

Title of the project: C-Band Low Noise Block Downconverter for Satellite Receiver

Theory:

A Low Noise Block Downconverter (LNB) is an important front-end circuit in satellite communication receivers. It receives a weak C-band satellite signal, amplifies it using a low-noise amplifier and converts the received high-frequency signal to a lower intermediate frequency using a local oscillator and mixer. The proposed circuit consists of input band-pass filtering, a two-stage low noise amplifier, a local oscillator, a frequency mixer, an intermediate-frequency band-pass filter and an IF amplifier. The proposed design will be reproduced and simulated in eSim to verify its frequency conversion and gain characteristics.

Proposed System:

C-band input: Receives the RF signal in the 3.4–4.2 GHz range.

Input band-pass filter: Selects the required C-band signal.

Two-stage LNA: Amplifies the weak received signal.

Local oscillator: Provides a 2.45 GHz signal for frequency conversion.

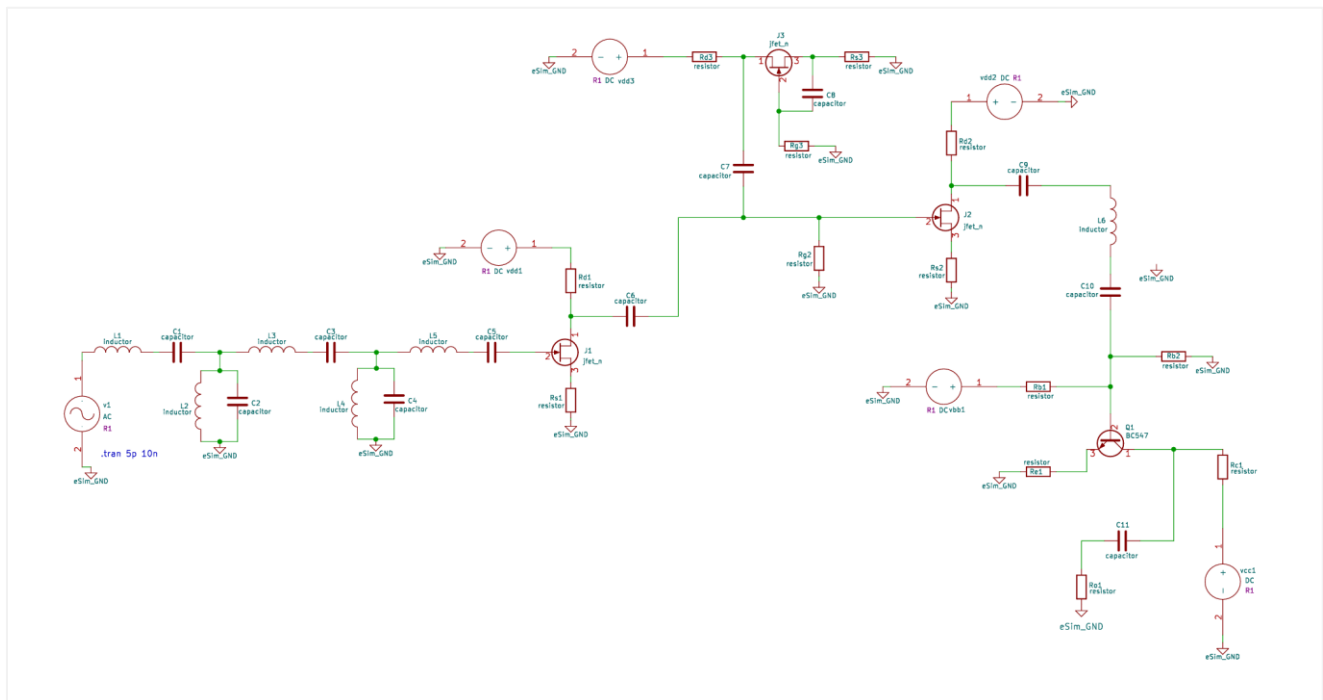
Mixer: Combines the amplified RF signal and local oscillator signal to perform downconversion.

IF band-pass filter: Selects the required intermediate-frequency component.

IF amplifier: Amplifies the downconverted IF signal.

IF output: Provides the downconverted signal in approximately the 950–1750 MHz range.

Circuit Schematic:



(fig.1: Complete eSim/KiCad circuit schematic of the C-Band Low Noise Block Downconverter)

Circuit Implementation:

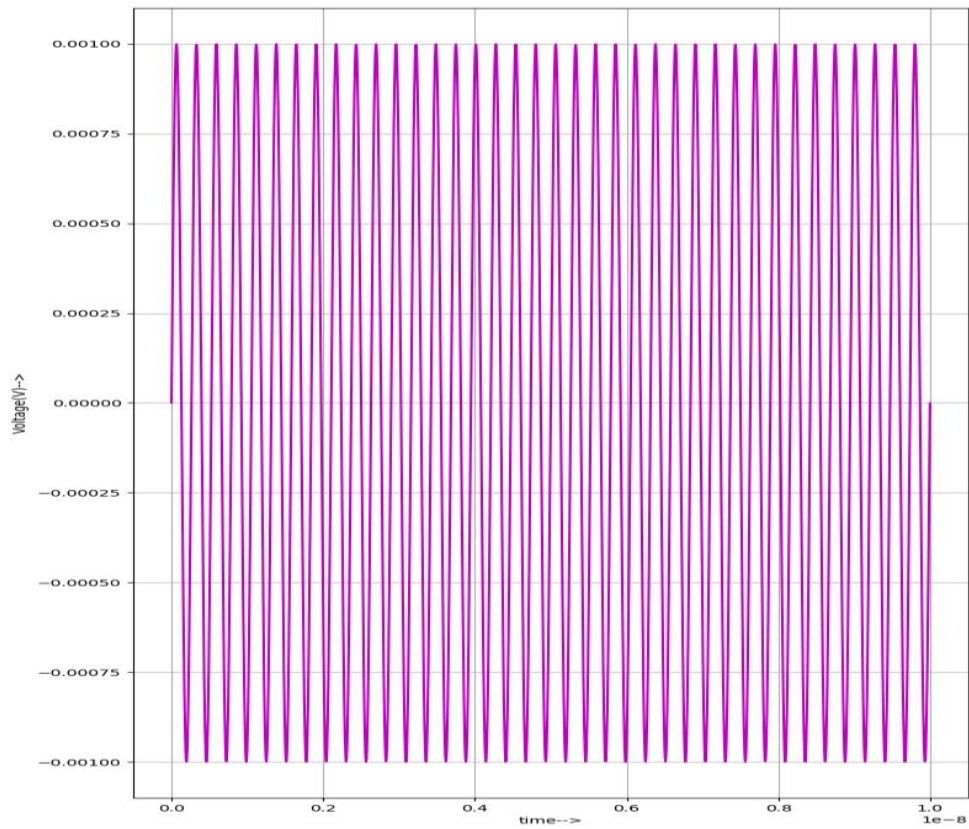
The circuit is intended to be reproduced and simulated at circuit level in eSim. The signal path consists of an input band-pass filter followed by a two-stage low noise amplifier. The amplified RF signal is then applied to a mixer together with a 2.45 GHz local oscillator. The resulting signal is passed through an IF band-pass filter and an IF amplifier to obtain the intermediate-frequency output.

Block Diagram:

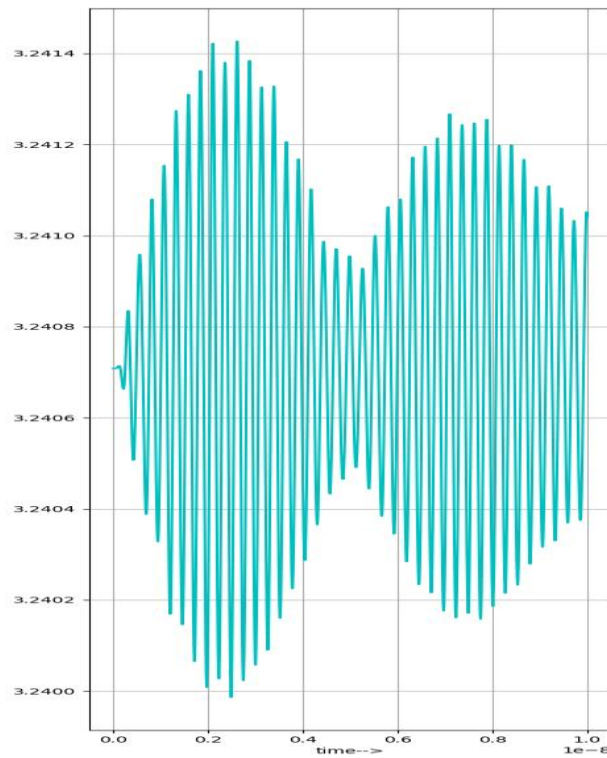
C-band Input (3.4–4.2 GHz) → Input Band-Pass Filter → Two-Stage LNA → Mixer 2.45 GHz Local Oscillator → IF Band-Pass Filter → IF Amplifier → IF Output (950–1750 MHz)

Simulation Results:

The source document specifies the expected simulation output as amplification of the weak input signal and frequency downconversion from the C-band input to the intermediate-frequency output. Frequency response, conversion gain and output spectrum are to be analyzed and compared with the results reported in the reference publication.



(fig.2: Ngspice input RF waveform)



(fig.3: Ngspice output IF waveform or spectrum showing the downconverted component)

Expected Results (Input, Output waveforms and/or Multimeter readings):

Parameter	Expected value / observation
Input	C-band RF signal in the 3.4–4.2 GHz frequency range.

Local Oscillator	2.45 GHz
Output	Downconverted IF signal in approximately the 950–1750 MHz range.

Working Principle:

The C-band RF signal is first passed through the input band-pass filter and then amplified by the two-stage low noise amplifier. A 2.45 GHz local oscillator supplies the second mixer input. The mixer performs frequency conversion, producing an intermediate-frequency component. The IF band-pass filter selects the required IF component, and the IF amplifier provides the final amplified output. The expected IF output range is approximately 950–1750 MHz.

Research Paper:

Title: Low Noise Block Downconverter Design for satellite Receiver System Vinasat 1 Operating at C-band.

Author: Tran Van Hoi, Hoang Duc Long, Bach Gia Duong

Page No.: 110–115

Link: https://www.researchgate.net/publication/303406172_Low_noise_block_downconverter_design_for_satellite_receiver_system_Vinasat_1_operating_at_C-band

Source/Reference(s): Low Noise Block Downconverter Design for satellite Receiver System Vinasat 1 Operating at C-band research paper.

Expected Outcome:

The expected outcome is a functional eSim simulation of the proposed C-band LNB demonstrating amplification of the weak input signal and frequency downconversion from the C-band input to the intermediate-frequency output. The frequency response, conversion gain and output spectrum can be analyzed and compared with the reference publication.

Conclusion:

Thus, the C-band Low Noise Block Downconverter provides a complete satellite-receiver front-end signal chain consisting of input filtering, two-stage low-noise amplification, local-oscillator generation, mixing, IF filtering and IF amplification. The proposed eSim reproduction is intended to verify the expected frequency conversion and gain characteristics, with a 3.4–4.2 GHz C-band input, a 2.45 GHz local oscillator and an approximately 950–1750 MHz IF output.