

## 1. SCOPE

Supply, installation and commissioning of PXIe / equivalent data acquisition and control system with necessary data processing node, display nodes, rack, power supplies and the application software as per the details given below.

## 2. GENERAL

1. The measurement and control channel requirements for the data acquisition system are given below:

<b>ANALOG INPUT</b>	
Input Signals	No. of Channels
Current (4- 20 mA)/Voltage( $\pm$ 10V)	64
<b>ANALOG OUTPUT</b>	
Signal Type	No. of channels
Current (4 – 20 mA)	16
Voltage ( 0- 10 V)	16
<b>DIGITAL I/O</b>	
Type	No. of Channels
Digital Input (24 V DC)	24
Digital Output (24 V DC)	24

2. The main elements in the data acquisition system are listed below:
  - a. Data acquisition chassis
  - b. Controller
  - c. Analog Input modules
  - d. Analog output modules
  - e. Digital input modules
  - f. Digital output modules
  - g. Data Processing and Display nodes
  - h. Remote configuration system
  - i. Instrumentation Rack
  - j. Power Supply
  - k. Cable and connectors
  - l. Ethernet Switch
  - m. Operation System Software along with Drivers and Libraries with Licence
  - n. Application Software with Licence
  - o. Application development as per user requirement.
3. Rack mountable type DIN rail/Chassis based system is considered.
4. The data acquisition is developed with PXIe controller or equivalent system as a real time server with one data processing/server PC and two display nodes for parameter and graphical display.
5. Data acquisition system with integral signal conditioners and variable sampling rate is planned. The input signal shall be band limited and conditioned as per the user requirement.

6. Software should have provision for channel configuration, calibration, monitoring, acquisition, control, recording and diagnostics of the system.
7. Control valves/motor to be controlled using 4-20 mA/0-10 V analog output through manual mode/software PID loop.
8. Manual/Auto operation, interlock, abort sequence etc shall be considered in the development of control system.

### 3. TECHNICAL SPECIFICATION

#### 3.1. CHASSIS

Type	Chassis-19 inch rack mountable with features like timing and synchronization
Compatibility	PXI/PXIe/Similar modules
Bus Type	PXI Express or similar
LabVIEW RT Support	Yes
Number of slots	≥ 9 (One system slot and 8 or more peripheral slots )
System Bandwidth	5 GB/s
Reference clock	10 MHz or higher
Total available power	300W or higher
Input Voltage	230V AC
Input frequency	50Hz
Cooling	Forced air cooling
Operating Temperature range	0°C - 50°C

#### 3.2. CONTROLLER

Controller Type	Embedded
Processor	i7 or better
RAM	Minimum 16 GB RAM .
Hard Drive	500 GB SATA minimum.
Operating System/ target	Lab VIEW Real Time/ Windows 10 or higher version
Ethernet Port Type	1000Base-T ports to be provided
USB Ports	USB 3.0 to be provided
Compatibility	Fully compatible with PXI Express or equivalent
Execution Target	Lab VIEW Real Time version

#### 3.3. ANALOG INPUT

Total Channel requirement	Minimum 64 differential voltage/current channels
Resolution	24 bits
Type of ADC	Delta-sigma
Sampling mode	Simultaneous
Sampling Rate	5kS/s per channel or better
Input coupling	DC coupling
Input voltage range	±100mV to ±10V ( user selectable)
Gain stability	10 ppm/° C
Offset stability	Max 35µV/° C
Phase linearity	±1° at 2kHz or better
Maximum working voltage	±10.4 V

Input impedance	> 50 M $\Omega$
Over voltage protection	30 V between any two pins
Total harmonic distortion (THD) in 10V range	- 98 dB or better at 1KHz
CMRR (DC to 60 Hz) in 10V range	85 dB or better
Cross talk @ 1kHz	-95 dB or better
Spurious free dynamic range @ 1kHz	120 dB or better
Form factor	x1 PXI/equivalent peripheral module with no of modules based on channel requirement.
Slot compatibility	PXIe or equivalent slots
Terminal block and cable	Party should provide the compatible terminal block and cable.

### 3.4. ANALOG OUTPUT MODULE

Form Factor	PXI or equivalent
Measurement Type	Voltage and Current
No. of voltage output channels	16
No of current output channels	16
Resolution	16 bits
Settling time	12 mS max. ( $\pm 0.01\%$ accuracy)
Terminal block and cable	Party should provide the compatible terminal block and cable.
<b>Voltage output</b>	
Voltage output range	$\pm 10$ V
Output impedance	0.1 $\Omega$ max
Current drive	$\pm 10$ mA
Power on state	user defined values
<b>Current output</b>	
Current output range	0.1 to 20.2 mA
Type	Source, without using an external source
Output impedance	100 M $\Omega$ min
Power on state	user defined values

### 3.5. DIGITAL INPUT / OUTPUT MODULE

PXI Bus Type	PXI or equivalent
Measurement Type	Digital I/O
Input channels	Minimum 24
Output channels	Minimum 24
Timing	Software
Logic Levels	0V, 24 V
Input current flow	Sinking, sourcing
Output Current Flow	Sinking
Current Drive	150 mA or better
Maximum Input Range	30 V
Maximum Output Range	30 V
Terminal block and cable	Party should provide the compatible terminal block and cable.

### 3.6. DISPLAY / DATA PROCESSING NODES

One PC is to be configured as the server node or data processing node and two PCs to be configured as display nodes. One portable system is required for the remote configuration of the smart transmitters used in the facility

#### 3.6.1 Configuration for display and data processing nodes.

Screen	27-inch or above, LED-backlit, Resolution 1920×1200
Processor	Intel core i7 13 <sup>th</sup> Gen processor
Memory	16 GB DDR4 RAM or higher version
Hard Disk	500GB SSD or higher
Graphics	Integrated HD Graphics
Network	10 /100/1000 Ethernet controller in-built
USB Ports	USB 4 Nos; Minimum 2 ports in front side
Optical Drive	16× DVD +/- RW (Optional)
OS	64 bit Windows 10 prof. or higher version

#### 3.6.2 Specification for Remote configuration node

Screen	14-inch or above, LED-backlit, Resolution 1920×1200
Processor	Intel core i7 13 <sup>th</sup> Gen processor
Memory	8 GB DDR5 RAM or higher version
Hard Disk	500GB SSD or higher
Graphics	Integrated HD Graphics
USB Ports	USB 3.0 minimum 2 Nos
OS	64 bit Windows 10 prof. or higher version

### 3.7. INSTRUMENTATION RACK

- 3.7.1. Size : 19 inch rack conforms to EIA 310 with minimum height-42U. Party can choose the height to properly place all the equipment in the rack with ensuring minimum gap between equipment for removal and maintenance
- 3.7.2. Aluminium extruded frame along with side, top and bottom panels in steel.
- 3.7.3. Lockable front door made of toughened tinted glass of 5 mm Thick. Steel frame of 18 Gauge CRCA sheet.
- 3.7.4. Rear steel door to be provided with a lock facility made of 18 Gauge CRCA sheet
- 3.7.5. Side panels with slam latches vented top cover made of 18 Gauge CRCA sheet.
- 3.7.6. Base frame to be made up of 13 Gauge CRCA sheet
- 3.7.7. 19" Mount for equipment mounting channels and support angles are to be made of 14 Gauge CRCA sheet
- 3.7.8. Maximum Load rating of 500 kg.
- 3.7.9. Cooling fans and trays (in a group of 4 fans, two sets per rank) to be provided.
- 3.7.10. One No of AC mains distribution board with 5 Nos of 5A socket (Horizontal mounting to be provided).
- 3.7.11. Vertical cable tray to be made up of polymide with cover to be provided.
- 3.7.12. Internal lighting to be provided with On/Off Switch.
- 3.7.13. Rollers to be provide at the bottom for moving the racks. The rollers should be lockable type for positioning the racks.
- 3.7.14. Side panels, Top and Bottom panels and doors to be power coated EPOXY/Anti flame property specified in RAL 7035 grey.

3.7.15. Frame to be made of Aluminium extrusions power coated specified in RAL 7037 Dark Grey.

3.7.16. The cabinet shall be supplied with all necessary hardware and accessories with complete wiring.

### 3.8. POWER SUPPLY 24V/5A

Item Description	DC power supply
Output	24 V DC $\pm 20\%$ , Current rating 5 Amps.
Line Regulation	$\leq \pm 0.5\%$ (for $\pm 10\%$ change in supply voltage)
Load Regulation	$\leq \pm 0.5\%$ from no load to full load
Ripple @ Noise	$\leq 100$ mVrms
Output impedance	$\leq 0.2\Omega$
Over Voltage Protection	To be provided
Current Limit(Overload)	To be provided
Stability	$\leq 0.1\%$ for eight hours
Operating Power	230V AC $\pm 10\%$ 50Hz
Operating Temperature	0-50°C

### 3.9. INDUSTRIAL ETHERNET SWITCH

Type	Layer 2 Manageable switch
Standards	802.3 Ethernet, 802.3u fast Ethernet, 802.3ab gigabit Ethernet
No of Ports	8 Ports
Form factor	Rack mount
Network media	UTP cable
Switching capacity	10 Gbps or higher
Transmission method	Store and forward
Packet forwarding rate	14 Mbps or higher
Power supply	24V DC/ 230 V+ 10%AC, 50+1Hz

### 3.10. ETHERNET CABLES

Category	CAT6
Type	Stranded and Shielded
Wire Gauge	23 or 24 AWG
Cable impedance	100 $\Omega$
Operating temperature	0°C to 60°C
Connector	RJ 45

### 3.11. MULTIPIN CONNECTOR

Male and Female connectors

Type	Crimp
Contact material	Copper alloy- hard gold plated Au over Ni
Gold plating thickness	0.8 $\mu$ m(min)
Ni thickness	2 $\mu$ m(min)
Contact size	18 AWG or 20 AWG
Working current	5 A
Working voltage	300 V
Contact resistance	$\leq 4$ milli ohm

### 3.12. TECHNICAL SPECIFICATION OF RELAY MODULE

Type	Electro Mechanical moulded Relay
Operation voltage	24 V DC
Nominal input current	≤25 mA
No.of poles	2 Pole [ NO, COM, NC ]
construction	Supply status indication LED , Freewheeling diode and Reverse polarity protection diodes shall be assembled as integral part of the socket
Limiting continuous current	6 amps
Power rating (ohmic load)	≥140 W
Contact material	Au Ni /Ag Alloy
Mechanical life	≥ 1×10 <sup>7</sup> cycles
Response time	≤ 20 ms
Release time	≤ 10 ms
Ambient temperature range	Up to 60°C
Type of connection	Screw connection
Identification label	Provision is to be provided
Removal of relay	Provision is to be remove the relay from socket
Standards/ regulations	IEC 60 664/IEC 60 664 A/ / IEC 60695-2-11
Approvals/ Certification and certificate	Relay modules shall have approval confirms to UL508/ EN61810- 1/GL standard / IEC 61810-1

## 4. WIRING

- 4.1. Wiring shall comply with the applicable IEC codes. Wiring for different voltage signals or different function shall be terminated separately on dedicated terminal strips with colour coding. Cable tags shall be used for identification and labelling.
- 4.2. Wiring shall be accomplished with flexible stranded tinned copper wires sized 20/22 AWG, PTFE Shielded cable in compliance with the applicable codes.
- 4.3. Wires shall be hosed in plastic raceways of suitable dimensions to accommodate system cables, I/O signal cable etc. having 20% spare space for future expansion.
- 4.4. Suitable and sufficient size wire ways must be provided inside the cabinet for proper routing and for neat, elegant look.
- 4.5. Raceways shall be organized to run electric wires according to their voltage level and function. Power supply wires and low voltage signal wires shall not be grouped together in the same raceways.
- 4.6. Signal blocks and power terminal blocks in the data acquisition system cabinet shall be separated and identified properly ( colour coding is preferred )
- 4.7. The panel shall have at least 20% extra terminal for future use.
- 4.8. Terminations, cables, wiring, components shall be properly tagged with ferruling at both sides of the termination.
- 4.9. Terminal strips shall be of adequate size min 1.5mm<sup>2</sup>
- 4.10. For grounding, the system cabinet shall have two separate bars, one for safety purposes- power earth for equipment / cabinets / console body grounding of appropriate size etc and the other one for operation purposes- instrument earth for system input / output signals.

- 4.11. The supplier of the Data Acquisition System shall be responsible for providing all the DC power supplies required for the different system components. Power supply shall be sized with 30% spare capacity considered at normal continuous load.
- 4.12. Distribution of power shall be with proper isolation through required rating of fuses and MCB.
- 4.13. Supplier should also provide the following-Terminal, Fuses, DIN rails, cable channels, lugs, ferrules, stickering, Electrical accessories and consumable like Contactors, MCB, TBs, Power cable and cords
- 4.14. All analog input channels should be wired with isolators. LPSC will provide the isolators required for the same. But the power supply modules and power rail for the isolators has to be supplied by the party.
- 4.15. Notes: This specification provides the minimum requirement of the system but it does not relieve the supplier from his responsibilities for completeness of the system concerning the design, the reliability and the safe operation of the supplied equipment.

## 5. SPECIFICATION OF DATA ACQUISITION AND CONTROL SOFTWARE

The software should be developed in latest version of LabVIEW with following feature.

1. The vendor has to supply the complete data acquisition, control, storage, and analysis software package with source code.
2. Supply of source code for data acquisition system application program development with details for modification during future requirement.

### 5.1 LOGIN

- The software should have two levels of security namely Administrator and Operator. The administrator should have access to all the features provided by the software and operator's accessibility should be limited to conducting the tests.

### 5.2 CONFIGURATION SETTING

- The acquisition software shall be capable of scanning the selected user required channels at user required sampling rate.
- The software should be capable of entering/selecting channel wise legends, description, units, lower and upper range values in the configuration tab.
- Logging of set configuration in notepad or in spread sheet format.

### 5.3 ACQUISITION

- The acquisition software shall be capable of being operated with acquisition ON/OFF and file writing ON/OFF features. Data to be stored in controller hard disk and in server.
- Data from each channel should be acquired in the selected engineering unit. The data should be displayed in three different PC's in the control room. A detailed mimic diagram should be provided for each test. The control valves and solenoid valves should be controlled in the open loop/ closed loop using necessary setting in the software.
- All the data should be logged as per the instruction from the PC with necessary command. All necessary information should be stored while logging such as Run number, Start time of the test etc.

- Real time numeric display of configured parameters along with Graph in 4 different tabs is required. In each graph have minimum 4 channels to be selected and scaling of the channels shall be done as per the configured lower and upper range values.

#### 5.4 ONLINE DISPLAY AND OFF-LINE ANALYSIS

- The online display at minimum two client nodes and one data processing node. The online display may be of graphical or numerical from.
- The EU or voltage selection shall be made available in the numerical display and graphical display.
- The graphical display shall start with trigger signal or based on time from an Ethernet based countdown clock.
- The graphical display shall have different scales user selectable for each parameter and shall have four parameters per screen.
- The graphical change over to different screen shall be by timing reference or by keyboard control.
- The numerical display shall have selected no: of configured channels in one page. The required parameters for display shall be entered in a text file.
- The numerical and graphical display shall have the option for color change when threshold limits are not met.

#### 5.5 OFFLINE PROCESSING

- Off line processing of selected channels in EU or Voltage with selectable averaging, printing intervals and time offset correction. The file shall have header and stored in DAT format.
- Offline plotting of selected channels in EU or Voltage with headers.
- Each plot and data files with option header and footer.
- Mathematical and statistical analysis tools (Average, Min, max, curve fitting) for analysing offline processed data.
- The party shall provide customized software based on the above requirements.

#### 5.6 General software Requirements :

- 6.1 Detailed software specification should be prepared after the detailed system study and the software specification should be submitted to LPSC and only after the approval, the party should start the necessary coding for our application.
- 6.2 The software should be modular and documentation should be provided for the same in detail.
- 6.3 Source code for the software, operation and maintenance of the software should be provided along with the software.
- 6.4 Source code should have provision for future up gradation such as increasing the channel count.
- 6.5 The software should be accepted only after necessary satisfactory test run at our site and the party should be responsible for correcting any bug detected in the software within six months from date of acceptance of the software by LPSC.
- 6.6 Vendor shall be responsible for chain checking which shall include checking of the configuration, interconnection to data acquisition system and display node.



- 6.7 Chain checking shall be carried out to check the functional performance of all elements in the chain and thereby ensuring proper functioning.
- 6.8 Event data Acquisition at every 20 msec and analog acquisition sampling rate can be user selectable.
- 6.9 Data updating in display and graph within 1 sec.
- 6.10 Auto sequence command generation with 20 msec interval.
- 6.11 There should be provision for calibration of measurement chain and also storage of sensor constant.
- 6.12 Also provide provision for manual and auto mode operation.
- 6.13 The supplier shall provide adequate training for the source code to department Engineers (2 persons), during control system and data acquisition system integration and software development at LPSC, Valiamala.
- 6.14 The training shall be so organized for control system and data acquisition system to provide complete understanding of the functions of the system, overall system concepts and routine operation for maintenance of the system and application software development. It is essential that all the system and other required document shall be available before commencement of training.

## 6. Final commissioning and validation

After completing all the installation and software development activities party has to do the chain calibration, verification and validation of all measurement and control channels. Report of the same shall be submitted. The format of the report will finalise in the detailed engineering phase. Following check has to be done in Data Acquisition System

- Integrated System Performance
- Evaluation tests
  - Functional check
  - Linearity check
  - Gain accuracy
  - Filter performance evaluation
  - Time accuracy check
  - Cross talk check
  - A.C signal check
  - Over voltage check
  - Stability
- Data Acquisition System Sampling rate with full channel capacity.
- CMRR, Isolation and CMV checks.
- Error diagnostics of the network failure, system failure, input card failure.
- Display updating Test.
- Data storage test (continuous storage for 5 hours with selectable sampling rate).
- Any other mutually agreed test.

## 7. DETAIL ENGINEERING

The detailed engineering shall be done on the basis of finally agreed Data Acquisition and display philosophy and process Input list. Hardware shall be selected accordingly. The quantity and model number for hardware and software version to be provided. The following documents shall be prepared and submitted by the party for the approval from the Department during detailed engineering.

- Instrument rack General Assembly diagrams
- Instrumentation rack wiring diagram
- Equipment earthing scheme/layout inside control room
- Data Acquisition system:
  - ❖ System Architecture & Configuration drawing
  - ❖ Wiring diagram with connector pin details
  - ❖ Interconnections diagram including communication links
  - ❖ Electrical power supply distribution diagram
  - ❖ Software life cycle model followed for software development should be mentioned.
  - ❖ Error budget calculation sheet for individual cards to be provided
- Quantity Estimation of items and its specifications
- Testing and Evaluation plan
- Inspection & Quality assurance plan
- Chain checking procedures.

Supplier shall supply detailed engineering documents (2 copies) with required specifications and drawing as Hard & Soft copies to the purchaser for review and approval. Only the approved configuration by the purchaser has to be followed for all commissioning activities.