Controller for RF Stations for Booster of NICA Project

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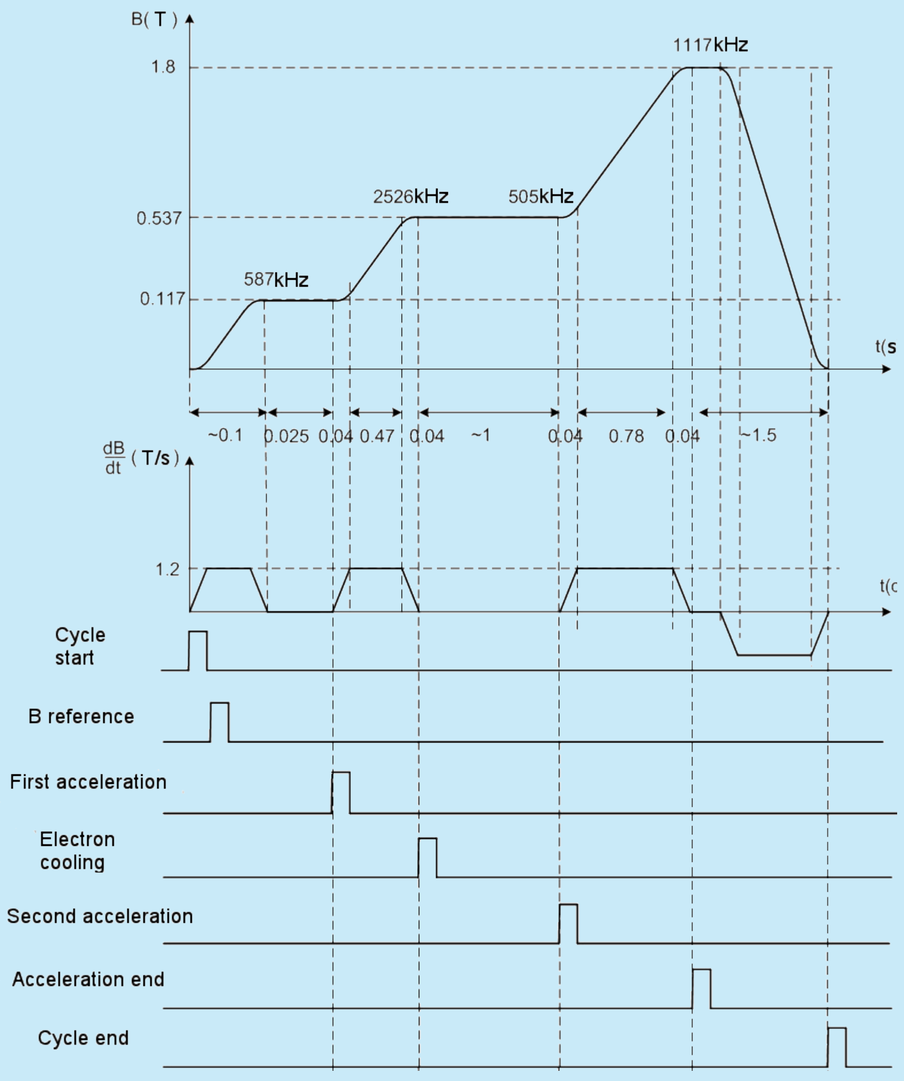
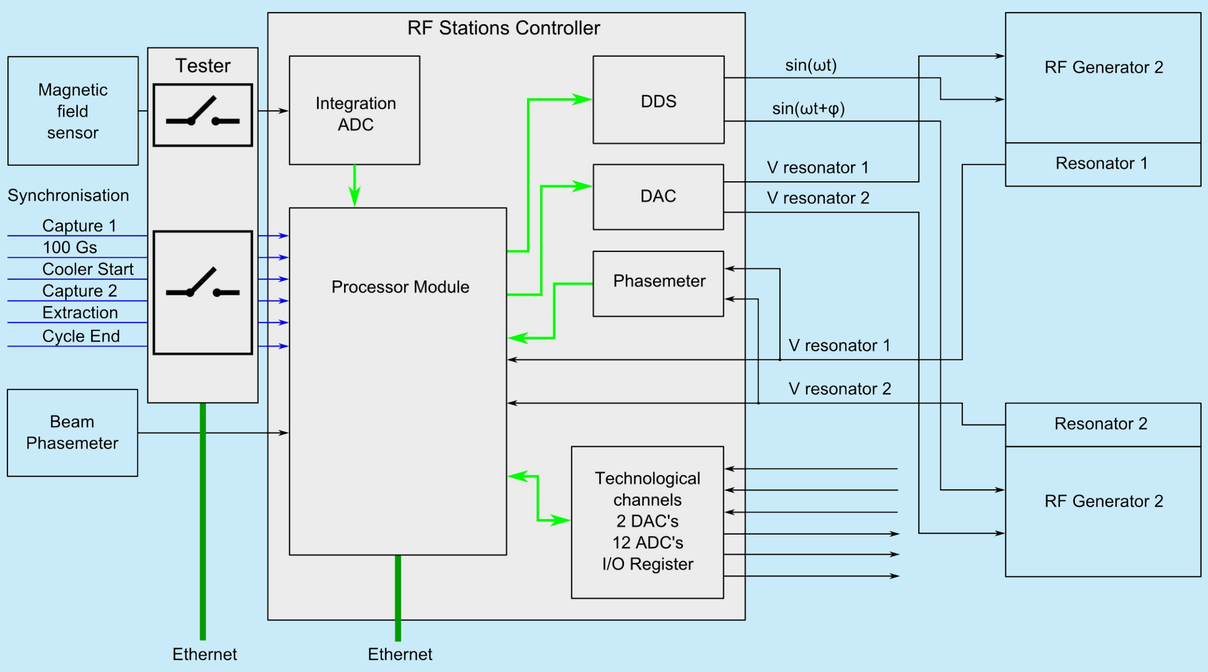
Intellectual Controller for RF stations based on CPU Module SAMA5D31-CM for Booster of NICA Project is presented. Controller measures magnetic field using induction coil and provides corresponding real-time tuning of frequency according to non-linear law with 20 μs period and better than 5·10-4 accuracy. Controller also allows setting up and monitoring several parameters of RF stations. The tester module that generates a sequence of events and signals imitating acceleration cycle is alo presented.

Acceleration Cycle Time Diagram



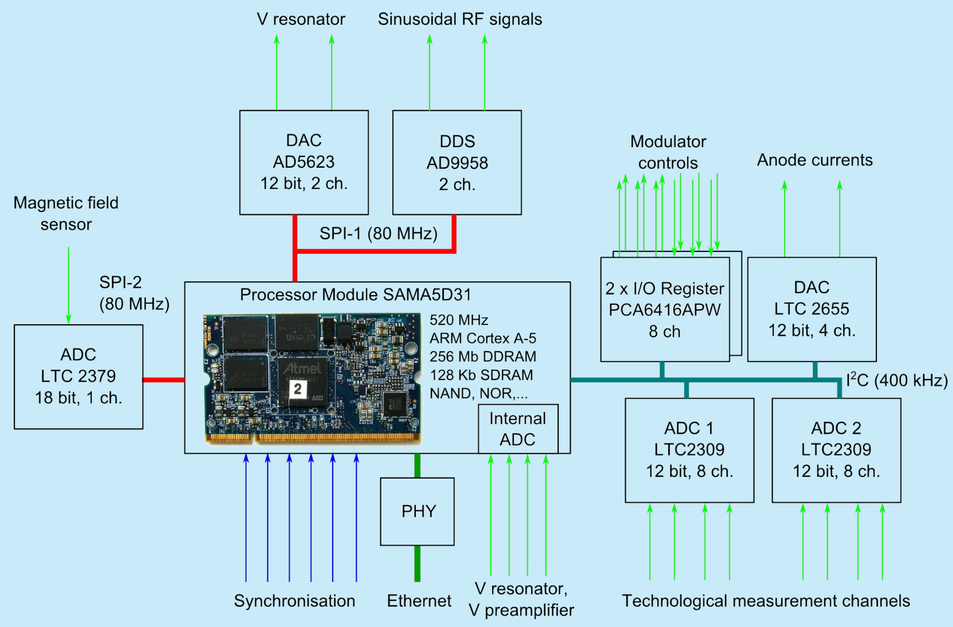
Control Architecture



Main controller signals

Signal	Channels	Sample rate	Resolution
Controls			
Master frequency	2	50 kHz	24
V resonator	2	50 kHz	12
I anode	2	1 kHz	10
Synchonisation	7	N/A	N/A
Measurements			
Field Sensor	1	50 kHz	18
V resonator	2	50 kHz	12
V preamplifier	2	5 kHz	12
I anode	4	1 kHz	12
V rectifier	6	1 Hz	12
V filament	2	1 Hz	12

Controller Module



Signal from magnetic field sensor is integrated and resulting magnetic field value B is used to calculate frequency according to the following formula:

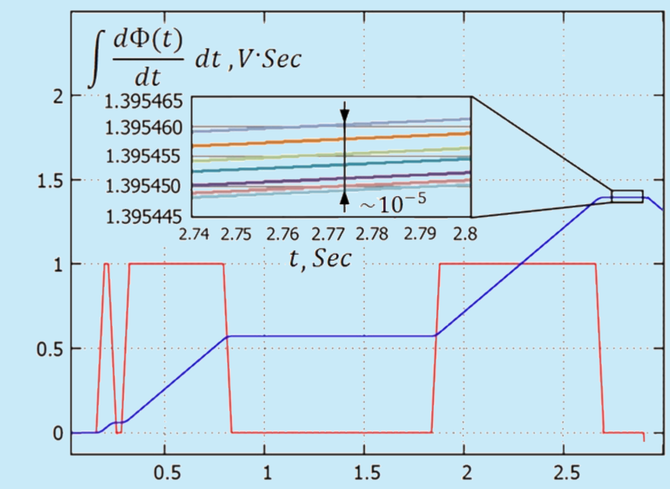
$$F(B)=\frac{c^2/LZ/A_n\rho 1/10^6 B}{\sqrt{m_n^2+(Z/A_n\rho c/10^6)^2 B^2}}$$

Calculated value is used to generate two master frequency sinusoidal signals. These signals are generated with specified phase difference defined by distance between resonators. In future it is intended to provide suppress synchrotron oscillations by variation of this phase according to signal from beam phase measurement system.

Tester Module

Imitation of the signal from induction magnetic field sensor and generation of synchronization pulses sequence according to the booster mode is the main task of this auxilary module.

For the operational check of RF stations tester has a multiplexor that allows to disconnect controller module from booster systems and check it's operational capability. Generally, tester will be in through-pass mode when real signals from booster are provided to the controller inputs.



Imitation of magnetic field sensor signal

Software

Both tester and controller modules are managed over the Ethernet interface using text-based command protocol over telnet. RS-232 interface is provided for reprogramming and debug.
Apart from adequate embedded programs, testing software was developed. This software will also serve as a reference for implementation of corresponding modules in NICA booster control system.

References

[1] Eliseyev A.V., Meshkov I.N. and others, “Longtitudal Dynamics of AU-197**(32+) and AU-197**(79+) Beams in the NICA Collider Injection Chain”, PEPAN Letters, vol 78, no7 2010. p.774-780
[2] Kurkin G. Ya. and others, “RF System of the Booster of NICA Facility”, TUCB02 RUPAC'14, these proceedings.