

# Indian Institute of Technology-Kanpur

(Department of Mechanical Engineering)

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Name of Indenter: Professor N.S.Vyas

Enquiry Number: NSV/12-13/ADA100/March 28, 2013

Closing Date of tender: 08<sup>th</sup> April 2013

Sealed Tenders are invited for “Portable Data Acquisition System, Instrumentation of an Existing small family car in the laboratory and Data Collection under different operating conditions using suitable Sensors” as per following terms and specifications.

#### **Terms & Conditions:-**

1. Supply, installation and commissioning of Data Collector and other accessories are within the scope of supplier only.
2. Tender shall be submitted along with Original & Color Brochure.
3. All the optional components/equipments/software/ up gradation of software if any should be mentioned very clearly.
4. Please send best techno-commercial offer **in a sealed envelope in the office of the undersigned**
5. The indenter reserves the right to withhold placement of final order.
6. The rates offered should be inclusive of all taxes, packaging, forwarding, installation, commissioning & training etc.
7. The delivery period should be specifically stated. Earlier delivery may be preferred
8. Validity of quotation should not less than 90 days
9. The right to reject all or any of the quotations and to split up the requirements or relax any or all of the above conditions without assigning any reason is reserved.
10. Please clearly mention enquiry number on the top of envelop.

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## **Technical specifications of Portable Data Acquisition System and Instrumentation of Existing Family Car Tata Indica using suitable Sensors**

### **Scope of work:**

1. Supply of a rugged & portable cRIO (Manufacture National Instruments-USA) based data acquisition system to collect data from the instrumented vehicle.
2. Supply of suitable application software Lab View (Manufacturer National Instruments-USA) for the data acquisition system to configure, collect & present the data acquired from the data acquisition system.
3. Supply of sensors for Instrumentation of Existing Family Car Tata Indica.
4. Integration of all the supplied sensors with the data acquisition system.

### **1. General requirements:**

The quoted Data Acquisition System should be of international repute and should have been used for measurement and control applications for at least 5 years in automotive industries. Purchase orders for similar cRIO based Data acquisition system for their In-vehicle data logging application should be provided while submitting the tender. The bidder should also provide Authorization Certificate along with the tender.

### **2. Specifications of Data Acquisition System:**

The DAQ system shall be enclosed in a light weight portable rugged chassis with LEMO connectors in the front to connect individual input channels. Logger should be easily portable for easy lifting & installation purposes. The DAQ system should be an Independent unit having a Real time operating system to ensure reliable data acquisition in harsh conditions. The DAQ system shall communicate with the Laptop or PC through standard Ethernet Communication (TCP/IP). The DAQ controller should have USB and Serial Ports available and shall be enabled in future with suitable software for communication with peripheral devices.

The data collected by the DAQ will be transferred to a local desktop or laptop via standard Ethernet (TCP/IP) where the Graphical User Interface will be running. The user can configure the tests, log data, view graphs and monitor alarms on the GUI running on the local display unit. The data should also be logged in industry standard ASCII format. ASCII files can be directly viewed and analyzed in MS EXCEL or Notepad and can be routed into standard Data Base Management Systems for further statistical analysis or for the records. An optional feature to log the data in XML format shall be provided by the bidder.

The connection terminals for all individual input channels of the DAQ system shall be of LEMO connectors only. Suitable patch cables of each 3 meters length for all individual input channels with Lemo connector at the DAQ system end and industrial grade allied connector at the sensor

end shall be provided. All the sensors supplied shall be provided with suitable mating Allied connectors.

**1.1. Data Acquisition System Controller – 1 Unit:**

The DAQ system controller shall be of cRIO platform and shall feature atleast a 800 MHz real-time processor for deterministic, reliable real-time applications and shall have atleast 512 MB of DDR2 RAM and 4 GB of nonvolatile storage for holding programs and optionally logging data.

This DAQ system controller shall be designed for low-power consumption with dual 9 to 35 VDC supply inputs that deliver isolated power to the chassis/modules. The controller shall accept 9 to 35 VDC power supply inputs on power up and 6 to 35 VDC power supply inputs during operation, so it can function for long periods of time in remote applications using a battery or solar power.

Operating System/Target	Real-Time
LabVIEW RT Support	Yes
CE Compliance	Yes
Processor Core Type	PowerPC
CPU Clock Frequency	atleast 800 MHz
System Memory	atleast 512 MB
Ethernet (# of ports)	2
Ethernet Port Type	100BaseTX , 10BaseT
Serial Ports (RS232)	1
USB Ports	1
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C
Maximum Altitude	2000 m
Ingress protection	IP 20
Operating humidity (IEC 60068-2-56)	10 to 90% RH, noncondensing
Internal Real-Time Clock accuracy	200 ppm; 35 ppm at 25 °C

**1.2. Data acquisition system Chassis – 1 Unit:**

The DAQ system’s reconfigurable embedded chassis shall be of cRIO platform and shall have minimum eight-slots. Being a customized development, It is mandatory that it shall have a user-programmable FPGA to achieve high processing power & rugged operating abilities.

Operating System/Target	FPGA
LabVIEW RT Support	Yes
CE Compliance	Yes
Number of Slots	8
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C
Maximum Altitude	2000 m
Accuracy	±100 ppm (max)

### 1.3. Analog Voltage Sensor Input Module - 1 Unit:

The analog input module shall be of cRIO platform and shall have minimum 32 single-ended or 16 differential analog inputs, 16-bit resolution, and a maximum sampling rate of 250 kS/s. Each channel shall have programmable input ranges of  $\pm 200$  mV,  $\pm 1$ ,  $\pm 5$ , and  $\pm 10$  V. To protect against signal transients, the module shall have up to 60 V of overvoltage protection between input channels and common (COM). It shall also include a channel-to-earth-ground double isolation barrier for safety, noise immunity, and high common-mode voltage range. It shall be rated for 1,000 Vrms transient overvoltage protection.

Measurement Type	Voltage
Isolation Type	Ch-Earth Ground Isolation
Single-Ended Channels	Minimum 32
Differential Channels	Minimum 16
Resolution	Minimum 16 bits
Sample Rate	Maximum 250 kS/s
Maximum Voltage Range	-10 V - 10 V
Maximum Voltage Range Accuracy	6220 $\mu$ V or better
Max Voltage	10 V
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.4. Strain Sensor Input Module - 1 Unit:

The strain sensors input module shall be of cRIO platform and shall be a simultaneous bridge module containing all the signal conditioning required to power and measure up to four bridge-based sensors simultaneously. The module shall provide direct connectivity to torque sensors. The module shall offer high sampling rate atleast 50 kS/s per channel to ensure high-quality, high-speed torque measurement with zero inter-channel phase delay. The module shall have 60 VDC isolation and 1,000 Vrms transient isolation and high common-mode noise rejection. The module shall be able perform offset/null as well as shunt calibration and remote sense

Measurement Type	Torque based sensor
Isolation Type	Ch-Earth Ground Isolation
RoHS Compliant	Yes
Signal Conditioning	Voltage excitation , Bridge completion , Anti-aliasing filter
Differential Channels	Minimum 4
Resolution	Atleast 24 bits
Sample Rate	Atleast 50 kS/s per channel
Max Voltage	25 mV/V
Maximum Voltage Range	-25 mV/V - 25 mV/V
Maximum Voltage Range Accuracy	0.038 mV/V
Simultaneous Sampling	Yes
Excitation Voltage	5 V , 3.3 V , 2.5 V , 10 V
Bridge Configurations	Half Bridge , Full Bridge , Quarter Bridge

Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.5. Accelerometer/Microphone Module - 2 Units:

The Accelerometer/Microphone shall be of cRIO platform and shall have atleast four-channel dynamic signal acquisition channels for making high-accuracy audio frequency measurements from integrated electronic piezoelectric (IEPE) and non-IEPE sensors. The module shall have 102 dB of dynamic range and incorporate software-selectable AC/DC coupling and IEPE signal conditioning for accelerometers and microphones. The four input channels should be able to simultaneously digitize signals at rates up to 51.2 kHz per channel with built-in antialiasing filters that automatically adjust to the user's sampling rate.

Measurement Type	Accelerometer , Microphone
RoHS Compliant	Yes
Signal Conditioning	Current excitation , Anti-aliasing filter
Differential Channels	Atleast 4
Resolution	Atleast 24 bits
Sample Rate	Maximum 51.2 kS/s
Bandwidth	23.04 kHz
Max Voltage	5 V
Maximum Voltage Range	-5 V to 5 V
Simultaneous Sampling	Yes
Input Impedance	305 kOhm
Dynamic Range	102 dB
Excitation Current	2 mA
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.6. CAN Interface Module - 1 Unit:

A CAN module of cRIO platform to measure the vibration data from the MEMS based triaxial accelerometers (provided by IIT Kanpur) shall be supplied with the DAQ system. It should be able achieve communication with devices at transfer rates up to 1 Mbit/s at 100 percent bus load. There should be possibility to synchronize the CAN module with any I/O module to achieve CAN and data acquisition hardware synchronization with up to 25 ns resolution. The CAN module shall have 11-bit and 29-bit arbitration ID support and should be able to communicate on J1939 networks.

Isolation Type	Port-Port Isolation
Number of Ports	2
Physical Layer	High-Speed
Max Baud Rate	1 Mbits/s
Min Baud Rate	40 kbits/s
Termination	External
Hardware Synchronization	Yes
Synchronization Frequency	20 MHz
Hardware Timestamping	Yes
Timestamp Resolution	1 us
Advanced Mode Support	Sleep/Wakeup Mode

Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.7. Thermocouple Interface Module - 1 Unit:

The thermocouple input module shall be of cRIO platform and shall include a 16 channel thermocouple channels, a 24-bit delta-sigma ADC, antialiasing filters, open-thermocouple detection, and cold-junction compensation for high-accuracy thermocouple measurements. The module should have NIST-traceable calibration and channel-to-earth ground double isolation barrier for safety, noise immunity, and high common-mode voltage range. In high-speed mode each channel should sample at 75 S/s. When 12 or fewer channels are used, the max sample rate per channel should increase to 100 S/s.

Measurement Type	Temperature , Thermocouple , Voltage
Isolation Type	Ch-Earth Ground Isolation
RoHS Compliant	Yes
Signal Conditioning	Cold-junction compensation
Differential Channels	Atleast 16
Resolution	Atleast 24 bits
Sample Rate	Maximum 1200 S/s
Measurement Sensitivity	0.02 deg C
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.8. Digital signal Input Module - 1 Unit:

The Digital Input Module shall be of cRIO platform and shall have atleast 6-channels differential/single-ended digital inputs. Each channel shall be compatible with  $\pm 5$  to 24 V signals. The module should e able to work with industrial logic levels and signals for direct connection to a wide array of industrial switches, transducers, and devices.

Measurement Type	Digital
Isolation Type	Ch-Earth Ground Isolation
RoHS Compliant	Yes
Input-Only Channels	Mimimum 6
Timing	Hardware
Max Clock Rate	2 MHz
Logic Levels	2.5 V
Input Current Flow	Programmable Current
Supports Handshaking I/O?	Yes
Supports Pattern I/O?	Yes
Maximum Input Range	0 V to 24 V
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 1.9. Current signal Input Module – 1 Unit:

The current signal module shall be of cRIO platform and shall have a programmable input ranges of  $\pm 20$  mA or 0 to 20 mA, minimum 16-bit resolution, and a 200 kS/s maximum sampling rate. To protect against signal transients, the module shall include a channel-to-earth ground double isolation barrier (250 Vrms isolation) for safety and noise immunity.

Measurement Type	Current
Isolation Type	Ch-Earth Ground Isolation
RoHS Compliant	Yes
Signal Conditioning	0-20 mA current input
Single-Ended Channels	8
Resolution	16 bits
Sample Rate	200 kS/s
Maximum Current Range	-20 mA - 20 mA
Maximum Current Range Accuracy	0.049 mA
Minimum Current Range	0 mA - 20 mA
Minimum Current Range Accuracy	0.049 mA
Minimum Operating Temperature	-40 °C
Maximum Operating Temperature	70 °C

### 2. Specifications of Data Acquisition Software:

The DAQ software, a LabVIEW based application software for testing and validation of hardware and real time configuration, acquisition and recording of data using the supplied system shall be provided.

It shall be possible to vary the sampling rate through the logging rate to a maximum of 1000 samples per second per channel and also use the available filters on signal conditioning modules. The application program shall also allow the use of the calibration, DC offset and other important features of data acquisition modules. The following are the key mandatory features of the software.

#### Test Configuration

- Select the Channels to be logged
- Set the Data Logging Rate
- Select the type of User Interface Display required including Graphs, Dials, Numeric Indicators, Bar Graphs.
- Save and Create Multiple Test Configurations for Quick Retrieval and Re-usage.

#### Channel Configuration

- Assign Names to Channels
- Select & Edit Scales for Channels
- Select & Edit Physical Units for Channels
- View the Raw Data being acquired.
- Save and Create multiple Channel Configurations for Quick Retrieval and Re-Usage

### Scale Configuration

- Create Independent Scales for measurements
- Scaling Options include Linear , Tabular , Polynomial , Multiple Data Points or from any file
- Configure Multiple scales for the measurement application having different sensors
- Set the Calibration factors such as Zero Offset, Full Scale Offset, Zero Scale and Full Scale Engineering Units.

### Testing & Data Acquisition

- View Data with Analog, Digital and Graphical Indicators
- Drag 'n' Drop Features for configuring Displays and Viewing Data
- Start and Stop the Data Logging at the hit of a Button
- TARE any ZERO Offsets from sensors outputs

## 3. Specifications for Sensors for instrumentation:

### 3.1. Microphones – 2 Units:

2 units of microphones of specification, 1/2 prepolarized free-field condenser, 50 mV/Pa ( $\pm 1.5$  dB), 3.15 Hz - 20 kHz ( $\pm 2$  dB) with 1/2 ICP preamplifier shall be supplied to measure the Sound signals at various locations of the four wheeler. The technical specifications of the microphone are provided below

Performance	
Nominal Microphone Diameter	1/2"
Frequency Response Characteristic (at 0° incidence)	Free-Field
Open Circuit Sensitivity (at 250 Hz)	50 mV/Pa
Open Circuit Sensitivity (at 250 Hz) ( $\pm 1.5$ dB)	-26 dB re 1 V/Pa
Frequency Range ( $\pm 1$ dB)	5 to 10000 Hz
Frequency Range ( $\pm 2$ dB)	3.15 to 20000 Hz
Lower Limiting Frequency (-3 dB)	1 to 2.4 Hz
Dynamic Range (3% Distortion Limit)	146 dB re 20 $\mu$ Pa
Dynamic Range (Cartridge Thermal Noise)	15 dB(A) re 20 $\mu$ Pa
Standards Designation (IEC 61094-4)	WS2F
Temperature Range (Operating)	-40 to +120 °C
Capacitance (Polarized)	12 pF
Polarization Voltage	0 V



### 3.2. Accelerometer – 2 Units:

2 units of tri-axial accelerometer of specification,  $\pm 50g$  measurement range, 100 mV/g ( $\pm 10\%$  sensitivity), 2 Hz - 5000 Hz ( $\pm 5\%$ ) shall be supplied along with necessary connecting cables to measure the vibration signals at various locations of the four wheeler. The technical specifications of the accelerometer are provided below

Technical Specification	
Sensitivity ( $\pm 10\%$ )	100mv/g
Measurement Range	$\pm 50g$
Frequency Range ( $\pm 5\%$ )	2 to 5000 Hz
Frequency Range ( $\pm 10\%$ )	1.4 to 6000 Hz
Resonant Frequency	$\geq 25000\text{Hz}$
Non-Linearity	$\leq 1\%$
Broadband Resolution (1 to 10000 Hz)	0.0002 g rms
Traverse Sensitivity	$\leq 5\%$
Overload Limit (Shock)	$\pm 7000g$
Temperature Range (Operating)	$-54^{\circ}\text{C}$ to $+121^{\circ}\text{C}$
Base Strain Sensitivity	0.001 g/ $\mu\text{e}$
Excitation Voltage	20 to 30VDC
Constant Current Excitation	2 to 20 mA
Output Impedance	$\leq 200\ \text{Ohm}$
Output Bias Voltage	8 to 12 VDC
Discharge Time Constant	0.2 to 0.8 sec
Settling Time (within 10% of bias)	$< 5\ \text{sec}$
Sensing Element	Ceramic
Housing Material	Titanium
Sealing	Hermetic
Size (Height x Length x Width)	14.0 mm x 20.3 mm x 14.0 mm
Weight	10.5 gm (typical)

### 3.3. Thermocouples – 8 Units:

For measurement of temperature of Brake linings & disc, contact based K type thermocouples shall be utilized of suitable range.

### 3.4. Hydraulic Pressure sensors – 4 Units:

Hydraulic pressure sensors shall be used to measure line pressures at various points of the vehicle. Suitable tapings shall be made in the vehicle's hydraulic lines where the pressure sensors shall be mounted. The specification of the pressure sensor is as below

Measuring ranges	0 to 250 bar
Temperature range of media	-40°C to 125°C
Shock and vibration resistance	> 1000 g shock, > 20 g vibration
No internal transmission media	(fully welded, "dry" measuring cell)
Protection class	IP67
Compact and rugged model	stainless steel
Output signal	0...10 mA
Accuracy @ RT % of the range	±0.5% F.S. (RT) standard
Measuring medium T [°C] -	-40...125
Ambience T [°C] -40...105	-40...105

### 3.5. Wheel speed sensors – 4 Units:

4 units of wheel speed sensors along with cables shall be provided by IIT Kanpur. Based on the sensor type suitable mounting arrangements shall be fabricated & integrated with the DAQ system

### 3.6. Travel sensors – 3 Units:

In order to measure the pedal travel of Accelerator, Clutch & Brake, 3 units of pedal sensor shall be used with fabricated mounting arrangements. The specifications of the Draw wire sensor is as given below

Measuring range	300mm
Linearity	±0.25 %FSO 0.75mm
Resolution mm	Quasi infinite
Sensor element	hybrid potentiometer
Temperature range	-20 ...+80 °C
Material	aluminum
Protection class	DIN EN 60529 IP 65
Vibration	50g, 10ms

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