Development of Data Acquisition and Control System based on Fast Controller

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Abstract— The paper is about a fast controller based Data Acquisition and Control System. System consists of several plant systems varying from cryogenics, mechanical components, laser based diagnostic systems and gas feed systems to high voltage and high current power supplies. The operational mandate for is to undertake long duration experimental shots of up to 3600 sec. During the experimental durations various signals are to be sampled and acquired at various speeds ranging from 5 Sps to 100 MSps. The total number of signals to be acquired ~800. To operate the facility coordination between multiple plant systems is required for which a matured DACS is required. The DACS has several challenges like online monitoring of slow and fast signals for long duration. The fast controller prototype is based on NI hardware. Also a preliminary file management system will also be developed in the prototype. Prototype is based on LabVIEW2012 software.

Key words: fast controller, DACS, fast signals, LabVIEW2012

I. INTRODUCTION

The system is about Data Acquisition system for acquiring data from the controller at high sampling rate. For this purpose industrial controllers can be used which are meant for high speed data acquisition and for controlling purpose. The Data acquisition and control system has the important responsibility of operating the entire facility in an integrated manner. To ensure proper operation of the DACS must be able to satisfy certain criterions which ensure proper and safe operations. It must be able to integrate multiple plant systems for a proper coordinated operation of the facility. Must be able to monitor important system parameters like heat load on mechanical structures, grid breakdown for power supplies etc. for protection of facility. Due to the long duration of 3600sec of the beam pulses stringent requirements are there on both data transfer throughput and storage space. Should be able to manage the large amount of data (in order of 100MB/s) generated by each experimental shot. To be able to facilitate online monitoring of some of the signals for real time study of the facility. The DACS must include a mature Data management facility which should be able to save all the data in servers and should facilitate the data for post analysis in proper format. The fast control and Data acquisition system is based on NI hardware. The fast control and data acquisition system will be based on LabVIEW software.

II. TOOLS TO BE USED:

For the DACS the tools that we can used are stated as below by consulting different references based on this type of system.

A. Hardware:

For Fast Controller the hardware that will be used is National Instrument's PXI controller.PXI is a modular PC-based platform that consists of 3 components: chassis, embedded computer, and measurement modules.PXI is a rugged PC-based platform for measurement and automation systems. PXI combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features. PXI is both a high-performance and low-cost deployment platform for applications such as manufacturing test, military and aerospace, machine monitoring, automotive, and industrial test. The NI PXI DAQ platform provides the highest performance in accuracy, synchronization, signal conditioning and channel count options. A widely adopted industry standard, the PXI hardware architecture defined using LabVIEW or other software tools, offers the ideal modular solution to meet the needs of even the most challenging data acquisition application.

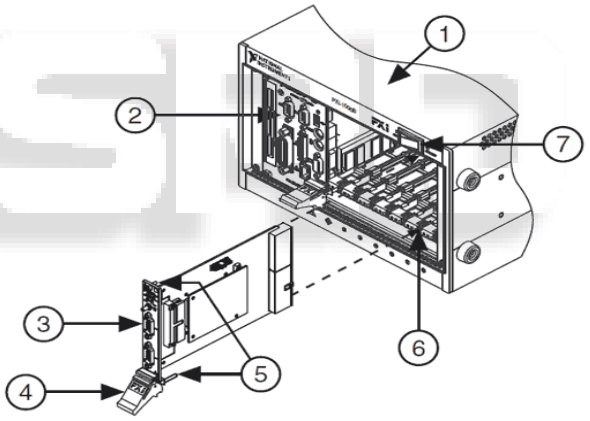

Fig. 1: Installing A PXI/PXI Express Module In The Chassis: (1) PXI/PXI Express Chassis, (2) PXI/PXI Express System Controller, (3) PXI/PXI Express Module, (4) Injector/Ejector Handle, (5) Front-Panel Mounting Screws, (6) Module Guides, And (7) Power Switch

B. Software:

1) NI LabVIEW:

For data acquisition and control programming, runtime data view, data backup. For more than 30 years, National Instruments has revolutionized the way engineers and scientists in industry, government, and academia approach measurement and automation. Leveraging PCs and commercial technologies, virtual instrumentation increases productivity and lowers costs for test, control, and design applications through easy-to-integrate software, such as NI LabVIEW, and modular measurement and control hardware for PXI, PCI, USB, and Ethernet.

C. Software and Hardware Platform for DAQ:

Acquisition cards from national Instruments are recommended. Standard PXIe 6259 card will be able to handle most of the signals for acquisition. Apart from this, PXIe 6683 card for timing synchronization is recommended which works on IEEE 1588 protocol to provide timing. Software platform: This forms the most critical portion in the entire data acquisition system and hence the decision on software was extended until single software is obtained which can fulfill all the requirements.

III. DACS ARCHITECTURE

There will be one main PXIe chassis which will have some cards and one timing card which will provide timing to the entire system. Other diagnostic systems will get the timing from this card and have acquisition cards. The data will be transferred directly to the acquisition system for storage or online view.

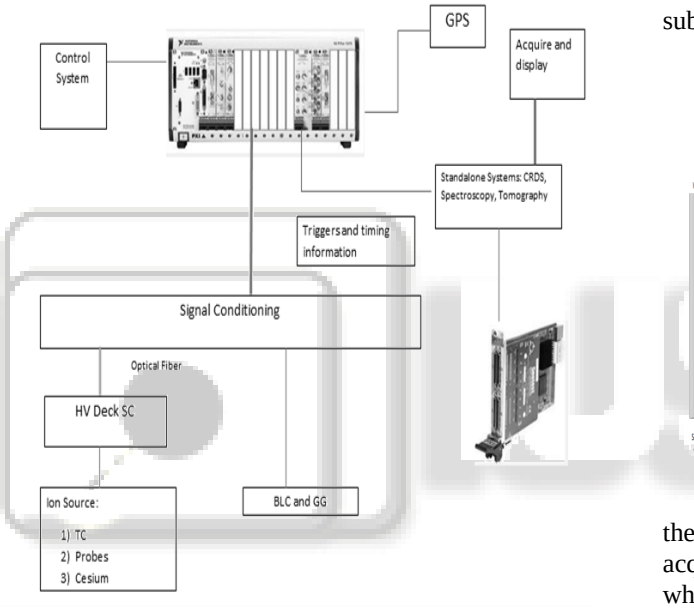

Fig. 2: Data Acquisition System

IV. CORRECT DATA FORMAT FOR SAVING THE DATA

For many new measurement systems, choosing the right data storage approach is an afterthought. Engineers often end up selecting the storage strategy that most easily meets the needs of the application in its current state without considering future requirements. Yet storage format choices can have a large impact on the overall efficiency of the acquisition system as well as the efficiency of post processing the raw data over time. Today's complex products require data acquisition throughout the complete design and development process. Companies make a significant investment in the data they collect. Increasing microprocessor speed and storage capacity together with decreasing costs for hardware and software have resulted in an explosion of data stored in files and databases. While technology is enabling faster and richer data retention, managing and making good use of this data remains the real challenge. There is certain consideration while choosing the correct data storage format. LabVIEW supports different file formats like ASCII, binary, XML, Database, TDMS, HDF5 out of them considering all the parameters we choose HDF5 which is the best fit for the system.

V. LABVIEW CODE DEVELOPMENT

For the whole system development we can code the entire system as a prototype in LabVIEW2012. Which gives the idea of the system. LabVIEW provides GUI(Graphical User Interface) and VI (Virtual Instruments) that can give us the actual scenario of the DACS system that is developed by the coding. For a long duration data acquisition a better file management system is required and for that we have to add extra plug-in HDF5 by the Package Manager that is compatible with the current LabVIEW version with all HDF functionalities. More over DAQmx provides different functionalities for fast controller based data acquisition system for setting the acquisition type, mode, sampling rate, samples per seconds ext. and that helps us to build the GUI. For a file management we can programmatically generate a files as per our requirement by shorting them into different sub files.

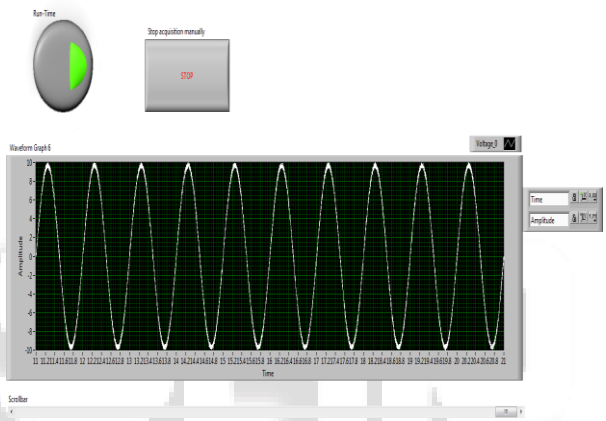

Fig. 3: GUI For Run-Time Acquisition Per Second

There are two types of mode one is Run-time and the other is off-line the first one mode gives us the current acquire data signal that is indicated into the waveform graph which has a window size of ten seconds that is continuously increasing per second for the 3600 secs as per the requirement and the another mode is off-line mode which can be selected by press the green-button which provides us the waveform graph of the signal that is already acquired earlier and if we want to monitor it then by the scroll bar we can see the data that is saved into the files by calling the files as per our requirement. That is also programmatically done by LabVIEW itself.

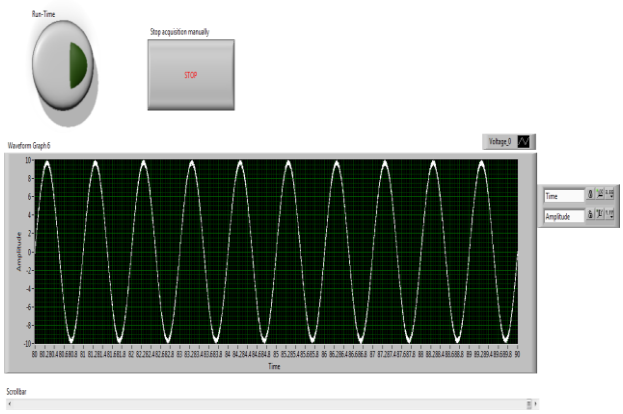

Fig. 3: GUI for Off-Line Monitoring

For data management the file I have chosen is HDF for the viewing the acquired data, HDFView we have to install in our PC which is open software free to use.

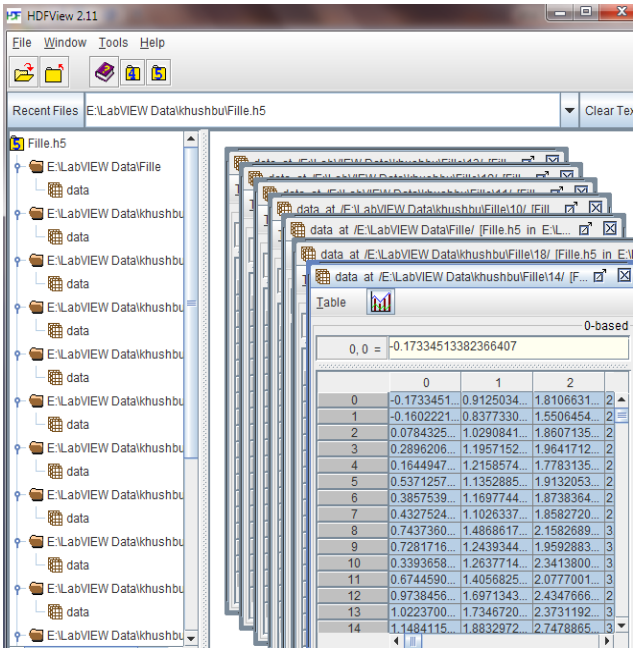

Fig. 3: HDF view For Viewing The Acquired Data

Thus by the viewer we can analyze the whole set of acquired data into single file and then by calling the particular file we can view the data by off line mode. Thus it's a new feature file that is introduced into LabVIEW

VI. Conclusions

The developed LabVIEW code provide interactive graphical user interface with features of online monitoring, control, data plotting and report generation facility. The component interacting of the software was successfully executed with Universal Serial Bus (USB) and Local Area Network (LAN) with third party hardware of NI hardware. The use of LabVIEW software for monitoring and control of these two components with instrument drive was presented.

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References

[1] Lennart Svensson, Ronald S. Hemsworth, Beatrix Schunke, "Instrumentation and diagnostics for the ITER Neutral Beam System", March 2011, Fusion Engineering and Design 86 (2011) 934–937 © 2011 Elsevier B.V.

[2] A. Luchetta, G. Manduchi, C. Taliercio , A. Soppelsa, A. Barbalace, F. Paolucci, F. Sartori, P. Barbato, M. Breda, R. Capobianco, F. Molon, M. Moressa, S. Polato, P. Simionato, E. Zampiva, "Architecture of SPIDER control and data acquisition system" Nov 2012, Fusion Engineering and Design 87 (2012) 1933– 1939 © 2012 CONSORZIO RFX Associazione EURATOM-ENEA sulla Fusione.

[3] Manika Dey , H.D. Pujara, "Real-time acquisition and remote monitoring of steady state tokamak (SST-1) diagnostics data", March 2007, Fusion Engineering and Design 82 (2007) 1198–1202 © 2007 Elsevier B.V.

[4] A. Luchetta, G. Manduchi, C. Taliercio ," Fast control and data acquisition in the neutral beam test facility", May 2014, Fusion Engineering and Design 89 (2014) 663–668 © 2014 Elsevier B.V.

