CONTRIBUTION TO THE ESS LLRF SYSTEM BY POLISH ELECTRONIC GROUP *

J. Szewinski, Z. Golebiewski, M. Gosk, P. Krawczyk, I. M. Kudla, National Center for Nuclear Research, Otwock, Poland
W. Cichalewski, D. R. Makowski, A. Napieralski, TUL-DMCS, Lodz, Poland
A. Abramowicz, K. Czuba, M. Grzegrzolka, I. Rutkowski, Warsaw University of Technology, Warsaw, Poland

Abstract

Development of the LLRF system at ESS is coordinated by the Lund University, but part of it, LLRF systems for M-Beta and H-Beta sections, will be delivered within in-kind contribution from Poland. This document will describe the scope of work, work plan, and technical details of the selected components of the M-Beta and H-Beta LLRF systems sections. Described contribution will be made by the Polish Electronic Group (PEG), a consortium of three scientific units. LLRF system for ESS will be made of both, commercially available components and components designed specially for this project, and those last ones will be presented and described here. Except the technical details, the organizational aspects, such as schedule, project management or quality control, will be presented as well.

POLISH ELECTRONIC GROUP

For the purpose of participation in ESS LLRF system development within polish in-kind contribution (IKC), a consortium of three polish research units has been established and called Polish Electronic Group (PEG). PEG consortium is made of National Centre for Nuclear Research (NCBJ) – the consortium leader, Warsaw University of Technology (WUT) and Technical University of Lodz (TUL). All three institutions are experienced in development of the LLRF systems for FLASH and X-FEL. Due to common technologies, such as MTCA.4 [1], used in X-FEL and ESS, PEG members skills can be directly applied at ESS.

ESS LLRF SYSTEM AND SCOPE OF PEG CONTRIBUTION

LLRF System for ESS [2] (Fig. 1) will be implemented as FPGA based digital feedback system, based on the MTCA.4 electronics standard. All together planned M-Beta and H-Beta cavities will require 120 LLRF units, while in the period covered by the PEG IKC contract, only 80 LLRF units will be installed. Each LLRF unit will be single MTCA.4 crate, where both, commercially available and custom designed components will be used. PEG will design for ESS following devices:

- RTM Carrier Board – low cost MTCA.4 board capable of supporting selected RTMs (Rear Transition Modules).
- LO generation and distribution unit.
- Piezo driving and sensing unit for cavity resonance control.

Except of mentioned custom designed components, PEG will be responsible for assembling, testing, delivery and partial (in-rack) installation of the 80 LLRF systems for the M-Beta and H-Beta cavities.

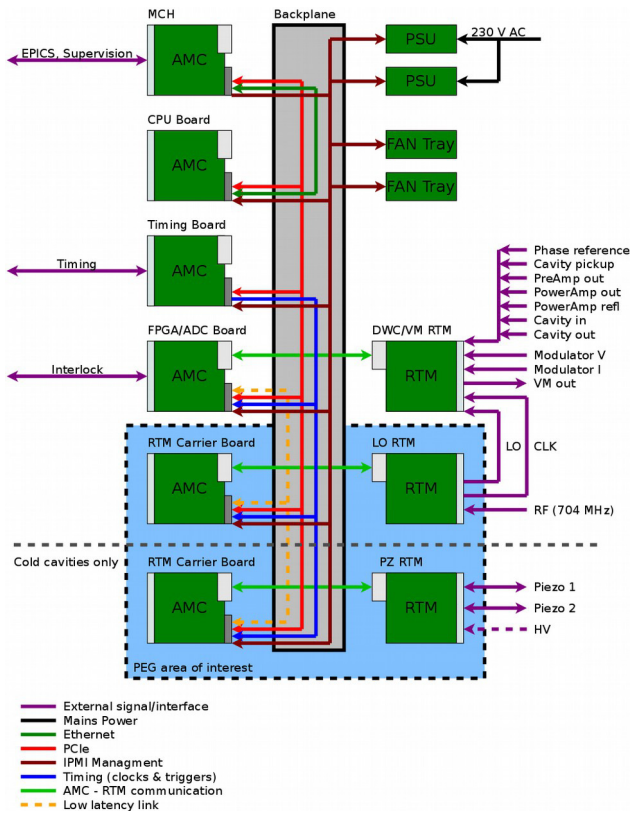

Figure 1: General layout of single ESS LLRF unit, custom designed devices has been marked with the rectangle at the bottom.

RTM Carrier

RTM Carrier (Fig. 2) will be simple and low-cost FPGA based board, which will be focused on the providing minimal resources required to support LO generation RTM and Piezo Control RTM.

* Work supported by Polish Ministry of Science and Higher Education, decision number DIR/WK/2016/03 from 30 May 2016

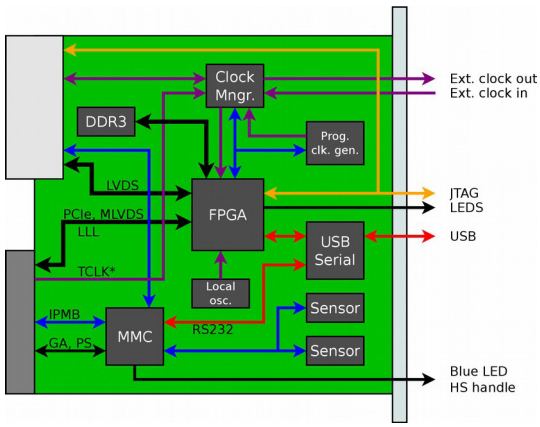

Figure 2: RTM Carrier block diagram.

LO Generation RTM

LO Generation RTM (Fig. 3) will be responsible for generation of the local oscillator clock signal for down-converters. This device will be made in the MTCA.4 RTM form factor and will be supported by the RTM Carrier board. Single unit of the LO RTM will generate LO signals for 4 neighbour LLRF systems.

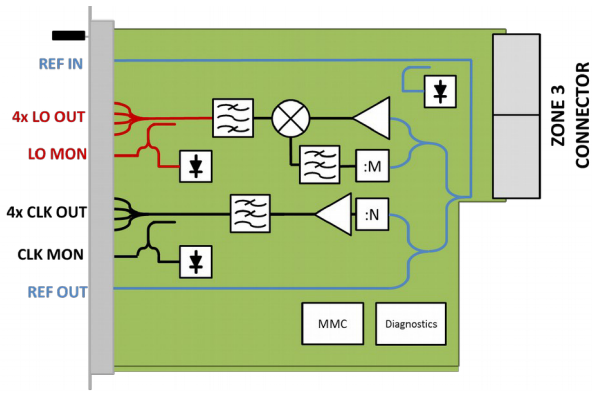

Figure 3: LO Generation RTM block diagram.

Piezo Control Unit

This device will be responsible for cavity resonance control, in addition of the LLRF control. One of the possible implementation of this device may be MTCA.4 RTM, but it haven't been finally decided yet. Issues such as driving +/- 100V directly from the MTCA crate has to be considered, and accepted first. The conceptual block diagram is shown in Fig. 4.

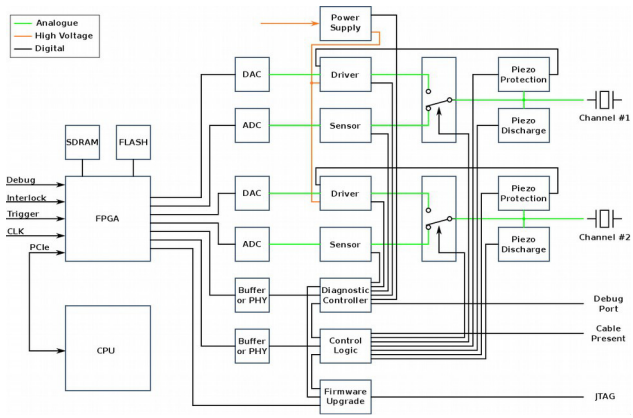

Figure 4: Conceptual block diagram of the piezo resonance control system.

MANAGMENT AND QUALITY CONTROL

PEG Consortium has internally established own management structure, where particular functions and responsibilities are distributed to persons from all member institutions. PEG Consortium Board is top-level steering body, where major decisions are taken.

For particular tasks and use cases, dedicated procedures has been defined. For example task completion and internal acceptance procedure provides template for internal acceptance protocol, describers process who should accept it and in which order: Research Unit Leader, PEG Quality Control Manager and finally PEG Project Leader.

SCHEDULE AND ACTUAL STATUS

PEG IKC contract been signed in November 2016, and it describes work which shall be done until 2021. M-Beta units are foreseen to be installed in 2019, and H-Beta installation is planned in 2021.

In the actual project stage, work is focused on the design of described above custom MTCA.4 components, first prototypes are expected to be available in July 2017.

REFERENCES

[1] MTCA, https://www.picmg.org/openstandards/microtca/

[2] A. J. Johansson and A. Svensson and F. Kristensen and R. Zeng, “LLRF System for the ESS Proton Accelerator”, in *Proc. IPAC’14*, Dresden, Germany, June 2014, paper WEPME079

ISBN 978-3-95450-182-3