

IMPLEMENTATION OF A NEW RF MONITORING SYSTEM FOR THE SRS USING LABVIEW

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Abstract

The SRS Computer Control System is undergoing a programme of upgrade from a system of Concurrent Computer Corporation mini computers to a network of PCs [1]. The old RF monitoring system, based on CAMAC hardware, has been replaced with two Industrial PC front end computers running Windows 95 and controlling Hewlett Packard instrumentation and Eurotherm Temperature Controllers. Measurements on the new system are now performed using the data acquisition software LabVIEW® combined with standard PC cards for GPIB and serial communication. This paper describes the hardware and software used in this project, and also how it has been interfaced onto the existing SRS ISOLDE PC control system.

1 INTRODUCTION

The Daresbury SRS is a second-generation light source based on a 2 GeV electron storage ring. The current control system upgrade programme, based on the CERN PS ISOLDE Control system [2,3], is being introduced progressively. The main magnet power converters and steering system have now been in routine operation on the new control system for some time [4].

One of the new projects taking place is the development of an RF monitoring system using LabVIEW® on a PC running Windows. This will be used for monitoring the RF systems' parameters as well as control of the klystron voltage ramp procedure and will be integrated into the ISOLDE system.

2 THE UPDATED SRS RF MONITORING SYSTEM

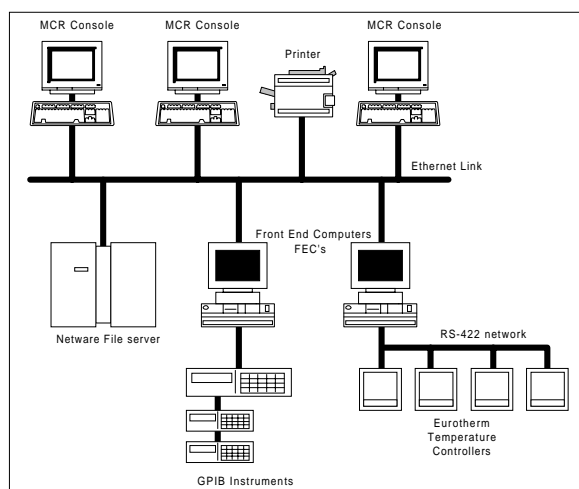


Figure 1: Diagram showing the layout of the system.

An overview of the new system can be seen in Figure 1. Both of the new RF Front End Computers (FECs) are installed, along with all the instrumentation within a single nineteen inch rack.

2.1 RF Power level monitoring

Upon the SRS RF system, twenty three independent RF power signals are currently monitored. This is achieved by using an Industrial enclosed Pentium 100MHz PC, as the Front End Computer, to perform all the processing of the signals and control of the ISA hardware inserted within it, and external Hewlett Packard 3488A Switch/Control unit and 437B Power meter. Windows '95 is used as the operating system.

Each signal is connected to the HP Switch/Control unit and fed through, in turn, to the HP power meter. The resulting power levels are analysed by the National Instruments LabVIEW® data acquisition and control software on a GPIB bus through a National Instruments AT-GPIB/TNT(PnP) 16bit card. All the power levels received are displayed on a graphical representation of the SRS RF system, showing the exact position of the signal in the RF system and the status within a predetermined range.

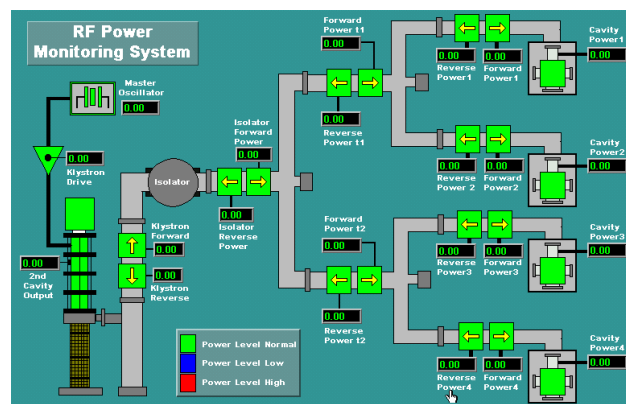


Figure 2: RF Power Monitoring application on the remote console in the SRS control room.

All of the power signals are displayed in watts and a colour coded status warning is included.

2.2 RF system Klystron Efficiency and Flow Monitoring

The second of the two FEC's analyses data from the RF systems water cooling network of flow meters. Seven flow meters are present in the network. This PC is also

Pentium powered installed within an Industrial enclosure running at 133 MHz but using Windows NT Workstation Version 4.0 as its operating system. Again, all the programming is done using LabVIEW® to read back the rates of flow from each of the seven meters in turn and display the outputs on a graphical front end display. Using the rate of flow of the cooling water through the klystron, along with the differential temperature change of the klystron's output, (the differential temperature change being available through a TCP/IP connection from the temperature monitoring LabVIEW® program running on FEC1), it is possible to calculate the klystron's efficiency.

$$\text{Efficiency} = \frac{\text{Output Power (in KW)}}{\text{Input Power}} \times 100\%$$

$$= \frac{K \times \text{Differential Temperature change} \times \text{flow}}{\text{Klystron Voltage} \times \text{Current}}$$

Where :

Differential Temperature Change = differential change in temperature calculated in the Temperature Monitoring LabVIEW® vi (Degrees Celsius).

K = 0.3172 if Flow is measured in gallons/minute
 = 0.06979 if Flow is measured in litres/minute

This can also be displayed remotely on the control room console.

2.3 RF system temperature monitoring

The temperature monitoring system uses the same Industrial P100 PC as its Front End Computer. There are nineteen temperature levels that are monitored within the RF system through an RS-232 and RS-422 link using three different types of hardware monitors.



Figure 3: The LabVIEW® cavity body temperature control application for a Eurotherm 902s Controller.

On each of the four cavity bodies are Eurotherm 902s controllers, on the cavity windows are infra-red temperature detectors and to monitor the rest of the RF

system, an Anafaze Independent Alarm Scanner (IAS) is used. The latter simply scans through all of its connected thermocouple inputs and downloads the data to the FEC via the RS-232 COM port on the rear of the FEC. The Eurotherm 902s controllers not only monitor the temperatures of each of the four cavity bodies but can alter the temperatures by changing the rate of flow of cooling water through the cavity bodies. The controllers are communicated with via a National Instruments 2-port RS-485 interface 16bit card. Remote operation of the cavity body temperature control is available from the SRS control room only by specified users with password protection.

3 KLYSTRON VOLTAGE RAMP PROCEDURE

3.1 Updated procedure for ISOLDE control system

The second Front End PC also controls and monitors the klystron voltage ramp procedure; parameter name PROG. This is achieved through LabVIEW® using National Instruments NI-DAQ software and an AT-MIO-16XE-50 data acquisition ISA card, as shown in Figure 4.

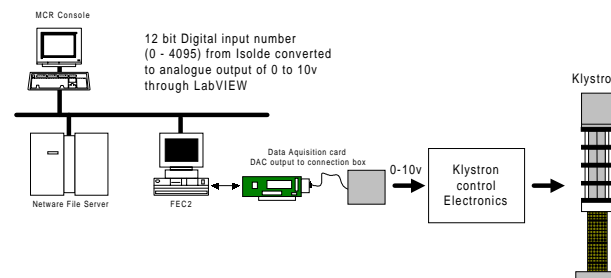


Figure 4: Diagram of hardware used for controlling klystron voltage.

The ISOLDE control system sends the FEC a ramp table over the etherlink connection. This table is in the form of a series of consecutively increasing numbers along with a time in which the step up in voltage should occur. A LabVIEW® program interprets the input table and converts the control values to a voltage out between zero and ten volts through the 16-bit DAC on the data acquisition card. (Using the on board ADC on the same card, the output voltage is analysed.) This voltage is then connected to the klystron voltage control electronics.

4 INTEGRATING TO THE ISOLDE CONTROL SYSTEM

4.1 Porting The ISOLDE Software to Windows NT.

As it was intended to implement the RF control system using LabVIEW® running under Windows 95/NT, it was necessary to port the 16-bit DOS based front end software and equipment modules written in 'C' to Windows NT. This has been done using the 32-bit Visual C++ Version

2.0. Network connections are now handled through the Winsock API rather than the PC/TCP socket library used under DOS and has been made multi-threaded to handle network requests and user input more effectively. All configuration information is now stored in the system registry, but the software still makes use of Excel CSV formatted database files.

4.2 OLE Database Server

It has been necessary to store the most recently monitored values in memory to be read back when a parameter is requested. This is because the SRS ISOLDE system has a timeout of 2 seconds for an acquisition, which is shorter than the time it takes to read a power level. Ideally, this would have been done by using LabVIEW® as an OLE server and the FEC process retrieving the value through an OLE method. However, as LabVIEW® can only act as an OLE client, this has been achieved by using a separate out-of-process OLE server which LabVIEW® writes to and the FEC reads from. The OLE server has been implemented using Visual Basic and is flexible in that extra parameters can be added simply by inserting an extra line into the parameter database file.

4.3 Klystron Ramp and Temperature Control

There is an element of control required through the ISOLDE system for ramping the klystron and controlling the cavity temperatures. A separate LabVIEW® VI has been written to cope with this and communicates with the FEC process using TCP, residing on the same computer. This LabVIEW® VI can then control the hardware using the same sub-VIs which are used for local control.

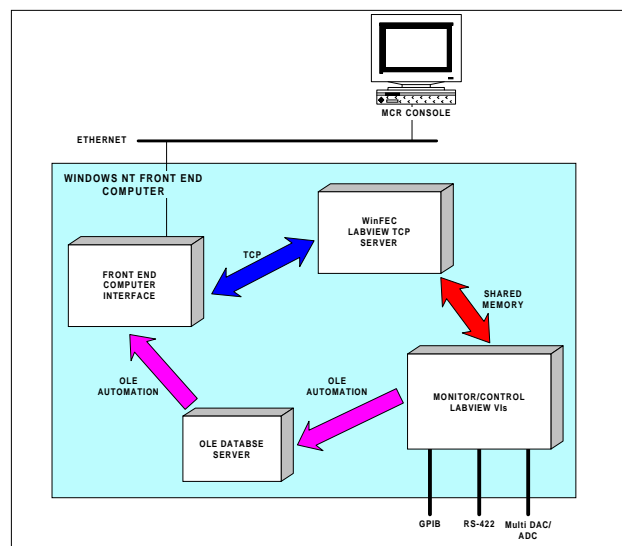


Figure 5: Diagram showing data flow in a Windows NT FEC.

An equipment module has been written to allow klystron ramp tables to be loaded remotely from the control room which can be executed or aborted on request. This

software has only been tested with the DAC output connected to a chart recorder but gives expected results. It is planned to integrate this into the ramping of the main dipole magnets which are already controlled through the ISOLDE system. The temperature control software has been implemented but is untested.

Due to some doubts over the stability of software running on a Windows PC using LabVIEW®, the Windows NT machine has been set up so that the PC automatically reboots itself if the program crashes. On restarting, the software will load again and can continue to operate as before. This could be done without losing a user beam as the DAC outputs are not reset.

An overview of the software used to provide the interface to the Daresbury ISOLDE system can be seen in Figure 5.

5 CONCLUSIONS

Although there is still some work to be done in completing this project, it has been successful up to now. The RF power and temperature parameters can be monitored locally and in the control room over the network with a clear graphical representation of the RF system. The cavity temperatures can be controlled locally and the klystron voltage can be ramped.

There are already plans to re-use the Windows NT ISOLDE software to integrate small stand-alone systems onto the main control system, including beam profile measurements made in the SRS Synchrotron Light Area. LabVIEW® still has its own problems though as it is very memory and processor hungry and there are still some doubts over its stability. However, it would have been unlikely that such a project could have been undertaken by a non-programming specialist, if it had been implemented as a traditional front end computer using 'C'.

REFERENCES

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