Simulation of 6 Detectors Ganged Together and Amplified by Ideal Current Preamplifier

Detectors are connected to the summing point by striplines (Z0=50ohm, R=10Ohm).
The summing point is connected to the preamp via stripline (Z0=50ohm, R=10Ohm)
The preamplifier is the ideal current to voltage converter with G=10Kohm.

The source is the current pulse with 2ns rise time, 1ns top and 20 ns fall time. Amplitude 2mA, the total charge is 7400 fC, 1200 MIP.

Preamp input resistance = 1/6 of Z0.

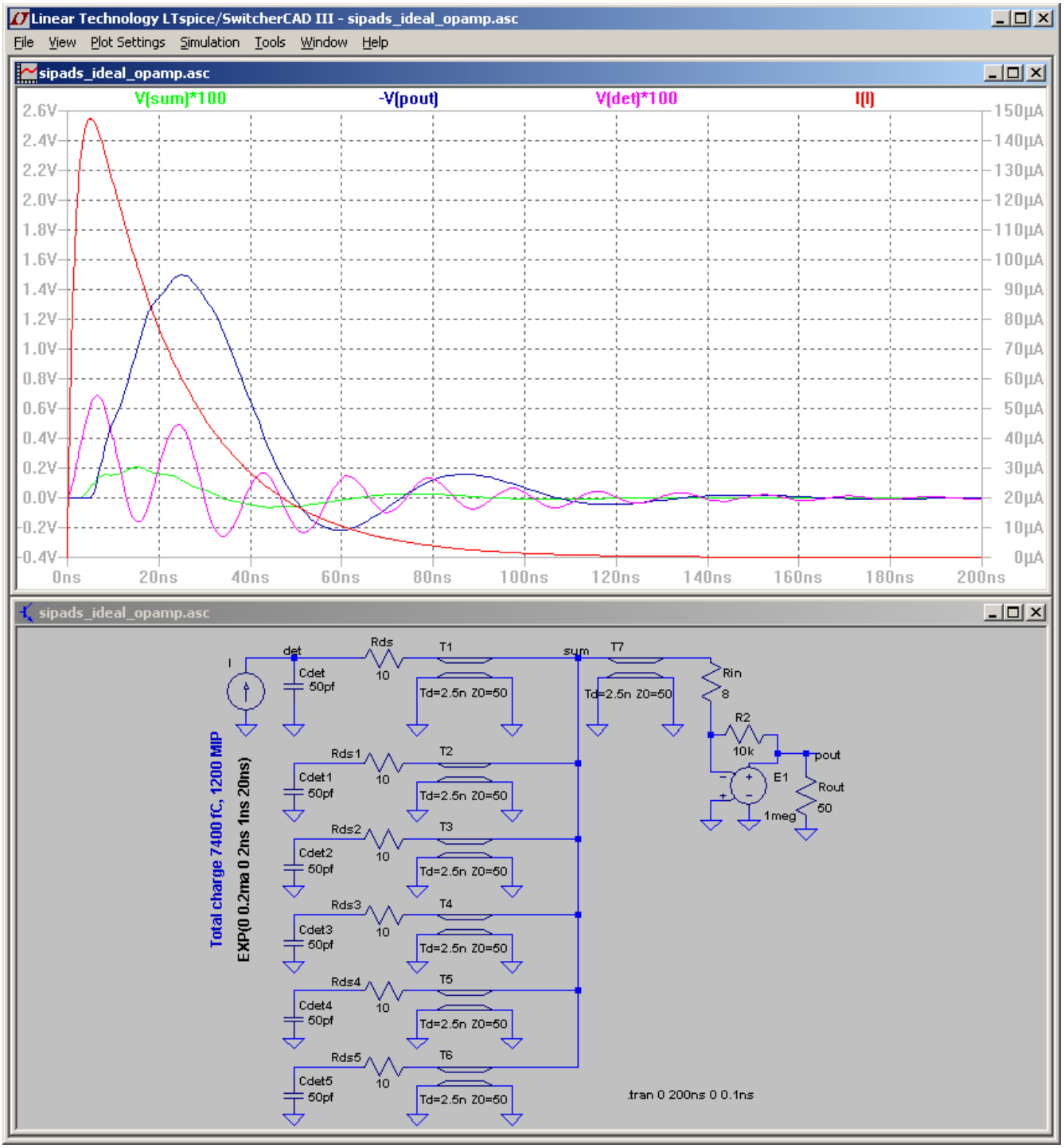

Figure 1. Worst case. Far detector connected to far preamp. Rin = 1/6 of Z0. The blue line is the output of the preamplifier. Note significant disbalance, the peak position is sensitive to the total delay.

Preamp input resistance = Z0

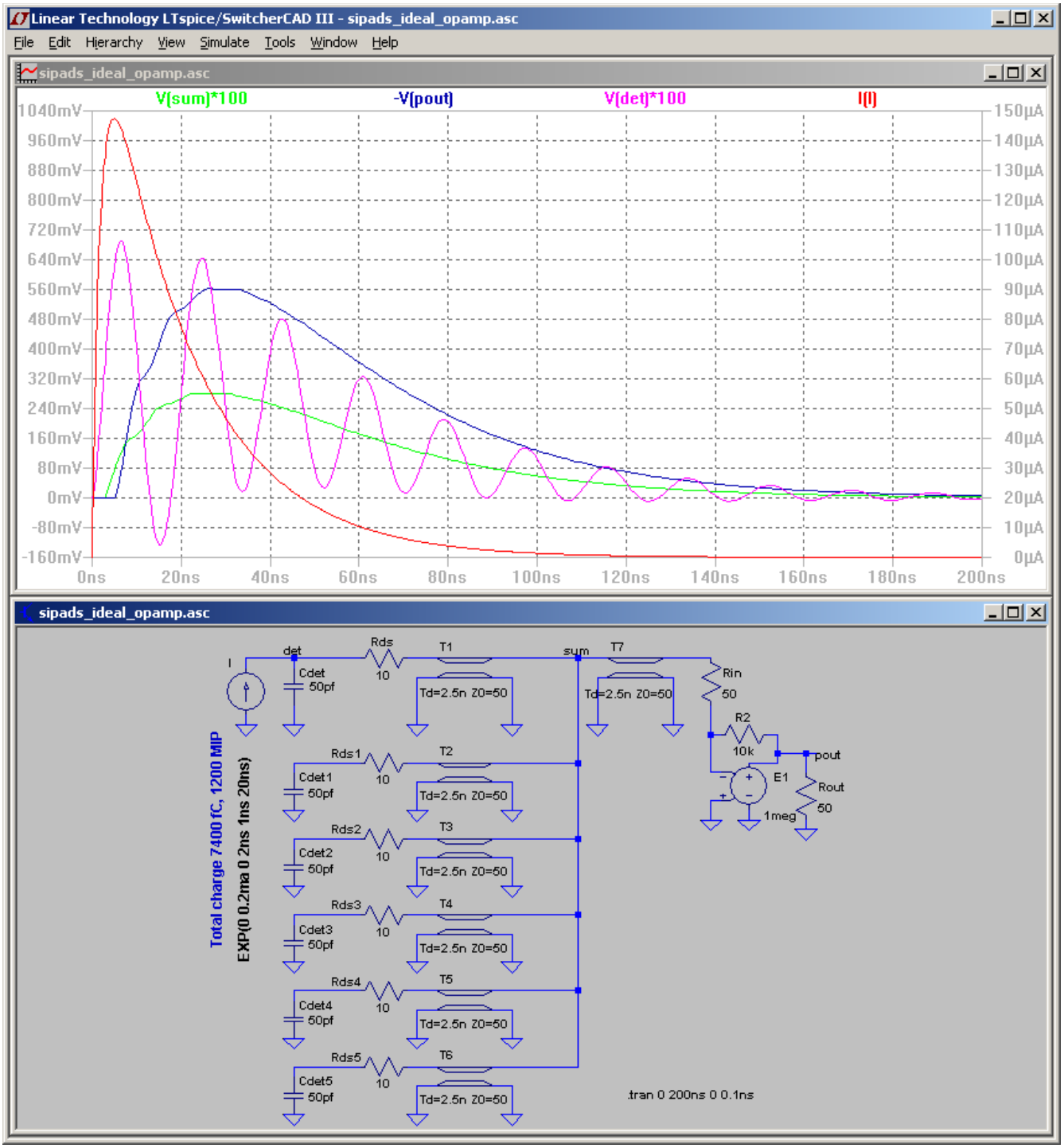

Figure 2. Worst case. Far detector connected to far preamp. Rin = Z0. Signal is lower but shape is better.

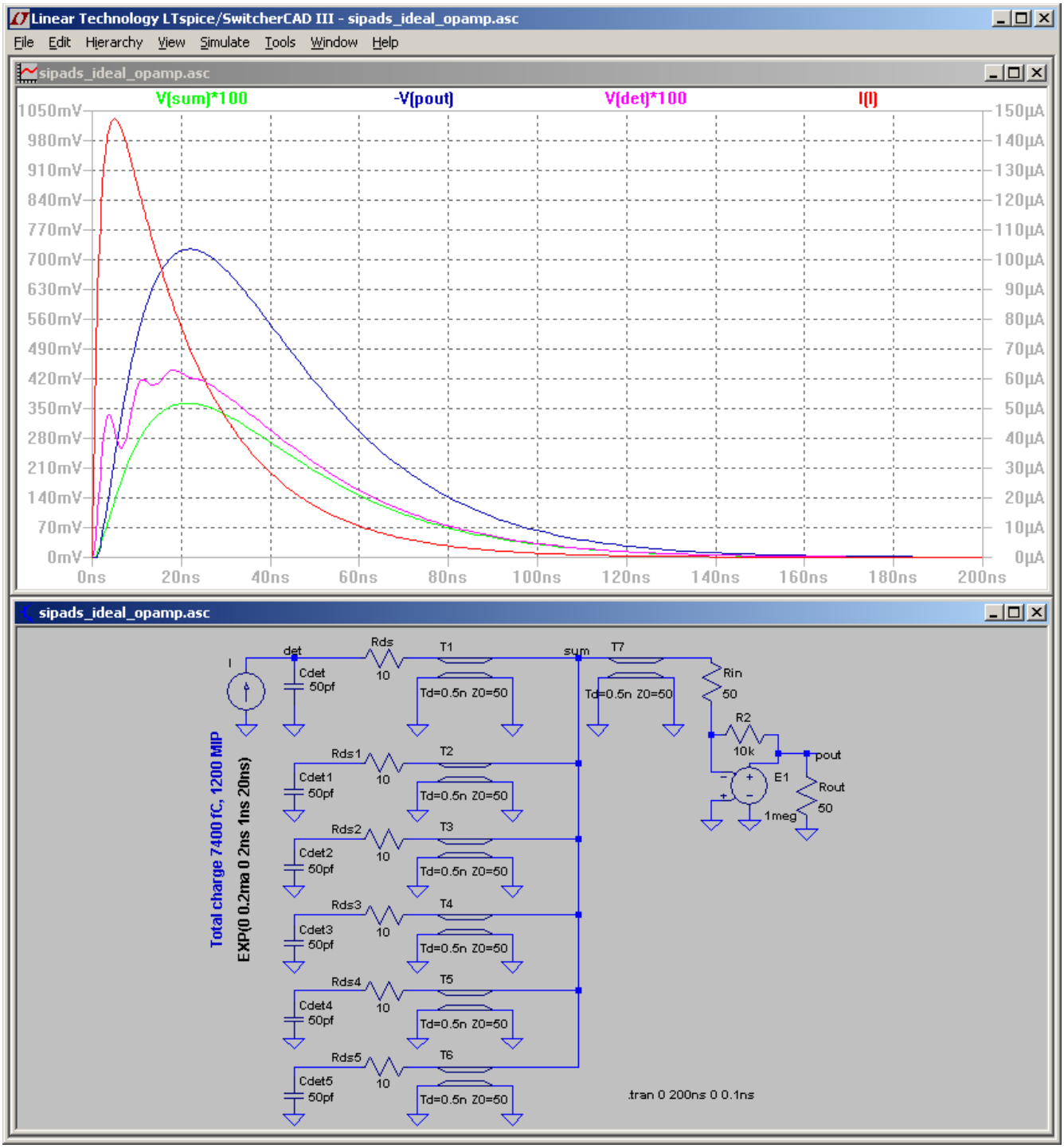

Figure 3. Best case. Near detector connected to near preamp. Rin = Z0. Signal (blue line) is very similar to fig. 2, i.e. it is less dependent on the distance from the source.

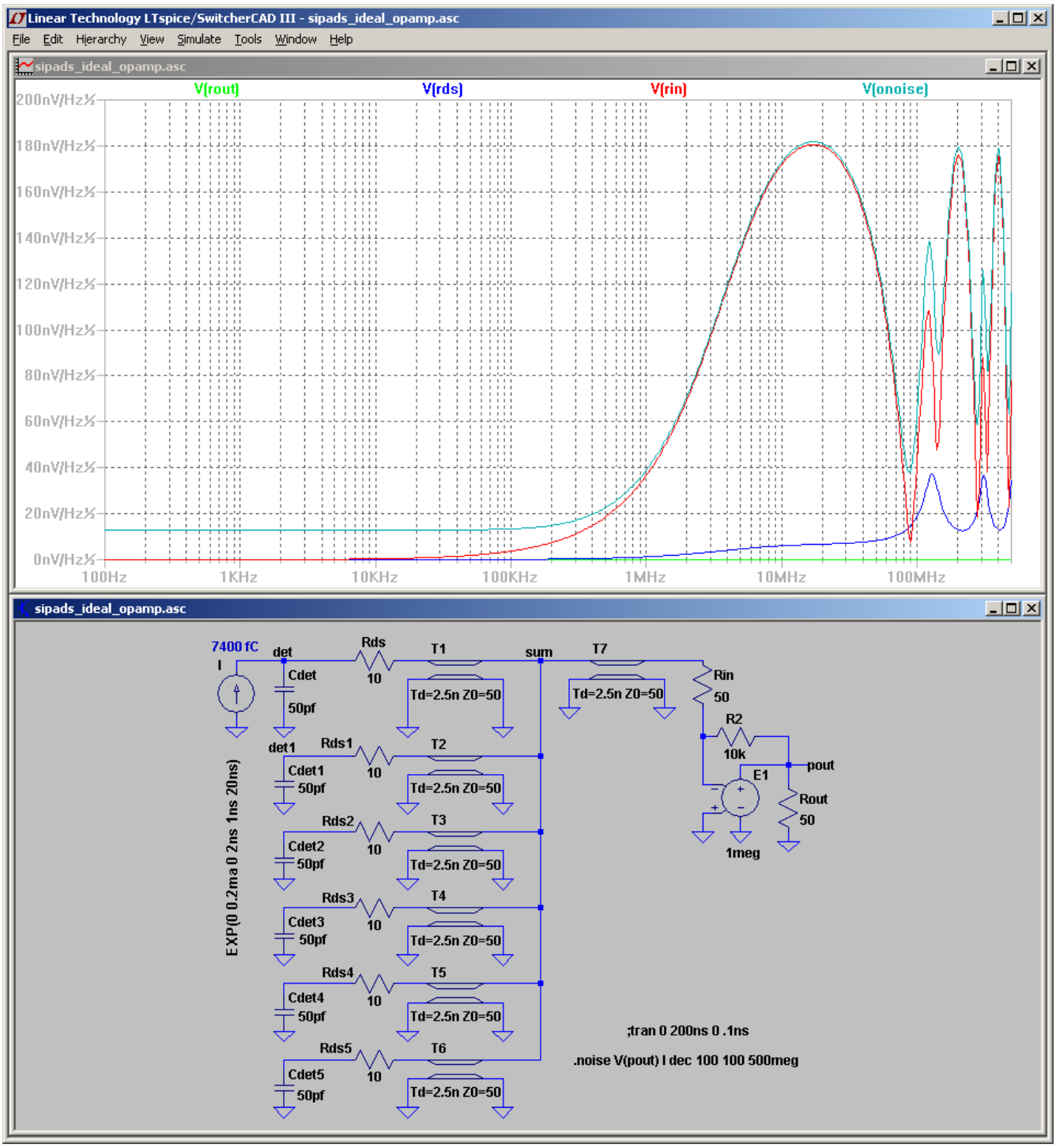

Figure 4. Noise analysis. Rin = 50.0 ohm. **Total RMS noise is 2.88 mV**. Rin contributes to 99% of noise.

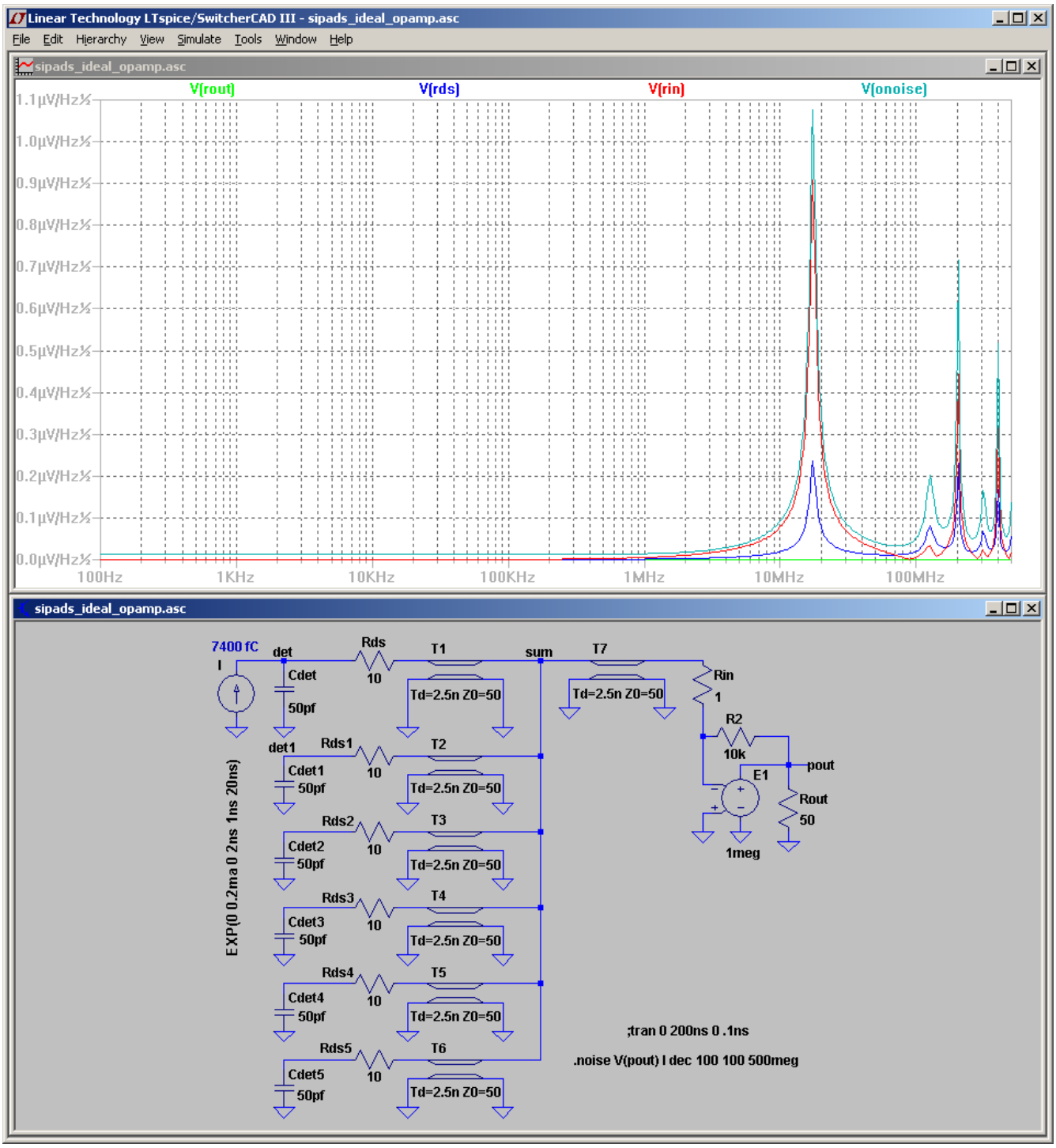

Figure 5. Noise analysis. Rin = 1 Ohm. **Total RMS noise is 3.81 mV** Rin is still main contributor to noise.

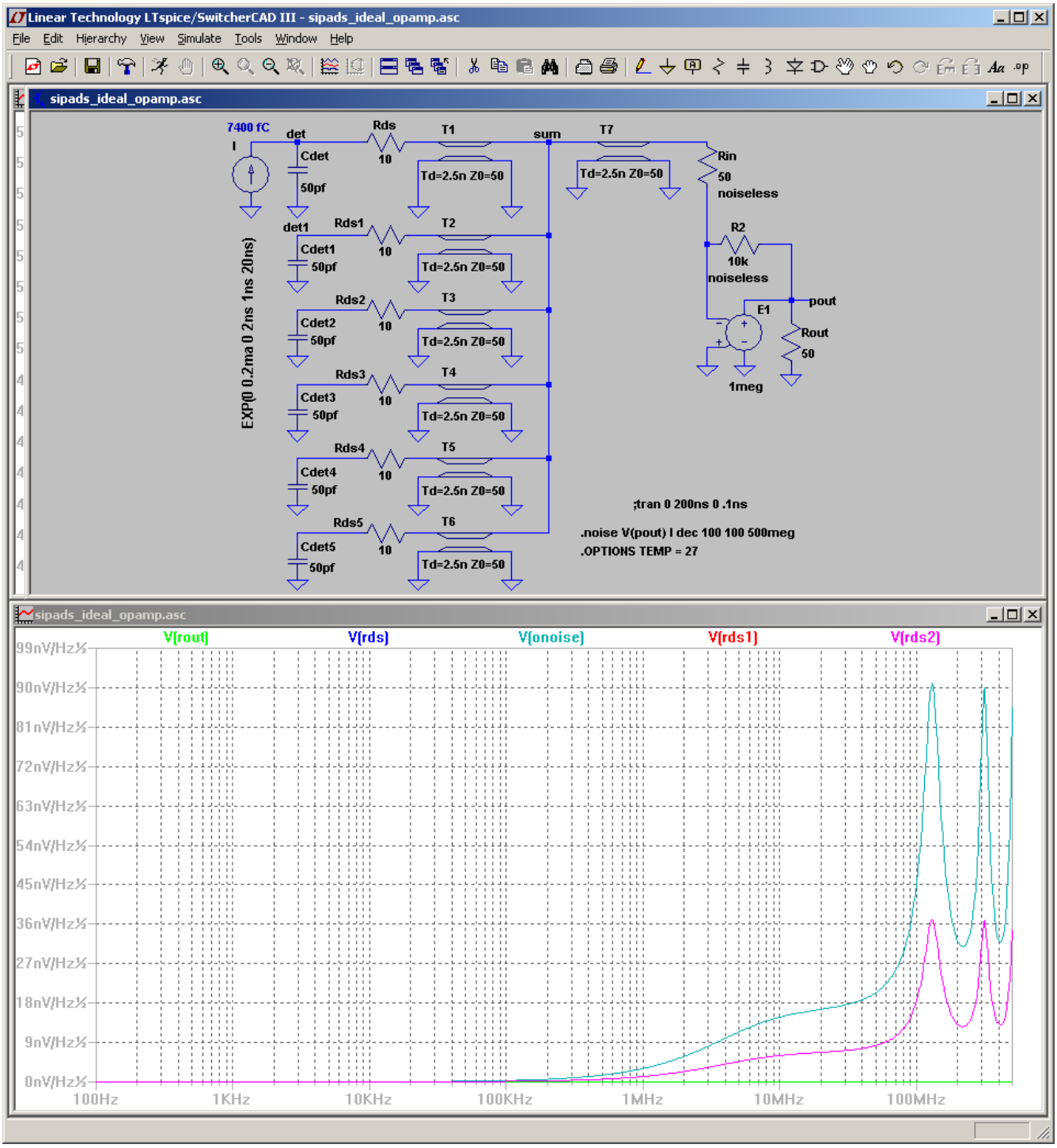

Figure 6. Noise analysis with noiseless Rin and R2. **Total RMS noise is 1.1 mV**, if all Rds = 1.0 then RMS drops to 0.475 mV.

Summary.

When input resistance of the preamp is equal to the Z0 of the transmission line then the shape of the signal does not change much for far and near connections. The signal is more smooth, it is better suited for AD conversion at 50-60 MSPS.
The main source of the noise at frequency higher than 40 kHz is load resistor Rin. Please note that noise contribution of the transmission line resistance in all cases is a fraction (<10%) of the contribution of Rin.

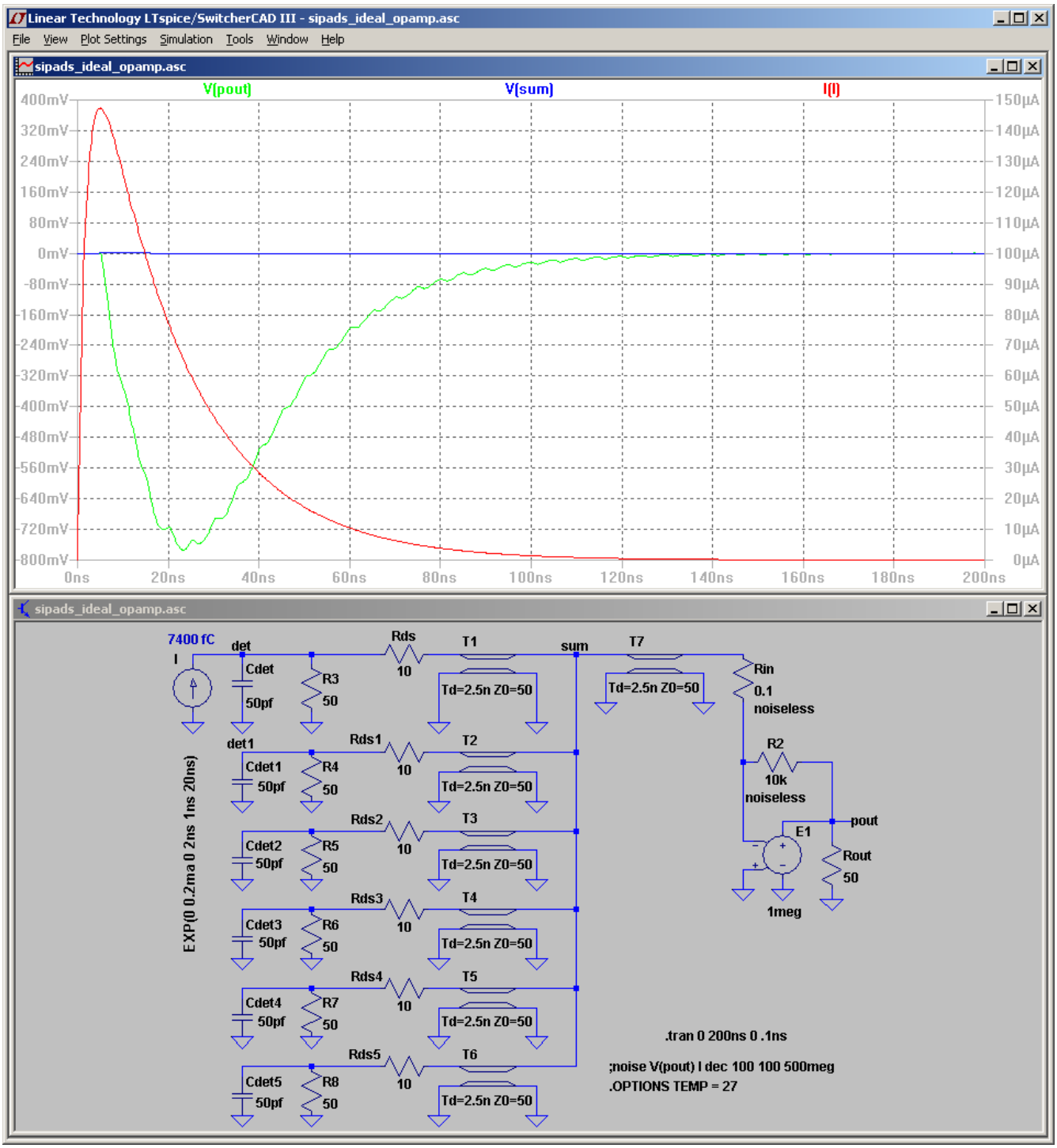

Figure 7. Load resistors at the detector end. Signal analysis.
RMS = 284 mV.

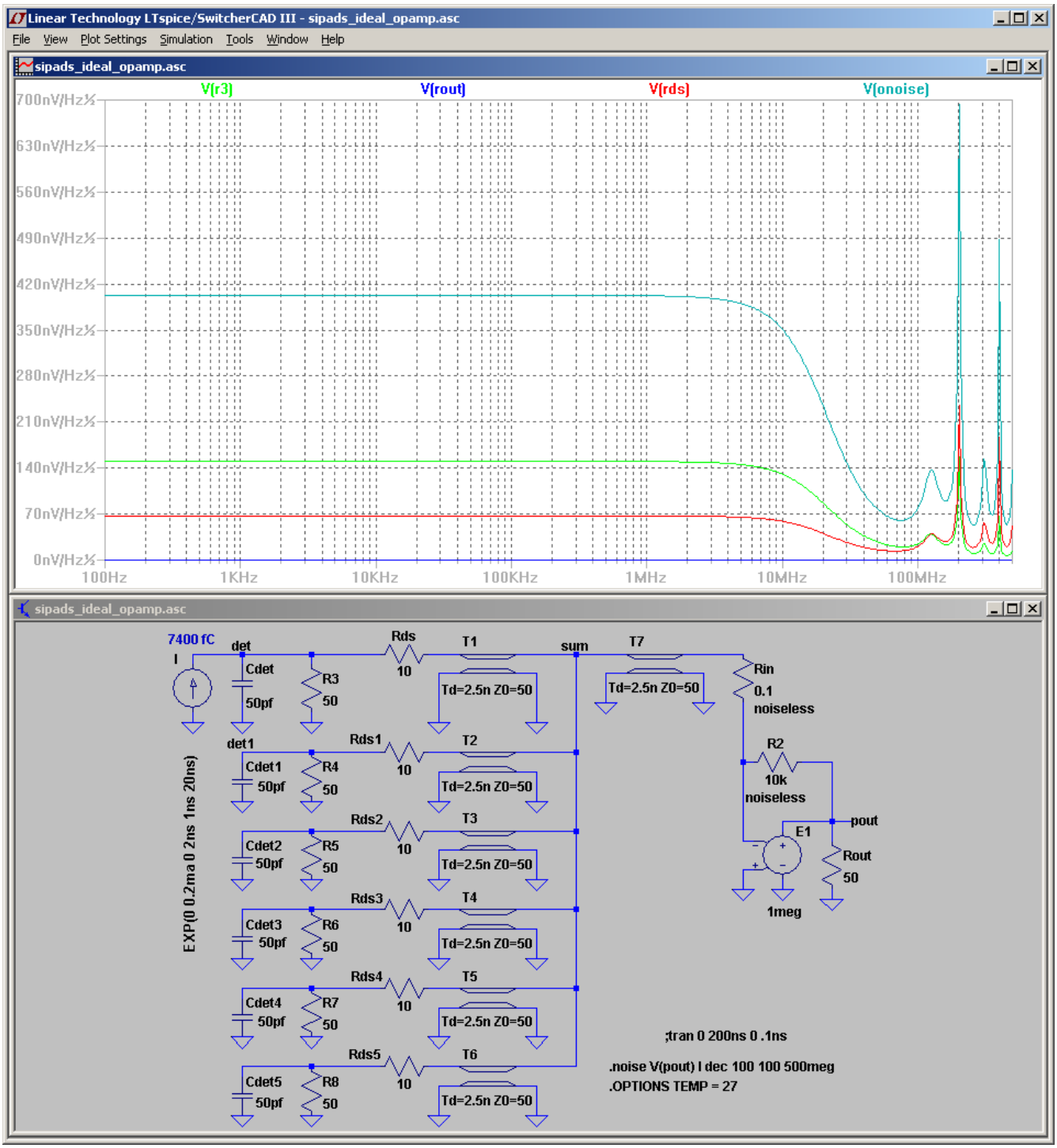

Figure 7. Load resistors at the detector end. Noise analysis.
RMS = 284 mV.Total RMS noise = 3.69mV.
S/N = 77.

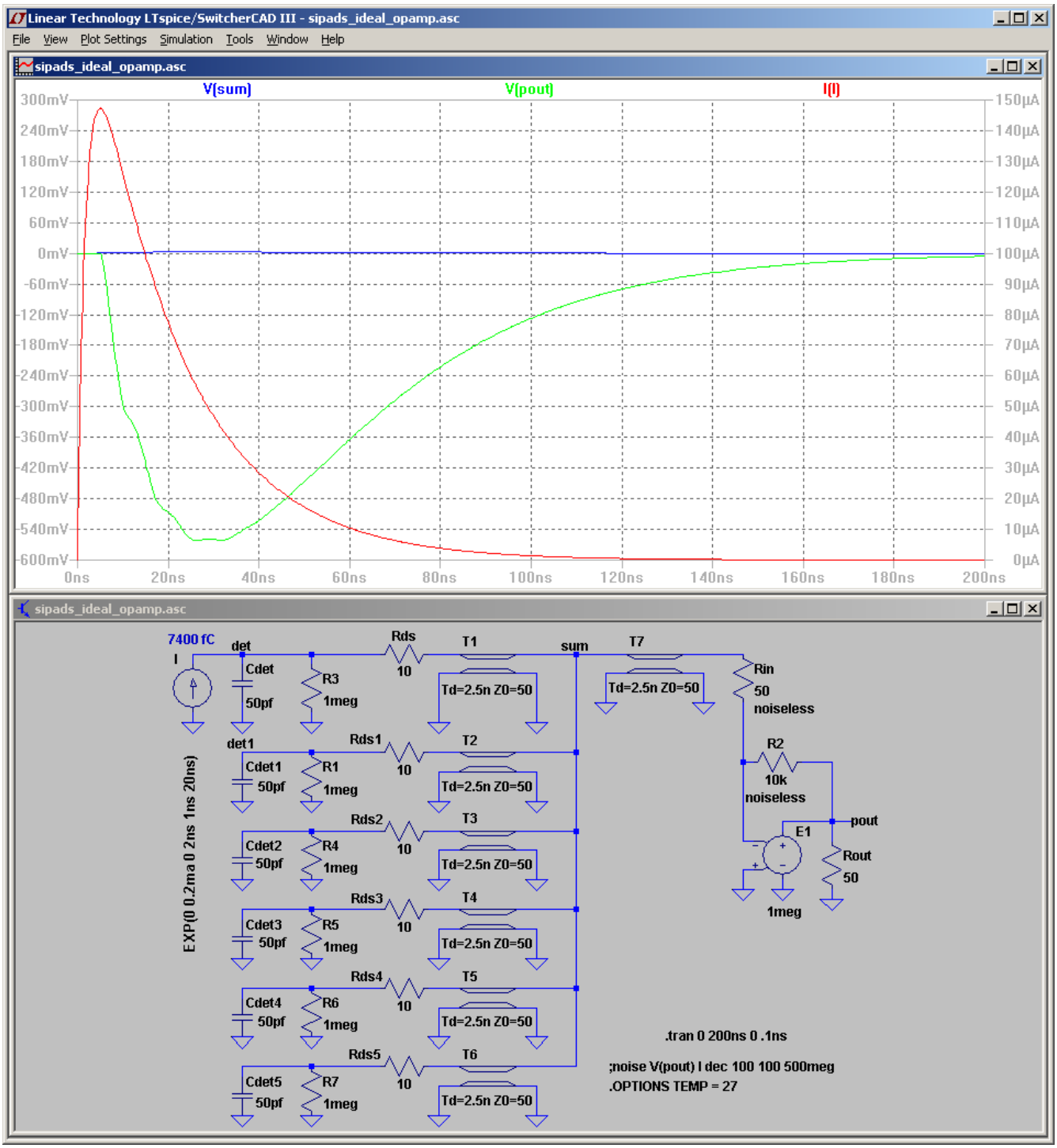

Figure 8. Similar to fig 2. Load 50.0 by the preamp. Signal analysis.
Signal RMS = 268.7mV

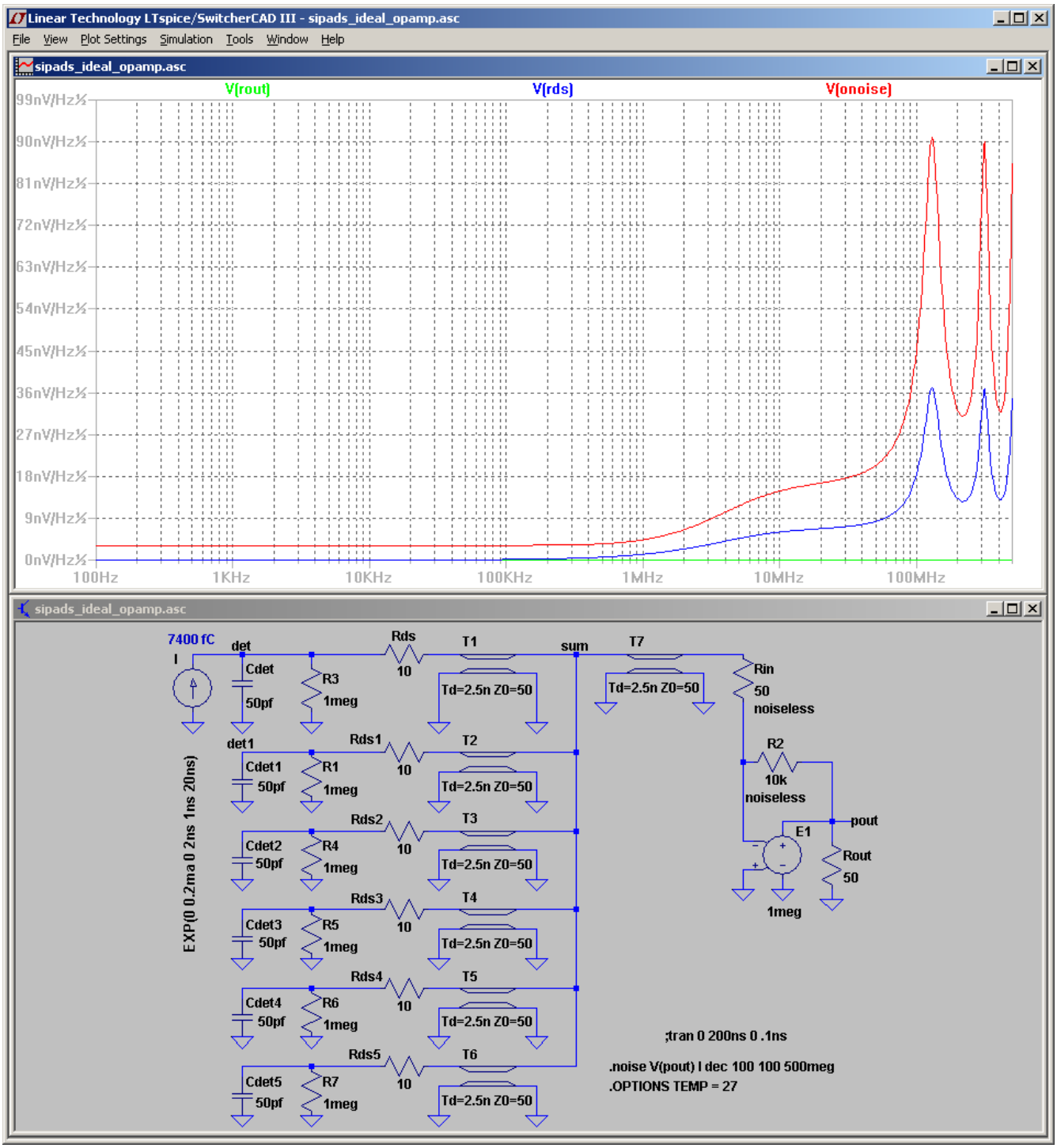

Figure 9. Similar to fig 2. Load 50.0 by the preamp. Noise analysis.
Total RMS noise [100Hz:500MHz] = 1.1mV, RMS noise [100Hz:100MHz]= 0.242mV.
S/N[500MHz] = 244.27,

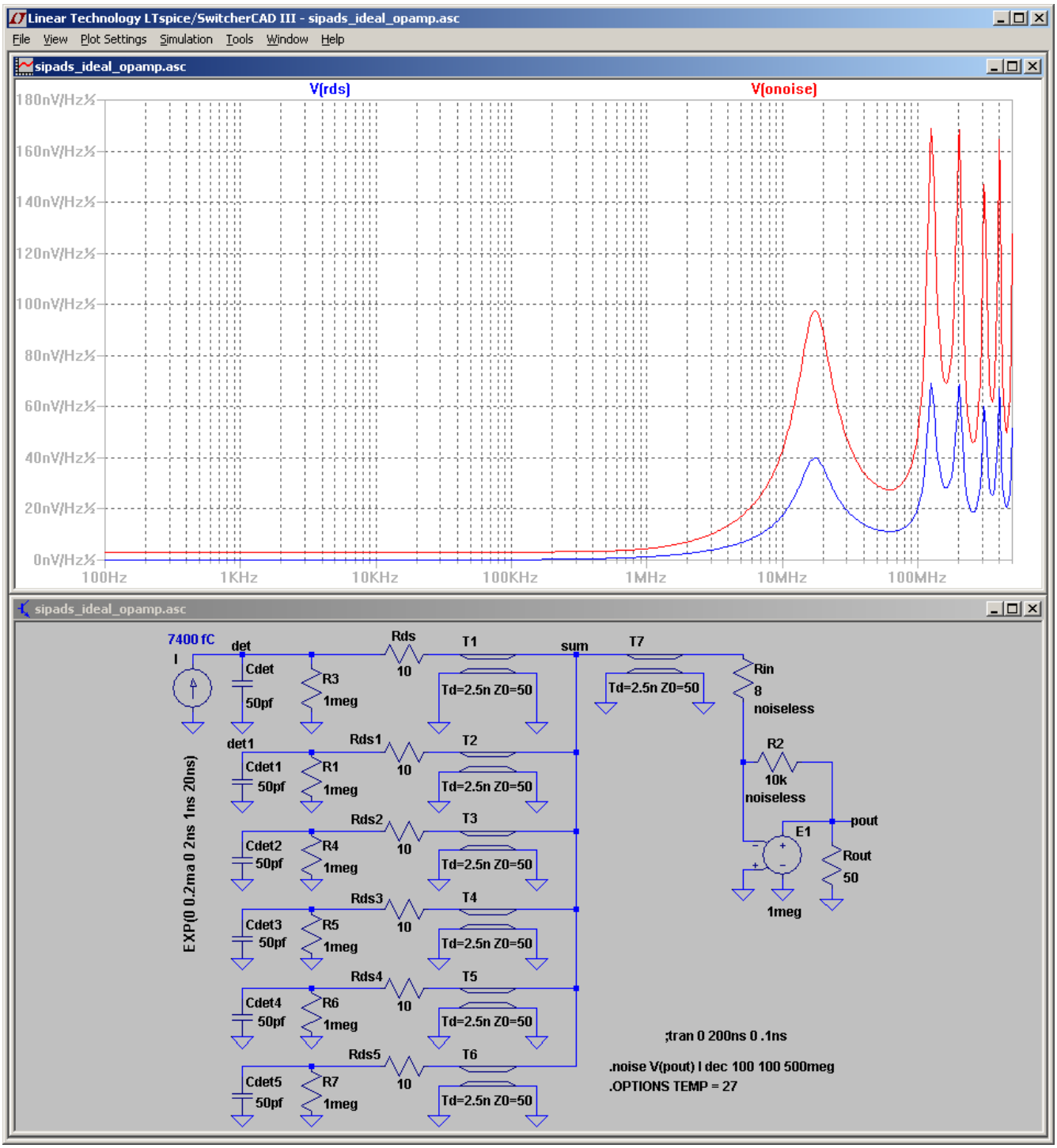

Figure 10. Rin = 8.0, the signal RMS = 471mV, Total RMS noise [100Hz:500MHz] = 1.94mV, Total RMS noise [100Hz:100MHz] = 0.44mV.
S/N[500MHz] = 242.8