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CAMAC based continuous/transient digitizer for long duration discharge

AMIT KUMAR SRIVASTAVA, RACHANA RAJPAL and H D PUJARA
Data Acquisition Group, Institute for Plasma Research, Bhat, Gandhinagar 382 428, India
Email: amit@plasma.ernet.in

Abstract. With the development of fusion research, in the next generation tokamak like SST1 and ITER the tokamak discharge duration time of the order of 1000 sec is planned. At the same time acquisition of rapid changes of plasma parameters during discharge is required and this demands for higher sampling rate to acquire the data. Hence a large size of RAM (memory) is required to fulfill the above requirements but normally CAMAC based digitizer has limited on-board RAM which can be emptied only after the buffer is completely filled. Therefore, acquisition period is dependent on sampling frequency of the signal as well as on existing size of RAM. This drawback of above is overcome in this design of CAMAC based digitizer where we are using combination of FIFO memory and RAM to get continuous lossless acquisition as well as transient acquisition. This paper includes design of 4-channel CAMAC digitizer with 32 K samples RAM per channel for on-board storage and 8 K samples FIFO per channel for continuous acquisition. The module can be operated in different modes like monitoring, transient acquisition and continuous lossless acquisition with selectable sampling rate

Keywords. CAMAC; continuous digitizer; transient digitizer.

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1. Introduction

The duration time of tokamak discharge has been prolonged in accordance with the development of fusion research. In the next generation tokamak like SST-1 and ITER [3], the duration time of the order of 1000 sec is planned. This demands for the special digitizer which can support either continuous lossless acquisition [1] or have a large on-board data storage [2]. Most of the available digitizers in CAMAC do not support for simultaneous reading and writing of data. Either the module is in the digitisation mode or in a computer read out mode. Hence it can not support lossless acquisition. It has a very limited local storage and hence cannot support high sampling rate for a long time. Limited storage compels one to restrict the sampling rate to value low enough to accommodate the entire shot. Hence one loses the high frequency component which may originate from unscheduled events. This hurdle is overcome in this design of CAMAC based digitizer to get continuous lossless acquisition as well as transient acquisition.

2. Hardware description

The designed CAMAC digitizer can support continuous lossless acquisition as well as transient acquisition. The module consists of two on-board storage elements: FIFO (first in first out) memory for continuous acquisition and a 32 KB RAM for transient acquisition. Front panel signal and CAMAC commands initiate the acquisition sequence depending upon the acquisition mode selected. It is a single width CAMAC module 4 input channel with −5 V to +5 V analog input range.

The available sampling rate is from 0.1 Hz to 1 MHz. In continuous acquisition mode the digitized data is stored in FIFO and when it becomes half full, which is indicated by HF flag, the data is transferred from CAMAC to PC. In transient acquisition mode the digitized signal is stored in RAM and the data is transferred to PC after the shot.

The block diagram in figure 1 shows how various elements are inter connected to various buses for achieving the described features.

- CAMAC access to program various registers.
- Transfers of data from ADC to various FIFO and RAM buffers
- Transfers from memory to CAMAC data way
- Clock generation
- CAMAC function decoding
- Control logic generation

2.1 *Clock generator and sampling rate selector*

Crystal oscillator of 10 MHz is used for clock generator and the generated clock is fed to decade counter to generate 8 different clock 1 MHz to 0.1 Hz in steps of division of ten. There is one 8:1 multiplexer to select the one sampling rate out of 8 available. External clock can also be used for digitization.

2.2 *ADC section*

An instrumentation amplifier and bipolar to unipolar convertor is used before ADC to get −5V to +5V analog input range with common mode noise rejection. There is a 8-bit flash ADC supporting sampling range from DC to 20 MHz.

2.3 *FIFO*

To make sure that no data loss occurs due to high generation rate and continuous acquisition for long time, 8 K samples FIFO is used. FIFO is first in first out memory with asynchronous read and write operations.

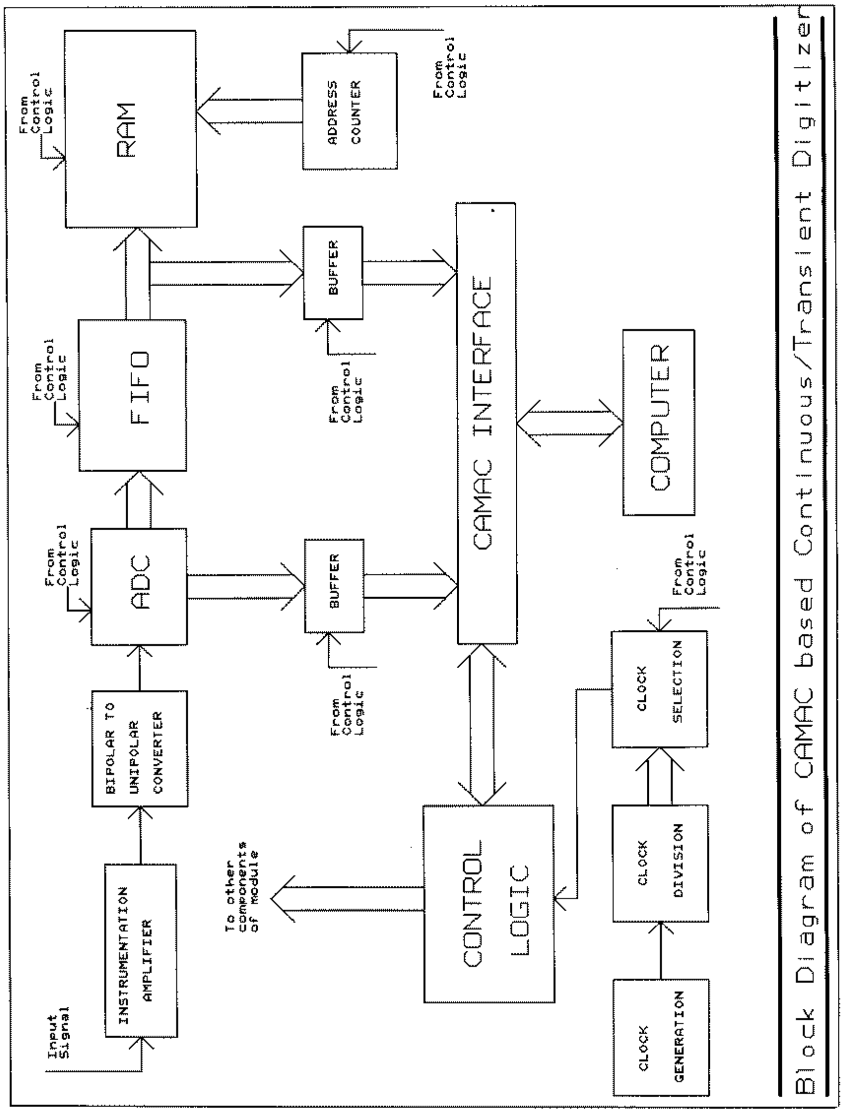

Figure 1. Block diagram.

2.4 *RAM*

A 32 K samples (32 K $\times$ 8 bit) RAM (random access memory) is used to store the large amount data in transient mode. The RAM is used as a circular buffer to store the data and upon receipt of a trigger the post-trigger samples are stored. Thus we have both pre-trigger data and post trigger data. In 32 K RAM 4 K samples are pre-trigger samples and rest are post trigger samples.

2.5 *Control logic circuits*

Control logic circuits are distributed all over the circuit to control the circuit in proper way. These logic are developed by digital gates (AND, OR, NOT gate) and flip-flops. The FIFO status flags like half full, full flag and empty flag are used to monitor the conditions like data overflow and underflow. The circuit controlling commands are either issued by the computer or generated by the circuit itself.

2.6 *CAMAC interface circuits*

These are the interfacing circuits between module and CAMAC backplane (Dataway). These include function decoder, read and write lines buffers, CAMAC control/acknowledgement signal generation circuits etc.

3. Applications

The module can be utilized in various operating modes for continuous acquisition as well as transient acquisition. It can also be used for monitoring by reading on-fly ADC data.

4. Operating modes

The module can be operated in three different modes: continuous acquisition mode for on-line continuous lossless acquisition for long duration with moderate sampling rate, transient acquisition mode to store pre/post-trigger data in on-board RAM with offline data transfer and the on-fly/monitoring mode for on-line display of acquired signal.

5. GUI

A user friendly software developed using LabWindows/CVI provides a very convenient usage.

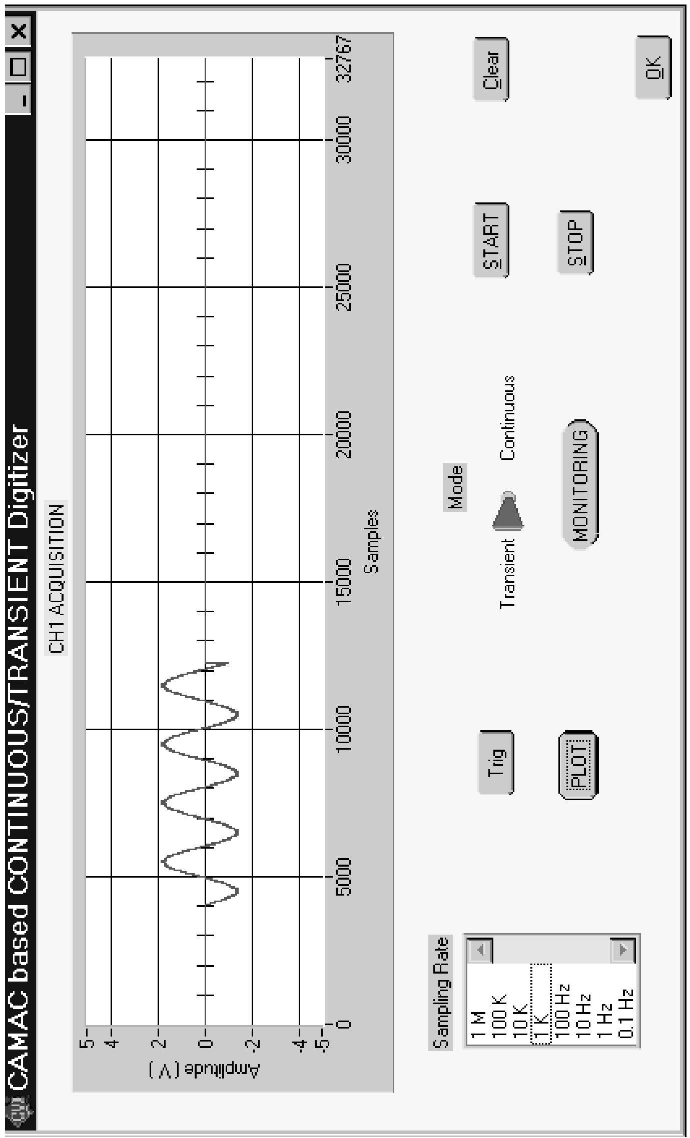

Figure 2. Data acquired in transient mode.

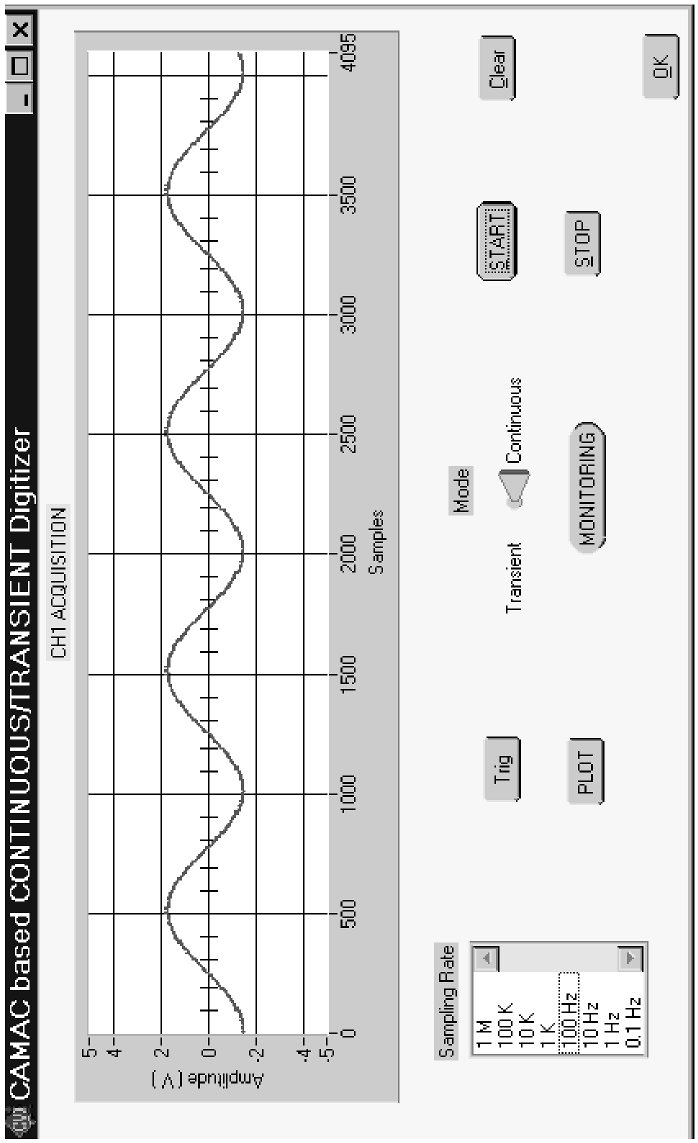

Figure 3. Data acquired in continuous mode.

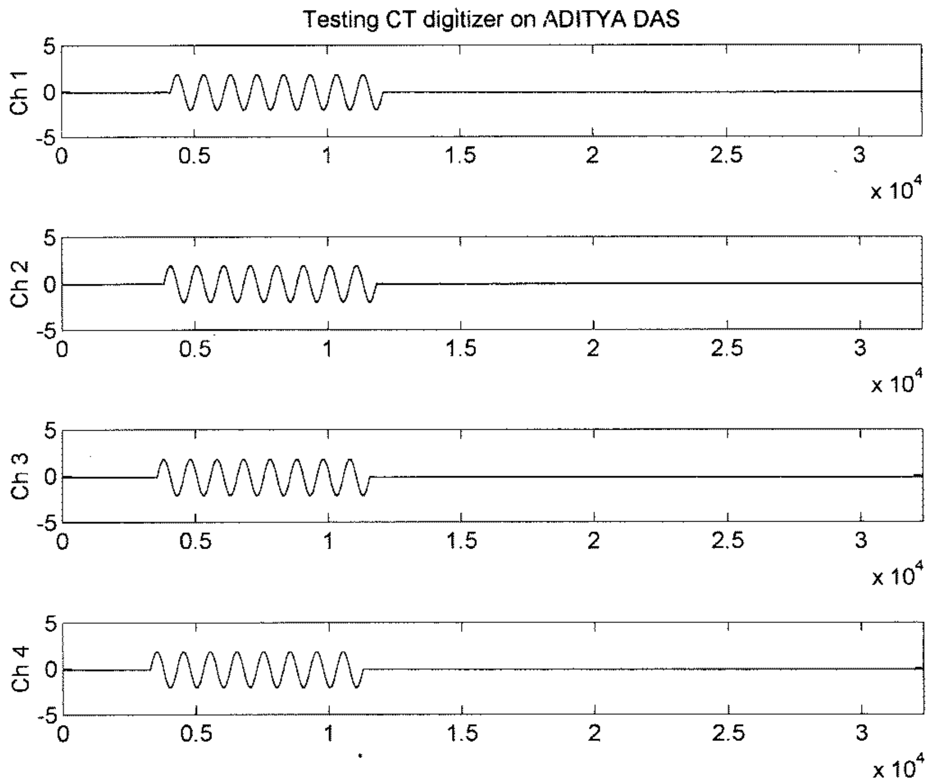

Figure 4. CT digitizer on ADITYA DAS.

6. Conclusion

The performance of the digitizer for continuous acquisition mode was observed on Windows-95 and Windows-NT. It was found that the sampling rate achieved in case of Windows-95 was higher than Windows-NT. Transient acquisition can be done up to 10 MHz sampling rate. Even the performance varies depending upon the CPU and clocking speed (figures 3, 4).

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