High Frequency Amplifier Notes

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9/30/2024

1 High Level Design

For the high frequency amplifier, we need:

- a large bandwidth (at least 200 MHz)
- a high gain
- large SNR

The MAR8ASM+ works for this application. It has:

- a large bandwidth (25 dB of gain at 1 GHz)
- a high gain (31.5 dB at 100 MHz)
- large SNR (It gives the figure 3.1 dB at 1 GHz. Assuming this is thermal noise, it is not frequency dependent so this would be the same as the noise at 100 MHz. This is a decently low value.)
- Added benefit - the amplifier is internally matched to 50 ohms.

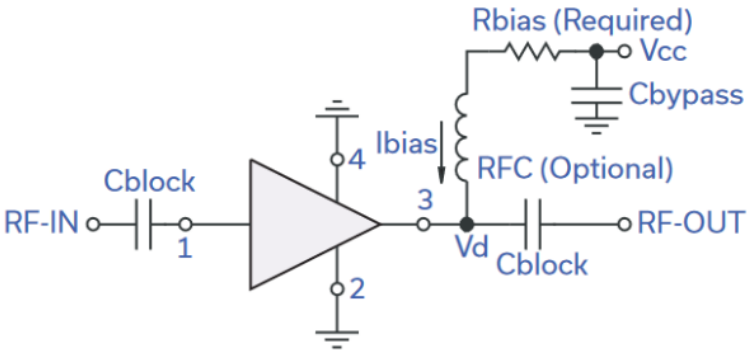
2 Detailed Design

Using the recommended application circuit:

- Assuming that Vd = 3.7V (since that is the supply voltage listed on the datasheet), Rbias dissipates $\frac{V^2}{R} = \frac{(12-3.7)^2}{226} = 0.30482300885W$. This means we can't choose a regular 1/4 watt or 1/10 watt resistor. Choosing the CRCW2512226RFKEG 1W resistor as a FOS of 3.
- For Cblock, we want it to block any signal frequencies below 88 MHz.
- Let's set it to 1uF, which would give us an impedance of $\frac{1}{2\pi j(100*10^6)(1*10^{-6})} - 0.0628j$ at 100 MHz and $\frac{1}{2\pi j(100)(1*10^{-6})} = 62.8k$ ohms at 100 Hz.
- Unfortunately, this won't work because I couldn't find any 1 uF capacitors online that would have a self-resonant freq. above 100 MHz.
- However, I did find a 0.1 uF broadband capacitor: https://www.digikey.com/en/products/det
avx/530L104KT16T/6570911?s=N4IgTCBcDaIKwGYAMAZABAYwIYAcsYEsAXAewCcQ

Mini-Circuits 50Ω DC to 1 GHz

RECOMMENDED APPLICATION CIRCUIT



Test Board includes case, connectors, and components (in bold) soldered to PCB

R BIAS[5]	
Vcc	Bias Resistor Value[6]
7	88.7
8	118
9	143
10	174
11	200
12	226
13	255

- It doesn't have a SPICE model, but it does have low insertion loss through 18 GHz, so it should be fine.
- What about the self-resonant frequency? According to perplexity, it seems like certain broadband capacitors can damp their resonance or use other advanced techniques to have a low insertion loss throughout the desired frequency range, despite their SRF being in the desired frequency range. Therefore, I am just going to use an ideal capacitor in LTSPICE, not worrying about the SRF.
- How much group delay is too much?
- From a quick google search, For FM radio, the baseband ranges from 50 Hz to 15 kHz. For 15 kHz, this corresponds to a period of 66 us.

Since the group delay for the amplifier is in the ns range, I don't think this is a problem.

- As for the MAR8ASM+, I was able to find an s-parameter model which I converted to LTSPICE using S2Spice.

3 Results

Here is the simulation of the amplifier, with the step like function being the group delay: