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Digital Low-Level RF control system for Accumulator Ring at Advanced Light Source Upgrade Project

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Currently ALS is undergoing an upgrade to ALS-U to produce 100 times
brighter soft X-ray light. The LLRF system for Accumulator Ring (AR) is
composed of two identical LLRF stations, for driving RF amplifiers. The
closed loop RF amplitude and phase stability is measured as $< 0.1\%$ and $< 0.1°$ respectively, using the non-IQ digital down conversion together
with analog up/down conversion, under a system-on-chip architecture.
Realtime interlock system is implemented with $< 2\mu s$ latency, for
machine protection against arc flash and unexpected RF power. Control
interfaces are developed to enable PLC-FPGA-EPICS communication to support
operation, timing, cavity tuning, and interlock systems. The LLRF system
handles alignment of buckets to swap beams between AR and Storage Ring
by synchronous phase loop ramping between the two cavities. The system also
includes an optimization routine to characterize the loop dynamics and
determine optimal operating point using a built-in network analyzer feature.
A cavity emulator of 31 kHz bandwidth is integrated with the LLRF system to validate the performance of the
overall system being developed.

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