

# Construction of Integrated Software Development Environment for Upgrade of Commercial Digitizer System

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## 1. Introduction

In KOMAC, ACCT and Faraday cup are used as beam diagnostic equipment to measure beam current in KOMAC accelerators and beamlines. The beam signal measured by the beam diagnostic equipment may be collected using an oscilloscope or ADC. The advantage of the oscilloscope is that it is a product with very high precision in signal analysis and is usefully used for data acquisition of beam current. The beam signal of the accelerator is closely related to operating conditions such as high frequency, power, and cooling, so simultaneous processing of all signals is important. In particular, the timestamp of data is used as important data to understand past operating characteristics. Therefore, collection of beam signals without omission should be able to be stored in real time. This paper describes the procedure for establishing and upgrading an integrated development environment for software upgrade of i-tech's Libera digit 125 [1] product to build a DAQ system that can collect beam current signals in real time

## 2. DAQ system

Libera DAQ internal software can sample beam current signals up to 125 MHz, 14 bits. At this time, the sampling digital value must be converted into a beam current value and provided to the user. The beam current signal collected by DAQ includes a procedure of converting digital data into beam current and generates a current value by averaging a certain section of the converted data. For this process, it can be easily implemented using two modules, aCalcout [2] and waveAnl [3] of EPICS [4]. Previously, the data collected by sampling from the digitizer was additionally installed by installing an EPICS IOC server outside to load PV to the CA link and process the data. The EPICS IOC server is composed of two modules, as shown in Fig. 1.

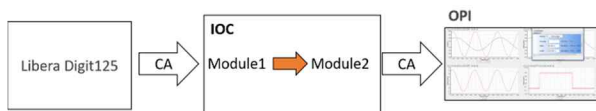


Fig. 1. Configuring EPICS IOC for data processing

The first module aCalcout converts the array data transmitted through the CA link from a digitizer to a beam current value, and the second module waveAnl

generates statistical parameters from the input array. Fig. 2 shows the currently installed and operating equipment.



Fig. 2. Installation and operation of digitizer system and EPICS IOC

The two system configurations increase network transmission and increase management costs. To configure this as a single system, modules are installed directly in the Libera IOC to simplify data transmission and management.

## 3. Configuration

The libera product is a general-purpose digitizer with 4 channels and 125 MHz sampling frequency. The data is configured to store 8M data samples per channel. The digitizer contains ARM Cortex-A9 chip based on the Xilinx ZYNQ SoC [5] as shown in Fig. 3.

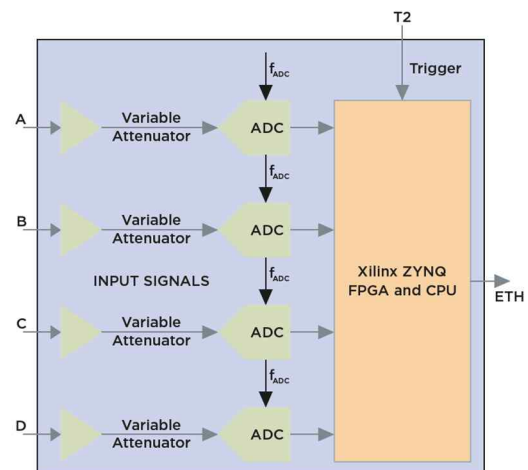


Fig. 3. Internal configuration of digitizer system

A compilation environment for the ARM Cortex-A9 chip is required to install aCalcout and waveAnl modules to add data conversion and analysis functions as shown in Fig. 4. The compiler provided by the product company I-tech is installed and the modules are compiled.

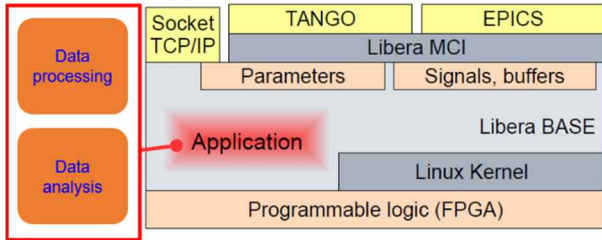


Fig. 4. Digitizer software configuration and module installation

### 3.1 Modules

Two records, aCalcout and waveAnl, are used to process sampling data from the digitizer. The aCalcout (Array Calculation Output) record extends the calcout record by supporting array operands and expressions. The record has 12-array field used as input variables for the expression, and it calls an extended version of the EPICS calculation engine that knows about arrays. Soft device support supplied with the aCalcout record writes array or scalar data to the record's output link, depending on the number of elements of the field to which it is linked. The waveAnl (Waveform Analysis) record is used to generate statistical parameters of the input array. Outputs generated by the record are maximum, minimum, peak-to-peak, mean, and standard deviation.

### 3.2 Compiling and record

Compilers supported by I-tech are used to compile two records and recompile libera-ioc. To compile the two records, the environment set and compilation are completed, and the libera-ioc is recompiled. As a result of downloading the compiled libera-ioc as a digitizer and re-executing the IOC, it was confirmed that the two records matched well. The design of the record is as follows. The values of the array in the aCalcout record are converted into current values by establishing a forward link with the digitizer sampling PV as an aCalcout record. The converted array is linked to a waveAnl record, and the data analyzed to generate statistical parameters of the input array.

```
record(liberaSignal, "$(P):signals:adc") {
    info(MCII, "mci:/${(D)/application.signals:adc}")
    field(NGRP, 2048)
    field(ACQM, "Event")
    field(SCAN, "I/O Intr")
```

```
    field(FLNK, "$(P):acalc:adc")
}
record(acalcout, "$(P):acalc:adc"){
    field(DESC, "waveform calc")
    field(NELM, 2048)
    field(NUSE, 2048)
    field(DTYP, "Soft Channel")
    field(CALC, "AA/8192 *0.0012")
    field(INAA, "$(P):signals:adc.A PP NMS")
    field(SCAN, "Passive")
    field(DISV, "1")
    field(SIZE, "NUSE")
    field(OUT, "$(P):waveanal:adc PP")
}
record(waveAnl, "$(P):waveanal:adc"){
    field(DESC, "wave analysis")
    field(SCAN, "Passive")
    field(NELM, 2048)
    field(INP, "$(P):acalc:adc PP NMS")
    field(PREC, "5")
    field(EGUX, "samples")
    field(HORX, 2048)
    field(LORX, "0")
    field(EGUY, "V")
    field(HORY, "5")
    field(LORY, "-5")
}
```

## 4. Conclusion

Previously, additional EPICS IOC was installed to process the sampling data of a digitizer. In this study, EPICS modules were installed in the libera-ioc so that data processing can be performed directly at the libera-ioc. In the future, it is planned to expand the module record to process the digitizer 4-channel data and test beam current measurement after signal gain adjustment.

## Acknowledgement

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## REFERENCES

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- [2] aCalcout, <https://epics.anl.gov>
- [3] waveProc, <https://epics.anl.gov/modules/waveProc>
- [4] Experimental Physics and Industrial Control System (EPICS). <http://www.aps.anl.gov/epics/index.php>
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