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MEBT Faraday Cup Software Design Document

A. Milla

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Project: MEBT

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Revised by: A. R. Paramo

Approved by: I. Bustinduy

Change History

Rev.	Date	Author(s)	Description
0.1	2016-06-15	A. Milla	First version.
1	2016-11-03	A. Milla	Approved version.

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1 Introduction

The Faraday Cup (FC) will be used to measure the beam current and as beam stopper for accelerator start up. The FC is designed in order to withstand the commissioning beam modes.

1.1 Purpose

The purpose of this document is to describe the design of the software for the MEBT Faraday Cup. We aim to describe in detail the design that was already presented and approved during the Faraday Cup's Preliminary Design Review (PDR) [1].

The document summarizes the systems involved and the functionalities of the Faraday Cup for its integration in the control system.

The intended audience is the Beam Diagnostics group and the ICS division at the European Spallation Source, ERIC (ESS) and the Control & Diagnostics group at ESS Bilbao (ESSB).

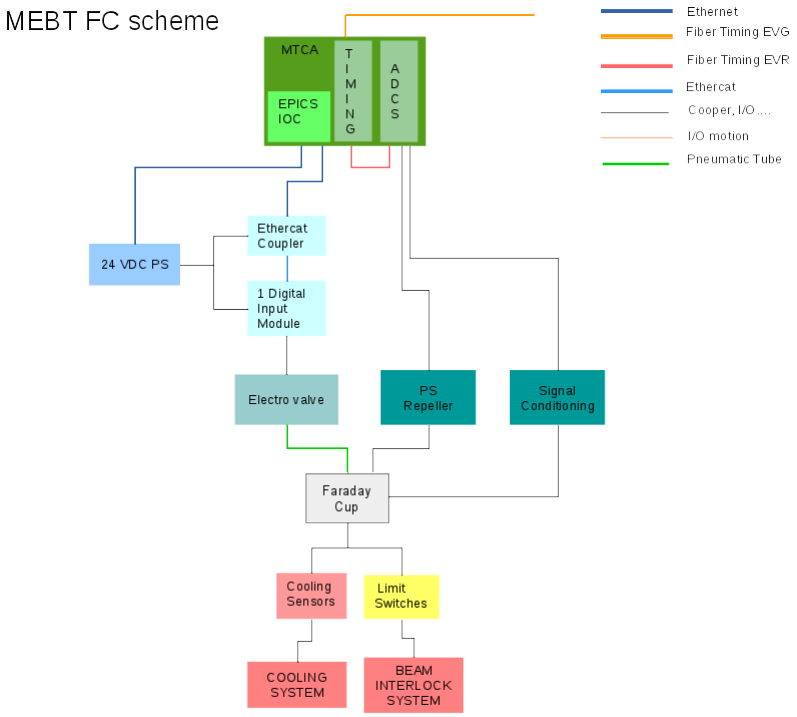
2 Hardware description

2.1 General interface layout

In this section we explain the control interface layout for the Faraday Cup, starting from the the top level, the network, to the device itself.

The FC will use the optics and beam instrumentation subnet. It will also need an indirect connection (not through the control box) with the cooling and interlock PLCs.

In the next scheme we show the main components involved in the control system of the Faraday Cup:



2.2 Available hardware

Next, we describe in more detail the hardware needed by ESSB for the development. The main hardware systems for the FC will be:

- VME Crate
- Motion control.
  - Bus ethercat
- Power supply control for motion control feeding.

- Repeller power supply control to avoid secondary electron intensity.
- Electromechanical pneumatic valve.
- Analog front-end interrelation for signal conditioning.

Taking into account the previous list and the hardware recommended by ESS, ESS Bilbao is doing its developments in the next VME platform:

- VME Crate: ELMA type 39 horizontal, 4U, 84HP.
- CPU: IOxOS IFC 1210
- Digitizer board: D-Tacq ACQ420FMC-4-2000-16:
  - 4 analog channels
  - 2 MSPS
  - 16 bits
- Event Receiver Board PMC-EVR-230
- Event Generator Board VME-EVG-230

ESS Bilbao will develop all the software in the VME environment. ESS ICS group will be the responsible of migrating the developments done by ESS Bilbao in VME to the final hardware platform in μTCA.

3 Software description

3.1 Brief description

Next, we describe the software of the MEBT FC. The software will be developed following the EEE recommendations.

The estimation of the software elements needed are the next:

- Driver for VME crate:
  - IOxOS VME drivers.
  - MRF (Timing) drivers.
- EPICS modules:
  - Environment
  - Pevdrv
  - Asyn
  - Mrfio 2
  - ifcdaq
  - ifcaqdrv
  - NDS
- Motion control modules

The previous software elements belong to the EEE. Therefore the ESS ICS group will be the responsible of having the software ready for production and it will be in charge of the software maintenance.

For the software, ESSB is going to develop an IOC. The IOC will have the next functionalities:

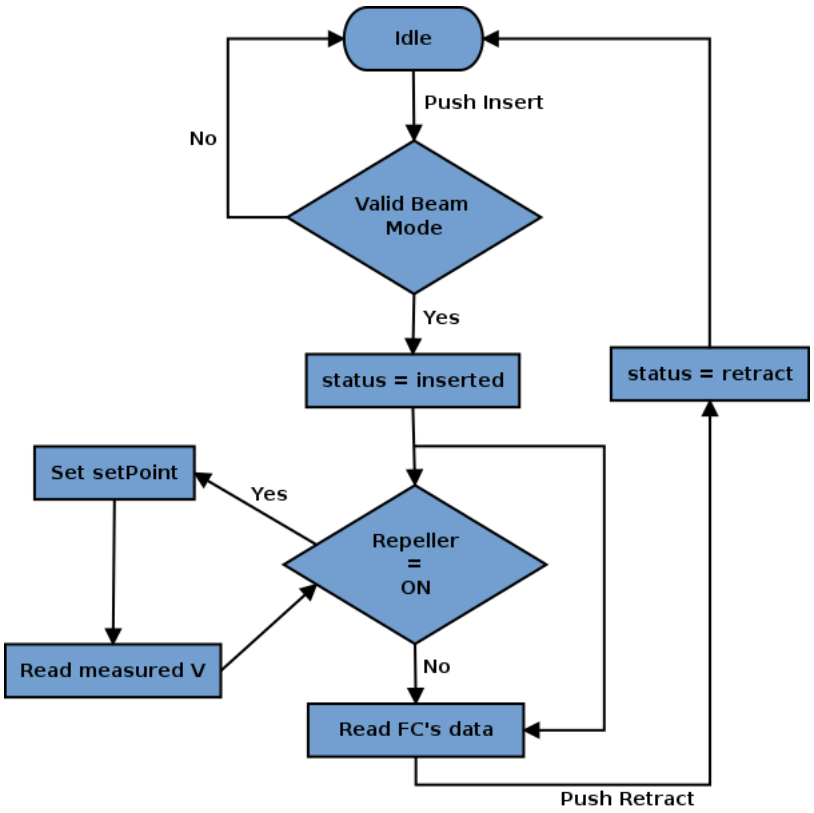
- MEBT_FC_ctrl
  - Send insert/retract instruction to the motion controller IOC.
  - Control the repeller PS.
  - Get the data from the FC.
  - Responsible for the interaction with the motion controller (actuator).

ESSB also will develop an engineering screen. This engineering screen will have the next functionalities:

- MEBT_FC_GUI:
  - Interface for the MEBT_FC_ctrl.
  - Show the data.
  - Perform statistics.

3.2 IOC development

In order to have an idea of how will be the basic functioning of the FC, we show the next flow diagram:



From the flow diagram we observe that from the idle position the operator decides to insert the FC. The IOC will check the Beam Mode status and depending of this status will continue to block the user in the idle position or will allow the setting of the repeller. The use of the repeller will be optional.

Once the FC is inserted the IOC will start reading until the operation is finished and the FC is retracted.

3.3 Requirements

Based in the Faraday Cup functionalities document [2] the next requirements have to be taken in account:

- The operator shall be able to control remotely the insertion/retraction of the FC.
- The operator shall be able to set the value of the bias voltage provided by the power supply.
- The status of the power supply shall be flagged on the engineering screen.
- The status of the beam permit (Beam mode) shall be flagged on the engineering screen.
  - The engineering screen shall be locked if the beam permit is not in the right status.
- The start and the end of the FC signal acquisition shall be triggered by the operator.
  - The operator shall define the time of acquisition by choosing the number of samples.
- The operator shall be able to choose the interval needed for the background subtraction, before and after the beam pulse.
- The operator shall be able to decimate the number of samples in order to simulate a lower sampling rate.
- The operator shall be also able to delay or advance the trigger of the acquisition with respect to the timing system trigger.
- All the acquired signal raw data has to be converted to mA .
- A time interval will be implemented in order to estimate the beam intensity on the flat top after the transient.

  - From the user selected flat top basic data statistic might be implemented, like:
    * Peak current value.
    * Minimum current value.
    * Standard deviation of the beam current fluctuation over the pulse.
    * Average current value.

- Displaying
  - Raw data from FC shall be displayed at a refresh rate of 14Hz.
  - A second plot panel shall display the analysed data at a lower refresh rate that will be defined by the operator (1 second at least).
  - The basic statistic shall be refreshed at the same rate than the analysed data.

4 References

[1] D. de Cos, A. Milla, C. de la Cruz, J. Ortega, I. Rueda, R. Miracoli, and I. Bustinduy, "Preliminary design of the ESS MEBT Faraday Cup," *PDR BILBAO MEBT DIAGNOSTICS*, 2016-7. [Online]. Available: `https://indico.esss.lu.se/event/592/contribution/3/material/slides/`.

[2] B. Cheymol and H. Kocevar, *Faraday cup functionalities*, version 1, European Spallation Source, ERIC, 2016.