

# **Techno Commercial Document for 600 channels Data Acquisition System**

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# 1. Introduction

## 1.1 Purpose:

This document gives the system requirements for realization and commissioning of a 600 channel data acquisition system for structural testing at Vikram Sarabhai Space Centre. Structural testing facility is primarily responsible for carrying out and building expertise in the field of structural qualification, acceptance and development testing as well as pressure testing of launch vehicle/ satellite structural components. This involves the structural qualification testing of interstages, pressure vessels, stage auxiliary systems & pressure testing of pressure vessels of all launch vehicles / satellites. Various measurements are involved in the testing of launch vehicle structures like strain, displacement, load, pressure, temperature etc, which would be used for assessing the behaviour of the hardware.

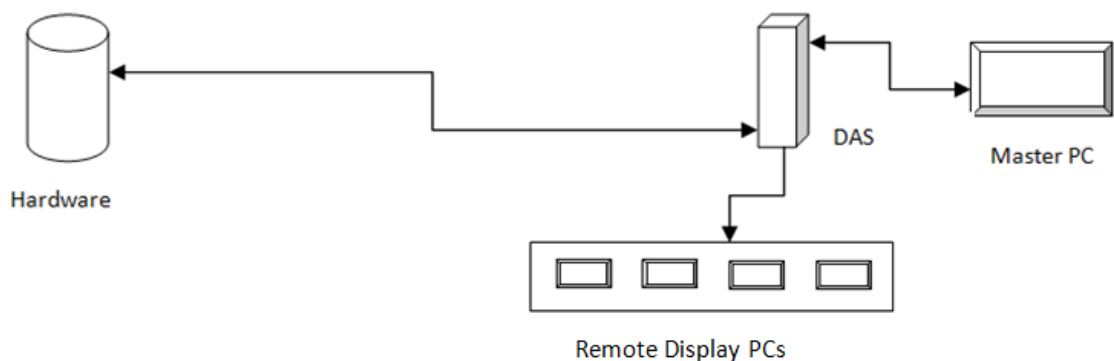
## 1.2 Scope:

The data acquisition system will be used for the measurement and acquisition of various parameters during the structural testing of Launch Vehicle hardware from various projects. The physical parameters measured during testing of structural test include strain, pressure, load, displacement, temperature, inclination and voltage/current measurements.

## 2. General Description

The supply conditions for the data acquisition system are given below:

- ◆ The data acquisition system (DAS) should be delivered as a turnkey with data acquisition systems placed in a rack and wiring of systems to connectors for interfacing with facility elements.
- ◆ Software for DAS should also be supplied as part of data acquisition and the system should be demonstrated as a total package.



**Fig 1: Data acquisition chain**

## 3. System Requirements

### 3.1 General Requirements

The DAS should be capable of carrying out following test requirements:

- a. Continuous acquisition of the following parameters shall be carried out during the test for all the configured channels: Load, Pressure, Strain, Displacement, temperature, angle, and voltage.
- b. Configuration of channels based on user requirements. The channel configuration need to be done either in a separate CSV file which can be read by the master PC software or in the application itself which has editing options as in a CSV file.
- c. The configuration and supervisory control need to be done from a central master PC. The real time data display needs to be provided in several remote nodes, where individual display configurations can be loaded. The data communication between data acquisition modules, master PC and remote PC nodes shall be through Ethernet. DAS should directly share data to remote PC.
- d. The logging intervals for continuous acquisition need to be user defined (100 $\mu$ s/10ms/100 ms etc). Along with continuous mode acquisition, an auto logging option need to be provided were data will be logged in the maximum sampling rate after getting triggered based on user defined events - that is the logging starts when the a user defined condition is met.
- e. Logging of acquired data in suitable format such as CSV or excel (manual and continuous data in separate files).
- f. Digitized data to be stored in Local controller hard disk/ Personal Computer (Master PC) and also in individual DAS units.
- g. The data acquisition modules must be housed in a rugged chassis, compatible for these modules.
- h. All the modules are required to be housed in the same chassis. If additional chassis are required for housing all the modules, these chassis must be connected together using Ethernet communication. In such a case, the data from all the modules must be synchronized.
- i. The system configuration and capacity should be able to acquire and store the required channels in the required sampling rate for the continuous duration of at least 24 hours, with multiple files for quick processing and retrieval.
- j. Data shall be received from Automated Multipoint Loading System (AMLS) and stored with the system data. Details are explained in section 3.3.4.
- k. All the acquired data shall be published in network as network shared variables, which could be accessed by any other application (clients).

### 3.2 Hardware Requirements:

- a. The Data acquisition system must be rack mountable and based on a standard open architecture: cPCI, PXI, LXI etc. The system must be easily expandable through Ethernet.
- b. Numbers of channels: total 600 (540 channels for strains (quarter bridge, half bridge and full bridge mode), transducers and voltage measurements + 20 laser based displacement measurements + 20 channels for temperature measurements (thermocouple) + 20 channels for current based transducers measurements).
- c. An industrial grade high speed IP camera based video recording system (120fps) which is time synchronized with the 600 channel DAS and with provision for connecting at least 16 IP cameras.
- d. An audio recording system (industrial grade microphone) which is time synchronized with the 600 channel DAS and with provision for connecting at least 15 channels (microphone input).
- e. Configuration of channels (540 channels) based on the requirements (any channel can be select as a strain (Quarter Bridge) or transducer (full bridge) measurement as per test requirements).
- f. In general, the sensors and transducers would be hooked up to the data acquisition system by means of shielded PTFE cables (from test setup side to DAS side). Suitable connectors need to be provided at the DAS end for termination of these cables.
- g. System should support the following sensors and the corresponding signal conditioning requirements:

Physical Parameter	Type of Sensor	Excitation voltage	Full Scale output	Number of channels	Range
Strain	Strain Gauge (120 Ω & 350Ω)	<= 10V	<= 1V	540	0 to ± 100000 μstrain
Displacement	Strain gauge based transducers				0 to ± 500mm
Load					0 to ± 1000 T
Pressure					0 to ± 2000 Bar
Temperature	K type thermocouple	NIL		20	70K to 1200K
Displacement	Laser based	Up to 24V	<= 15V	20	0 to ± 1000mm
Current based Transducer	Any transducer with current output	Up to 24 V	20 mA	20	4-20 mA
<b>Synchronized video input: A video recording system for connecting 16 IP based cameras. The system must be time synchronized with the 600 channel DAS.</b>					
<b>Synchronized audio input: A audio recording system for connecting 15 channels. The system must be time synchronized with the 600 channel DAS.</b>					

**Table 1: General hardware requirements.**

h. Data scanning requirements/features for each type of measurement:

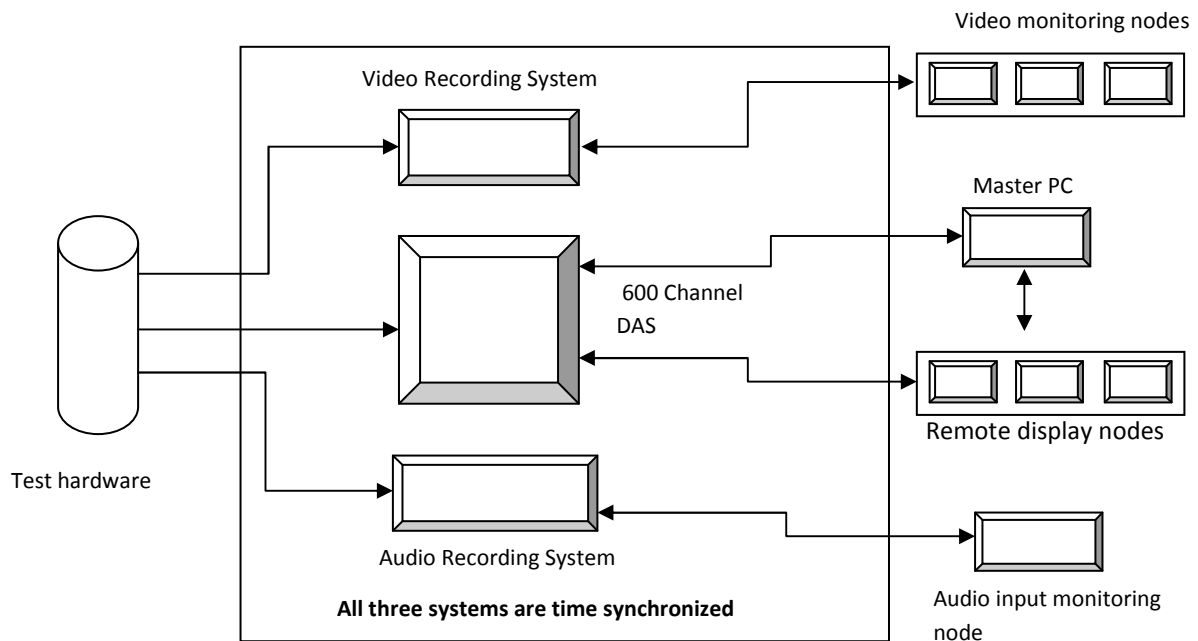
System requirement	Strain	Displacement	Load	Pressure	Temperature	Displacement (Laser sensor)	Current based Transducer
Data scanning rate	10 kHz for each channel						
Programmable excitation voltage	Non-multiplexed independent excitation of channel 1 to 10V excitation in steps, software selectable.					Variable excitation voltage up to 24V	Up to 24V
ADC resolution	24 bit						
CMRR	Greater than or equal to 110dB						
Non-Linearity	Less than or equal to $\pm 0.05\%$ of full scale						
Input voltage range	Software selectable for $\pm 100$ mV or $\pm 1$ V				Typical for K-type	0-15V	4-20mA
Measurement Resolution	$\pm 1\mu\epsilon$	$\pm 1\mu V$			$\pm 0.1^\circ C$		

Table 2: I/O scanning requirements.

- i. All channels should be capable of compensation of error due to wire length for more than 100 meters.
- j. Each channel should have individual ADC.
- k. Input impedance: Greater than or equal to 1 M $\Omega$ . Isolation between channels should be minimum 80 dB. Crosstalk between channels should be better than -110dB.
- l. All strain measurement channels should support 3 wire configuration measurements for quarter bridge configuration. Internal bridge completion resistors (120 $\Omega$  & 350 $\Omega$ ) must be available in the data acquisition module. 120 $\Omega$  & 350 $\Omega$  bridge should be software selectable for all channels (no difference between both type bridges in external connector termination).
- m. All strain gauge based transducers channels (full bridge) must support 6 wire connection (including sense + and sense-).
- n. Internal resistors across bridge for simulation of shunt resistance and should be software selectable for each channel.
- o. DAS should support the aggregate of maximum sampling rates/channel of each data acquisition module present in chassis.
- p. The sampling rate for each operation should be user defined.
- q. Chassis should be expendable to two or more and all chassis should be time synchronized and the time latency must be less than minimum data logging interval.
- r. All power cables and plugs provided must be for Indian standards.
- s. Configuration of control and processing unit (1 Master PC and 10 nos of remote PC):
  - i. Processor: 12<sup>th</sup> generation Intel core i7, 25MB cache, 12 cores, or better.
  - ii. RAM: 32 GB DDR4 or better.
  - iii. Operating system: windows 11 Pro 64 bit or latest version.
  - iv. Monitor size minimum 25".

- v. Monitor resolution: 1920x1080 minimum
- vi. Dedicated Graphics card: minimum 4GB.
- vii. I/O ports: 4 nos of USB 3.0, 1RJ 45, 2 nos HDMI.
- viii. Hard disk: 500GB SSD for operating system, & 1TB HDD for data storage with additional slots.
- ix. Power supply: 230V AC, 50Hz (Indian standard).
- x. Wired keyboard and mouse.
- xi. Microsoft office.

The complete system block diagram showing all components are shown below:



**Fig 2: Complete system block diagram**

### 3.3 Software Requirements:

#### 3.3.1 Master PC software Configuration:

- a) Software must be compatible with windows operating system version 11 or higher.
- b) Software must support all the required number of channels, including the channels considered for future argumentation.
- c) Provision to enter the test name, test details in the GUI should be available.
- d) Utility for configuration of channel details such as adding/deleting the channels, range setting, excitation voltage for each channel, gauge

factor, channel name, bridge type selection, sampling rate or any other configuration related to channel from GUI by the user.

- e) Configuration prepared for a particular test must be stored in the system which could be loaded as and when required.
- f) The data acquisition in software must start with user request and should stop when user requests to stop data acquisition.
- g) There should be provision to record continuous data and manual record data in separate files. Test data from all the channels must be merged in single test data file.
- h) All data points must be logged with date and time of logging.
- i) The transducer configuration details have to be maintained as a library - Range, Sensitivity, ID number, units etc and selectable based on ID number.
- j) The configuration of channels needs to be done in a CSV format or equivalent where there are options for editing of individual cells.
- k) Channels need to be configured either on individual or group basis. Each channel need to be configured separately. There should be provision to make a group for same type of channels like strain group, DT group, load cell group etc.
- l) Utility for software shunt calibration of all the configured channels should be available. A report of the calibration results need to be generated based on the typical shunt output for each type of measurement.
- m) There must be provision for adding virtual channels wherein, we can do numerical computations using the measured channels and AMLS channels (addition, scalar multiplication, division, subtraction) and assign the result of computations to a user defined virtual channel, which should be available for real time display and acquisition. A minimum of 100 virtual channels must be provided.
- n) Strain balancing option to be provided in the software and the channels could be balanced or initialized separately or as a whole.
- o) There must be provision to run and display an up/down counter.



- p) On the master software GUI, minimum 6 panels/pages should be available where numerical data; trend chart etc could be configured.

### 3.3.2 Remote display software configuration:

- a) System should support minimum 40 numbers of remote display nodes. 10 out of 40 remote PCs need to supply.
- b) Each remote display should have independent configuration.
- c) Minimum 10 panels/pages should available in each remote application.
- d) Each panel should have separate control to minimize, close and resize.
- e) Each panel could be configured for either numerical data display or chart display with real time update.
- f) Numerical data display should be available as a list/table with option for sorting the selected channels based on tag IDs. There should be provision to select font size, colour and also for highlighting required channels.
- g) There must be provision to run and display the countdown/up timer.
- h) The remote application must have chart options where the real time trend of measured channels could be plotted against a selected parameter (either one of the channels, a virtual channel or time).
- i) All the real time data should be available as network shared variables which could be accessible to other applications through the network.
- j) **Real time alerts:** The software must give real time alerts to the user regarding measurement values. The following alerts are required:
  - a) Non-linearity - Whenever a measured channel shows a non-linear trend with respect to a given parameter.
  - b) Abort prediction - Real time assessment of whether or not a certain measurement would cross the abort limit before the final load step based on current value, has to be made. The information from prediction and abort value file need to be used for this purpose.
  - c) Abort alert - Alert the user when any parameter actually crosses the given abort limit set for that parameter.

The alerts can be in the form of blinking, colour change etc. The alerts must reflect in numerical displays, 2D/3D displays and plots.

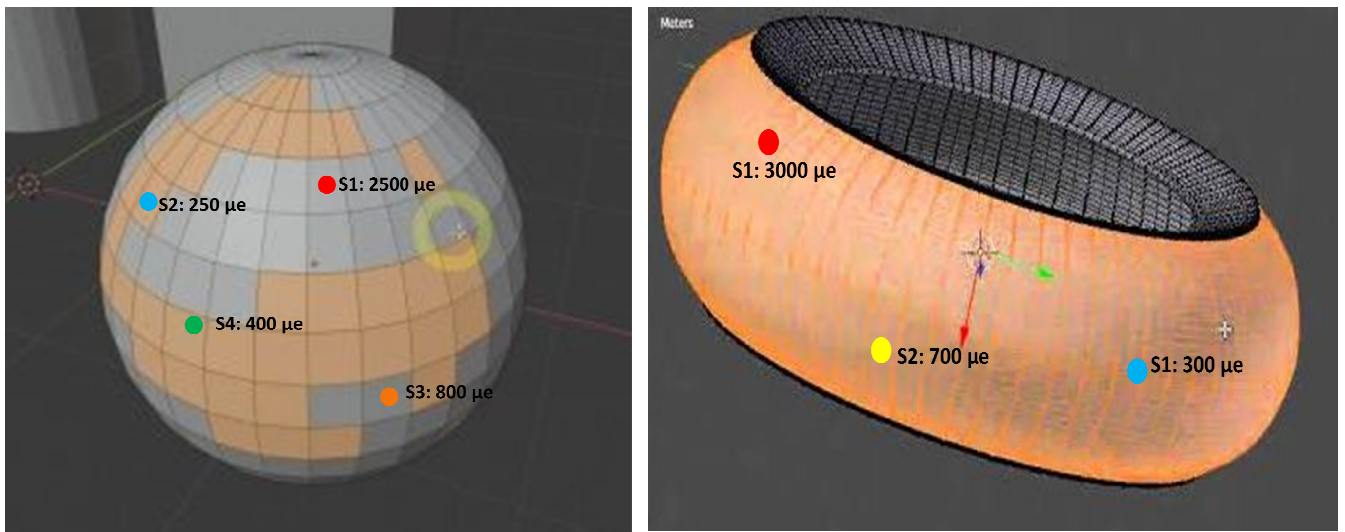
### 3.3.3 Display of real time data on 2D/3D models of test article:

There must be an option for uploading the 3D model of the test article in a suitable format to the software. The 3D model must have information regarding the location of sensors (by correlating node numbers and sensor ID numbers).

The node ids on 3D model could be assigned with the corresponding channel number and the real time data acquired can be displayed on the 3D model- numerical display and colour information based on thresholds set in the configuration file. Multiple thresholds can be set for each channel and different colours can be assigned for each level.

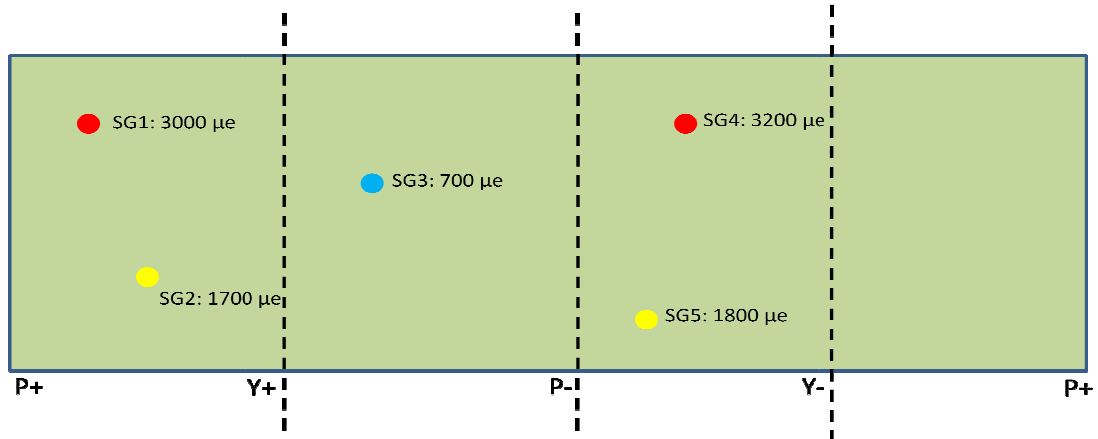
During the real time display, the user should be able to move the 3D model in all directions (including rotation), thus enabling the user to view every instrumented location of the test hardware for critical analysis.

The software must accept generic Finite Element analysis output mesh files (ASCII format) which contains node information - example: ABAQUS software output file. The files will be supplied as an input to the system by the user.



**Fig 3: Representative figures showing numerical display of channels along with tag ID on a 3D structural model**

As in the case of 3D-model display, the real time display of numerical values and colour information need to be provided on a 2D instrumentation drawing (to be uploaded as a PDF file in the software).



**Fig 4: Representative figure showing numerical display of channel along with tag ID on a 2D structural drawing**

### **3.3.4 Interface with Automated Load/Pressure application system software**

INTEF facility has an Automated Multi point Loading System (AMLS) which is developed using National Instruments LabVIEW platform. The system is for automated closed loop control of load/pressure applied on structural test hardware. The load cell/Pressure transducer data acquired by AMLS need to be communicated to the 600 channel DAS in real time for logging and display.

A suitable interface software need to be developed which acts as a client for AMLS and a server for 600 channel DAS to meet this requirement. The load/pressure data is communicated as shared variables by the National Instruments Shared Variable Engine (SVE) which includes an OPC Server so that Shared Variable data can be made available to OPC client applications. The Shared Variable Engine publishes all variables as OPC tags under the ID National Instruments. The interface software can access the data stored in a Network-Published Shared Variable and communicate it to the 600 channel DAS for real time logging and display.

### **3.3.5 Data and report generation:**

- a) Master software should auto generate the test data in csv or ms-excel format with proper channels details, name, time and test name on user request, for both the manual record data and auto record data.
- b) The master software should be able to generate a comprehensive test report after the test completion, summarizing the test data and

observations (including plots for linearity checking, comparison with prediction, comparison between applied and required loads, specific observations regarding non-linearity and deviation from predictions etc). For this the load table, prediction of DT and strains etc can be taken as inputs by the software.

### 3.4 Components under scope of supply

The consolidated list of components included in the scope of supply are listed below:

Sl. No	Item	Qty	Remarks
1.	600 channel high speed (10 KHz) data acquisition system including the following: Strain measurement: 540 channels Temperature measurement: 20 channels Laser transducer measurement: 20 channels Current based transducer measurement: 20 channels	1 lot	Individual units assembled in rack mountable chassis. Different chassis connected by Ethernet.
2.	Data acquisition and analysis software for master control PC. <i>Note: The software must support installation in any number of nodes as required by the user.</i>	1 no	Requirements as given in section 3.3.1.
3.	Data display and analysis software for remote terminals.  <i>Note: The software must support installation in any number of nodes as required by the user.</i>	1 no	Must support up to 40 remote nodes. Software requirements as per section 3.3.2.
4.	Audio input recording system : 15 channels:	1 Set	Time synchronized with 600 channel DAS.
5.	Video input recording/monitoring system: IP camera based system with provision for connecting 16 IP cameras.	1 Set	Time synchronized with 600 channel DAS.
6.	High end PC (Master and Remote PCs)	11 nos	Details as given in section 3.2.
7.	Mating connectors for termination of instrumentation cables with data acquisition system.	650 nos	50 nos as spare.
8.	Network switches	As required	Network switches for communication interface between DAS racks, master

			PC and remote PCs - as required.
9.	Software for display of real time data on 3D and 2D model of test article  <i>Note: The software must support installation in any number of nodes as required by the user.</i>	1 no	As per section 3.3.3

**Table 3: Consolidated list of items to be supplied by the party.**

**Note: In table 3, items 1 to 8 are compulsory for delivery. Item 9 is optional. However the separate quote is necessary for item 9 also. If all the items are technically suitable, order will be placed for items 1 to 8 and VSSC may or may not place order for item 9, based on review of price bid.**

#### **4. Documentation**

The following detailed engineering documents shall be provided:

- a. Finalized System Architecture and detailed configuration diagram including all subsystems.
- b. Finalized data storage and transfer details along with network configurations.
- c. Finalized Data time stamping schematic.
- d. Synchronization scheme between multiple chassis and systems.
- e. The quantity and model/version number of hardware & software.
- f. The specification/detailed catalogue of hardware, system software and other packages proposed.
- g. General assembly drawing of data acquisition system equipments in suitable industrial standard rack for the integration.
- h. Rack wiring & termination detailed diagram.
- i. Networking scheme in control room and observation room as per configuration drawing using suitable network equipments and cables with required drawing.
- j. Finalized Factory Acceptance Test (FAT) & Site Acceptance Test (SAT) Procedures.
- k. Software Life cycle model followed for software development.
- l. Supplier shall provide one copy of detailed engineering document in Hard & Soft form to the purchaser for review and approval.
- m. The soft copy shall be in editable version so as to enable modification in future.
- n. Only the purchaser approved document shall be followed for all further commissioning activities.

## 5. Supply and installation conditions

The party must adhere to the following conditions:

- a) While complying with any technical specification, the party must provide the data sheet of the product being quoted which agrees with the technical specification mentioned by ISRO. If a proper technical data sheet or technical note (from manufacturer) is not provided, it will be considered as non-compliance.
- b) Party should have carried out realization of similar work (systems of similar capacity and functionality) carried out in ISRO or DRDO. The details of these shall be produced in the quotation.
- c) The integrated data acquisition system hardware shall be assembled and integrated as per approved detailed engineering documents. The required software shall be loaded.
- d) Any software customization required to meet the specification requirement shall be done in discussion with Department.
- e) The party should prepare a Software definition document to be submitted to ISRO for review after placing the purchase order. The document should explain in detail the complete software implementation and features.
- f) The data acquisition system as a whole shall be made ready at vendor's site for Factory Acceptance test and at the Department site for Site Acceptance Test (SAT).
- g) The complete functional testing of all hardware and software after the installation needs to be completed and demonstrated by the party. If any defect is noticed, the Vendor shall arrange to rectify the defects noticed.
- h) The supplier shall provide adequate training to department Engineers (3 persons), at vendor's site for a minimum period of 7 working days during system integration and software development.
- i) The supplier shall organize the FAT after training, so that the same team shall participate in both FAT & Training program.
- j) The supplier shall provide adequate training to 3 Operational Engineers at Department's site after commissioning of the system for a minimum period of 10 working days to maximum of 15 days.
- k) The training shall be so organized to provide a complete understanding of the functions of the system, overall system concepts and routine operation for maintenance of the system and application software development in data acquisition system by themselves.
- l) The party must provide software development support of 2 years from the date of installation of the system for correcting the bugs identified

during system operation, enhancement of features for better usability etc.

- m) The party must provide warranty for 4 years for all the hardware components supplied, from the date of installation.
- n) The party must ensure the availability of spares for all hardware modules for minimum 15 years from the date of completion of the installation. If any module becomes obsolete, an equivalent new module which can seamlessly replace the original one must be identified and the same must be informed to ISRO.

## **6. Commercial Requirements**

The previous sections have elaborated on the basic technical details, to enable the vendor to assess the requirements involved in realizing the system vis-à-vis their capabilities and estimating the cost involved in realizing system.

The vendor shall ensure that all the requirements – specified in the technical part of this document is met in the final realized system. The system is to be operated at a place very close to sea shore environment with higher humidity level and therefore, it is necessary to take utmost care in material selection. For the realization of the total system, corrosion resistant stainless steel (AISI SS304/316) grade material shall be selected and used, wherever possible. The vendor shall assess the requirements in total and shall offer the appropriate price bid.

### **I. Vendor's Responsibilities**

The vendor will be responsible for the following:

- a. Incorporating VSSC requirements, with the state of the art technology, available in realising & configuring the system, as detailed in this techno-commercial document.
- b. License of any software to develop the system should be in the name of VSSC.
- c. Integration, calibration and testing of the systems at their work center confirming to VSSC specifications, for demonstrating the full features during Pre-Delivery Inspection.
- d. Supply, Installation & Commissioning of the above systems at VSSC, Thumba, Trivandrum and demonstrating the performance.

- e. The front end software needs to be submitted to VSSC along with source code. The vendor shall offer software modifications, during initial warranty period and under AMC contract period, if necessary.

## II. Eligible Vendors

Any vendor with substantial experience & capability in realizing similar Data acquisition systems and well versed in the field of Electronics/ Data Acquisition are eligible, to submit their offer against this techno-commercial document, subject to the following.

- The vendor shall arrange for a free demonstration of the system capabilities, of the already commissioned system as above, at the place of installation/ operation to the Technical committee, for assessing the performance, if necessary.
- If the vendor intends to subcontract any part of the work, such details should be given in the offer. A subsystem-wise listing and capability in fabricating each system and plan of integration, calibration and testing will be a part of the techno-commercial bid. However the prime responsibility of realizing the parts within the stipulated schedule, meeting all the specifications shall be with the vendor. Delivery schedule shall also form part of the bid.

## III. Selection Criteria

Those vendors, who are interested and submit the quotation in two parts, (i) techno-commercial bid and (ii) the price bid against this document, within the specified last date and within the stipulated time, shall be considered for selection.

**The techno-commercial bid shall not include or have any price indications.**

Those who meet all the mandatory requirements of a tender as detailed herein shall be evaluated by the Committee at VSSC to short list the Vendors who are assessed to be capable of realizing the units as detailed in this document. Final selection will be based on the evaluation of the techno-commercial bid.

## IV. Major Milestones

### Major Milestones after Placement order

11	Submission of the design document by the vendor	$T_1 = T_0 + 26$ weeks
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12	Preliminary Design Review – Presentation Clarification/ Modifications – if necessary, & Approval of the design	$T_1 + 8$ weeks
13	Realization and testing at work site	$T_1 + 30$ weeks
14	Transportation, Installation, Commissioning and testing at VSSC	$T_1 + 50$ weeks

\*  $T_0$  is Purchase order released date.

#### **V. Details to be submitted in Techno-Commercial bid**

The technical bid should contain details of the vendor. The total vendor profile may be submitted to enable, VSSC to assess the capabilities of the vendor. Details on the management, product line, annual turnover, should be highlighted. The strengths of the vendor in electronics, Data Acquisition systems should be given in detail.

All components should be from the standard, reputed manufactures.

Clear listing of components details including make, part No., specification, country etc. to be submitted. Working diagram shall be provided with detailed technical description.

The techno-commercial offer should address all aspects mentioned in this document. All commercial aspects including the plan of action on how the vendor proposes to realize the system shall be included. If the vendor intends to subcontract any part of the work, such details should be given in the offer.

#### **VI. Details to be submitted in Price bid**

The price bid should contain a detailed breakup of the cost element associated with each of the subsystem industry perceives to be necessary for realizing the DAS. The price bid should also contain the overall cost and all other cost details corresponding to every item perceivable as per this document. Break-up cost of all components shall be submitted.

**Format for Cost break-up:**

Sl. No	Item	Qty	Unit Price( Rs)	Total Price(Rs)
1.	600 channel high speed (10 KHz) data acquisition system including the following: Strain measurement: 540 channels Temperature measurement: 20 channels Laser transducer measurement: 20 channels Current based transducer measurement: 20 channels	1 lot		
2.	Data acquisition and analysis software for master control PC	1 No.		
3.	Data display and analysis software for remote terminals	1 No.		
4.	Audio input recording system : 15 channels	1 system		
5.	Video input recording/monitoring system: IP camera based system with provision for connecting 16 IP cameras.	1 system		
6.	High end PC (Master and Remote PCs)	11 Nos.		
7.	Mating connectors for termination of instrumentation cables with data acquisition system.	650 Nos.		
8.	Network switches	As required		
9.	Display of real time data on 3D and 2D model of test article	1 No.		

**Compliance matrix:**

Note: In the case of hardware specifications, the party has to supply the data sheets of whichever product they are quoting as a proof of compliance to the specifications. In the case of software specifications, necessary technical notes may be uploaded as a proof of compliance to the features mentioned.

Sl.No	Specification	Compliance (attach data sheets/Technical notes wherever applicable)
1	Continuous acquisition of the following parameters shall be carried out during the test for all the configured channels: Load, Pressure, Strain, Displacement, temperature, angle, and voltage.[Ref: Section 3.1.a]	
2	Configuration of channels based on user requirements. The	

	channel configuration need to be done either in a separate CSV file which can be read by the master PC software or in the application itself which has editing options as in a CSV file. [Ref: section 3.1.b]	
3	The configuration and supervisory control need to be done from a central master PC. The real time data display needs to be provided in several remote nodes, where individual display configurations can be loaded. The data communication between data acquisition modules, master PC and remote PC nodes shall be through Ethernet. DAS should directly share data to remote PC. [Ref: section 3.1.c]	
4	The logging intervals for continuous acquisition need to be user defined (100µs/10ms/100 ms etc). Along with continuous mode acquisition, an auto logging option need to be provided were data will be logged in the maximum sampling rate after getting triggered based on user defined events - that is the logging starts when the a user defined condition is met. [Ref: section 3.1.d]	
5	Logging of acquired data in suitable format such as CSV or excel (manual and continuous data in separate files). [Ref: Section 3.1.e]	
6	Digitized data to be stored in Local controller hard disk/ Personal Computer (Master PC) and also in individual DAS units. [Ref: Section 3.1.f]	
7	The data acquisition modules must be housed in a rugged chassis, compatible for these modules. [Ref: Section 3.1.g]	
8	All the modules are required to be housed in the same chassis. If additional chassis are required for housing all the modules, these chassis must be connected together using Ethernet communication. In such a case, the data from all the modules must be synchronized. [Ref: Section 3.1.h]	
9	The system configuration and capacity should be able to acquire and store the required channels in the required sampling rate for the continuous duration of at least 24 hours, with multiple files for quick processing and retrieval. [Ref Section: 3.1.i]	
10	Data shall be received from Automated Multipoint Loading System (AMLS) and stored along with the system data. Details are explained in section 3.1.j & 3.3.4	
11	All the acquired data shall be published in network as network shared variables, which could be accessed by any other application (clients). [Ref Section 3.1.k]	
12	The Data acquisition system must be rack mountable and based on a standard open architecture: cPCI, PXI, LXI etc. The system must be easily expandable through Ethernet. [Ref Section 3.2.a]	
13	Channel breakup: total 600 (540 channels for strains (quarter bridge, half bridge and full bridge mode), transducers and voltage measurements + 20 laser based	

	displacement measurements + 20 channels for temperature measurements (thermocouple) + 20 channels for current based transducers measurements. [Ref Section: 3.2.b]	
14	An industrial grade high speed IP camera based video recording system (120fps) which is time synchronized with the 600 channel DAS and with provision for connecting at least 16 IP cameras. [Ref section 3.2.c]	
15	An audio recording system (industrial grade microphone) which is time synchronized with the 600 channel DAS and with provision for connecting at least 15 channels (microphone input). [Ref section 3.2.d]	
16	Configuration of channels (540 channels) based on the requirements (any channel can be select as a strain (Quarter Bridge) or transducer (full bridge) measurement as per test requirements). [Ref section 3.2.e]	
17	Suitable connectors need to be provided at the DAS end for termination of shielded PTFE field cables (for sensor hook up). [Ref section 3.2.f]	
18	Signal conditioning requirements for different type of sensors and transducers. [Ref section 3.2.g, (Table:1General hardware requirements)]	
19	Data scanning requirements/features for each type of measurement: [Ref section 3.2.h, Table 2: I/O scanning requirements ]	
20	All channels should be capable of compensation of error due to wire length for more than 100 meters. [Ref section 3.2.i]	
21	Each channel should have individual ADC. [Ref section 3.2.j]	
22	Input impedance: Greater than or equal to 1 MΩ. Isolation between channels should be minimum 80 dB. Crosstalk between channels should be better than -110dB. [Ref section 3.2.k]	
23	All strain measurement channels should support 3 wire configuration measurements for quarter bridge configuration. Internal bridge completion resistors (120Ω & 350Ω) must be available in the data acquisition module. 120Ω & 350Ω bridge should be software selectable for all channels (no difference between both type bridges in external connector termination). [Ref section 3.2.l]	
24	All strain gauge based transducers channels (full bridge) must support 6 wire connection (including sense + and sense-). [Ref section 3.2.m]	
25	Internal resistors across bridge for simulation of shunt resistance and should be software selectable for each channel. [Ref section 3.2.n]	
26	DAS should support the aggregate of maximum sampling rates/channel of each data acquisition module present in chassis. [Ref section 3.2.o]	
27	The sampling rate for each operation should be user	

	defined. [Ref section 3.2.p]	
28	Chassis should be expandable to two or more and all chassis should be time synchronized and the time latency must be less than minimum data logging interval. [Ref section 3.2.q]	
29	All power cables and plugs provided must be for Indian standards. [Ref section 3.2.r]	
30	Specifications for control and processing unit (1 Master PC and 10 nos of remote PC): [Ref section 3.2.s]	
31	Software must be compatible with windows operating system version 11 or higher. [Ref section 3.3.1.a]	
32	Software must support all the required number of channels, including the channels considered for future augmentation. [Ref section 3.3.1.b]	
33	Provision to enter the test name, test details in the GUI should be available. [Ref section 3.3.1.c]	
34	Utility for configuration of channel details such as adding/deleting the channels, range setting, excitation voltage for each channel, gauge factor, channel name, bridge type selection, sampling rate or any other configuration related to channel from GUI by the user. [Ref section 3.3.1.d]	
35	Configuration prepared for a particular test must be stored in the system which could be loaded as and when required. [Ref section 3.3.1.e]	
36	The data acquisition in software must start with user request and should stop when user requests to stop data acquisition. [Ref section 3.3.1.f]	
37	There should be provision to record continuous data and manual record data in separate files. Test data from all the channels must be merged in single test data file. [Ref section 3.3.1.g]	
38	All data points must be logged with date and time of logging. [Ref section 3.3.1.h]	
39	The transducer configuration details have to be maintained as a library - Range, Sensitivity, ID number, units etc and selectable based on ID number. [Ref section 3.3.1.i]	
40	The configuration of channels needs to be done in a CSV format or equivalent where there are options for editing of individual cells. [Ref section 3.3.1.j]	
41	Channels need to be configured either on individual or group basis. Each channel need to be configured separately. There should be provision to make a group for same type of channels. [Ref section 3.3.1.k]	
42	Utility for software shunt calibration of all the configured channels should be available. A report of the calibration results need to be generated based on the typical shunt output for each type of measurement. [Ref section 3.3.1.l]	
43	There must be provision for adding virtual channels wherein,	

	we can do numerical computations using the measured channels and AMLS channels. A minimum of 100 virtual channels must be provided. [Ref section 3.3.1.m]	
44	Strain balancing option to be provided in the software and the channels could be balanced or initialized separately or as a whole. [Ref section 3.3.1.n]	
45	There must be provision to run and display an up/down counter. [Ref section 3.3.1.o]	
46	On the master software GUI, minimum 6 panels/pages should be available where numerical data; trend chart etc could be configured. [Ref section 3.3.1.p]	
47	System should support minimum 40 numbers of remote display nodes. 10 out of 40 remote PCs need to be supplied. [Ref section 3.3.2.a]	
48	Each remote display should have independent configuration. [Ref section 3.3.2.b]	
49	Minimum 10 panels/pages should be available in each remote application. [Ref section 3.3.2.c]	
50	Each panel should have separate control to minimize, close and resize. [Ref section 3.3.2.d]	
51	Each panel could be configured for either numerical data display or chart display with real time update. [Ref section 3.3.2.e]	
52	Numerical data display should be available as a list/table with option for sorting the selected channels based on tag IDs. There should be provision to select font size, colour and also for highlighting required channels. [Ref section 3.3.2.f]	
53	There must be provision to run and display the countdown/up timer. [Ref section 3.3.2.g]	
54	The remote application must have chart options where the real time trend of measured channels could be plotted against a selected parameter (either one of the channels, a virtual channel or time). [Ref section 3.3.2.h]	
55	All the real time data should be available as network shared variables which could be accessible to other applications through the network. [Ref section 3.3.2.i]	
56	Real time alerts: The software must give real time alerts to the user regarding measurement values. [Ref section 3.3.2.j]	
57	Display of real time data on 3D model of test article: [Ref section 3.3.3]	
58	Display of real time data on 2D model of test article: [Ref section 3.3.3]	
59	Interface with Automated Load/Pressure application system software. [Ref section 3.3.4]	
60	Master software should auto generate the test data in csv or ms-excel format with proper channels details, name, time and test name on user request, for both the manual record	

	data and auto record data. [Ref section 3.3.5.a]	
61	The master software should be able to generate a comprehensive test report after the test completion, summarizing the test data and observations. [Ref section 3.3.5.b]	
62	Documentation [Ref section 4]	
63	Compliance to all the Supply and Installation conditions in Section 5.	
64	Compliance to all the Commercial conditions in Section 6	