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A hybrid LINAC low level RF control system for FRANZ

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The FRANZ linac, consisting of a coupled RFQ-IH cavity and a subsequent CH rebuncher, requires an LLRF system with moderate performance demands. These include amplitude control to maintain a constant field in the cavity, constant phase synchronization between the accelerator and rebuncher, and plunger control to stabilize the cavities frequency at 175 MHz. Given the dead time from LLRF RF output to probe input is approximately 150 ns and the system operates in cw or 1 ms pulsed mode, a decision was made to design a system with a reaction time of 1 µs.
To ensure flexibility, the system was designed with digital control. Consequently, an analog-digital hybrid system was implemented. The RF signal processing is performed using classical analog components, while the control and readout of the analog signals are managed by a ZYNQ SoC, which combines FPGA and ARM processors.
The first proof-of-concept prototype for amplitude control, including reflection and vacuum monitoring, has been successfully operational with the RFQ since late 2023. Development of the next version, which will include phase and plunger control, is underway and is expected to undergo beam testing in 2025.

Footnotes

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