TELE4651 Wireless Communication Technologies

TELE4651 Pre-Lab Report (Lab 1)

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1 Pre-Lab Questions

As several hyperlinks in the laboratory guidance manual are expired, additional documents are used which are listed in the reference.

1.1 What is the range of allowable carrier/center frequency supported by the NI-USRP?

According to [1], [2], [3], and [4], the NI-USRP-292x series typically supports a bandwidth of 20 MHz. Specifically, 2920 is a 50 MHz to 2.2 GHz USRP Software Defined Radio Device. 2921 supports 2.4 GHz to 2.5 GHz and 4.9 GHz to 5.9 GHz and 2922 supports 400 MHz to 4.4 GHz. These ranges allow a broad spectrum of applications in wireless communication systems, including cellular, satellite, and radar systems.

1.2 What is the maximum allowable bandwidth supported by the NI-USRP?

As is pointed out in 1.1, the NI-USRP-292x series supports a maximum bandwidth of up to 20 MHz.

This bandwidth determines the range of frequencies that can be transmitted or received, which is crucial for high-data-rate applications like Wi-Fi or LTE.

1.3 What is the maximum sampling rate of the NI-USRP?

According to [5], [6], and [7], the maximum sampling rate for the NI-USRP-292x series is 50 MS/s (8-bit sample width). When it comes to 16-bit sample width, the maximum I/Q sampling rate is 25 MS/s.

1.4 Why do you think the DDC is implemented? What is its main benefit?

The Digital Downconverter (DDC) is implemented to shift high-frequency signals to baseband (low frequencies), making them easier to process digitally. Its main benefit is that it reduces the amount of data that needs to be processed by filtering and decimating the input signal, thus reducing the computational load on the system and allowing more efficient signal processing.

1.5 In your own words, describe what the bandwidth of an instrument is.

Bandwidth refers to the frequency range within which a device can operate, or to say, it refers to the range of frequencies that an instrument can transmit or receive. For a communication device, it represents the difference between the highest and lowest frequency it can process. A higher bandwidth allows for the transmission of more data, leading to higher communication speeds.

1.6 What is meant by the sampling rate of an instrument?

The sampling rate is the number of samples taken per second by an instrument, typically measured in samples per second (S/s) or megasamples per second (MS/s). In the context of signal processing, it defines how frequently the analog signal is measured to be converted into a digital signal. A higher sampling rate increases the resolution and accuracy of the digitized signal.

1.7 Why are these specifications important for designing a transmitter and receiver in a wireless communications system?

These specifications are critical because they define the limits of how the transmitter and receiver can operate:

- Frequency range affects which signals the device can capture or transmit, determining compatibility with specific wireless communication standards (e.g., Wi-Fi, LTE, etc.).
- Bandwidth impacts data throughput—higher bandwidth allows for faster data rates, essential in high-speed applications.
- Sampling rate influences the accuracy and fidelity of the signal processing, which is crucial for ensuring reliable data transmission and minimizing errors. The implementation of DDC and other digital processing techniques ensures that signals can be processed efficiently, reducing system complexity while maintaining high performance.

These factors ensure optimal performance, reduce errors, and ensure compatibility with various communication standards in wireless systems.

References

[1] National Instruments 2013, *USRP-2920/2921/2922 Getting Started Guide*, National Instruments, viewed 28 September 2024, Available: https://download.ni.com/support/manuals/376358b.pdf.

[2] https://www.ni.com/en-au/support/model.usrp-2920.html.html

[3] https://www.ni.com/en-au/support/model.usrp-2921.html.html

[4] https://www.ni.com/en-au/support/model.usrp-2922.html.html

[5] https://www.ni.com/docs/en-US/bundle/usrp-2920-specs/page/specs.html

[6] https://www.ni.com/docs/en-US/bundle/usrp-2921-specs/page/specs.html

[7] https://www.ni.com/docs/en-US/bundle/usrp-2922-specs/page/specs.html