

# LINAC PARAMETER ACQUISITION SYSTEM (LIPAS) FOR 9MEV RF LINAC

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## Abstract

A 9MeV RF Electron accelerator is being jointly developed by BARC and ECIL for Cargo scanning at ECIL, Hyderabad. In order to operate the Linac from control room, various parameters, like Vacuum, RF Power, Pulse Repetitive Rate, RF Frequency, Focusing coil current, RF Driver Gain of the Linac, etc., need to be monitored and controlled. These parameters are acquired from various devices Vacuum Controller, Power Meter, Synchronous Trigger Generator, Signal Generator, Solenoid Coil Supply and Driver Amplifier respectively. All the devices have their own set of command formats and protocol, which need to be integrated into a single system. This paper describes the design features of the software and experience of use of control software during beam operations.

## INTRODUCTION

A 9 MeV RF Electron accelerator [1] is being jointly developed by BARC and ECIL for Cargo scanning at ECIL, Hyderabad. The RF power of 2.7 MW and Beam current of 75mA is required for generation of X-rays for Imaging. At the start of linac operation, RF conditioning is to be carried out followed by operation with the electron beam. During these processes, it is required to remotely observe vacuum conditions in the linac system, monitor various RF signals, and set the parameters for proper operation. For this purpose, a PC operated control system was designed and developed.

## SYSTEM REQUIREMENT

The devices like Vacuum gauge Controller, Synchronous Trigger Generator, and Solenoid Coil Supply are placed in the power supply room. Whereas devices like Power Meter, Signal Generator and Driver Amplifier are placed in the high radiation area (Linac area). These devices are required to be adjusted and controlled remotely for RF Conditioning and Beam trial Operation. The features required for the PC operation of Acquisition system are:

- GUI to display all the required parameters.
- Provision for changing the parameter in steps.
- Provision for Direct setting the parameter.
- Software controlled limits for parameters.
- To display Arc and Fault indication.
- Refresh rate of minimum 1 Minute.
- Database to store the parameters at various time intervals.
- To view the required stored data as per user requirement.

## DESIGN ASPECTS

Each device has its specific hardware and software protocol. All the devices are available with either RS-232 serial port or GPIB port. To acquire the data we need to send the query and get the data. To set the parameter we need to send the command.

Devices like Vacuum Controller, Power Meter, Signal Generator and Solenoid Coil Supply follows Standard Commands for Programmable Instrumentation (SCPI).

SCPI standards are developed as a common interface language between computers and test instruments. The SCPI Standard is built on the foundation of IEEE-488.2, Standard Codes and Formats. SCPI syntax is ASCII text, and therefore can be attached to any computer test language, such as BASIC, C, or C++. It can also be used with Test Application Environments such as LabWindows/CVI, LabVIEW and Microsoft Visual Studio. SCPI is hardware-independent. SCPI strings can be sent over any instrument interface. It works equally well over GPIB, RS-232, VXibus or LAN networks.

Driver amplifier sends and receives the data in HEX. The syntax for driver amplifier is Starting Character, Command, Data and Checksum.

The Synchronous trigger generator has its own set of syntax. It is microcontroller based pulse generation circuit. It sends and receives data in string format. The syntax is Starting Character, Command, Data and End OF String.

All the devices having different protocol are required to be integrated in a single PC.

All the devices are communicated over RS-232 Port. Fig.1 shows the schematic of Acquisition system LiPAS. Three devices, Vacuum Controller, Synchronous Trigger Generator and Solenoid Coil Supply are kept in power supply room and three devices Power Meter, Signal Generator and Driver Amplifier are kept in Linac room, two MOXA make 5054I Ethernet to 4 port Serial converter were used for communicate with the devices. Ethernet to 4 port Serial converter were connected to the PC via Ethernet switch. Each port of the converter can be individually configured for the setting like port number, baud rate etc.

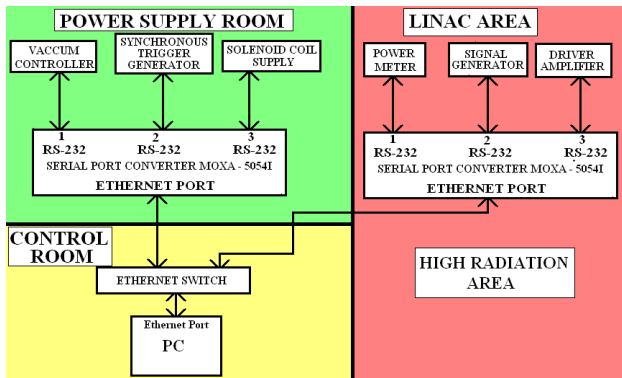


Fig 1. Schematic of Acquisition System LiPAS

### Details of Software

VB.Net 2005 (.NET Framework 2.0) [2] is used for developing software for control and GUI of LiPAS, shown in Fig.2. The SerialPort class is used to access the gain of RS-232 port of the converter for communication with the devices. To access a COM port, the designed application creates a SerialPort object, sets the communication parameters as ComPortName = New SerialPort("COM", 9600, Parity.None, 8, StopBits.One), where COM is the Com port number, 9600 is the Baud rate at which the data is communicated, Parity is none, 8 Data Bits and stop bit is one. After assigning the parameters to the port it opens the port for communication by command ComPortName.Open(). Once the port is open, read and write operations to the port can be performed.

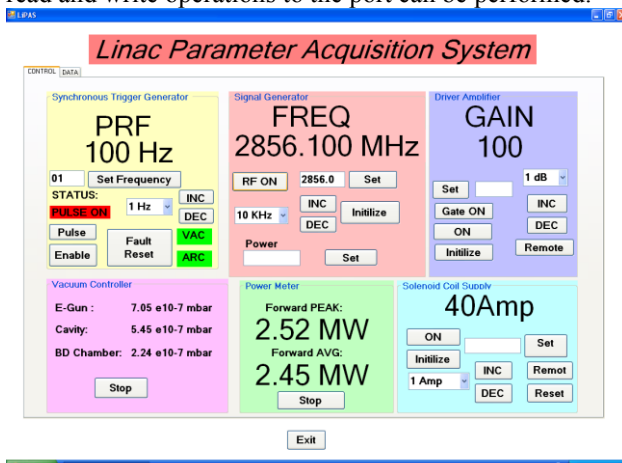


Fig 2. GUI of LiPAS

Timer event is used for to update the data every second. To receive the data a query is sent to each device by using ComPortName.Write() command. Delay of 100 msec is introduced as each device requires ~50 msec of time for processing the query. After delay data from respective port is read using ComPortName.Read() command and updated simultaneously. The option of storing the data at various time intervals has been provided. Various step sizes are provided for changing the parameters like PRF, Solenoid current, RF Frequency. By selecting the required step size from combo box parameters can be incremented / decremented as per step size. Also provision for setting the parameter directly is provided. Upper limit and lower

limit of the parameters to be changed is controlled by the software. If user enters the text value in place of numeric or out of range value appropriate message is displayed.

Database is developed in SQL Server 2005 for storing the data. The table was designed to store all the required data of the Linac along with time and date. To view the data, user selects the date for the data required and the data of that particular date is displayed in the Dataview control.

### Details System.IO.Ports namespace and Serial Port Class

The **System.IO.Ports** namespace contains classes for controlling serial ports.

The class SerialPort, provides a framework for synchronous and event-driven I/O, access to pin and break states, and access to serial driver properties.

### Details of MOXA Ethernet to 4 Port RS-232/485 Converter

It is an Ethernet to 4 port Serial converter, with 10/100M auto-sensing Ethernet. It has built-in 15 KV ESD surge protection for all serial signals and it has Versatile socket operation modes, including TCP Server, TCP Client, and UDP.

### TESTS

Individual modules were developed for each device. Queries and commands were sent and data was read back as per the hardware and software protocol of the respective device. After testing all the devices individually, devices were integrated one by one to the system. The system has worked successfully with the hardware installed. This software is being extensively used during RF conditioning and beam trials. The Maximum current of 146 mA at 50 Hz and 2.7 MW RF forward power with positive 3 kV grid bias, was measured.

### CONCLUSION

The development of the above described control system is complete and installed at ECIL, Hyderabad. Control of all these devices is being done remotely through PC. The software is successfully used during RF Conditioning and Beam operation.

### REFERENCES

- [1] K.C.Mittal, et al, "Performance of the 9 MeV RF linac for cargo scanning", these proceedings
- [2] Anne Prince, Murach's Beginning visual basic.NET, Ed. (ISBN 1-890774-15-4)