Data acquisition with new CAMAC controllers

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Introduction

Data acquisition using CAMAC systems is widely used in accelerator based nuclear physics experiments. At BARC-TIFR Pelletron and LINAC the LAMPS system (Linux Advanced Multi-Parameter System) for data acquisition has been in use for over a decade [1]. The system is based on CC2002 crate controller developed by Electronics Division [2]. However the C2002 hardware being rather old is difficult to maintain. It also has a performance limitation with a readout time of 4.5 μs/word whereas readout times approaching the CAMAC standard of 1 μs/word is desireable. In this paper we report setting up LAMPS data acquisition with two new crate controllers: CMC100 available from Cheescote Mountain Camac [3] and ECC supplied by Electronics Division, BARC [4]. For the ECC controller we had previously completed software and testing [4], however the ECC hardware has changed substantially since that time.

CMC100 Controller

The CMC100 is a very well designed crate controller having an inbuilt host to carry out CAMAC instructions. It has an internal buffer memory of 1K words for the host interface and 1MB for the response buffer. It can be read out via USB2.0 and RS232 interfaces. It has a List Processor (LP) which can include a command list of upto 512 words. The execution of the LP program can be triggered by LAM, NIM pulse or external command. For our purposes we make use of only the USB interface and execute the LP program by LAM trigger. The controller has also FAST CAMAC capabilities (Level 1 and Level 2) and these could be utilized in future. Using this controller, coupled to LAMPS software as described below we are able to acquire data at a throughput of 1.2 μs/parameter.

LAMPS Software for CMC 100

A driver under LINUX for USB readout of the CMC100 is provided by the manufacturer. A version of the driver which allows multi endpoint access was also made available. A second USB endpoint is used to determine the state of the FIFO buffer without disturbing the flow of data from controller to PC.

Initialization and Event List:

The file based mechanism of crate initialization in LAMPS was retained. In this mechanism, the LAMPS user interface generates an INI file. When a run is started, this file is parsed and the relevant instructions are sent to the controller. Similarly, from the user interface a list of NAF instructions for data readout and a CLR file with commands for clearing the modules after each event are generated. Since CMC100 supports only an event list in its LP, the INI instructions are communicated as separate single instructions before starting the LP program. The CLR instructions are added to the event list.

Readout

The readout method is by polling. This is conveniently done by obtaining the FIFO status periodically from the extra USB endpoint. Readout is started when the status word shows that the FIFO buffer is ¼ full.

Camac Scalers

During data acquisition, CAMAC scalers are to be read out periodically for status and dead-time monitoring. This has been achieved by adding the NAF instructions for scaler readout in the event list. We have now received a clarification from the manufacturer that single readouts are possible without interrupting the main List Mode flow, but this is not yet implemented.

Sparse Readout Mode

The CMC100 includes the Q-Stop CAMAC algorithm in its LP. In this mode, while reading e.g. 16-channels from a Phillips 7186 TDC, channels that are not within a specified interval of values are skipped during readout. Sparse readout is a big saving in terms of readout time. However it requires decoding the output stream.

Data Stream

The CMC100 has a set of internal commands which allow the insertion of arbitrary 24-bit words in the data stream. We have utilized this feature to insert key-words into the data stream. During readout we add a key value defined as SEQUENTIAL_START for CAMAC modules that are read out normally, but e.g. for a Phillips TDC readout in Q-Stop mode we add PHILLIPS_START to the data stream. So data can be taken mixing the normal (sequential) mode and zero-suppressed (Q-Stop) modes. Separate functions for decoding are provided, since these are specific for different module types. While writing the data to disk, the headers are removed and the data is compressed into the usual zls format native to LAMPS or in the format of the IUAC program Freedom/Candle [5].

The system has been used in the recent measurement [6] of the 4^+-to-2^+ gamma transition in ^{8}Be.

ECC Controller

The Embedded CAMAC Crate Controller (ECC) supplied by Electronics Division BARC incorporates a Pentium based Single Board Computer (SBC). It is linked to PC over Ethernet. Communication with PC is achieved by the socket model of TCP/IP. A message format is specified. Commands are sent in this format and replies are received in the same format. For list mode data acquisition, it accepts the following commands: “Load Ini List”, “Load Event List”, “Start Acquisition”, “Pause Acquisition”, “Resume Acquisition” and “Stop Acquisition”.

The setup of LAMPS software in this case is similar to that described above for the CMC100, however we have not yet implemented the Q-Stop mode. Data streams do not have the embedded words described above. Before sending the “Start Acquisition” command, “Load Ini List” is done, based on the LAMPS generated INI file. The commands in the CLR file are added to the event list. After acquisition starts the data are received by means of the standard recv call of the TCP/IP socket model in a separate program thread. No polling is necessary as the recv call blocks and awaits the availability of data. To stop acquisition, the “Stop Acquisition” message is transmitted from the main thread. This results in a “Stopped Acquisition” response from the controller which is used to terminate the acquisition thread. The above method (blocked recv call in a separate thread) is convenient and efficient and it avoids polling.

The system has been tested using a pulser. Further tests are in progress before use in experiments.

References

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