SOSDAQ - A DATA ACQUISITION AND SLOW CONTROL SYSTEM FOR THE SWISS LIGHT SOURCE 500 MHz 65 kW SOLID STATE POWER AMPLIFIER*

M. Gaspar† and T. Garvey,
Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Abstract

The Paul Scherrer Institut has developed a compact 500 MHz 65 kW solid state RF power amplifier intended for applications in booster and storage rings of modern synchrotron light sources. The solid state power amplifier is presently under evaluation in the booster ring of the Swiss Light Source (SLS). In order to achieve this high RF output power levels using the present state of the art solid state technology, a large number of power amplifier modules, each one including its own power amplifier module and a local monitoring and control, are combined, configuring a complete distributed system. In order to monitor and control this large distributed system, we developed a specific data acquisition, monitoring and control system, called SOSDAQ. This system offers flexibility for efficiency optimization, easy addition and replacement of components, easy configuration for different types of power and efficiency requirements, among other features. We will discuss about the control system architecture, the software and the hardware implementation, and the results obtained.

INTRODUCTION

Modern very high power solid-state RF amplifiers are commonly composed of a large number of MOSFET based RF power amplifiers. A larger number of amplifiers is required due to the limitation of maximum power available from a single MOSFET amplifier which is presently around 1 kW.

Transistor amplifiers normally require only two separated power supplies, a high power one to bias the output (the MOSFET drain), which is the one that has to deliver high DC power, and a second low power one, to bias the input (the MOSFET gate), which is the one used to set the device operating or "quiescent" point. Due to the simple operation of transistors the two required power supplies can be easily integrated with the RF power amplifier itself. And, by adding the monitoring and control system, it is then possible to build a complete and autonomous distributed RF amplification system, which is one of the propositions of this present work [1].

SYSTEM DESCRIPTION

An overview of the SOSDAQ system is presented in Fig. 1. The system is divided into two specific parts, one dedicated to the control of the distributed amplification system (left) and a traditional PLC (programmable logic controller) system to control other devices which cannot easily be integrated into the distributed system (right). The PS Controller (power supply controller) is the main component of the distributed control system. It houses a multitasking script operating system (SOS) developed in house. Each PS controller monitors and controls its own RF power amplifier module. A total of 110 PS controllers are connected to a communication network. All the analogue information is locally converted to digital so that no extra cabling is required for analogue signals. All the information sent to the server through the network is then purely digital. The PS controllers also have extra analogue and digital connections which allow other devices to be added to the distributed part of the control system. An example of such devices, the power meter which is used to monitor RF power in different parts of the system, is shown in Fig. 1. The PS Master (power supply master controller) is responsible for the connection of the central server computer to the network. In the present configuration, the PS Master is the only master controller in the network, all the other devices are slaves, i.e., can only reply to requests sent by the master.

The traditional PLC based part of the system is used to monitor the cooling system (water temperature and flow) and to control the "step-start" system. We will replace the PLC system by a new system developed in house in an effort to reduce the costs and have a system completely free of licenses.

All other components which are outside of the distributed network (Fig. 1 right), as for example, the traditional PLC and the mains power analyser, are connected to the central server computer through TCP/IP protocol over standard ethernet network.

The control system strategy proposed in this work requires a reduced amount of connections, i.e. mostly network cables, which gives advantages such as easy system construction, low cost and highly modular system.

Figure 2 shows the constructed system and the location of each specific component [2, 3].

The SOSDAQ system is installed in a central server computer which runs Debian Linux as an operating system. All channels monitored by the SOSDAQ, which are, at the moment, around 2000, are stored in a database of type MySQL. A channel monitoring rate higher than 1000 channels per second is normally obtained. The SOSDAQ software was developed using; at the server side, only shell-script (GNU/BASH) for the standard applications including the web-server and

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† marcos.gaspar@psi.ch

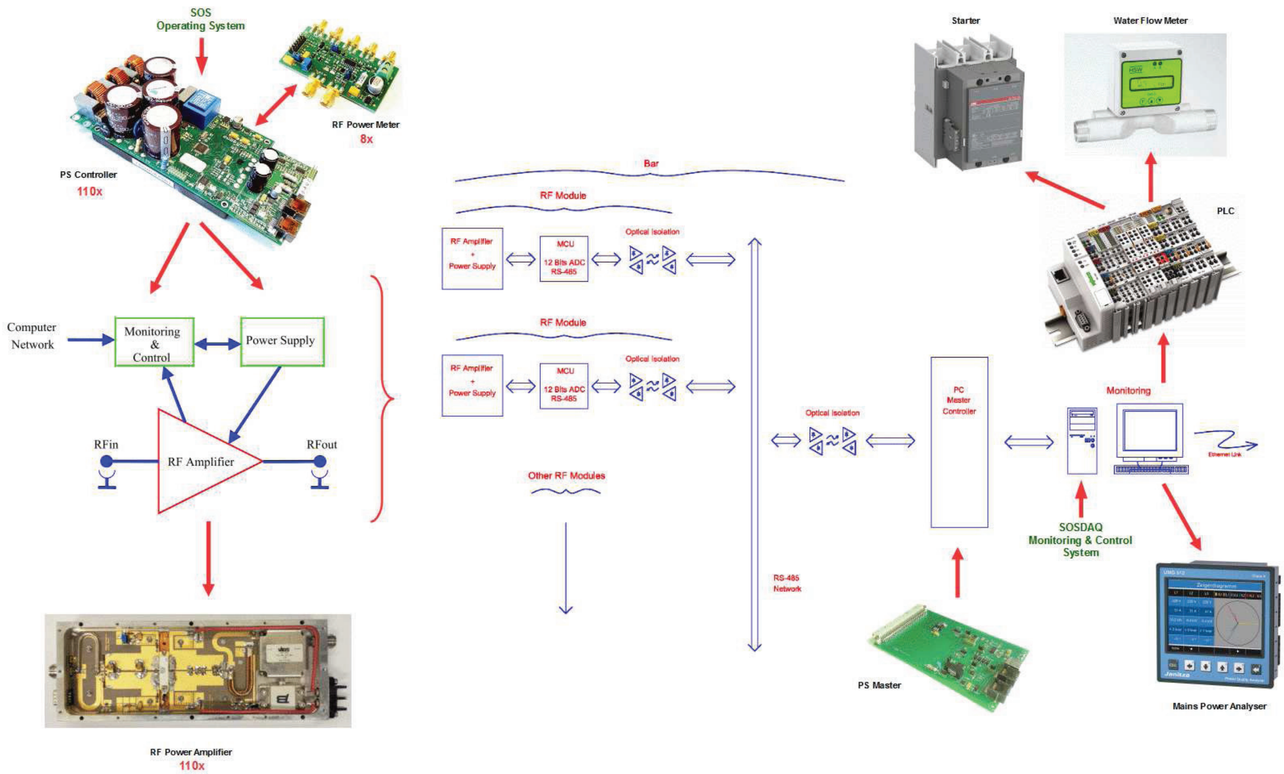

Figure 1: System configuration.

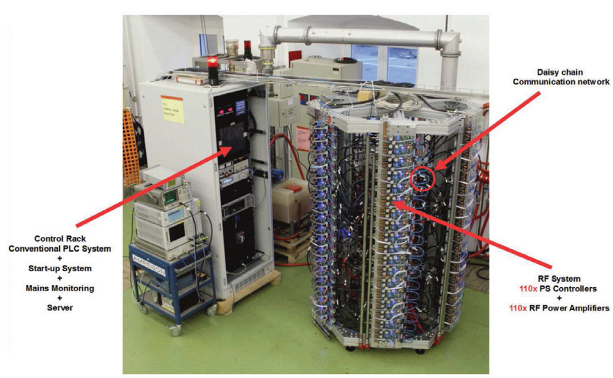

Figure 2: 65 kW amplifier in the test area.

C for the applications which required high execution speed; and, at the client side, JavaScript. These programming languages were chosen in order to obtain the highest compatibility and portability across different Linux distributions.

The simplified flow diagram of the SOSDAQ is shown in Fig. 3 (top-left). The monitoring, control, data acquisition and storage tasks are performed by the kernel of the system called Scanner. A more detailed flow diagram is shown in Fig. 3 (top-right). The Scanner sequentially queries all devices reading their variables, and if needed also setting some of the variables. The variables, which are also called channels, are then translated through a polynomial interpolation to human readable format, checked for interlocks, and stored in a database. All the relevant information about all devices, device drivers, interlock settings, system configura-

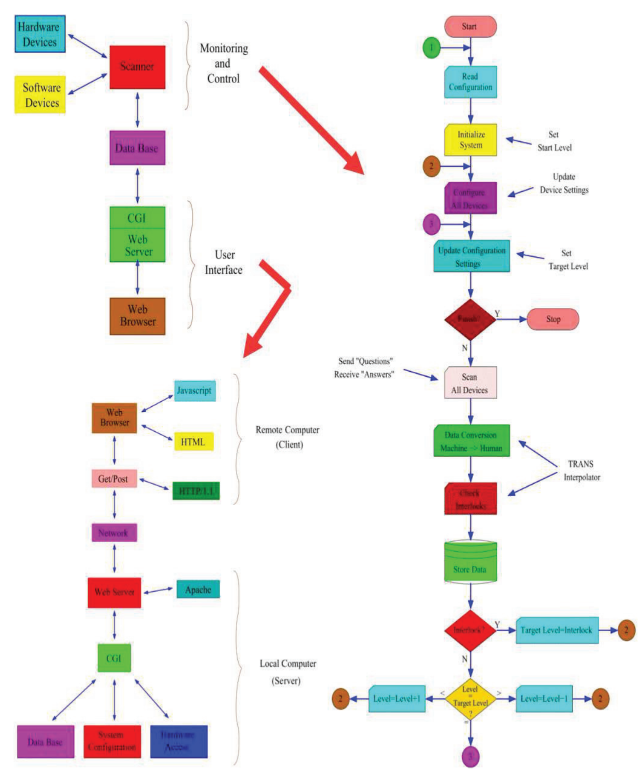

Figure 3: System flow diagram.

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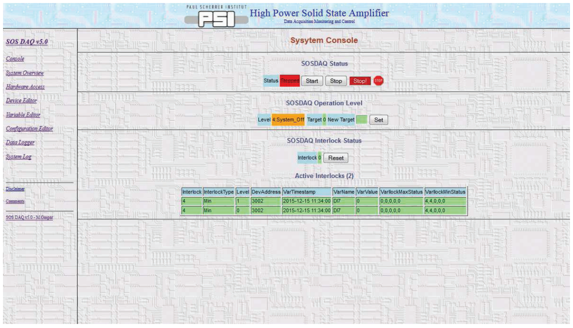

Figure 4: User interface: System Console.

tion, etc. are also stored in the database. The present system is configured for 5 operating levels, which are the following: System Off, Stand By, System Ready, RF Off and RF On. Depending on interlocks and the target operation level given by the user the system changes the level automatically to the suitable operating level.

A web-server is used to provide the user interface by means of a standard web-browser [4]. This increases the cross platform compatibility of the user interface. A web-page interface gives access to the different services provided by the SOSDAQ, such as, system console, system overview, hardware access, variable editor, system configuration editor, datalogger, etc.. Figure 4 shows the SOSDAQ system console. The system overview is shown in Fig. 5.

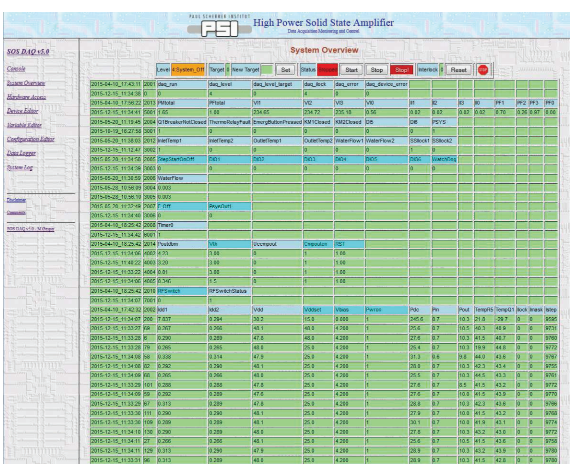

Figure 5: User interface: System Overview.

Table 1: SOSDAQ System Parameters

Parameter	Value
Channel update rate	≈ 1000 channels/s
Number of channels	≈ 2000 channels
Number of operating levels	5
Average time to change level	5 s
Fast interlock reaction time	10 ns
Slow interlock reaction time	5 s
Server request rate (minimum)	>100 requests/s

Some of the parameters of the SOSDAQ system are listed in Table 1.

CONCLUSIONS

In this work we presented the SOSDAQ, a control and monitoring software targeted to the supervision of large distributed amplification systems based on solid-state technology. The application of this software for the current constructed system has been successful providing the needed means to optimize the system for best efficiency at any required RF output power. We presently envisage the deployment in larger systems.

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