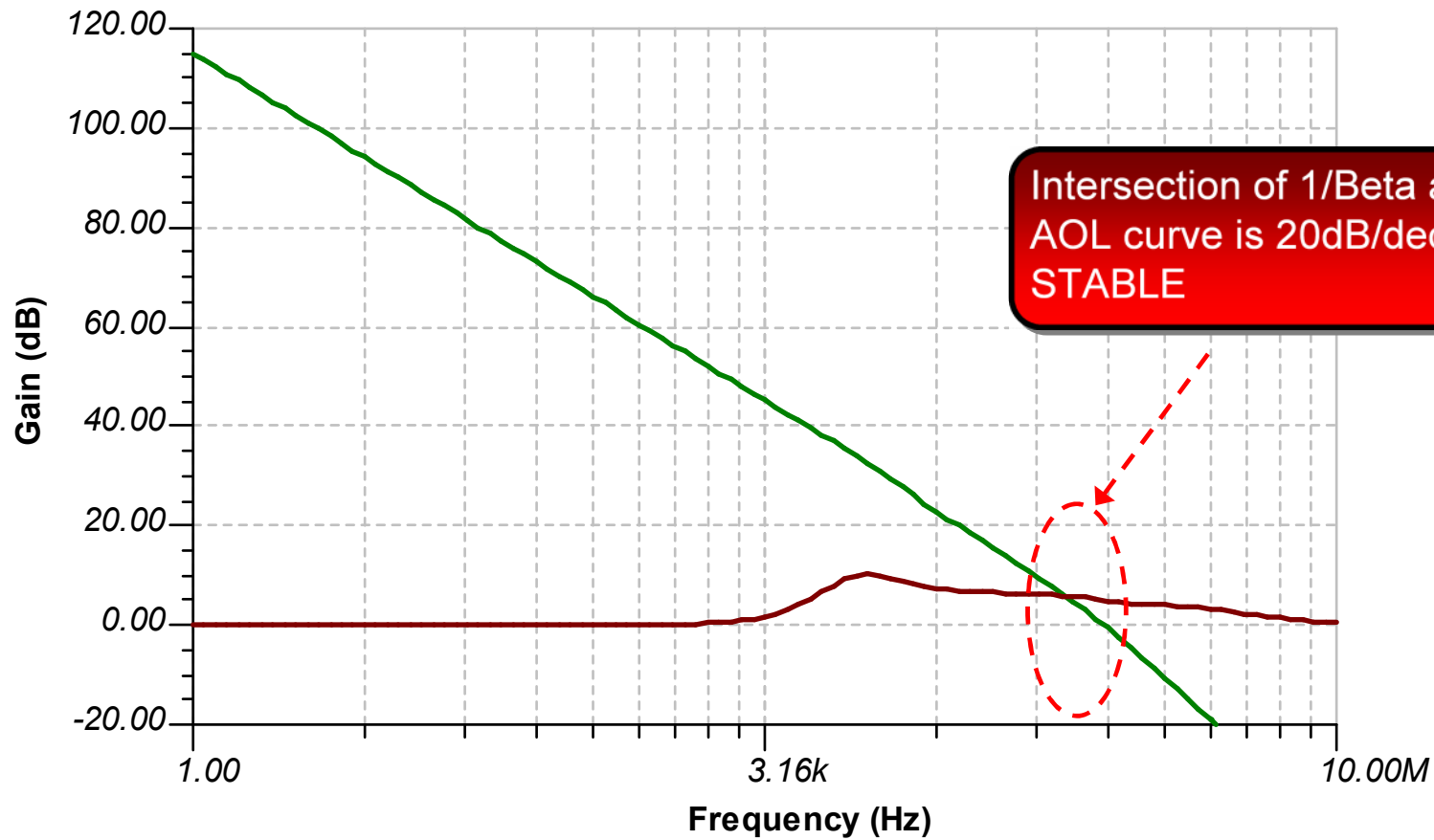
RLD Stability Circuit with Compensated Amplifier





The INA Front End

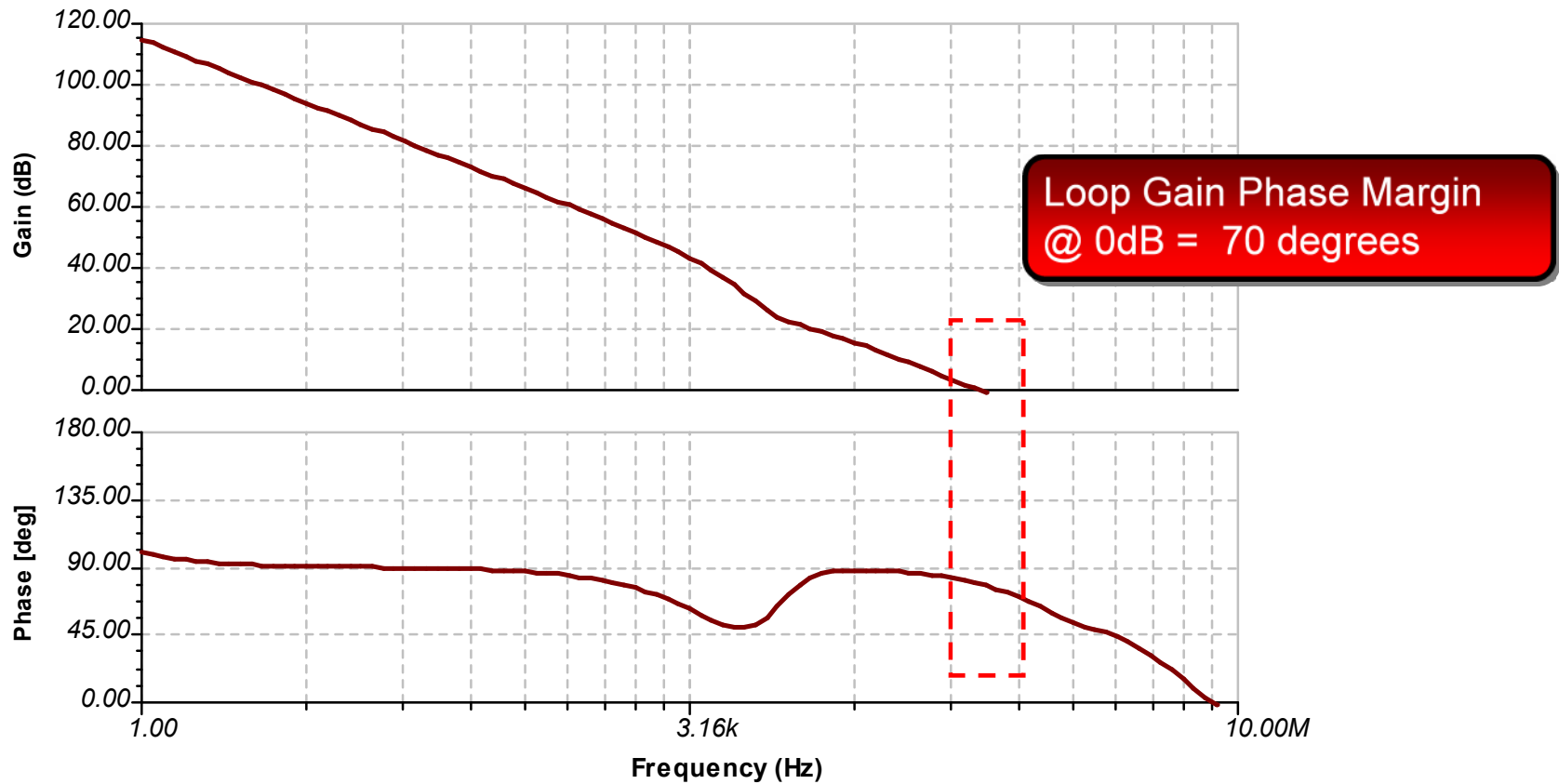
Compensated RLD Circuit Simulation of 1/Beta and AOL Intersection





The INA Front End

Gain and Phase Margin Plots of Compensated RLD Amplifier





The INA Front End

Step Response of RLD Amplifier and ECG Output

