PLC-BASED CONTROL SYSTEM FOR LINEAR ACCELERATOR (LCS)

Alka S. Chachondia
Reactor Control Division, BARC, Mumbai
alka@barc.gov.in

Introduction to LINAC

- 10 MeV Linear Accelerator
- Located at Electron Beam Centre, Kharghar, Navi Mumbai
- Used for irradiation jobs by

  BHEL, L&T

  Pidilite, Technocraft India

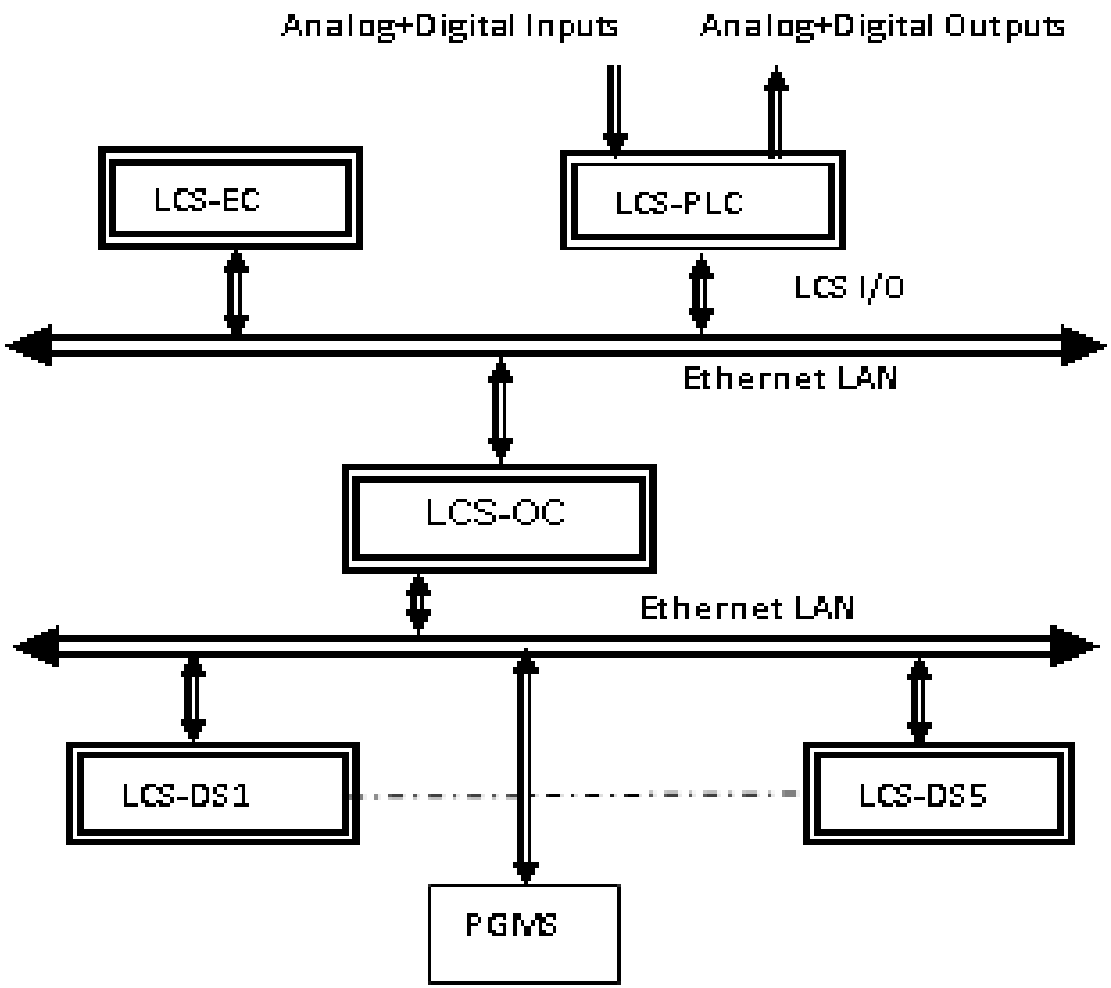
  NIT Calicut, Kerala University, Mangalore University

  BARC Scientists

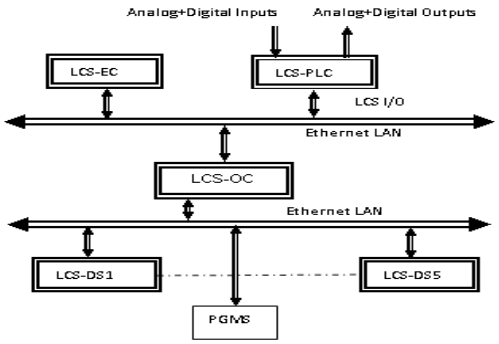
LINAC Control System (LCS)

- PLC based
- State-of-the-art system
- All advantages of a PLC are available to the system user.
  - ❑No programming knowledge required
  - ❑Changes to the control logic can be carried out by the process engineer without developer's involvement

System Configuration

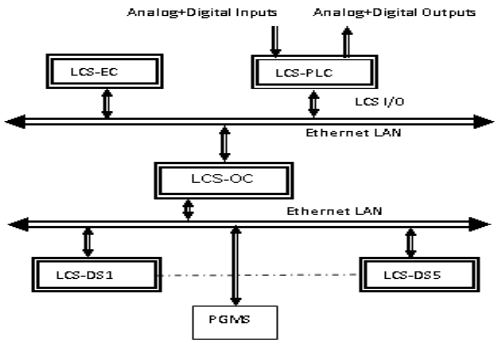


System Description



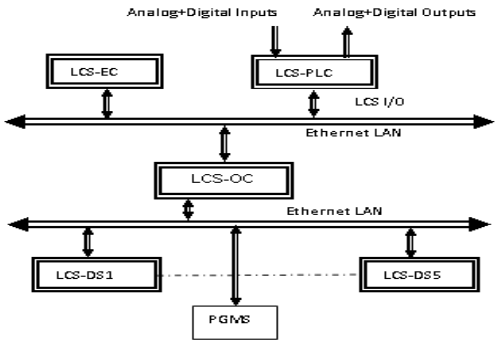
- In-house developed PLC used as Data Acquisition System
- COTS SCADA package for data storage and data display
- Server Computer as Operator Console; stores data and works as Control Station
- Personal Computers used as Data Display Stations. No control action possible from them

System Description



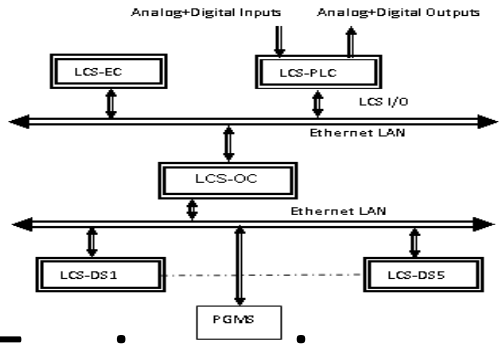
- PLC samples input signals every 100 msec
- Sends real-time data to OC on a 100Mbps LAN. Industry standard OPC Server used.
- PLC also sends the alarms and trips identified along with time stamp
- The OC saves the important signals at regular configurable intervals and sends the user commands to PLC.

System Description



- The LCS-OC communicates with Pulse Generation and Measurement System (PGMS) comprising of oscilloscope, function generator and RF driver.
- Pulse signals of 10 μs pulse width like klystron current, reflected RF power, forward RF power, Beam Energy, Beam Current etc. are monitored using an oscilloscope and sent to OC for storage and display.

System Description



- The PLC is programmed using the Engineering console (EC).
- Application Development Environment software package running on EC is used for configuring the system hardware details and the application in the form of Function Block Diagrams.
- Changes to the configuration can be made by authorized personnel.

System Functions

- Trip the following against unhealthy condition of digital and analog inputs.
  - ❑Gun Modulator High Voltage
  - ❑Klystron Modulator High Voltage
  - ❑Electron Gun Power Supply
- Fail-safe operation, with sequential start-up, sequential shut-down in all modes of operation.

System Functions

- Check a programmed (but modifiable) set of interlocks (built as function block diagrams) at every stage of the start up and shutdown sequence.

LINAC Modes of Operation

- RF Conditioning Mode
- Vacuum System Maintenance Mode
- Beam Trial Mode
- Job Irradiation Mode

LCS Role

RF Conditioning Mode

- Beam is not energized (GM and EG PS is not energized)
- RF Power is fed to cavity by energizing the Klystron and Klystron Modulator.
- LCS checks the vacuum level, water flow, human safety interlocks before feeding the RF power to the cavity. LCS does not allow operating other sub-systems in this mode.

LCS Role

Vacuum System Maintenance Mode

- Linac operates in this mode when the vacuum of the order of 10^{-7} torr has to be generated from atmospheric pressure.
- In this mode LCS ensures that only vacuum related systems can be turned ON. It ensures that Sputter Ion Pumps can not be turned ON till rotary backed Turbo Molecular Pump is operated to achieve the vacuum of the order of 10^{-5} torr.

LCS Role

Beam Trial Mode

- Linac has to operate in this mode before declaring the facility ready for the user's application.
- In this mode, Linac is energized for normal beam operation.
- LCS checks start-up and shutdown interlocks.
- Beam Energy, Beam Current, Beam Power, conveyor speed and radiation dose for the irradiation job are validated using LCS.

LCS Role

Job Irradiation Mode

- LCS checks start-up interlocks
- Linac is energized as per the job's requirement (Beam energy, Beam current etc. are set to the desired level)
- After successfully completing the irradiation job, LCS checks shutdown interlocks for smooth shutdown of Linac

HMI Design

- HMI will play an important role in all modes of operation
- HMI will guide the user during startup and shutdown
- HMI will prevent unsafe actions by the user
- Interlocks will be built into the HMI to achieve this. For ex starting of SIPs will be prevented unless vacuum has reached 10^{-5} Torr

HMI Design

- Use of COTS SCADA package provides flexibility in design.
- Modifications to the can be carried out without having any programming knowledge.

Questions?

Thank You