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THE IEEE1451 STD APPLIED TO DATA ACQUISITION SYSTEMS IN THE TJ-II NUCLEAR FUSION DEVICE

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Abstract –A Nuclear Fusion device is composed, among others, of thousands of sensors connected to a variety of data acquisition systems through hundreds of km of cables. One of the objectives of the INTELLECT is the application of standards to improve self-identification and configuration of the sensors side from the data acquisition system. The paper describes the application of IEEE 1451 Std. to integrate a Transducer Electronic Datasheet (TEDS) in a specific sensor for measuring radiation. The proposal is applied to an existing bolometer system in the TJ-II stellarator [1], located at CIEMAT (Madrid, Spain).

Keywords: Smart bolometer, Smart Data Acquisition System, nuclear fusion, TEDS, IEEE 1451 Std.

1. INTRODUCTION

The bolometer system measures the power of the incident radiation from the plasma. In the present work, a remote and intelligent gain control with an offset voltage level was added to the current amplifiers. Then the DAQ system through standard communication based on IEEE1451 is able to identify and configure system parameters. The hardware and software has been developed to replace the current acquisition system, which enhance its functionality

A custom hardware, designed to measure the radiation produced by plasma particles interactions, is installed in the TJ-II nuclear fusion device, located in the facilities of the Centre for Energy, Environment and Technology (CIEMAT) [1] in Madrid.

The design is based on a set of bolometers (photodiodes) plus its amplifiers and voltage level shifters.

For optimal readings of radiation signal, which depends on the performed fusion test, it is necessary that the system can adjust different parameters such as the gain of the amplifiers. At present, the existing system has a physical and manual system for setting four different gains.

For this work, a board has been designed to allow a remote gain configuration for 16 amplifiers based on the IEEE 1451 Std. and the addition of the TEDS to such system.

Electronic control is managed by a microcontroller based board (Netduino Plus 2 development platform [2]).

The use of TEDS [3, 4, 5] allows reading and writing of important hardware design parameters to be taken into account at certain times during the TJ-II discharges.

2. CONTROLLER BOARD

The control system is based on a Netduino Plus 2 development board (Fig. 1). This board has a micro-SD card on which it has been installed an electronic data sheet (TEDS) [6] with basic system parameters. The TEDS data format is ASCII (Fig. 2). The TEDS can be based on XML[7] or ASCII format. In order to reduce the data sheet size a custom TEDS template has been designed.

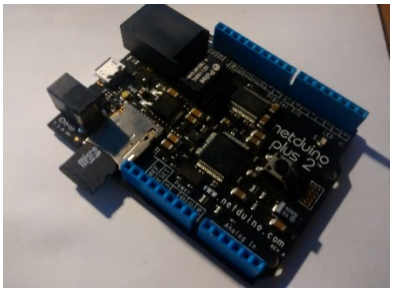

Fig. 1. The controller board Netduino Plus 2 and the micro-SD card.

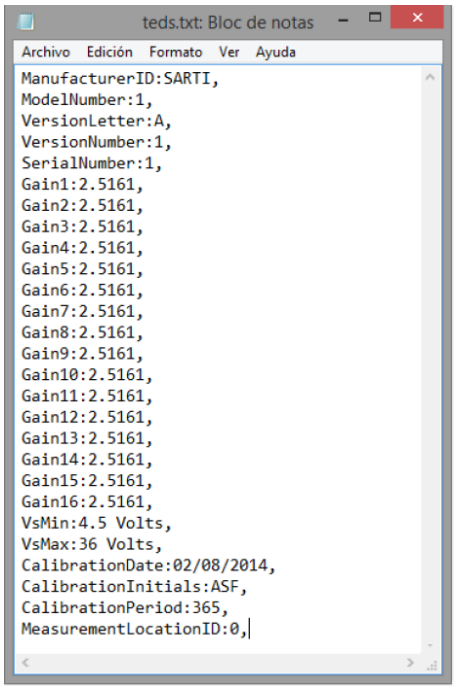

Fig. 2. TEDS txt file

3. HARDWARE

It has been designed a custom hardware responsible for adapting the voltage levels between the set of bolometers. This board consists of a differential line receiver for analog signal, and an instrumentation amplifier with selectable gain to adapt the signal levels to input data acquisition as illustrated in Fig. 3.

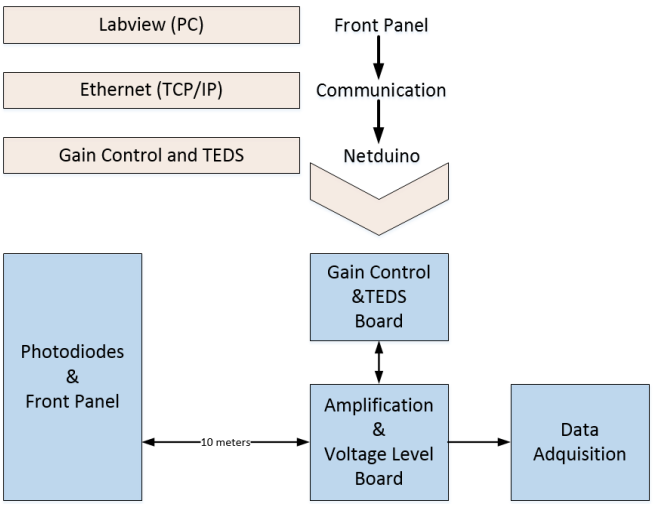

Fig. 3. Hardware Block Diagram

For the configuration of all different gain combinations (16-channel, 4 gains per channel) 64 digital signals are necessary. Therefore, a second hardware board has been developed no minimize digital lines based on shift registers and multiplexers in order to produce the 64 necessary digital control signals from only 3 digital outputs at the microcontroller side.

4. SOFTWARE

A C# firmware is programmed in Netduino board. The microcontroller is responsible to establish a TCP communication with a Labview application in a computer and to create a client connection.

Then, the microcontroller waits for READ or WRITE command. If a READ command is received, the microcontroller reads the TEDS information from SD Card and send this information to the client application. If a WRITE command is received, the microcontroller applies the new gain parameters to amplifiers and updates the corresponding TEDS fields stored into the SD Card.

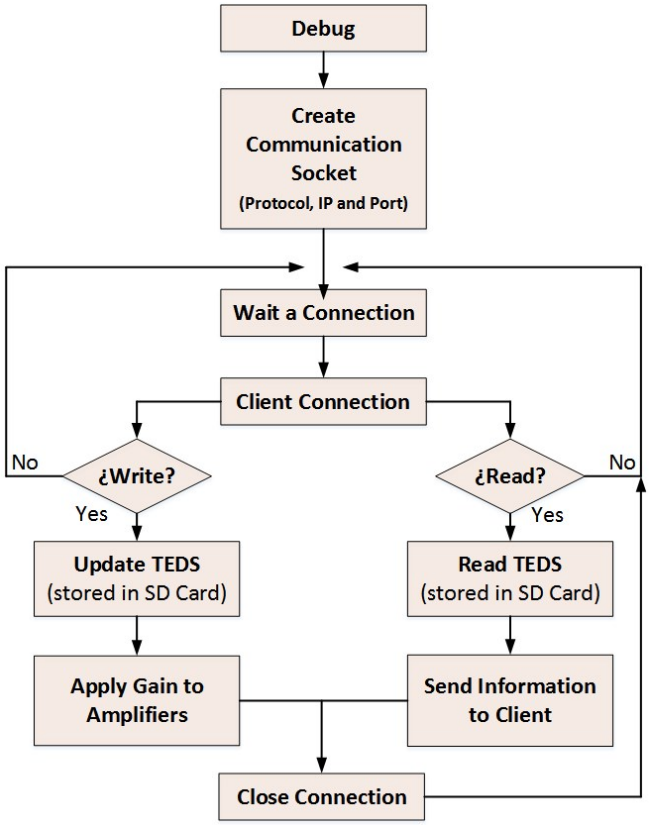

Fig. 4. Software Block Diagram

5. VISUALIZATION PANEL

A LabVIEW application has been designed to control the system. In Fig. 5 is illustrated the connection with the Netduino board. When the READ button is pressed a TCP communication with the Netduino controller board is established. The Netduino board receives the READ command and sends all information from TEDS, encoded into a txt file, to LabVIEW program which in turn displays the information in the front panel.

Moreover, the program allows the users to perform changes to the TEDS and gains control. These changes are

reflected in the Netduino board that update all processes automatically according to the information entered on the front panel.

Before the information can be modified, the user should enter in the edit mode pressing the EDIT button. Once pressed, the user can apply changes to the active channel pressing APPLY CHANGES button.

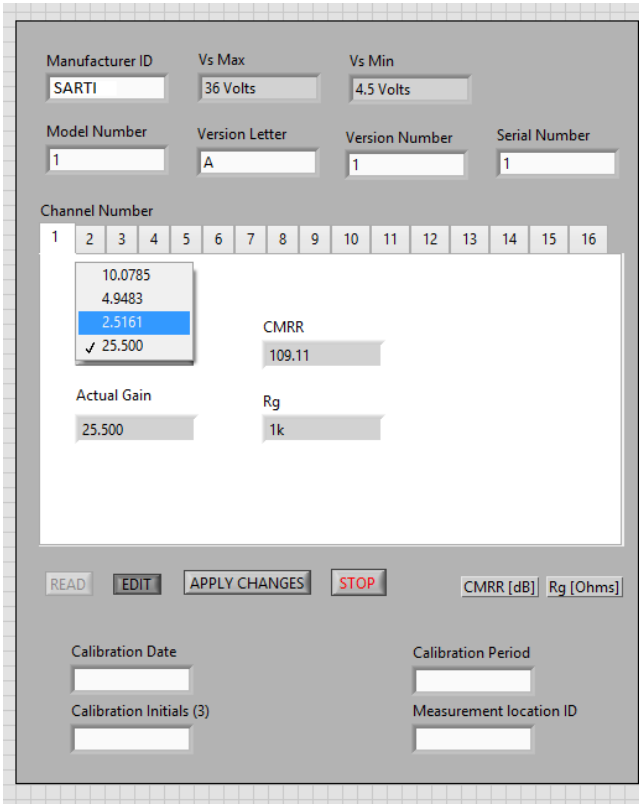

Fig. 5. LabVIEW Front Panel for TEDS read and writes operation and parameters and gains selection.

6. CONCLUSIONS

The application of IEEE 1451 Std. to the Bolometer sensor side offers an interoperable mechanism in order to identify and configure the acquisition parameters. The protocol used for writing and reading of TEDS in the Netduino board is acceptable for data transmission with low bandwidth.

ACKNOWLEDGMENTS

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