ECE 145B/218B, Lab Project 1: Low-Noise Amplifier

January 10, 2024

Precautions

Precautions to avoid instrument damage

(a) Observe static precautions when working with the network analyzer or spectrum analyzer. Wear the wrist strap.

(b) Never connect a network analyzer or spectrum analyzer directly to a circuit carrying dc. Make sure your circuit is dc blocked, or you will destroy the instruments..

Safety precautions

(a) Safety note: please be very careful with the X-acto razor-blade knives. Use the same level of care you would use with a very sharp kitchen knife ! We want no injuries.

(b) Common solder is tin-lead and is toxic. If ingested, lead accumulates in your body and slowly and progressively causes brain damage as well as damage to other organs. The shop sells non-lead-containing solder. ***Do not bring lead-containing solder into the lab.*** That means, do not purchase solder at Radio-shack or other vendors unless you very carefully check its metal composition. The new non-lead solders have a higher melting point, which makes soldering harder, particularly soldering to ground planes. Use a higher-power (hotter !) iron for soldering to the ground plane.

(c) In case some student fails to follow the solder rules above, ***do not eat or bring food into the lab, wash your hands immediately after leaving the lab***, and sweep up and dispose of any solder debris. ***Do not use solder-suckers for desoldering , as these spray a fine powder of solder all over the room***. Horribly toxic if some fool uses them with lead solder ! Use desoldering wick (braid) instead; it is better anyway.

(d) Basic rules for electrical safety apply. Circuit voltages are low (~5-15 Volts) but avoid bringing in high-voltage DC supplies, use common caution in plugging in 120 V connections, do not stand in or work around water, and do not work with electrical equipment with bare feet.

(e) students who violate these precautions will receive a lab grade of zero.

Assignment: ECE145B

Overall: Design a single-stage low- noise amplifier at 900 MHz, seeking to obtain as low a noise figure as possible and as high a gain as possible.

Use either an MRF901 or MRF951 bipolar transistor for this lab; as of 2024, we have a larger stock of MRF901's. Please note that the MRF901 is available in either a micro-cross or a surface-mount package. The ADS model is available only for the surface-mount package; the models will differ slightly because the internal bond-wires are shorter for the surface mount package. But, the micro-cross package has larger contacts and

hence it is much easier to solder by hand to the micro-cross package. I suggest that you use the micro-cross package version of the MRF901, and simulate circuits using the ADS model of the surface mount version. The model inaccuracy is probably smaller than that due to unmodelled PCB assembly parasitics.

Simulations: The design must be simulated using Keysight ADS.

Construction: The amplifier should be constructed on a Duriod board, with launcher blocks and SMA connectors, as with the ECE145A lab protect. The amplifier must have internal DC biasing, and must have DC blocking capacitors on the input and output.

Measurement: The amplifier S-parameters should be measured on a network analyzer. The noise figure should be measured *manually* with the hot-cold noise source, the (provided) commercial low-noise post-amplifier, and the spectrum analyzer.

https://www.mouser.com/ProductDetail/Infineon-Technologies/BFP181E7764HTSA1?qs=sGAEpiMZZMutXGli8Ay4kB11bbUbm59cYL6of3lsjs4%3D

Assignment: ECE218B

Overall: Design a two-stage or three-stage low-noise amplifier at a design frequency of your choice, between 1.8 GHz and 3 GHz. Your goal is to obtain the lowest possible cascaded noise figure, i.e. $F_C = F + (F-1)/G + (F-1)/G^2 + ...$

Try to obtain at least 10 dB gain.

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