LNA FOR SATELLITE MODE L/S OPERATION

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ABSTRACT

In this contribution a new low-noise amplifier (LNA) with notch filter is described. The LNA will serve as a part of satellite communication system for AO-40 Mode L/S operation. The notch filter has been developed to prevent disturbance of the S-Mode amplifier (a dual antenna for Mode L uplink and Mode S downlink will be used). The simulation tool Serenade 8.5 was used for design of the LNA with the notch filter.

1 INTRODUCTION

Typical low noise amplifier designs for S band utilize microstripline matching providing a noise match at the input and a conjugate impedance match at the output for maximum associated gain.

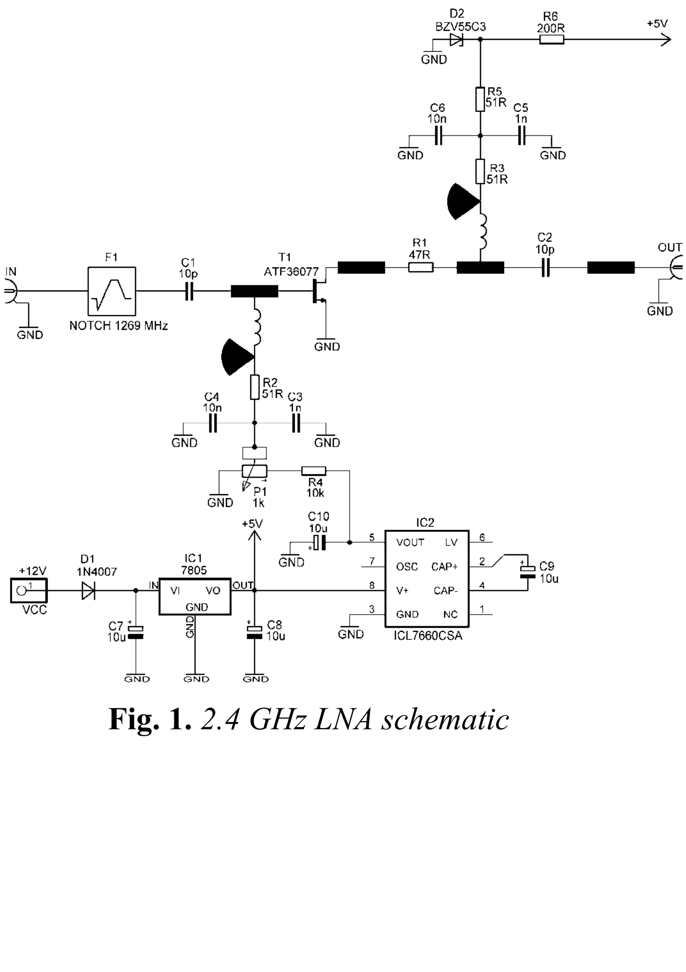

Fig. 1. *2.4 GHz LNA schematic*

Some of the limitations in noise figure are due to the microstripline losses at the input. The input circuit of the LNA contains a notch filter to prevent disturbance of the S-Mode amplifier. This provides a deep notch at 1269 MHz using a double quarter wave open stub connected to the 50 Ω line. The simulated through-loss of the filter is only 0.16 dB, so the filter should not add any significant noise figure to the system.

The LNA uses a wire inductor for the low noise input match in an attempt to minimize circuit losses and lower amplifier noise figure [1]. The device (ATF36077 PHEMT) is capable of providing noise figures lesser than 0.4 dB at 2.4 GHz. A microstripline network is used for output matching with a small resistor in series with the drain, to lower the gain and improve stability. Quarter wave bias decoupling lines are used to provide gate and drain bias to ATF36077. 50 Ω chip resistors are used along with the bias decoupling lines to provide low frequency terminations for the device [1]. Good grounding of device source for stable operation is offered by the use of two wires through holes on each source. The schematic of the LNA is shown in fig. 1.

2 SIMULATION

The simulation tool Serenade 8.5 was used for design of the LNA. The amplifier is designed with ARLON DiClad870 dielectric material with $\varepsilon_r = 2.33$ and 0.02 inches thickness. Nominal bias point for the ATF36077 model is a V_{DS} of 1.5 V and an I_{DS} of 10 mA. The nominal gate bias is -0.2 V.

Figure 2 shows scattering parameters of the LNA. Gain at 2.4 GHz is 16 dB (marker 1) and deep notch (more than 90 dB) at 1269 MHz is shown by marker 4. Output return loss is better than 25 dB from 2.3 GHz to 2.6 GHz. Good input return loss is more difficult to achieve, because the best noise match does not coincide with the best gain match. Input return loss is better than 6 dB at 2.4 GHz (marker 2).

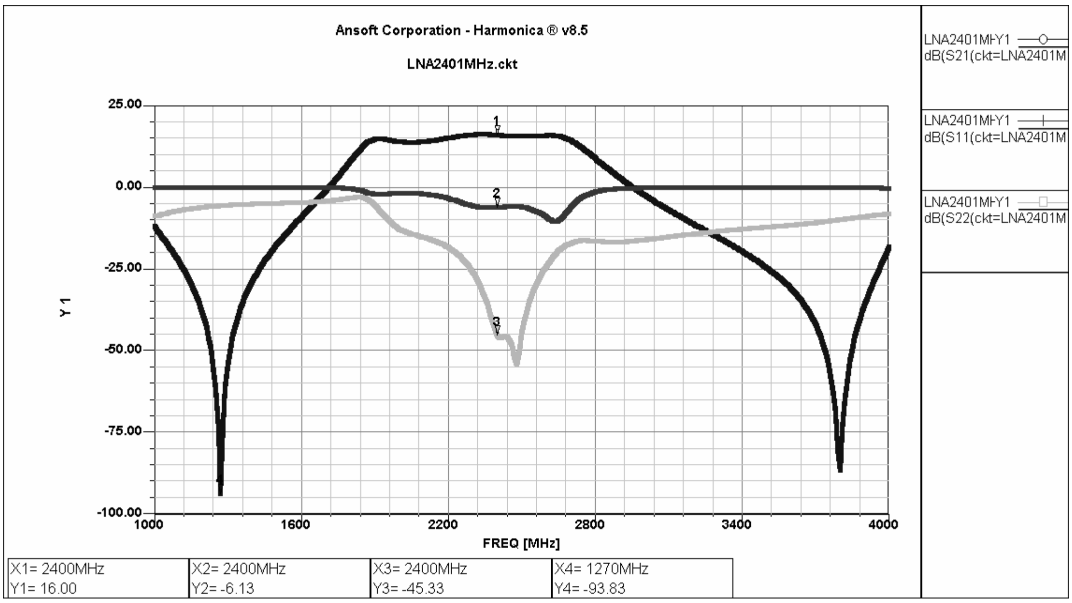

Fig. 2. *S-parameters simulation*

Noise figure versus frequency is shown in figure 3. The amplifier provides a minimum noise figure slightly under 0.6 dB at mid band (marker 1). The broadband input noise match provides an amplifier with a 0.8 dB maximum noise figure from 2.1 GHz to 2.7 GHz.

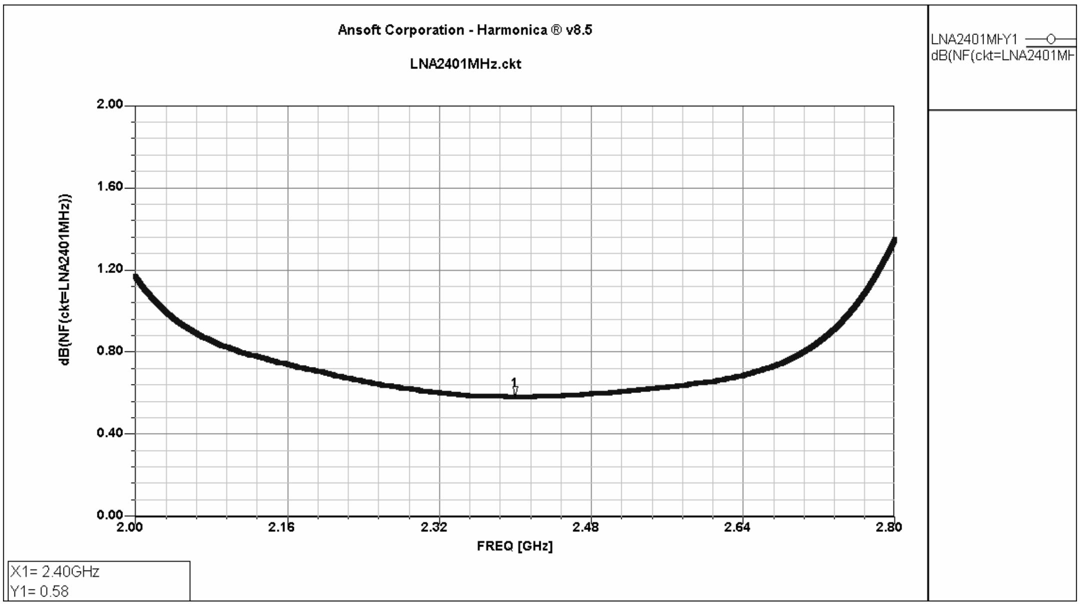

Fig. 3. *Noise figure simulation*

3 MEASUREMENTS

Figure 4 shows the measured gain versus frequency from 1 GHz to 3.2 GHz. The spectral analyzer R3132 Advantest was used for this measurement.

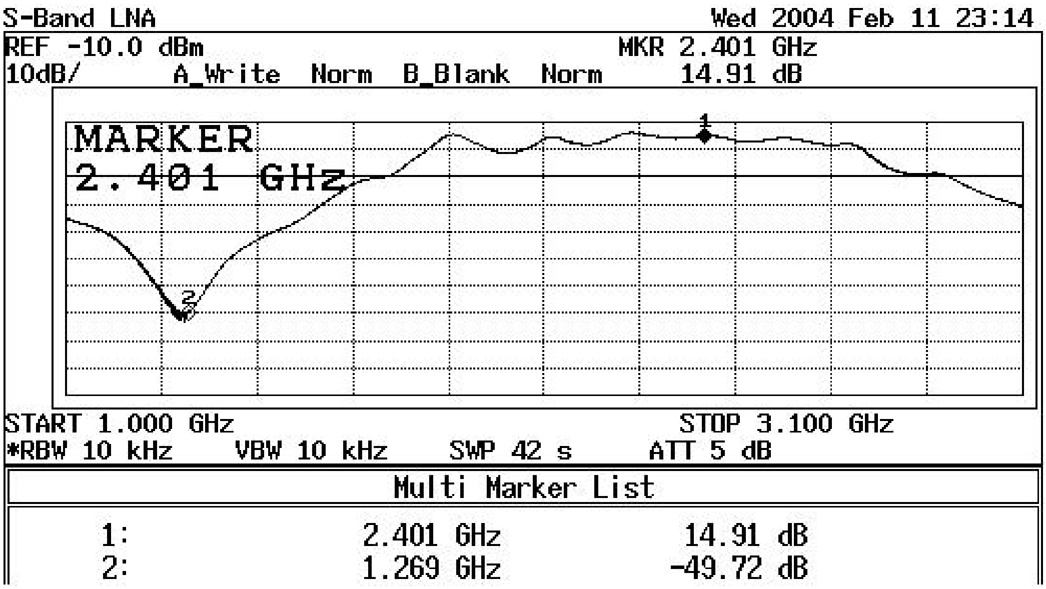

Fig. 4. *Gain vs. Frequency*

The tracking generator output power is set to −30 dBm. The continuous line marks the reference −30 dBm level (relatively 0 dB). The gain at the designed frequency (marker 1) is near to 15 dB. The measured signal rejection at 1269 MHz is better than 50 dB (detail in figure 5). The real rejection is even better than 50 dB. The limited dynamic range of the spectral analyzer causes this.

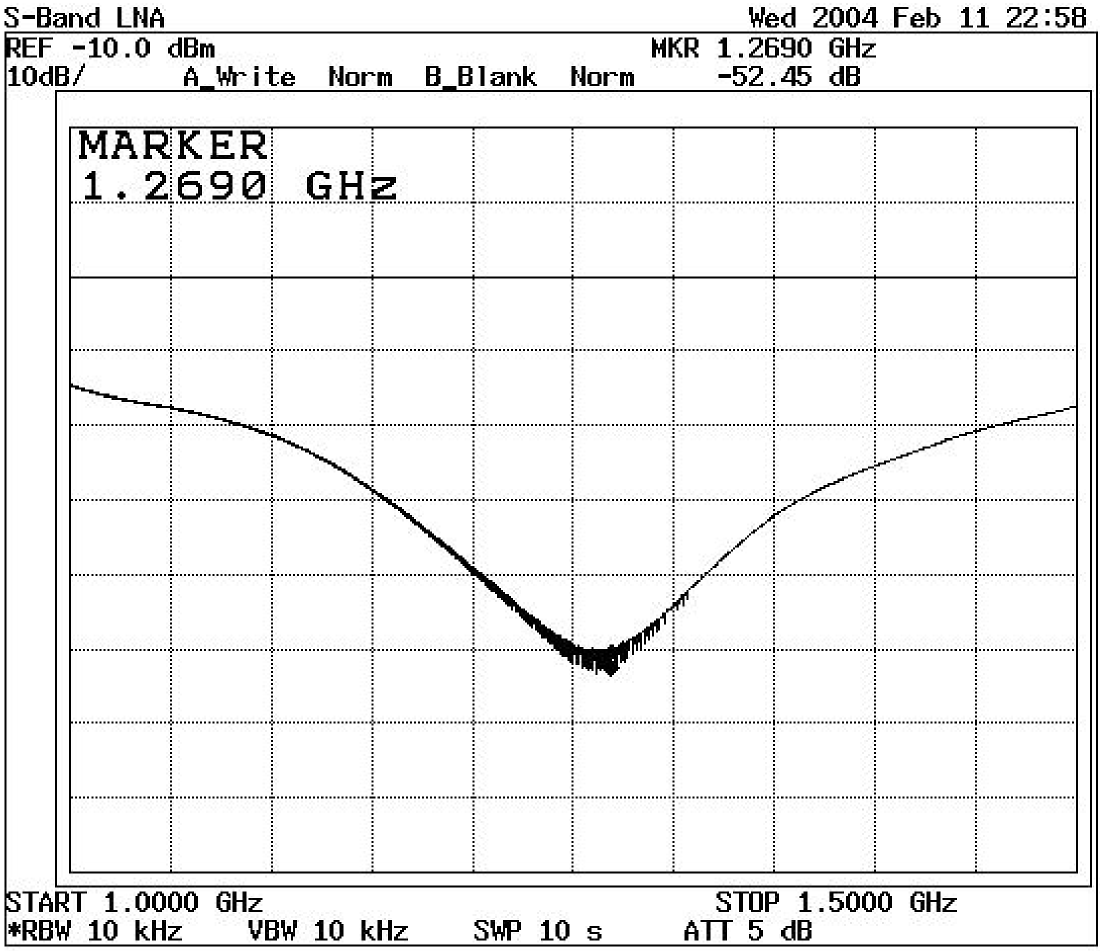

Fig. 5. *Notch detail*

Measurement of noise figure was not done but computer simulation gives us the approximate value (figure 3).

4 CONSTRUCTION

The board with a printed circuit is soldered in a shielding box at a height of 12.5 mm. Power supply is injected by a feed-through soldered capacitor. Tetra screws fix SMA connectors. The LNA is made on a two - sided PCB. ARLON DiClad870 was chosen as a substrate. Reinforced PTFE composite is designed for exacting stripline and microstrip circuit applications. Photo of the LNA module is shown in figure 6. Actual dimension of the module is 95 × 60 mm.

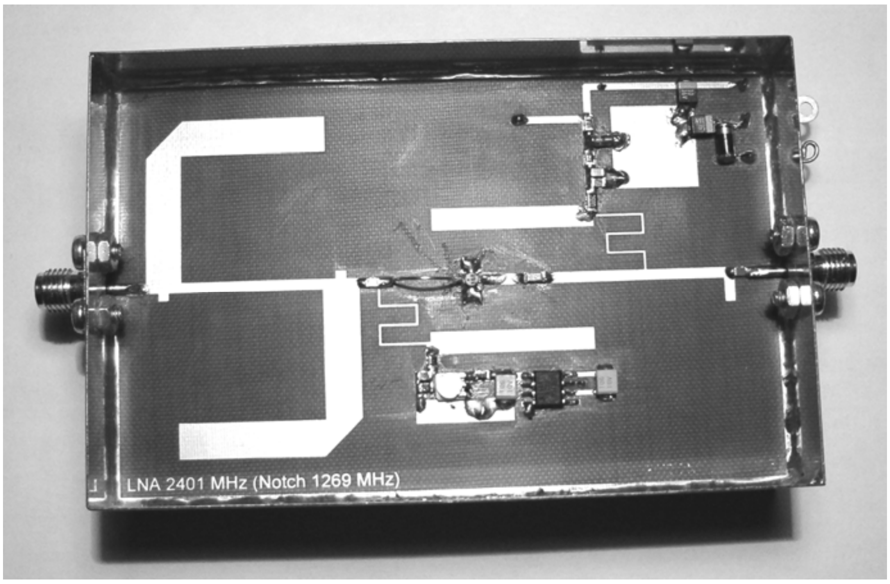

Fig. 6. *Photo of the LNA module (Top)*

5 CONCLUSION

The LNA for 2.4 GHz has been described providing low noise figures in the 2.1 GHz to 2.7 GHz frequency range and gain near the 15 dB level at 2401 MHz. A wire input network provides the match necessary for low noise performance.

ACKNOWLEDGEMENTS

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