Application Note

Designing for Low Noise and Excellent Matching in Amplifier Applications

AN001

This App Note outlines a methodology for optimizing noise figure and return loss when designing in an amplifier.

One challenge with cascading ultra-low noise amplifiers with high Q filters is the impedance matching. To achieve optimal passband and out-of-band responses, these filters often need to be terminated with an impedance close to 50 ohms or, equivalently, with a return loss >15 dB.

Ultra-low noise LNAs are typically presented with standard matches in their data sheets that optimize NF at the expense of return loss. The architecture of these LNAs also dictates that changes to their input matches strongly affect their output matches, and vice-versa. Attempting to reactively match the output for better S(2,2) will tend to disturb the input match and may even make it worse. Fortunately, there is a simple way around this problem.

Resistive loading can be added to the output match. The resistance will improve the output return loss while allowing the input to be matched with a high Q reactive network for improved S(1,1) and optimal NF. The loading can take the form of either a shunt R, series R, or a resistive Pi or T pad.

Below is an example of an improved return loss schematic for our ultra-low noise GRF2071. The high Q shunt L on the input side improves S(1,1) while the 500 Ohm resistor in parallel with the bias inductor increases S(2,2).

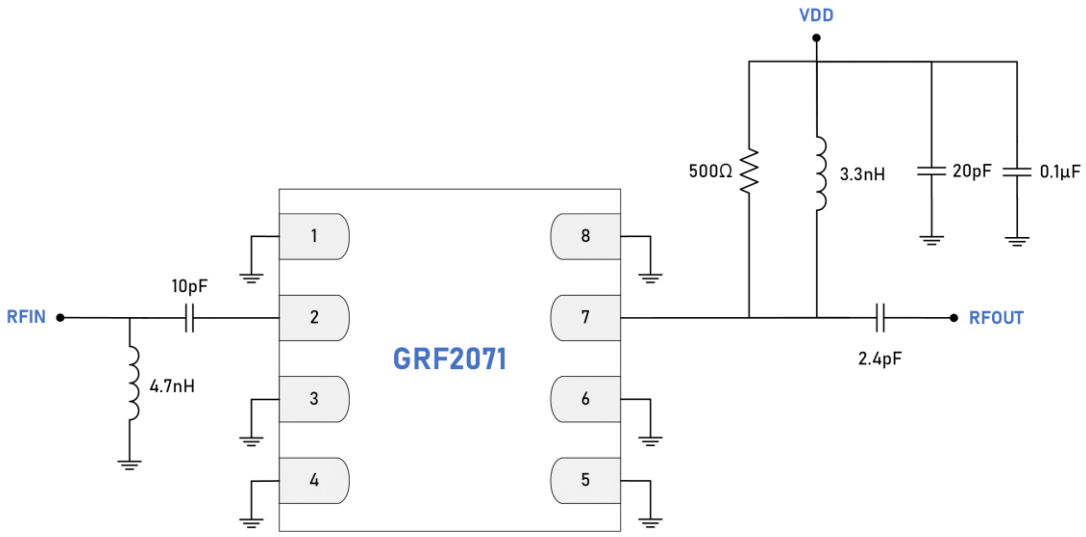

Figure 1. GRF2071 1.7 – 2.2GHz Applications Circuit

Negatives of this approach are that the device gain and output linearity are reduced by the loss of the resistor. For a high gain LNA, this resistive loss will have negligible impact on the noise figure. It should be noted that since the resistive loss occurs on the output side of the transistor, the input referenced linearity is relatively unaffected. An additional benefit of the resistive loading is that the stability margin of the amplifier is improved.

How much noise figure do we give up with this approach? For today's ultra-low noise pHEMT LNAs, matching for a high input return loss of perhaps 20 dB with high Q inductors and capacitors will typically result in a noise figure penalty of less than 0.2 dB.

Please take a look at some of our ultra-low noise amplifiers and contact our applications team at applications@guerrilla-rf.com with any questions!

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Revision History

Revision	Date | Reason for Revision
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