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EE 215C Winter 2009 | Homework 4
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Fig. 1 shows the Cadence schematic used for this problem. The I and Q paths were included in the schematic so a realistic load was presented to the output of the RF mixer.

1. Using a PSS analysis and sweeping L_1 and L_2, we get $\boxed{L_1 = 4.91 \text{ nH}}$ and $\boxed{L_2 = 23.59 \text{ nH}}$ as the inductance values necessary for resonance at their respective frequencies. Fig. 2 shows the spectrum at the output of the LNA with resonance at 5.2 GHz (when driven by an input power of −40 dBm). Fig. 3 shows the spectrum at the output of the RF mixer with resonance at 1.7 GHz. 10/10

2. Fig. 4 shows the spectrum at the baseband output, V_{BB}, when the input is driven by a −40 dBm (or 6.325 mV amplitude) signal. From this, we can see that the amplitude of the baseband signal is 12.26 mV. The total voltage gain is then:

$$A_v = \frac{12.26 \text{ mV}}{\frac{1}{2}(6.325 \text{ mV})} = 3.877 = \boxed{11.77 \text{ dB}}$$

(5)

3. Using an input signal at 1.8 GHz (the image frequency) with a power of −40 dBm, the output spectrum is as shown in Fig. 5. The amplitude of the baseband output due to the image is 2.047 mV.

   Since the signal and the image were input at the same power, the image reject ratio is simply the image-to-signal ratio at the output. The signal amplitude, from part (b), is 12.26 mV, giving:

$$IRR = \frac{2.047 \text{ mV}}{12.26 \text{ mV}} = 16.70 = \boxed{-15.55 \text{ dB}}$$

(5)

4. These are two mechanisms by which a 8.7 GHz interferer can be translated to baseband:

   - The interferer mixes with the first LO, giving a component at $\omega_{int} - \omega_{LO1} = 8.7 \text{ GHz} - 3.5 \text{ GHz} = 5.2$ GHz, which appears at the output of the RF mixer. This component mixes with the 3rd harmonic of the second LO, giving a component at $3\omega_{LO2} - 5.2 \text{ GHz} = 5.25 \text{ GHz} - 5.2 \text{ GHz} = 50$ MHz, which is the baseband frequency.
   - The interferer mixes with the 3rd harmonic of the first LO, giving a component at $3\omega_{LO1} - \omega_{int} = 10.5 \text{ GHz} - 8.7 \text{ GHz} = 1.8$ GHz, which appears at the output of the RF mixer. This component mixes with the second LO, giving a component at $1.8 \text{ GHz} - \omega_{LO2} = 1.8 \text{ GHz} - 1.75 \text{ GHz} = 50$ MHz, which is the baseband frequency.

   Running a simulation with an input at 8.7 GHz with an input power of −40 dBm gives the baseband spectrum shown in Fig. 6. From this spectrum we can see that the output amplitude is 539.1 µV, giving a gain of:

$$A_{v,int} = \frac{539.1 \text{ µV}}{6.325 \text{ mV}} = 0.0852 = \boxed{-21.39 \text{ dB}}$$

   Normalized to the gain from (b), we have: (10)

$$\frac{A_{v,int}}{A_{v,sig}} = \frac{0.0852}{3.877} = 0.0220 = \boxed{-33.16 \text{ dB}}$$

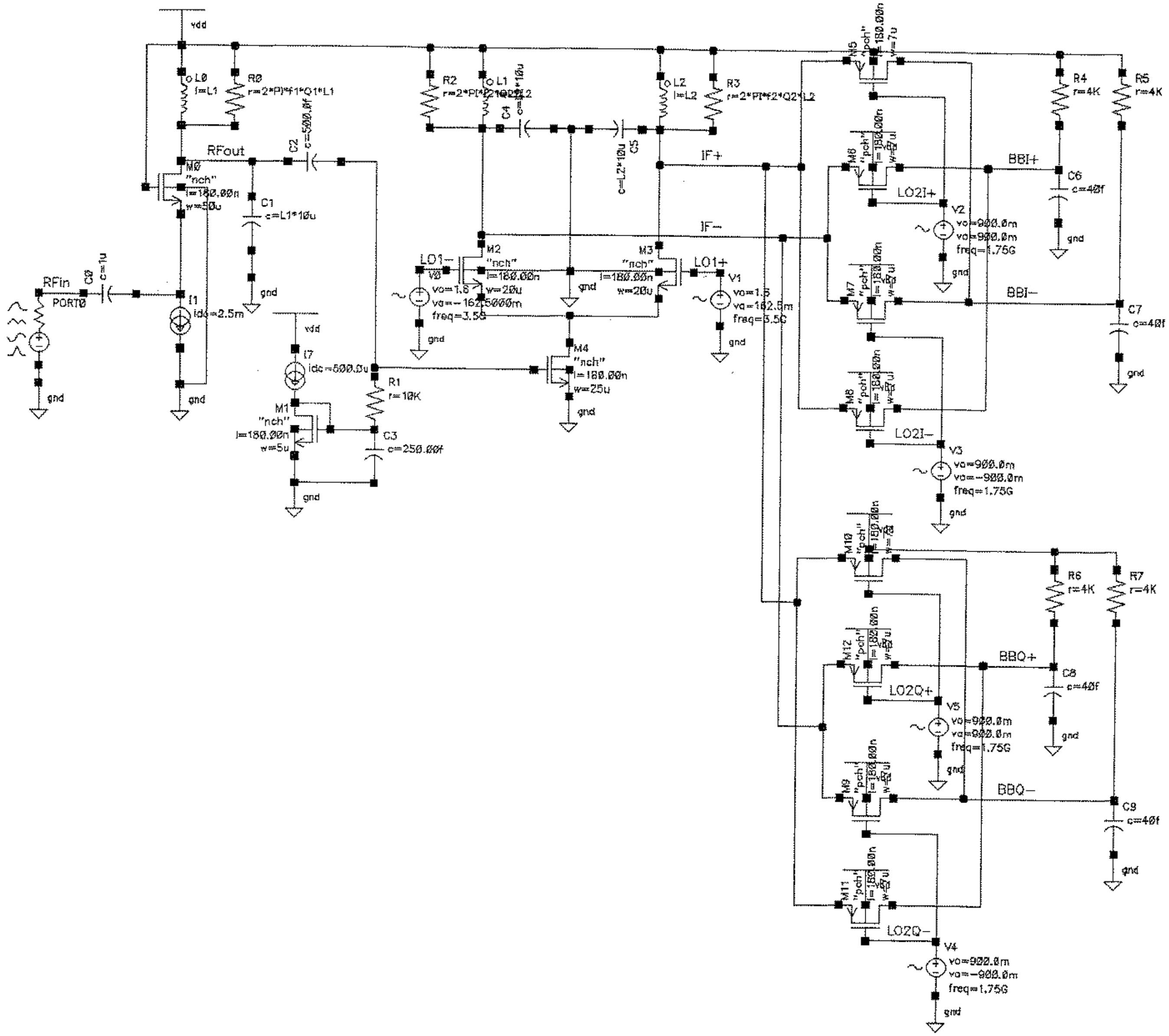

Figure 1: Cadence schematic

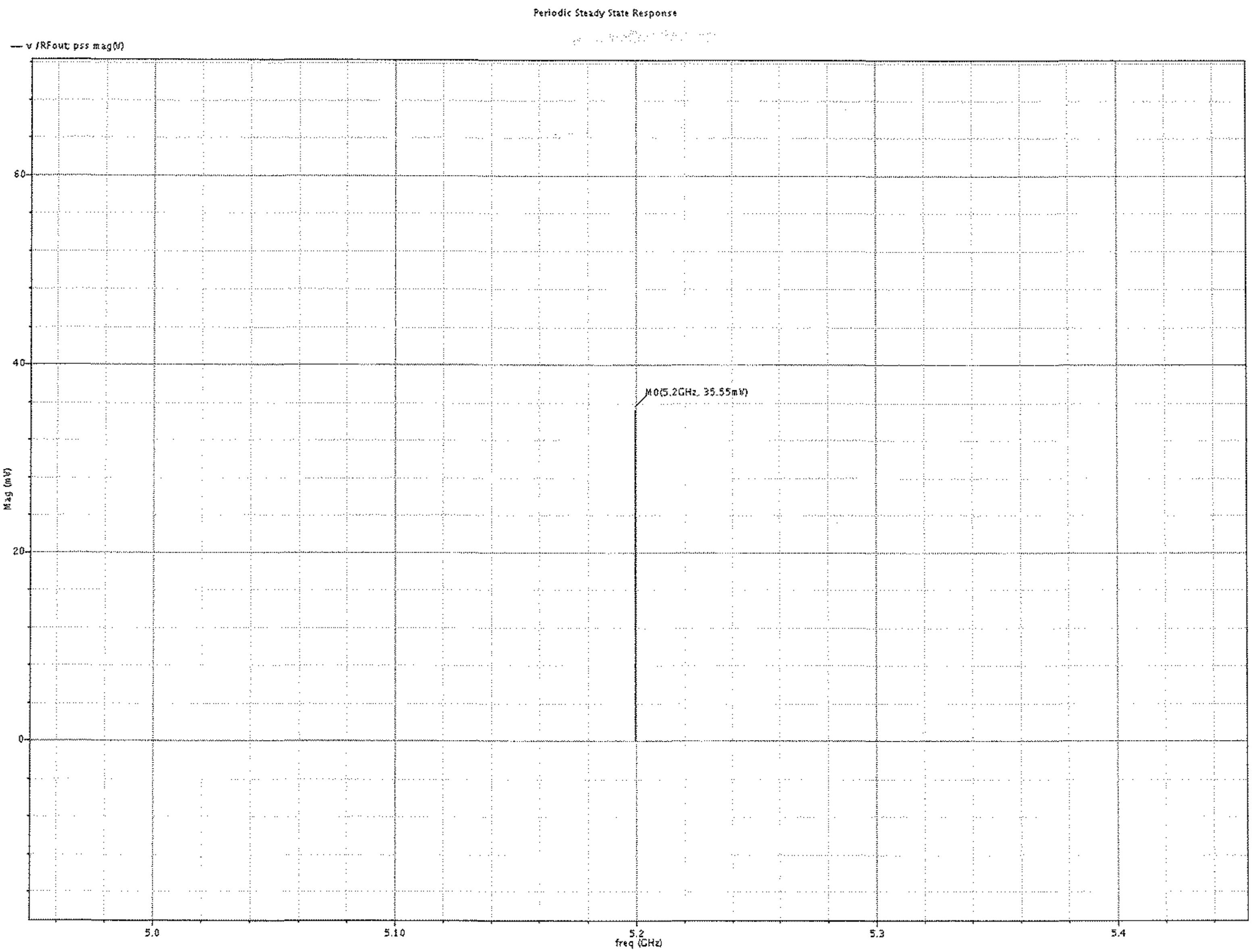

Figure 2: Spectrum at the output of the LNA showing resonance at $\omega_{RF} = 5.2$ GHz

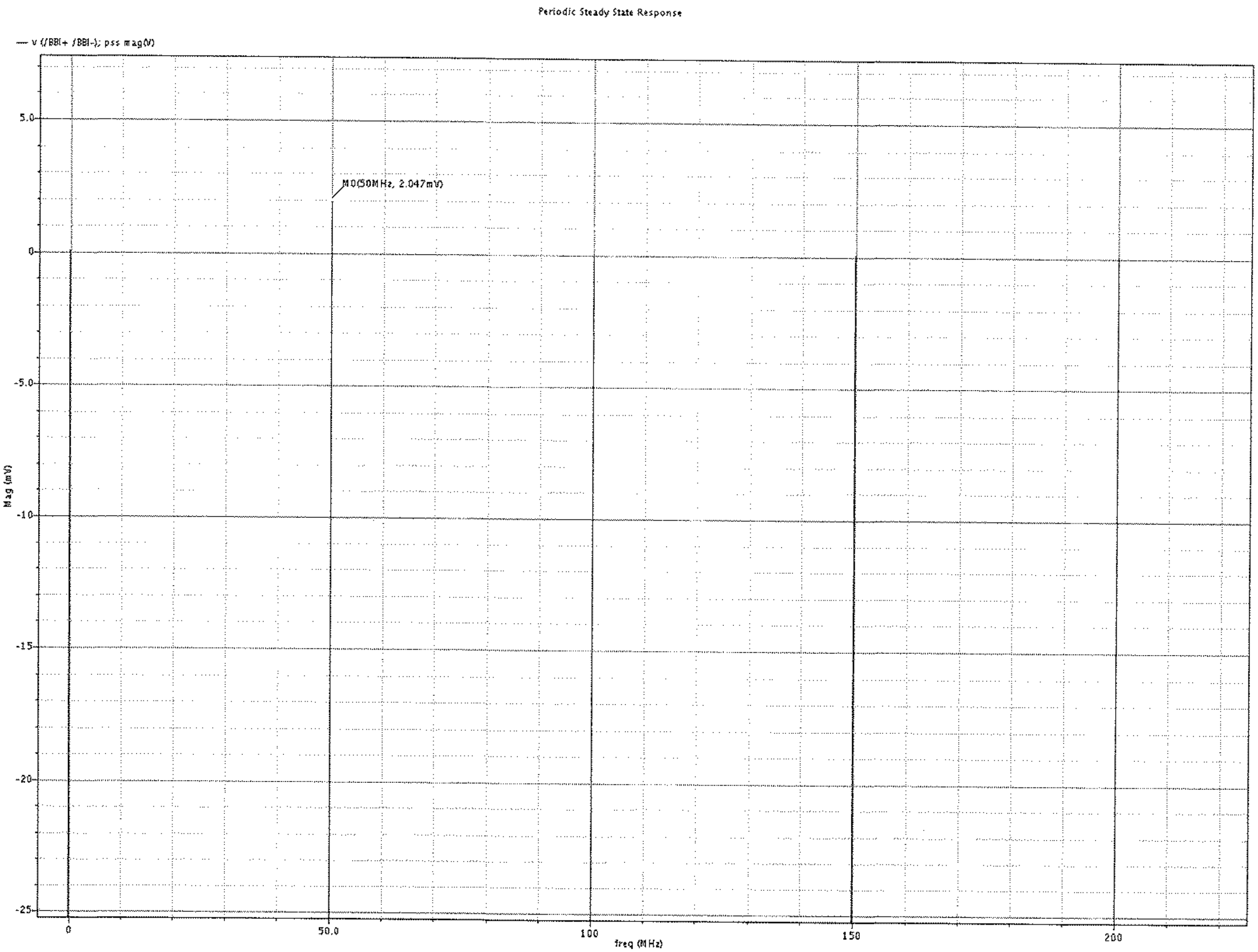

Figure 5: Baseband spectrum due to an input at the image frequency $\omega_{im} = 1.8$ GHz with an input power of -40 dBm

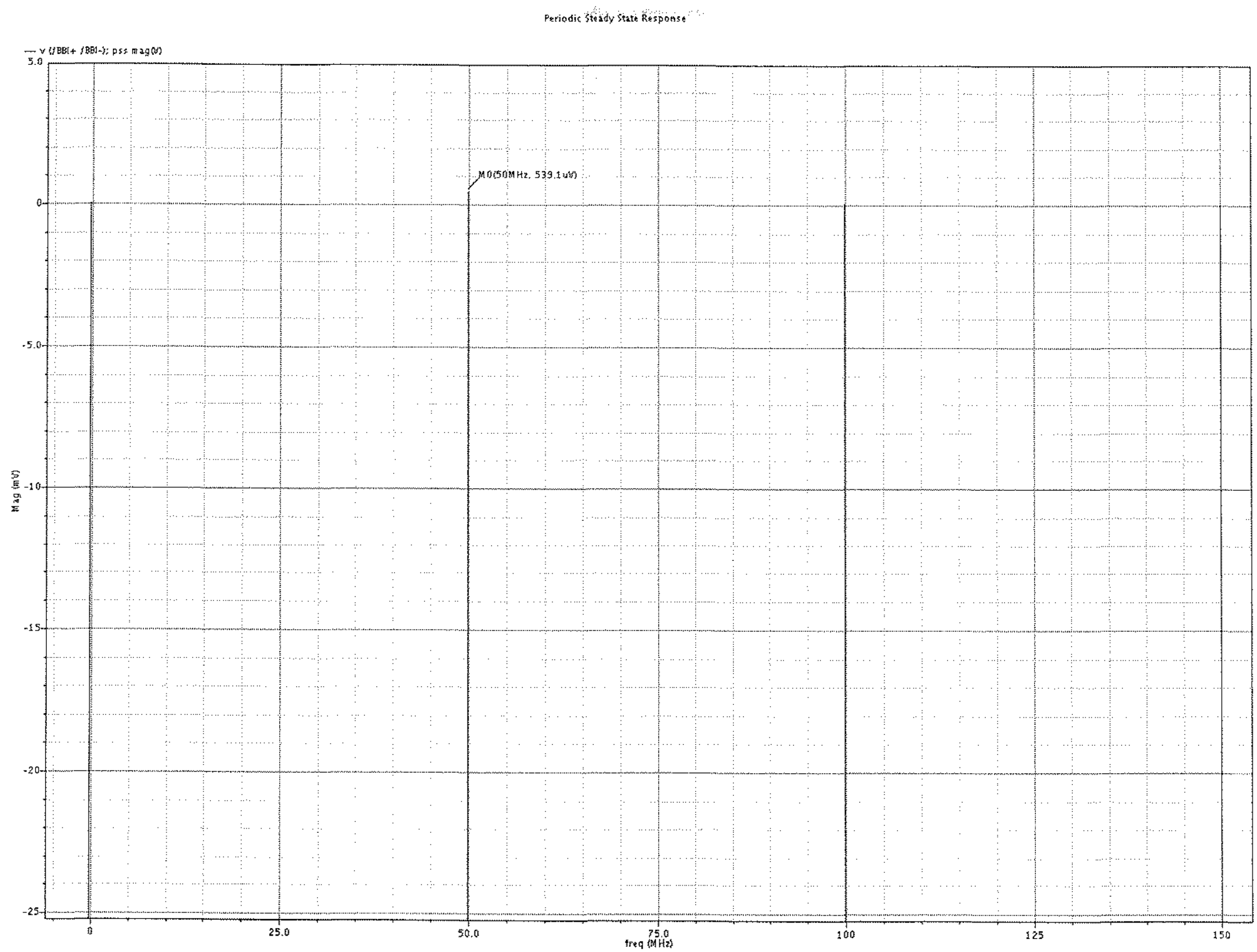

Figure 6: Baseband spectrum due to an interferer at $\omega_{int} = 8.7$ GHz with an input power of -40 dBm