ANNEXURE 1 - TECHNICAL SPECIFICATION OF

AUTOMATED ELECTRICAL TEST UNIT

1. INTRODUCTION

This proposal is for an Automated Electrical Test Unit (ATU) to carry out electrical tests of Flow Control Valves, Latch valves and Thrust chamber assemblies and pulsing/cycling operations on these valves.

The testing of Flow Control Valves and Latch valves calls for verification of various parameters which needs to be stored and analyzed at various sub-assembly stages and final assembly before clearing for inducting into various projects. The proposal is for Design, Realization, Supply, Installation, Testing, Commissioning & Demonstration of satisfactory performance of Automated Electrical Test Unit at LPSC(B) as per the specification mentioned in this document.

2. COMPONENTS OF THE UNIT

The unit shall be an integrated system comprising of the following:

i. Hardware – This shall include Chassis, Controller, Digital Multimeter, Oscilloscope, Switch Module, digital I/O Module, Power supply and necessary cards to acquire voltage, current and resistance.

ii. Application software – The software shall cover all the required functional requirement specified and shall be built using LabVIEW or equivalent software with user friendly interface.

iii. PC with preloaded latest operating system and office tools.

iv. Colour Printer with scanner

v. All required driver software

3. SOFTWARE REQUIREMENT

- The proposed Automated Electrical Test Unit will be used to carry out electrical tests on the following propulsion components:
  a) Flow Control Valve
  b) Latch Valve
  c) Thrust Chamber Assemblies

- The unit shall command and acquire electrical test data of these components. Minimum required sampling rate is 10,000 samples/sec**.** Sampling rate should be programmable from 1 sample/s to 10K samples/s.
- The response of the valves shall be captured in Graphical format also. The status of the valves shall be clearly displayed on GUI as well as on Electrical Test Unit.
- The unit shall provide real-time display of the test results and have provision to generate Test Report that can be saved and retrieved for future analysis. Before start of the test, inputs shall be obtained from the user that are required to test the respective component and generate the appropriate test report.
- Provision shall be available to update or create new component specification in the test report.

The details of test conducted for each component and the procedures are described below. These are done manually as of now. The software proposed should automate the tests conducted on different components and produce the test reports and graphs as detailed below.

3.1. Flow Control Valve (FCV)

a) Description of Flow Control Valve

A Flow Control Valve (FCV) has two coils: Upstream (US) and Downstream (DS). FCV is normally in closed condition. Whenever voltage is applied to both the coils only, FCV can be opened.

b) Electrical tests of Flow Control Valve

i. Coil Resistance
ii. Insulation Resistance
iii. Pull in & Drop out voltage
iv. ON & OFF Response
v. Pulsing Operation

3.1.1. Coil resistance

Coil resistance of US, DS shall be measured using 6 ½ digit multimeter card. Resistance measurement shall have repeatability of ±0.25Ω.

3.1.2. Insulation Resistance

Insulation resistance of US, DS shall be measured using High resistance meter. Insulation resistance is measured between leads and body of the valve. These values shall communicate to the ATU through IEEE – 488 bus (GPIB).

(High Resistance meter procurement is not in supplier scope, Available meters at LPSC(B): Agilent Technologies – 4339B, Keithley – 6517B).

3.1.3. Pull in & Drop out voltage

a. Configurable Parameters:

Configurable voltage US

Configurable voltage DS

Voltage Step for US

Voltage Step for DS

Configurable maximum safe voltage of US

Configurable maximum safe voltage of DS

b. Measurement Procedure:

- **To measure US coil pull in voltage:**

  The unit shall gradually increase DS coil voltage in steps as configured till the coil is open fully and then reduce the voltage to configured value to avoid overheating. Then, the US coil supply voltage shall be gradually increased in steps as configured and the current of the coil shall be captured and saved. The voltage corresponding to the current at which the coil opens shall be measured and recorded as pull in voltage of US.

- **To measure US coil drop out voltage**:

  The unit shall gradually reduce the voltage of US coil and the current shall be captured and saved. Measure & record the voltage corresponding to current of the coil where the coil closed as the drop out voltage of US. Now, the unit shall reduce the US & DS coil voltages to 0V.

- **To measure DS coil pull in voltage:**

  The unit shall gradually increase US coil voltage in steps as configured till the coil is open fully and then reduce the voltage to configured value to avoid overheating. Then, the DS coil supply

voltage shall be gradually increased in steps as configured and the current of the coil shall be captured and saved. The voltage corresponding to the current at which the coil opens shall be measured and recorded as pull in voltage of DS.

- **To measure DS coil drop out voltage**:

  The unit shall gradually reduce the voltage of DS coil and the current shall be captured and saved. Measure and record the voltage corresponding to current of the coil where the coil closed as the drop out voltage of DS. Now, the unit shall reduce the US & DS coil voltages to 0V.

- **To measure pull in voltage when US & DS are in parallel:**

  The unit shall gradually increase both the coil supply voltage in steps as configured, capture and save the current of the coils. The voltage corresponding to coil current (either US or DS) whichever open later shall be considered, measured and recorded as pull in voltage in parallel mode. For instance as unit increasing the voltage, first DS coil is opened then US coil is opened. So, for the measurement of pull in voltage, US coil current shall be considered.

- **To measure drop out voltage when US & DS are in parallel:**

  The unit shall gradually reduce the voltage of the coils. The voltage corresponding to the coil current (either US or DS) whichever closes first shall be considered, measured and recorded as the drop out voltage in parallel mode. For instance as unit decreasing the voltage, first DS coil is closed then US coil is closed. So, for the measurement of drop out voltage, DS coil current shall be considered.

  Note: The unit can only increase the voltage up to configurable maximum safe voltage of respective US and DS during the test. If the valve doesn't open within the configurable maximum safe voltage, test needs to be aborted.

c. Test Results:

Pull in Voltage of US

Drop out Voltage of US

Pull in Voltage of DS

Drop out Voltage of DS

Pull in Voltage in Parallel mode

Drop out Voltage in Parallel mode

3.1.4. ON & OFF Response

a. Configurable Parameters:

US: Configurable voltage of the pulse
Configurable duration of the pulse

DS: Configurable voltage of the pulse
Configurable duration of the pulse

Parallel mode: Configurable voltage of the pulse
Configurable duration of the pulse

b. Measurement Procedure:

The TTL pulse is applied to the input of the driver circuit. Output of the driver circuit shall be applied to the component. The current of the FCV shall be captured and saved.

Note: Driver Circuit shall be provided by LPSC(B).

- **To measure US coil ON & OFF response:**

The unit shall increase the voltage DS coil in steps as configured till coil opens fully and reduce to configured value to avoid overheating. The unit shall apply configured voltage pulse of configured duration to the US coil, capture and save the coil current graph, measure and record the ON & OFF responses.

- **To measure DS coil ON & OFF response:**

The unit shall increase the voltage US coil in steps as configured till coil opens fully and reduce to configured value to avoid overheating. The unit shall apply configured voltage pulse of configured duration to the DS coil, capture and save the coil current graph, measure and record the ON & OFF responses.

- **To measure ON & OFF response when US & DS are in parallel:**

The unit shall apply configured voltage of pulse of configured duration to the coils, capture and save the coil current graph and record the ON & OFF responses.

c. Test results

US ON response

US OFF response

DS ON response

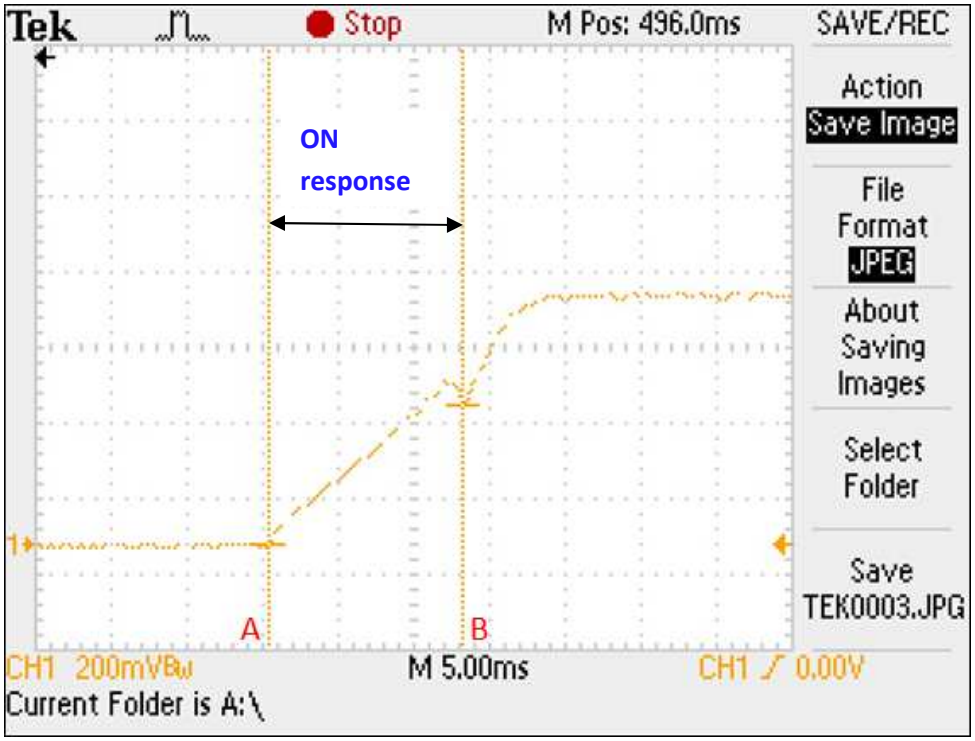
DS OFF response

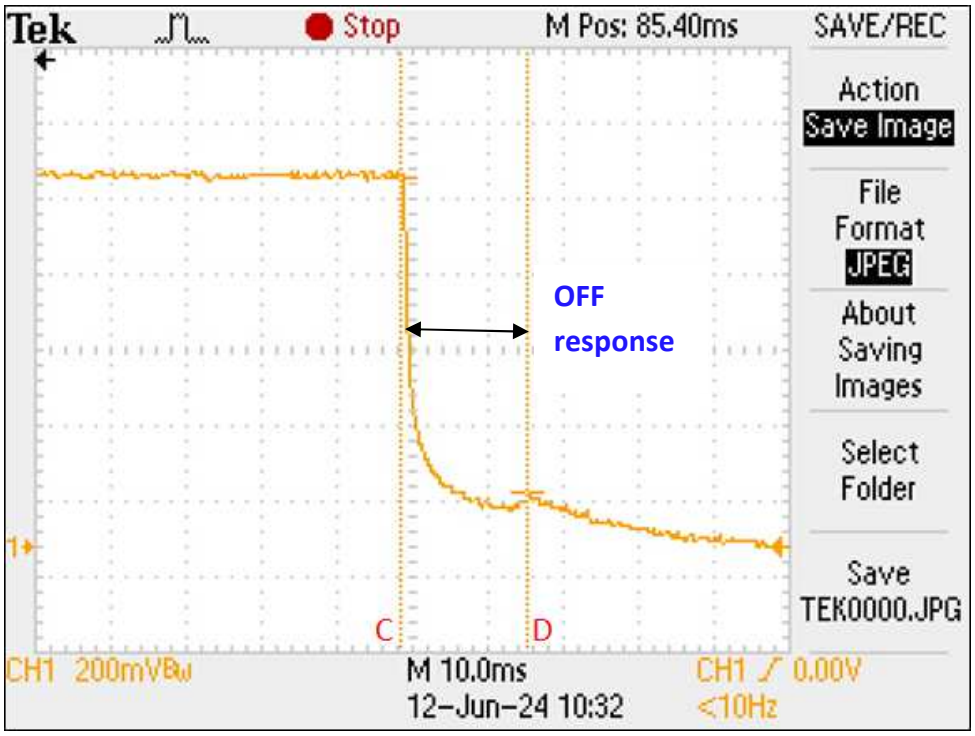
Parallel mode ON response

Parallel mode OFF response

Note: Current waveform should be saved for Pull in, drop out, ON & OFF response testing.

A typical coil current (both ON & Off) graph captured in CRO is as shown in the following Figure (for reference).





3.1.5. Pulsing OF FCV

- Pulse ON time settable from 1 to 9999 msec
- Pulse OFF time settable from 1 to 9999 msec
- Pulse ON and OFF times will be independently settable
- Number of pulses settable from 1 to 999999
- Number of pulses applied should be indicated
- TTL type pulse output signal
- Pulse fall/raise times less than 10nsec
- Accuracy of pulse ON/OFF times less than 0.1% of set time
- Accuracy of pulse frequency: $1x10^{-4}$ PPM
- Driver circuit to drive solenoid valve rated for 70V DC, 9A. Driver circuit should be protected from back EMF. [The design of driver circuit for the pulsing is supplier's scope]
- Continuous Solenoid ON option for a maximum period of 10 min
- Provision for real time monitoring, capturing and recording of solenoid valve current.
- Provision for continuous ON for maximum 10 minutes. The duration for continuous operation shall be programmable.
- Provision shall be given such that minimum 3 No of valves can be done simultaneously.

3.2. Latch Valve (LV)

a) Description of LV

A Latch Valve (LV) has two coils: open coil (OC) and close coil (CC). It has an inbuilt micro-switch with Pole, NC & NO. When voltage is applied to open coil, the LV is opened and continuity appears between pole and NO. When voltage is applied to close coil, the LV is closed and continuity appears between pole and NC.

b) Electrical Tests of LV

i. Coil Resistance
ii. Insulation Resistance
iii. Minimum actuation voltage
iv. Open & close Response
v. Cycling operation

3.2.1. Coil resistance

Coil resistance of OC, CC is measured using measured using 6 ½ digit multimeter card. Resistance measurement shall have repeatability of ±0.25Ω.

3.2.2. Insulation Resistance

Insulation resistance of OC, CC and micro switch is measured using High resistance meter. Insulation resistance is measured between leads and body of the valve. These values should communicate to the ATU through IEEE – 488 bus (GPIB).

(High Resistance meter procurement is not in supplier scope, Available meters at LPSC(B): Agilent Technologies – 4339B, Keithley – 6517B).

3.2.3. Minimum Actuation voltage:

a. Configurable Parameters:

Voltage Step for OC
Voltage Step for CC
Configurable safe voltage of OC
Configurable safe voltage of CC

b. Measurement Procedure:

- **To measure OC minimum actuation voltage:**

  The unit shall gradually increase the OC supply voltage in steps as configured, capture and save the current of the coil. The voltage corresponding to current at which the coil opens shall be measured and recorded as minimum actuation voltage of OC and status of the valve to be monitored.

- **To measure CC minimum actuation voltage:**

  The unit shall gradually increase the CC supply voltage in steps as configured till the LV closed, capture and save the current of the coil. The voltage corresponding to current at which the coil opens shall be measured and recorded as minimum actuation voltage of CC and status of the valve to be monitored.

  Note: If the valve not at all opening/ closing for the increased respective OC/CC coil voltage, then unit shall increase the voltage up to configurable maximum safe voltage of respective OC and CC.

c. Test results:

Minimum actuation voltage OC

Minimum actuation voltage CC

3.2.4. Response measurement Procedure of LV:

a. Configurable Parameters:

OC: Configurable voltage of the pulse

Configurable duration of the pulse

CC: Configurable voltage of the pulse

Configurable duration of the pulse

b. Measurement Procedure:

- **To measure OC response:**

The unit shall apply configured voltage of pulse for configured duration to the OC and capture the coil current graph. Measure and record open coil response.

- **To measure CC response:**

Apply configured voltage of pulse for configured duration to the CC and capture the coil current graph. Measure and record close coil response.

c. Test results

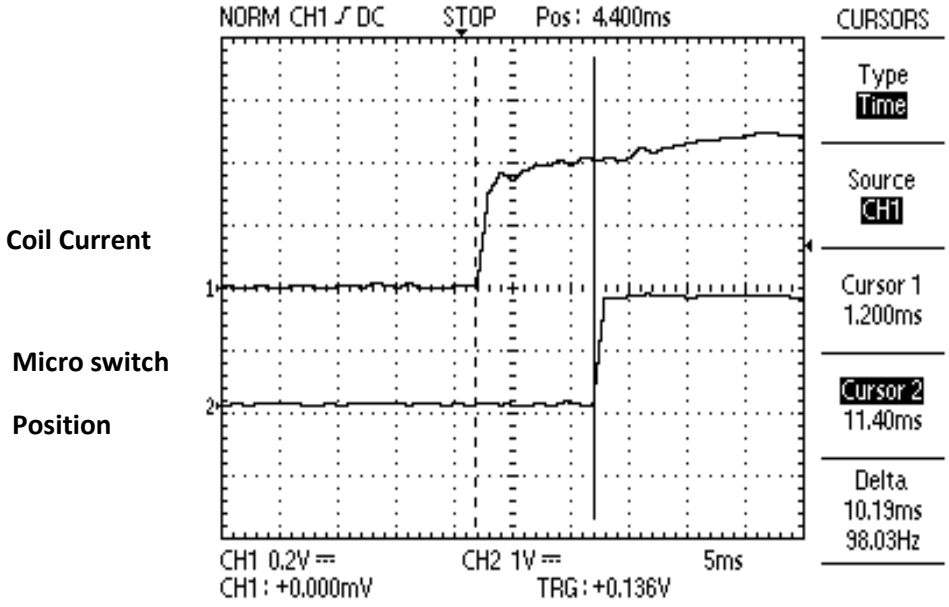
OC response

CC response

Note: Current waveform should be saved for Minimum actuation, ON & OFF response testing.

A typical coil current graph captured in CRO is as shown in the following Figure (for reference).

The micro switch indication shall be provided throughout the Latch Valve Testing.



3.2.5. CYCLING OF LV

- Pulse ON time settable from 1 to 9999 msec
- Pulse OFF time settable from 1 to 9999 msec
- Pulse ON and OFF times will be independently settable
- Number of pulses settable from 1 to 999999
- Number of pulses applied should be indicated.
- TTL type pulse output signal
- Pulse fall/raise times less than 10nsec
- Accuracy of pulse ON/OFF times less than 0.1% of set time
- Accuracy of pulse frequency: $1x10^{-4}$ PPM

- Driver circuit to drive LV coil rated for 70V DC, 9A. Driver circuit should be protected from back EMF. [The design of driver circuit for the pulsing is supplier's scope]
- Provision for monitoring the valve coil current
- Provision shall be given such that minimum 3 No of valves can be done simultaneously

NOTE: The microswitch indication shall be provided throughout the Latch Valve Testing.

3.3. Thruster Chamber Assembly (TCA)

a) Description of Thruster Chamber Assembly

TCA is the assembled combination of FCV, Catalyst Bed Heater (CBH) and Thermocouple. FCV is normally in closed condition.

TCA electrical tests are done at 42V and 70V. 42V test procedure is same as FCV electrical test. (section No: 3.1). In 70V test, both US and DS coils of FCV are connected in series and it will be a single coil.

b) Electrical tests of Thruster Chamber Assembly @ 70V

i. Coil Resistance
ii. Insulation Resistance
iii. Pull in & Drop out voltage
iv. ON & OFF Response

3.3.1. Coil resistance

Coil resistance of FCV, CBH (main & redundant), thermocouple, FCV heater and thermistor shall be measured and stored using 6 ½ digit multimeter card. Resistance measurement shall have repeatability of ±0.25Ω.

3.3.2. Insulation Resistance

Insulation resistance of FCV, CBH (main & redundant), thermocouple shall be measured using High resistance meter. These values should communicate to the ATU through IEEE – 488 bus (GPIB).

(High Resistance meter procurement is not in supplier scope, Available meters at LPSC(B): Agilent Technologies – 4339B, Keithley – 6517B).

3.3.3. Pull in & Drop out voltage

a. Configurable Parameters:

Configurable voltage Step of coil

Configurable maximum safe voltage of coil

b. Measurement Procedure:

- **To measure pull in voltage:**

  The unit shall gradually increase the coil supply voltage in steps as configured, capture and save the current of the coil. The voltage corresponding to current at which the coil is open shall be measured and recorded as pull in voltage. If the valve not at all opening for the increased coil voltage, then unit shall increase the voltage up to configurable maximum safe voltage of the coil.

- **To measure drop out voltage:**

  The unit shall gradually reduce the voltage of the coil, capture and save the current of the coil. Measure and record the voltage at which the coil is closed as the drop out voltage.

c. Test Results:

Pull in Voltage of FCV

Drop out Voltage of FCV

3.3.4. ON & OFF Response

a. Configurable Parameters:

Configurable voltage of the pulse

Configurable duration of the pulse

b. Measurement Procedure:

To measure ON & OFF response:

The unit shall apply configured voltage of pulse of configured duration to the coil, capture and save the coil current graph. Measure and record the ON & OFF responses.

c. Test results

ON response

OFF response

3.4. 100N FCV (Flow Control Valve)

100N FCV has single coil. FCV is normally in closed condition. Whenever voltage is applied to the coil, then FCV is in open condition.

a) Electrical tests of Flow Control Valve

i. Coil Resistance
ii. Insulation Resistance
iii. Pull in & Drop out voltage
iv. ON & OFF Response

3.4.1. Coil resistance

Coil resistance of FCV is measured using 6 ½ digit multimeter. Resistance measurement shall have repeatability of ±0.25Ω.

3.4.2. Insulation Resistance

Insulation resistance of FCV is measured using High resistance meter. Insulation resistance is measured between leads and body of the valve. These values should communicate to the ATU through IEEE – 488 bus (GPIB).

(High Resistance meter procurement is not in supplier scope, Available meters at LPSCB: Agilent Technologies – 4339B, Keithley – 6517B).

3.4.3. Pull in & Drop out voltage

a. Configurable Parameters:

Configured voltage Step of FCV

Configurable maximum safe voltage of FCV

b. Measurement Procedure:

- Actuate the coil for 10 times at 28V DC.

- **To measure coil pull in voltage at no load:**

  The FCV coil supply voltage shall be gradually increased in steps as configured and the current of the coil shall be captured and saved. The voltage corresponding to the current at which the coil opens shall be measured and recorded as pull in voltage at no load. If the valve not at all opening for the increased coil voltage, then unit shall increase the voltage up to configurable maximum safe voltage of the FCV.

- **To measure coil drop out voltage:** The unit shall gradually reduce the voltage of FCV coil, capture and save the current. Measure and record the voltage of the coil where the coil closed as the drop out voltage at no load.
- **Now unit should ask to apply the inlet pressure and acknowledge the inlet pressure value.**
- Again, actuate the coil for 10 times at 28V DC with the applied inlet pressure.
- **To measure coil pull in voltage at 25 bar (g):**

  The FCV coil supply voltage shall be gradually increased in steps as configured and the current of the coil shall be captured and saved. The voltage corresponding to the current at which the coil opens shall be measured and recorded as pull in voltage at no load. If the valve not at all opening for the increased coil voltage, then unit shall increase the voltage up to configurable maximum safe voltage of the FCV.

c. Test Results:

Pull in Voltage of FCV at no load

Drop out Voltage of FCV at no load

Pull in Voltage of FCV at 25 bar

3.4.4. ON & OFF Response

a. Configurable Parameters:

Configurable voltage of the pulse

Configurable duration of the pulse

b. Measurement Procedure of FCV

The pulse is applied to the input of the driver circuit. Output of the driver circuit shall be applied to the component. The current of the FCV should be captured.

To measure FCV coil ON & OFF response:

The unit shall apply configured voltage pulse of configured duration to the FCV coil and capture the coil current graph. Measure and record the ON & OFF responses.

c. Test results

ON response at 42V DC

OFF response at 42V DC

ON response at 28V DC

OFF response at 28V DC

Note: Current waveform should be saved for pull in, drop out, ON & OFF response testing.

4. HARDWARE SPECIFICATION

4.1. Chassis

Sl No.	Description	Specification
1	Power supply	230V AC, 50Hz
2	System bandwidth	8GB/s or higher
3	Cooling	Suitable cooling to be provided
4	EMI/EMC	EN61000-3-2, EN61000-3-3 or equivalent
Note: Chassis shall have 2 Nos. of dummy slots for future expansion		

4.2. Controller

Sl No.	Description	Specification
1	Controller	Embedded controller/ PXI/ PXle /Proprietary controller with real time storage and analysis
2	Processor	Core i7 or better
3	Processor speed	2.6 GHz or higher
4	Operating system	Latest Windows / Linux / RTOS / proprietary
5	RAM	16 GB and expandable up to 64 GB
6	Hard disk size	512 GB or higher
7	Communication	Shall support GPIB, RJ-45 port
8	Data Interface	Ethernet 10 GB, LAN, USB (4 Nos.)
9	LED indication	System failure, Power on Alarm, Network Connectivity Indication etc

4.3. Digital Multimeter card

Sl No.	Description	Specification
1	Digits of resolution	6.5 or better
2	Minimum DC voltage range	± 300V (minimum)
3	Maximum Sampling rate	1.8MS/s or higher
4	Basic DC voltage accuracy	25 ppm or higher
5	DC current range	-3 A to 3 A
6	Shall be capable of AC/DC voltage, AC/DC current and 2- or 4-wire resistance measurements, as well as diode tests.	

4.4. Oscilloscope card

Sl No.	Description	Specification
1	Minimum No. of channels	2
2	Resolution	8 bits or higher
3	Sampling rate	1G S/s or higher
4	Bandwidth	100MHz or higher

4.5. Switch module

Sl No.	Description	Specification
1	Maximum DC voltage	150V (DC & AC) or higher
2	Maximum current (carry)	1A or higher
3	Relay type	Electro Magnetic Relay (EMR)
4	Bandwidth	10MHz or higher
5	Minimum No. of cross points	128

4.6. Digital I/O module

Sl No.	Description	Specification
1	No. of digital Inputs	24 or above
2	No. of digital Outputs	24 or above
3	Digital input voltage range	-60 to 60 V
4	Output voltage range	-60 to 60 V

5	Signaling type	Single ended
Note: Channel to channel isolation is required		

4.7. Power supply

Sl No.	Description	Specification
1	Input voltage	230VAC, 50Hz, single phase
2	Rated output voltage	0 - 100V or higher
3	Rated output current	0 - 8A or higher
4	Minimum rated output power	800W or higher
5	Maximum line regulation	0.01% of rated output +2mV
6	Maximum load regulation	0.01% of rated output +2mV
7	Ripple and noise	< $10mV_{rms}$
8	Protection	Over voltage, over current and over temperature
9	Indications	Voltage & Current :4 digit Accuracy: 0.5%
10	Operating temperature	10-50˚C
11	Humidity	10 to 95%
12	Power factor	0.99
13	Cooling	Suitable cooling to be provided
Note: Power supply shall be interfaced to PC/controller, shall be programmable through software and obey maximum safe voltage condition.		

4.8. PC

Sl No.	Description	Specification
1	Processor	Core i5
2	Monitor	21” or above
3	RAM	8GB or above
4	Hard disk drive size	1TB or above
5	Operating system	Latest Windows / Linux / RTOS / proprietary
6	USB ports	4 or above
7	Input power supply	230VAC, 50Hz, Single phase
8	Office tools	Latest office tools with perpetual license

Note: Sufficient PCI slots, HDMI & RJ 45 ports shall be provided. Keyboard and mouse shall be provided.

4.9. Colour printer with scanner

Sl No.	Description	Specification
1	Printable Area	Shall support A4 size print & scan
2	Resolution	600 x 600 True DPI
3	Print direction	Duplex
4	Input power supply	230VAC, 50Hz, single phase
5	Print support	Both black, white and color

5. SCOPE OF WORK

5.1. SUPPLIER'S SCOPE OF WORK

- Design of Automated electrical test unit.
- Obtaining LPSC approval for the design.
- For technical evaluation, party shall provide design of hardware and software that includes algorithms used in the design flow.
- Party shall specify the make of all the bought-out items, mention the bill of materials and list of essential spares in the tender. Party should enclose the detailed specification catalogue and specification compliance matrix.
- The party shall provide factory acceptance test document. Validation is to be carried out at party's site before dispatch and after installation at LPSC(B).
- The product shall have protection for Electrostatic discharge, electromagnetic interference, over voltage/over current and output driver failure.
- Input power will be 220-240V AC, 50 Hz, single phase.
- Power requirement for timer, driver circuit, LEDs, push button, switches must be incorporated internally in the interface unit.
- All components of the unit shall be of industrial standard.
- The party shall provide interface box to connect various valves (Series/ parallel) to the test unit.

- The ATU should be supplied with latest supported Operating system and in case the OS of the ATU goes out of support, vendor should support in upgrading the software to a supported version of OS during warranty and AMC period.
- All Software shall be supplied with perpetual license.
- The party shall ensure driver circuit back EMF protection.
- All the parties should visit LPSC(B) before bidding on the notified date to understand the requirement by visualizing the manual mode of testing at LPSC(B). The offers submitted by parties participating in site visit only will be considered for evaluation.
- If the party is not an OEM, the party must provide an authorization certificate from OEM.
- The party shall provide earlier PO copies of similar Data Acquisition System delivered to other Aerospace / Government Institutions.
- **Warranty**: 12 months from the date of commissioning and acceptance of the system at LPSC.
- Party shall quote for non-comprehensive AMC for a period of three years after expiry of warranty period.
- Bid should contain split up cost of unit cost and AMC cost. Evaluation shall be based on both unit cost and AMC cost.
- The release of AMC order after completion of 1-year warranty is at the discretion of LPSC(B). In case AMC order is not released, service should be provided on chargeable basis.
- Party shall quote for minimum spares for trouble free operation of unit for 2 years.
- Party shall assure availability of all components of ATU for at least 6 years from date of supply.
- **Installation and commissioning**: The supplier shall take full responsibility of installation & commissioning of the systems at LPSC(B) including onsite acceptance tests and demonstration of performance of the system before handing over the system to LPSC(B). The party shall provide training to LPSC personnel after commissioning.
- **Documentation**: Operation manual, service manual, detailed engineering document with all necessary drawings of ATU shall be provided. After installation and validation of the system, application software code has to be given to LPSC(B).
- **Pre Dispatch Inspection (PDI):** PDI shall be carried out before the dispatch of item in presence of LPSC-B team.

5.2. LPSC SCOPE OF WORK

a. To review and approve the design of the system.
b. To make ready the installation site.
c. Insulation Resistance meter will be provided at the time of Installation and validation of the system.
d. The test components FCV, LV & TCA and the driver circuit required for the response test for these components will be provided by LPSC(B) at the time of testing the unit at LPSC (B).

5.3. QUALITY CLAUSE

a. Certificate of Conformance or Test Report for the ATU with all relevant data shall be provided by vendor.
b. Upon commissioning, validation shall be carried out as per the approved validation document at LPSC, Bengaluru.
c. All implemented protection methods shall meet the relevant safety standards.
d. Ensure proper grounding and shielding of the equipment.
e. The item shall be suitably packed as per standard procedure to avoid damage or deterioration during transportation, handling and storage.
f. The following standards shall be complied & OEM Certification shall be provided.
    i. Electromagnetic compatibility-2004/108/EC or equivalent.
    ii. Electrical equipment for measurement, control and laboratory use, Part 1(EN 61326-1:2006 or equivalent).
    iii. Safety requirements for electrical equipment for measurement, control and laboratory use, Part 1- EN 61010-1 or equivalent.

5.4. SCOPE OF WORK FOR AMC

Scope of the work includes that the party shall be held responsible to check the system thoroughly and identify the problems if any, rectify the same and demonstrate the system performance to a satisfactory level during preventive as well as breakdown maintenance.

Type: Non-Comprehensive

Duration of AMC: 3 years

Quantity: 01 No.

Preventive maintenance:

Preventive maintenance frequency: Half yearly

Preventive maintenance: Total 2 visits per year shall be made (6 visits in 3 years)

Breakdown maintenance:

Any number of breakdown calls during the contract period without any additional charges. The breakdown visit should cover the following:

- The party should respond and attend to the problem within 24 hours from the time of intimation by LPSC(B).
- Checking the system against breakdown.
- Identify the nature of problem/s.
- Rectify the identified problem/s and set right the system.
- Demonstration of satisfactory performance of the system.

6. VALVE SPECIFICATION (This is for reference to vendors)

6.1. Flow Control Valve

Sl No	Parameters	1N Valve	11N Valve	100N Valve
1	Coil Resistance	85±5Ω (US & DS each)	65±5Ω (US & DS each)	35 ± 2Ω
2	Insulation Resistance	>50MΩ at predefined DC voltage		
3	Pull in voltage	25V DC (max)		21V DC (Max)
4	Drop out voltage	1.5 V DC (min)		2V DC (min)
5	ON & OFF response	10ms (max) at 37V DC		25ms (max) at 28V DC 15ms (max) at 42V DC

6.2. Latch Valve

Sl No	Parameters	Value
1	Coil Resistance	90±5Ω (OC & CC each)

2	Insulation Resistance	>50MΩ at predefined DC voltage
3	Minimum actuation voltage (V_{MA})	3V DC ≤ V_{MA} ≤18 V DC
4	Response (in ms)	20ms (max) at 28V DC & 42V DC

6.3. Thruster Chamber Assembly @ 70V application

Sl No	Parameters	Value
1	Coil Resistance	130 ± 10 Ω
2	Insulation Resistance	>50MΩ at predefined DC voltage
3	Pull in voltage	50V DC (max)
4	Drop out voltage	3 V DC (min)
5	ON & OFF response	10ms (max) at 37V DC

6.4. Driver Circuit Pin details (25 pin connector)

Sl No	Description	Pin No.
1	Supply Voltage	9
2	Input -1, 0 to 5V	3
3	Output - 1	11
4	Input – 2, 0 to 5V	5
5	Output -2	13
6	D. Gnd, Ret	2, 23, 24

7. TEST RESULT FORMATS

LPSC Logo **LIQUID PROPULSION SYSTEMS CENTRE, BENGALURU** **ISRO logo**

Test result format of 1N/11N FCV

Project: (type/editable) **Date, Temp (˚C), RH (%)**

Post assembly test: (type/editable) **Inlet pressure (absolute bar):**

FCV ID	Spec	Valve ID 1	Valve ID 2	Valve ID 3	Valve ID 4
CR: (Ω)					
US	**85 ± 5 Ω (1N)**				
DS	**65 ± 5 Ω (11N)**				
IR: (MΩ)					
US	**> 50MΩ @**				
DS	**100VDC**				
Pull in Voltage (V)					
US	**25VDC(Max)**				
DS					
parallel					
Drop out Voltage (V)					
US	**1.5VDC(Min)**				
DS					
parallel					
On response (ms)					
US	**10ms (Max)**				
DS					
parallel					
Off response (ms)					
US	**10ms (Max)**				
DS					
parallel					

Test done: **Engr-in-charge:** **QA, Engr:**

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Test result format of SFLV/BPLV

Project: (type/editable) **Date, Temp (˚C), RH (%)**

Post assembly test: (type/editable) **Inlet pressure (absolute bar):**

Flow media: GN_2/DM water

SFLV/BPLV ID	Spec	Valve ID 1	Valve ID 2	Valve ID 3	Valve ID 4
CR: (Ω)					
OC	**90 ± 5 Ω**				
CC					
IR: (MΩ)					
OC	**> 50MΩ @ 100VDC**				
CC					
Micro switch					
Minimum actuation Voltage (V)					
OC	**3V < V_{MAV} < 18V**				
CC					
On response (ms) @ 28V (Configurable)					
OC	**20ms (Max)**				
CC					
Off response (ms) @ 28V (Configurable)					
OC	**20ms (Max)**				
CC					
On response (ms) @42V (Configurable)					
US	**20ms (Max)**				
DS					
Off response (ms) @42V (Configurable)					
US	**20ms (Max)**				
DS					

Test done: **Engr-in-charge:** **QA, Engr:**

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Test result format of TCA @ 42V

Project: (type/editable) **Date, Temp (˚C), RH (%)**

Post assembly test: (type/editable) **Inlet pressure (absolute bar):**

TCA ID	**Spec**	**TCA ID 1**	**TCA ID 2**	**TCA ID 3**	**TCA ID 4**
FCV ID		**Valve ID 1**	**Valve ID 2**	**Valve ID 3**	**Valve ID 4**
CBH (M) ID		**CBH ID 1**	**CBH ID 2**	**CBH ID 3**	**CBH ID 4**
CBH (R) ID		**CBH ID 1**	**CBH ID 2**	**CBH ID 3**	**CBH ID 4**
Thermocouple ID		**TC ID 1**	**TC ID 2**	**TC ID 3**	**TC ID 4**
CR: (Ω)					
US	**85 ± 5 Ω (1N)**				
DS	**65 ± 5 Ω (11N)**				
FCV heater H1	**3.2kΩ (Nominal)**				
FCV heater H2					
FCV heater H3					
FCV heater H4					
Thermistor T1	**10kΩ (Nominal)**				
Thermistor T2					
CBH (main)	**178 ± 10 Ω (1W)**				
CBH (redn)	**415 ± 10 Ω (3W)**				
TC	**16 ± 2 Ω**				
IR: (MΩ)					
US	**> 50MΩ @ 100VDC**				
DS					
CBH (main)					
CBH (redn)					
TC	**> 50MΩ @ 50VDC**				
Pull in Voltage (V)					
US	**25VDC(Max)**				
DS					

parallel					
Drop out Voltage (V)					
US	**1.5VDC(Min)**				
DS					
parallel					
On response (ms)					
US	**10ms (Max)**				
DS					
parallel					
Off response (ms)					
US	**10ms (Max)**				
DS					
parallel					

Note: FCV heaters exist after module assembly and can be 2 or more Nos depending on project requirement.

Test done: **Engr-in-charge:** **QA, Engr:**

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Test result format of TCA @ 70V

Project: (type/editable) **Date, Temp (˚C), RH (%)**

Post assembly test: (type/editable) **Inlet pressure (absolute bar):**

TCA ID	**Spec**	**TCA ID 1**	**TCA ID 2**	**TCA ID 3**	**TCA ID 4**
FCV ID		**Valve ID 1**	**Valve ID 2**	**Valve ID 3**	**Valve ID 4**
CBH (M) ID		**CBH ID 1**	**CBH ID 2**	**CBH ID 3**	**CBH ID 4**
CBH (R) ID		**CBH ID 1**	**CBH ID 2**	**CBH ID 3**	**CBH ID 4**
Thermocouple ID		**TC ID 1**	**TC ID 2**	**TC ID 3**	**TC ID 4**
CR: (Ω)					
FCV	**130 ± 10 Ω (1N)**				
FCV heater H1	**3.2kΩ (Nominal)**				
FCV heater H2					
Thermistor T1	**10kΩ (Nominal)**				
CBH (main)	**178 ± 10 Ω (1W)**				
CBH (redn)					
TC	**16 ± 2 Ω**				
IR: (MΩ)					
FCV	**> 50MΩ @ 100VDC**				
CBH (main)					
CBH (redn)					
TC	**> 50MΩ @ 50VDC**				
Pull in Voltage (V)	**50VDC (Max)**				
Drop out Voltage (V)	**3V (Min)**				
On response (ms)	**10ms (Max)**				
Off response (ms)					

Note: FCV heaters, thermisors exist after module assembly and can be 2 or more Nos depending on project requirement.

Test done: **Engr-in-charge:** **QA, Engr:**

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Test result format of 100N FCV

Project: (type/editable) **Date, Temp (˚C), RH (%)**

Post assembly test: (type/editable) **Inlet pressure (absolute bar):**

100N FCV ID	Spec	Valve ID 1	Valve ID 2	Valve ID 3	Valve ID 4
CR: (Ω)	35 ± 2 Ω				
IR: (MΩ)	> 50MΩ @ 250VDC				
Pull in Voltage (V) @ no load	21VDC (Max)				
Drop out Voltage (V) @ no load	2VDC (Min)				
Pull in Voltage (V) @ 25bar (g)	21VDC (Max)				
On response (ms) @ 28V	25ms (Max)				
Off response (ms) @ 28V	25ms (Max)				
On response (ms) @ 42V	15ms (Max)				
Off response (ms) @ 42V	15ms (Max)				

Note: As 100N FCV test involves with and without load, unit should be aware or ask the user whether load is given or not given.

Test done: **Engr-in-charge:** **QA, Engr:**