Architecture of Transverse MultiBunch Feedback Processor at Diamond

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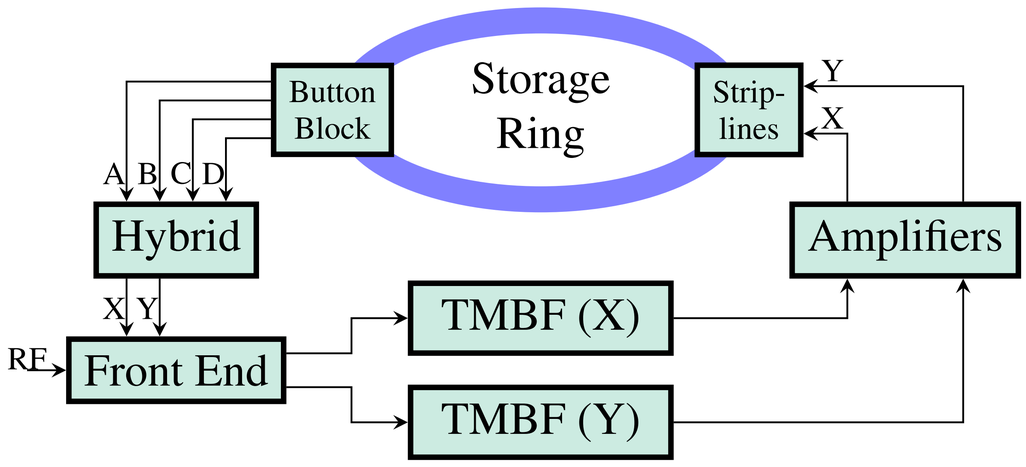
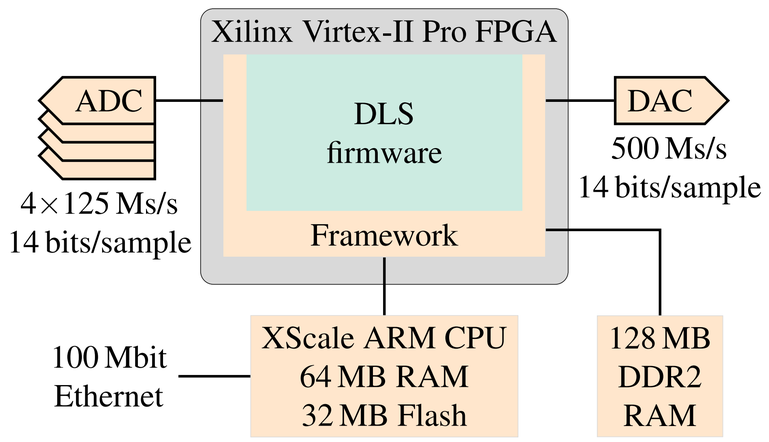
TMBF Overview



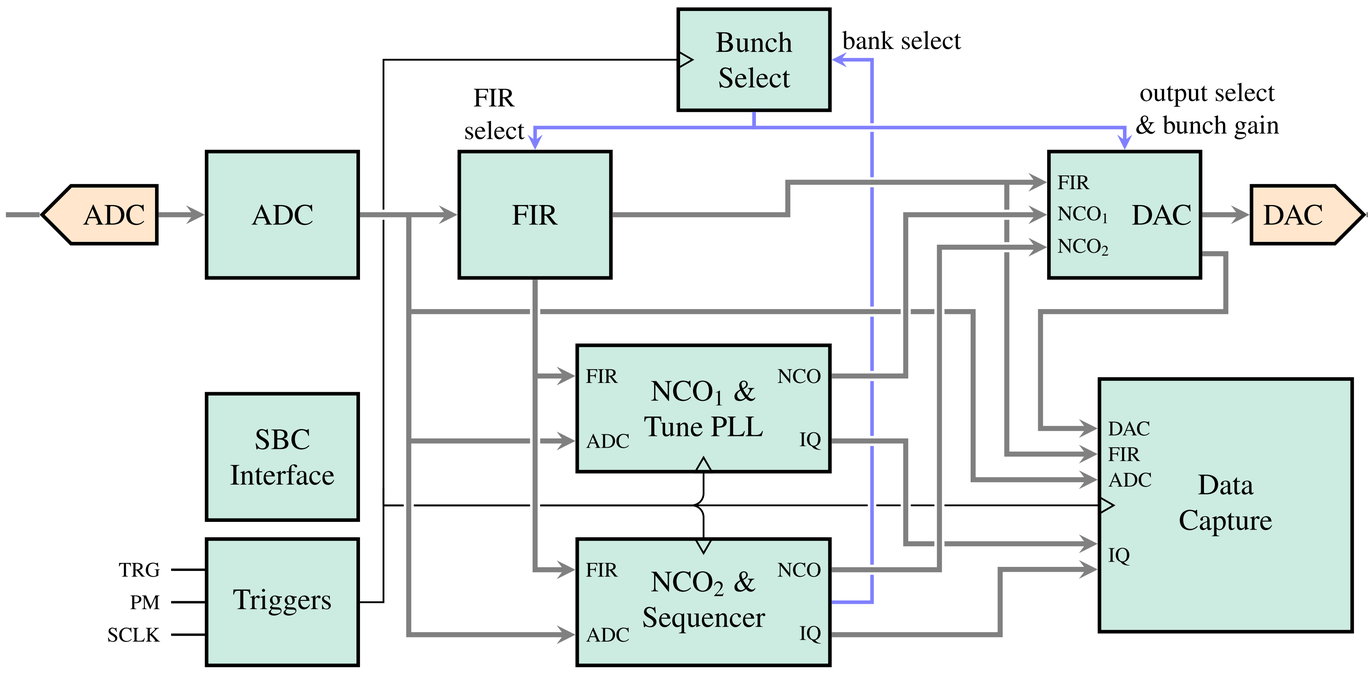
The Transverse Multi-Bunch Feedback system measures the position of each bunch, detects the betatron oscillations of each bunch, and generates a drive signal to suppress the oscillations.

Libera System Platform



The DLS TMBF system is implemented on the Instrumentation Technologies Libera platform with the control system running EPICS on an ARM based embedded Single Board Controller (SBC).

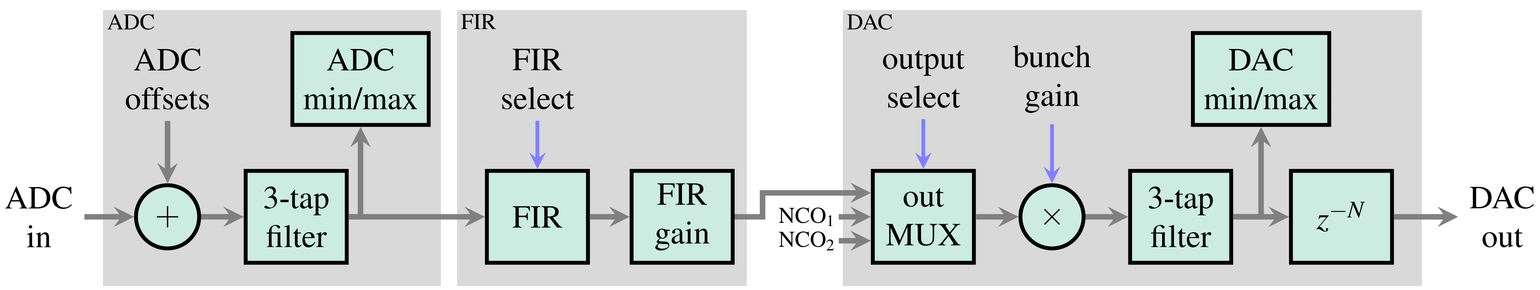
FPGA System Design And Data Paths

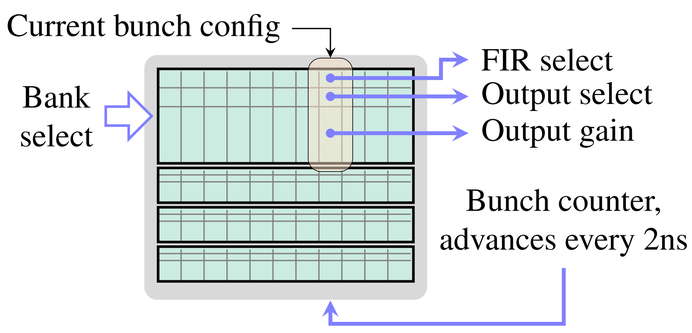


The main function of TMBF is to stabilise transverse oscillations of the beam. This is done by running a separate 10-tap FIR on the position of each of the stored bunches. The core data processing chain combines this feedback with up to two optional Numerically Controlled Oscillator (NCO) outputs.

The main data flow is from the ADC, through the FIR with a separate FIR filter selected for each bunch, and out through the DAC with the option of adding up to two internally generated sine waves. The other paths are for control and data capture. The SBC interface controls and communicates with all other components of the system: the EPICS interface is through this component.

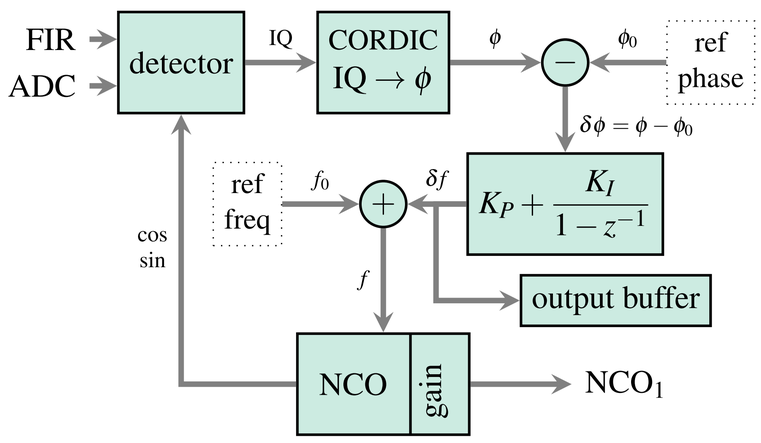
Data Processing Chain





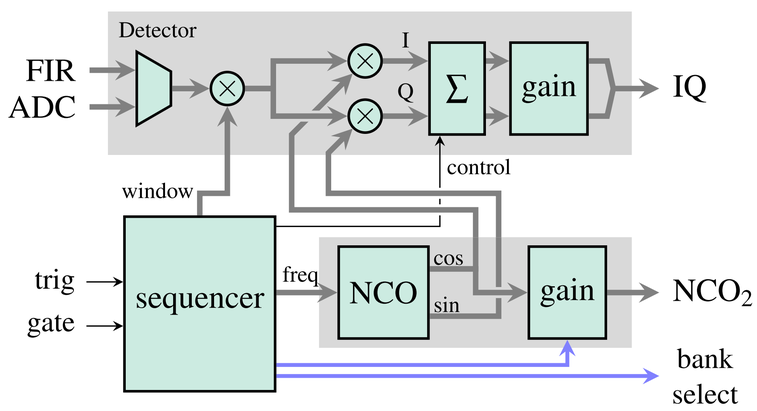
Data processing starts by adding a DC offset to each of the four ADC channels to compensate for static ADC errors, followed by a 3-tap filter to compensate for high frequency phase errors in the front end. The minimum and maximum value per bunch of both the ADC and DAC streams is captured for display. A 10-tap filter with programmable gain (in 6 dB steps) is applied in turn to each bunch in the ring. The output multiplexer adds any combination of its three inputs, which is then scaled by a bunch specific gain. Finally an output pre-emphasis filter corrects for amplifier errors and is followed by a delay line to correctly close the loop.

Tune PLL



The oscillator NCO_1, can be used as part of a tune tracking phase locked loop. The tune phase ϕ is measured at the operating frequency f and used to compute a sequence of frequency corrections δf to maintain the phase error $\delta\phi$ at zero. The phase and frequency are configured via EPICS.

Detector



Data from the beam is mixed with the excitation waveform in the detector to measure a complete complex IQ response. Operation of this system produces a waveform of IQ measurements which can be used for measuring betatron tune and other machine parameters.

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