DIGITAL LLRF FOR THE CANADIAN LIGHT SOURCE

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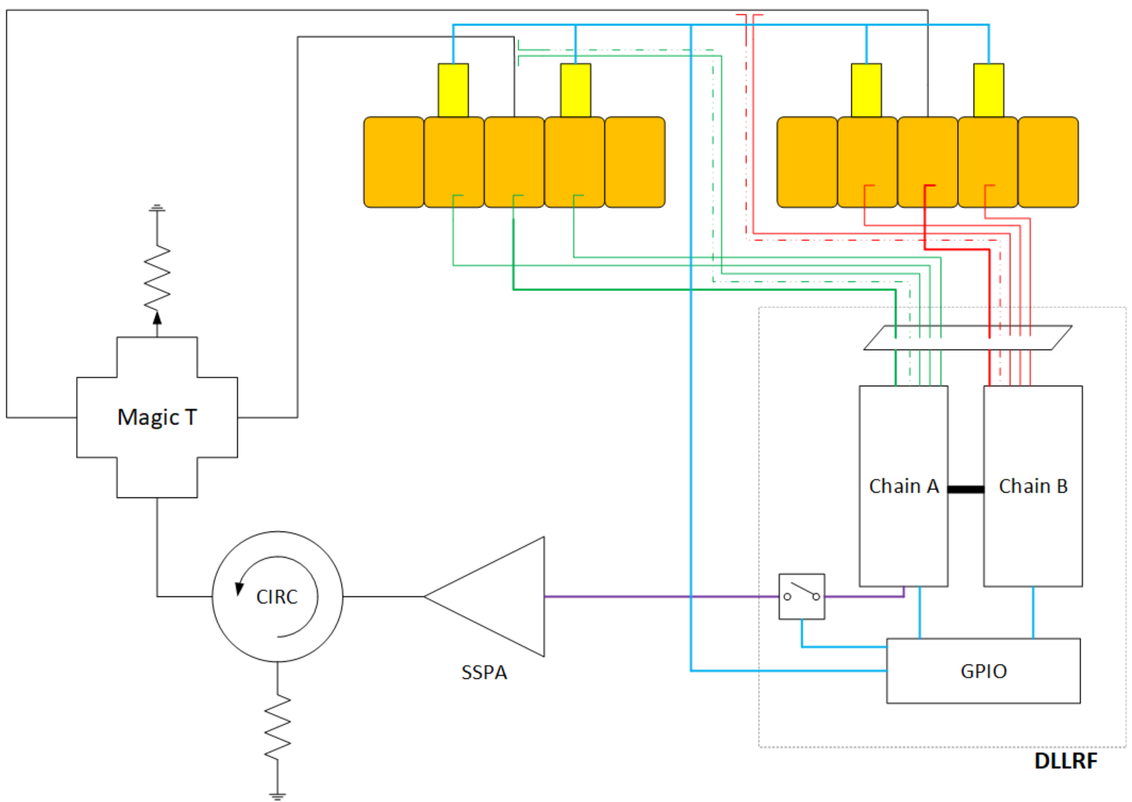
ABSTRACT

The Canadian Light Source, at the University of Saskatchewan, is a 3rd generation synchrotron light source located in the city of Saskatoon, Canada. The analogue LLRF for the booster has been replaced by a digital LLRF.

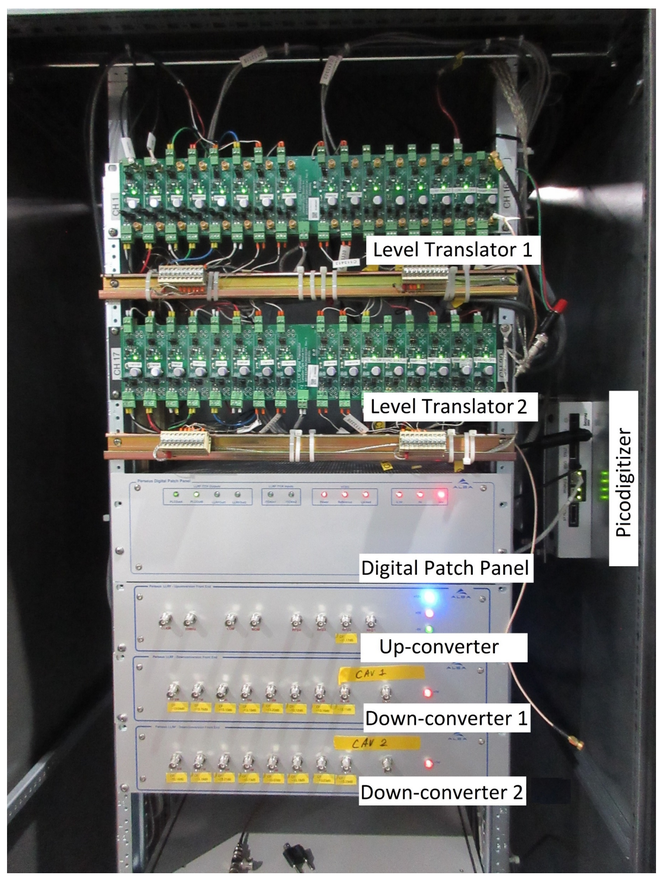
Also, the firmware of the new DLLRF is configurable to allow operation with a superconducting cavity feed with one amplifier, thus providing the possibility to replace the CLS SR LLRF as well.

Introduction

CLS booster consist of a single 100 kW SSPA feeding two DORIS-type 5-cell cavities. DLLRF is responsible of the amplitude and phase loops, tuning, interlocks, ramping and auto recovery of both cavities.



Hardware



DLLRF EMI Rack:

Picodigitizer

FPGA mother board + FMC boards for ADCs and DACs + mezzanine Mestor Breakout Box with digital GPIO bus.

Front ends

RF signals down-conversion, RF drives up-conversion and LO generation with MO reference.

Digital Patch Panel and Level Translator

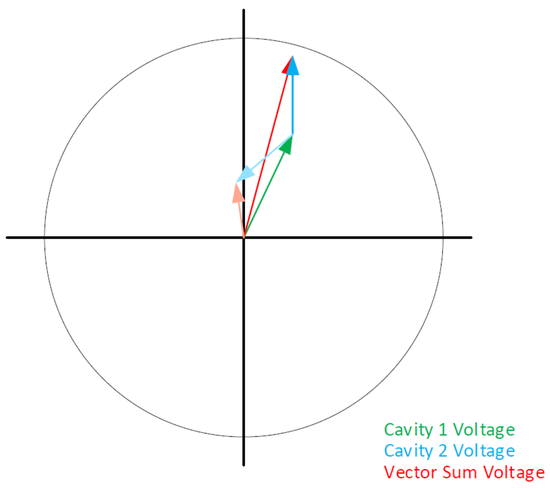
Connectors arrangements, voltage level conversion between DLLRF and RF plants sub-systems and electrical isolation.

Power supply unit

Main supply for active components of the DLLRF.

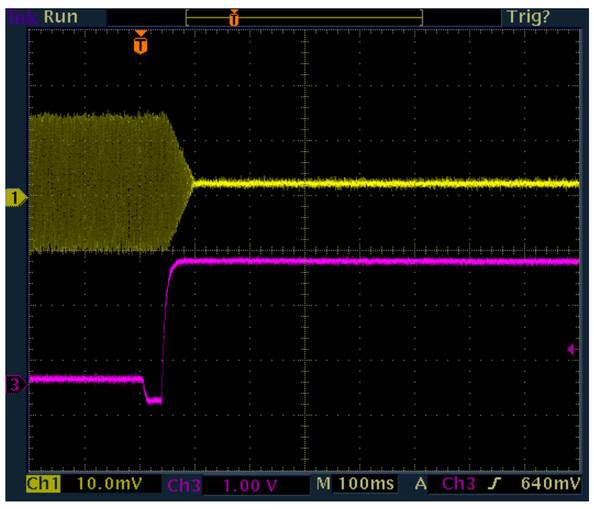
Firmware

Control loops: vector sum



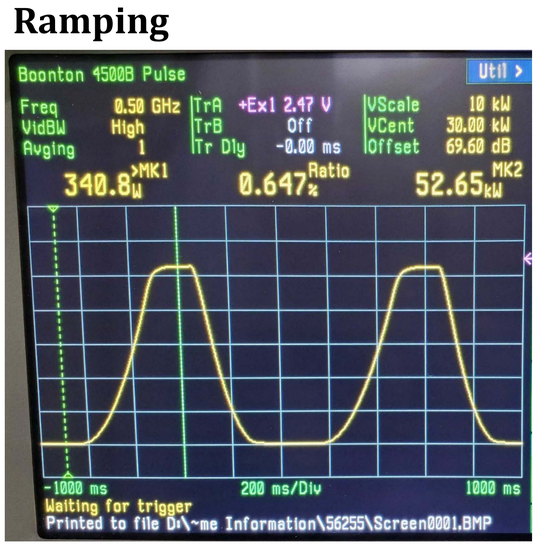
Amplitude and phase loop controls the vector sum of both cavities voltages. Digital phase shifters are implemented to avoid destructive addition and to avoid positive feedbacks instabilities in the loop.

Slow interlock



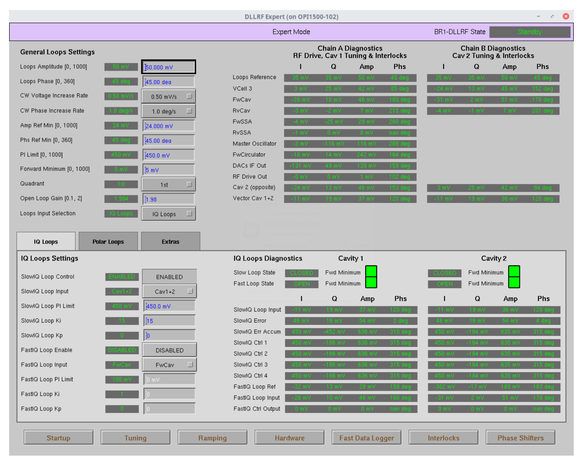
When the dedicated GPIO input *slow interlock* is triggered, the drive drops to minimum value and the pin diode is opened. Drop time is user adjustable.

Ramping



DLLRF has been properly configurated to match the CLS injection requirements. 21 dB of dynamic range are needed. Bottom and top amplitude and phase and rising, falling and flat times are user adjustable.

EPICS IOC

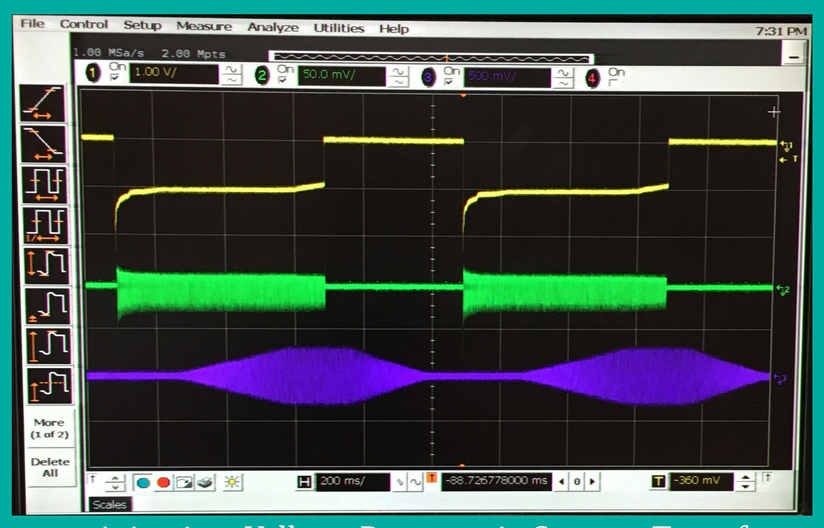


Based on driver software provided by the Diamond Light Source, an EPICS IOC application has been developed to integrate the LLRF in to the wider CLS control system.

CONCLUSIONS

The DLLRF for the booster CLS has been successfully installed, commissioned and adjusted for nominal operation in the facility. The flexibility of the system will allow CLS to install the DLLRF also in the SR if desired.

It has been demonstrated the feasibility of the system for injection according to CLS nominal operation, i.e., the capture of the beam in the booster and extraction to SR at high energy has been successful.



Booster injection. Yellow: Parametric Current Transformer; Green: Fast Current Transformer; Lilac: RF envelope.