Towards custom RFSoC firmwares for quantum control

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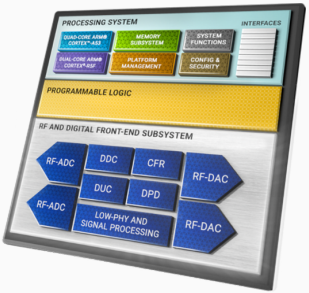


Why do we need custom RFSoC firmwares?

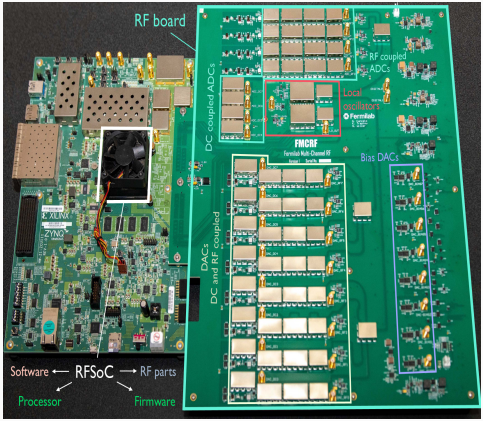
The QICK: Quantum Instrumentation Control Kit

- Developed at FNAL in 2021

  https://arxiv.org/abs/2110.00557

- Provides multiple firmwares for RFSoC4x2, ZCU111, ZCU216

- Exploits the PYNQ fraework to control the FPGA using `Python`



The QICK: Pros and Cons

Pros:

- Fast prototyping: various firmwares ready to use
- High phase-stability

  https://arxiv.org/abs/2311.17171
- Large community of users: QICK is used in many labs for different qubit technologies
- Open-source

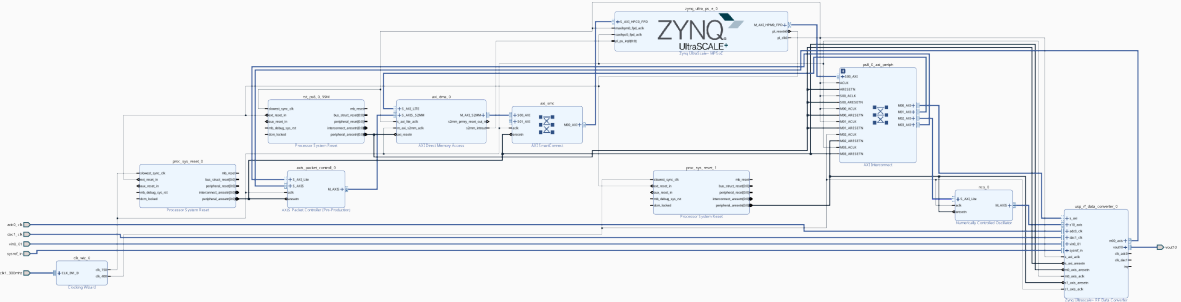
Cons:

- Small developer community
- Firmwares are static and non modifiable
- Local operations and only pulse-based ($\rightarrow$ Qibosoq required for computing applications) *https://arxiv.org/abs/2310.05851*
- Firmware contributions are **not** accepted

What are we working on?

The process of building a QICK-like application

Single DAC and ADC enabled



Conclusions

Realistic objectives

1. Being able to add (move) blocks to current QICK designs
2. Being able to add **custom** blocks
3. Extending QICK capabilities (adding memory, processing power)
4. Writing custom firmwares for specific applications (error-correction, defined architectures)