

Digital Communication Systems Engineering with Software-Defined Radio

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Lecture 26

Importance of an Ergonomic SDR Interface

- ▶ Software-defined radios are flexible and powerful development platforms
 - ▶ Software interfaces definitely have room for improvement
 - ▶ Underdeveloped documentation
 - ▶ Steep learning curve steep
 - ▶ Poorly tested examples fail in modes that the user would expect to work
 - ▶ Difficult for communication system engineers to start using software-defined radios
 - ▶ Slows the pace of development and frustrates the user

Design Flow

- ▶ Leveraging existing commercially-available and well-known software
- ▶ Streaming based software solutions are ideal for debugging radios in simulation and then running the radios in real time
- ▶ Interfacing these radios will accelerate research and development in the area of advanced wireless communications
- ▶ Graphical software environment lends itself to visual learners

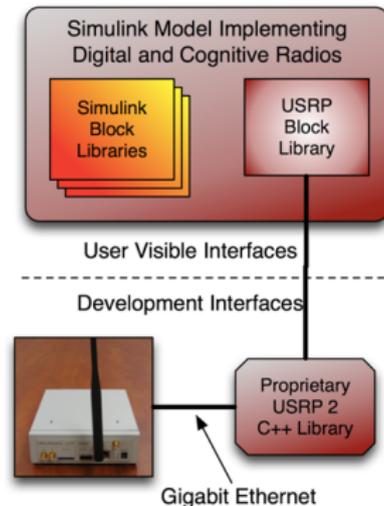


Figure : Proposed Design Flow of Simulink/USRP2 Interface.

Simulink Blocks and Parameter Interface

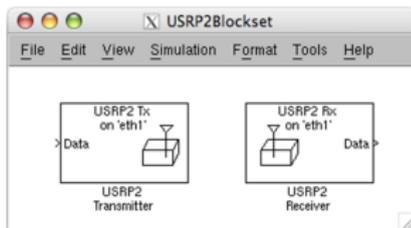


Figure : Proposed Simulink/USRP2 Blocks.

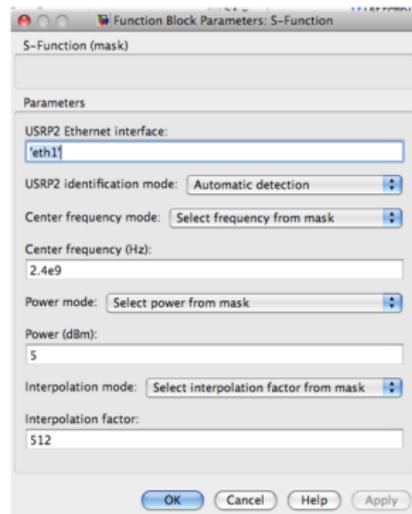
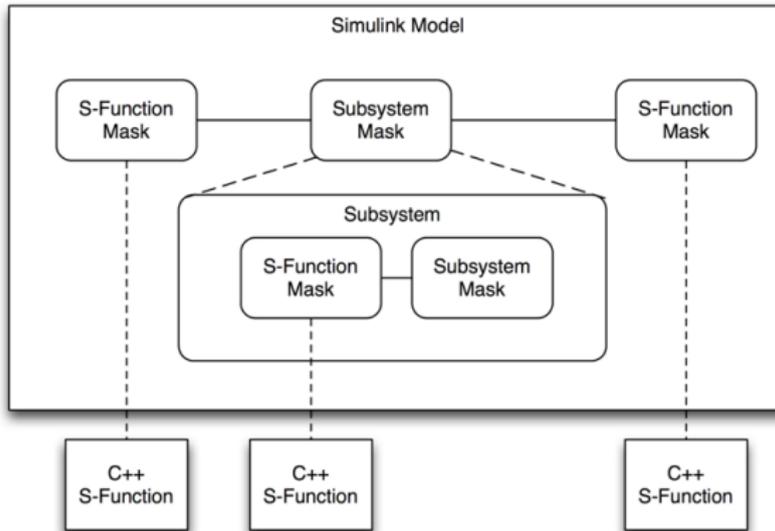
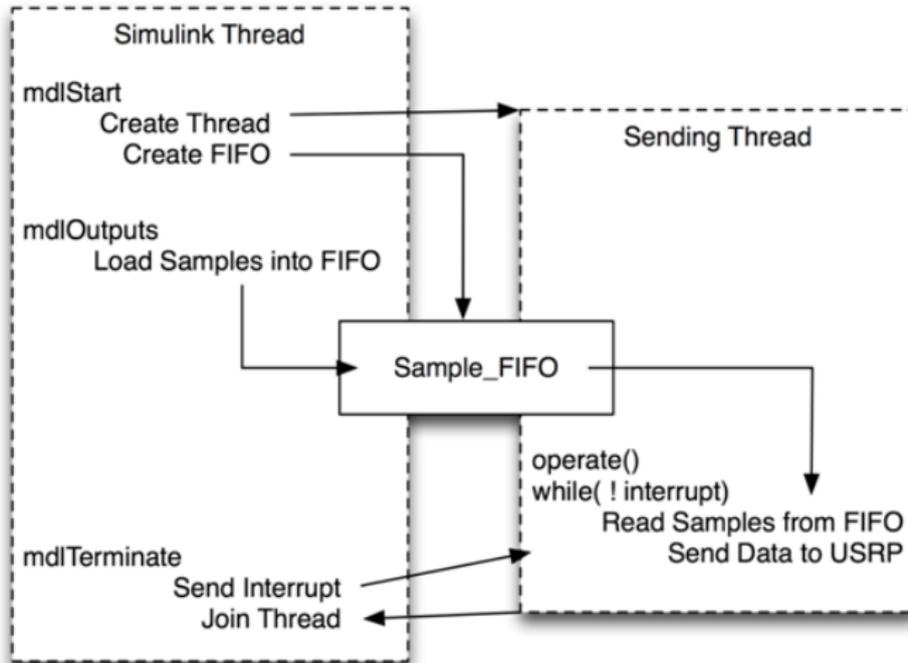


Figure : Proposed Simulink/USRP2 Parameter Interface.

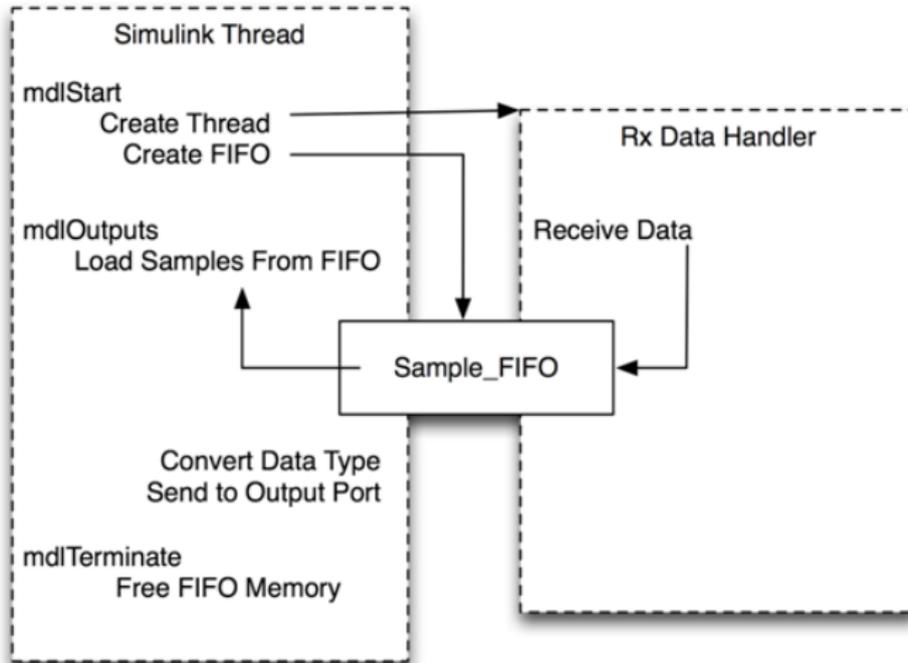
Simulink S-Function Blocks



Simulink/USRP2 Transmit Thread



Simulink/USRP2 Receive Thread



USRP2 Sampling

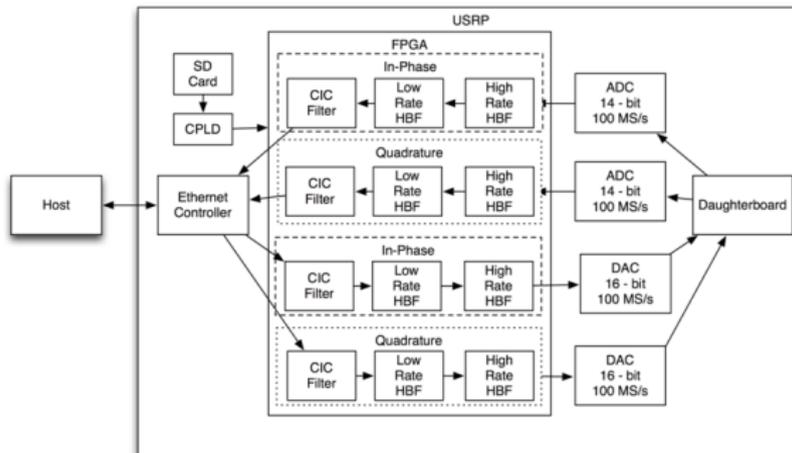


Figure : Schematic of USRP Sampling Implementation.

USRP2 Sampling

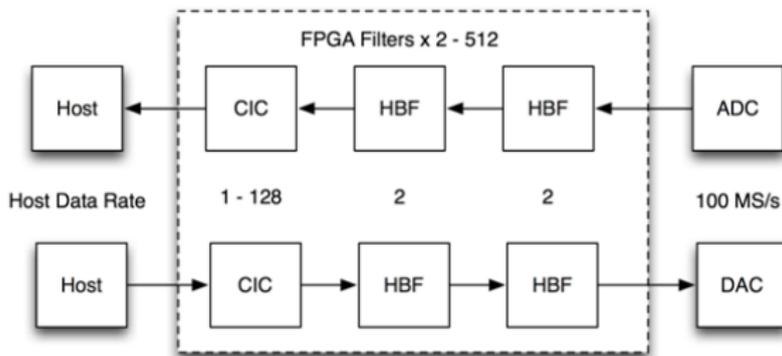


Figure : USRP FPGA-Based Filtering.

USRP2 Sampling

Table : Example Interpolation/Decimation Factors, Host Sampling Rates, and Bandwidths for USRP2 Transceiver.

Int/Dec Factor	Host Sample Rates	Bandwidth
512	195 kS/s	97.6 kHz
256	390 kS/s	195 kHz
128	781 kS/s	390 kHz
2	50 MS/s	25 MHz

Sampling Rate Issues

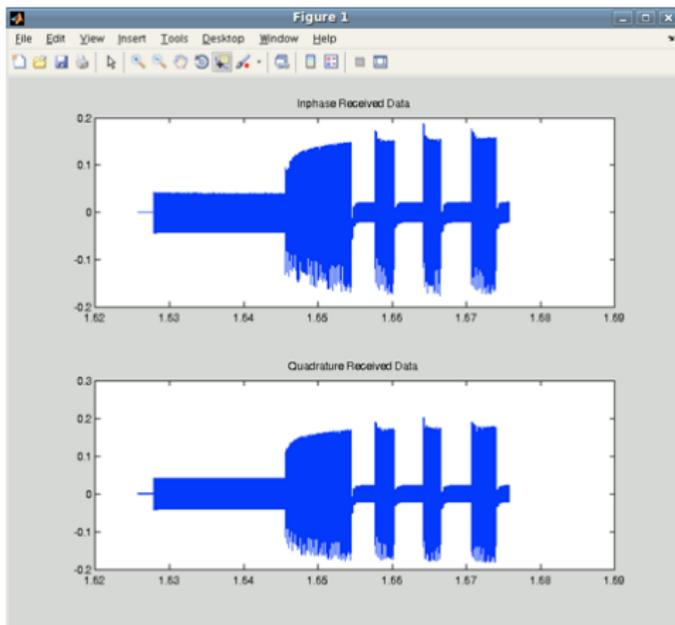


Figure : An Example of Sampling Rate Errors due to Intermittent Transmitter yielding “SSSSSS” Warnings.

Experimental Setup

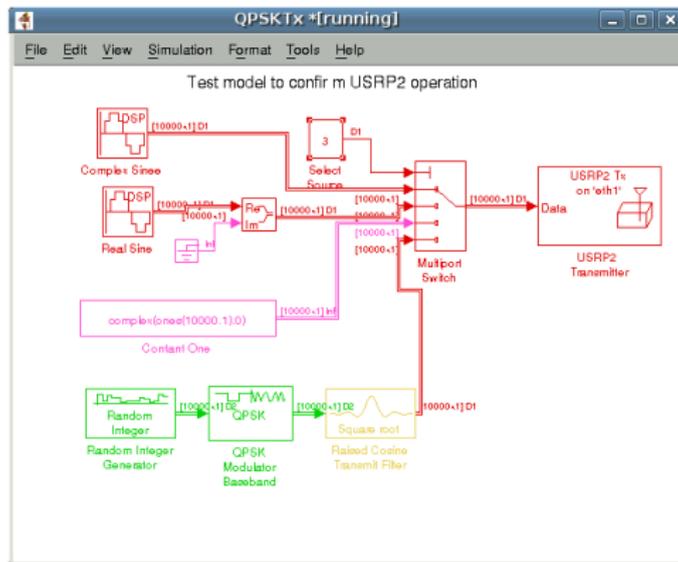


Figure : Experimental Setup Employing Proposed Simulink/USRP2 Interface.

Constant Transmission

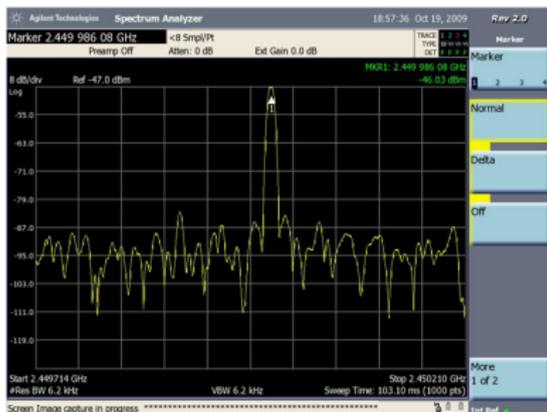


Figure : From Spectrum Analyzer.

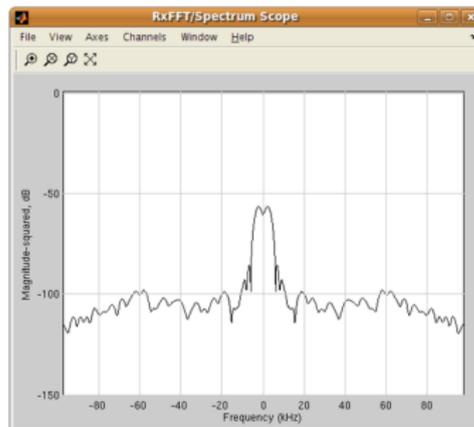


Figure : From Simulink Interface.

Complex Sinusoid Transmission

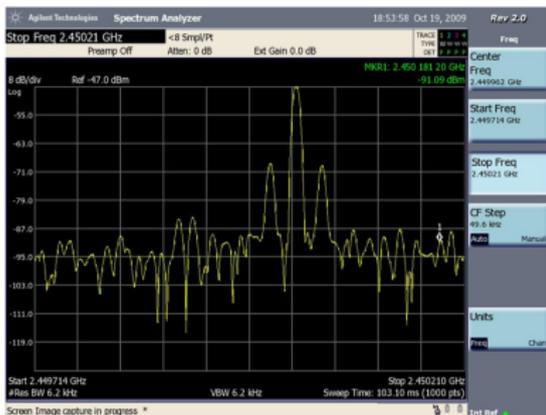


Figure : From Spectrum Analyzer.

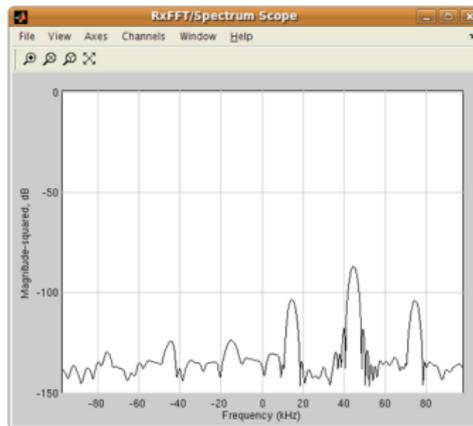


Figure : From Simulink Interface.

Real Sinusoid Transmission

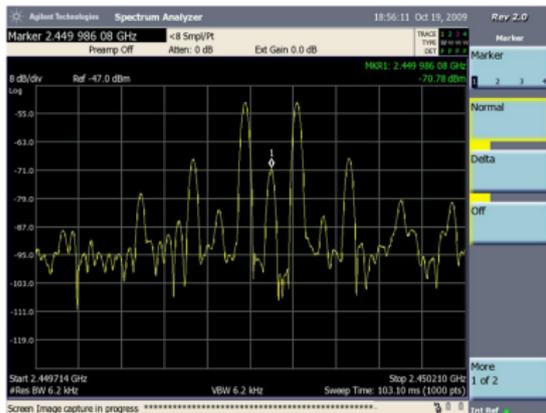


Figure : From Spectrum Analyzer.

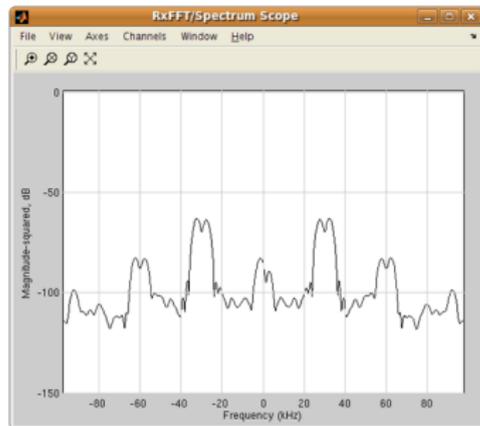


Figure : From Simulink Interface.

Quadrature Phase Shift Keying Transmission

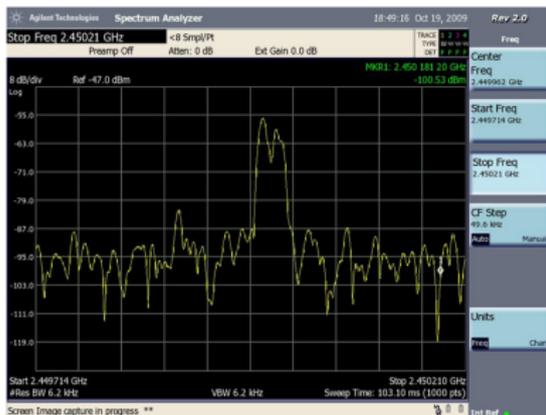


Figure : From Spectrum Analyzer.

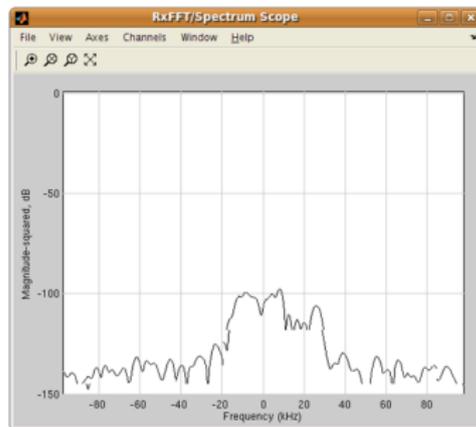


Figure : From Simulink Interface.