Final Project Introduction

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The Goal

- Build a mixed analog/digital signal processor for measuring and real-time processing of the signals in 158–162 MHz range.
- Turn your processor into a high-Q RF cavity simulator in the above frequency range.
- Tomorrow after dinner we will have a high-Q shootout — not graded, just for fun...

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Given

- RF frequency signal at 160 MHz and 0 dBm.
- LO frequency signal at 210 MHz and +5 dBm.
- LLRF4 clock at 250 MHz and sufficient level :)
- +15 V power supply.
- Time-shared access to network analyzers and the spectrum analyzer.

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Parts

Type	Part	Quantity
Mixer	Mini-Circuits ZLW-1W	2
2-way splitter	Mini-Circuits ZX10-2-12	1
Amplifier	Mixed	2
Filter	Mixed	2
Cables	Short & long	4
DSP	LLRF4 + Laptop	1
SMA hardware	Mixed	
Attenuator	3 dB	2
Attenuator	4, 5, 6 dB	1

- Each group will get two 160 MHz bandpass filters: one 4 or 10 MHz wide, and one 10/16/20 MHz wide.
- More attenuators and other RF components will be available on demand.

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What is Expected

- We will check the response on the network and spectrum analyzers.
- We expect to see only passband response between 10 and 300 MHz. Out-of-band $|S_{21}|$ should be at least 40 dB below the peak.
- You should create two configurations - one with maximum Q you can achieve, another with the damping time of 75 ns. Use config save/restore in EPICS.

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What is Expected (Continued)

- In the 75 ns damping configuration we will expect to see a response with the network analyzer output power set to -50 dBm.
- With a 0 dBm 160 MHz input we expect to see at least 40 dB from the signal peak in the ADC spectrum to the second largest line.
- We will also check the output spectrum on a spectrum analyzer with the DAC driven by DDS at 50 MHz. Anything other then 160 MHz should be at least 50 dB down.

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Grading

- Based 50% on group work and 50% on individual report.
- Each half is worth 50 points.
- On the group part, in the performance check you can lose points:
  - Input signal not on the ADC waveform: -10
  - No 160 MHz output with 50 MHz DDS: -10
  - No IIR response: -10
  - Every 3 dB over the specified limit: -2
- On your report, you should show the assembled system block diagram with (hopefully) signal level measurements.
- Comment on chosen design topology, tradeoffs, things to do better.
- Coefficient settings used.
- Document performance (nominal feedthrough gain, input spurious level, output spectral content).

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Hints

- Parts in your kit are there for a reason. Think how to use all of them.
  - Note: you might need extra attenuators or have some left over.
- Keywords: down- and up-conversion, full-scale, saturation, distortion, conversion loss, mixer isolation, IIR, DDS, FFT.