Servo Hydraulic Universal Fatigue Testing System
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(Capacity-Ranges from 10kN-1000kN)

HI100 Series of Servo Hydraulic Universal Fatigue Testing systems are suitable for fatigue and static loading applications, are compact in design, easy to operate, sturdy loading units with enough clearance both horizontal and vertical, to suit the test requirements of fracture mechanics, fatigue loading & static loading applications.

Application of the system

The system finds wide application in the following industries-

1. Automobile
2. Rubber
3. Textile
4. Metallurgy
5. Shock Absorber
6. Railways Components
7. Wood and many others.

Salient features of the System are

- Machine capacity- 10kN-500kN (Two pillar model) and above 500kN four pillar model
- Sturdy Floor standing Load frame with actuator mounted on the crosshead or at lower base plate
- Wide column spacing can accommodate large fixtures as well as environmental chambers
- Anti-vibration mounting for the Load frame and Hydraulic Power pack
- Fatigue rated double acting actuator for universal loading i.e. Tension and compression
- High speed servo valve for precise controlling
- Easily accessible service manifold
- Hydraulically operated cross head movement through jacks with hydraulic locking arrangement at desired position
- Simple to operate & accessible control switches
- Fully computer controlled operation with facility for standalone operation on request
- High speed controlling and data acquisition with minimum four control channels
- Suitable capacity Hydraulic Power Supply to run the system as per requirement
- The system is ideal for performing following tests and many more in Dynamic as well as Static loading with Load/Stress or Stroke or Strain control options as per relevant standard
  i) Tension
  ii) Compression
  iii) Bending Test (3-Point/4-Point)
  iv) Shear
  v) HCF
  vi) LCF
  vii) K1C & J1C
  viii) Fracture toughness
  ix) Fatigue crack growth
  x) Strength of components and their durability
  xi) Environmental Testing
Extra height frame option is also available for longer test specimens.

Wide range of test accessories, grips and fixtures are available which allows a wide range of testing options on stiff as well as soft materials.

The main components of the system are:

1. Load Frame with side jacks including
   a) Actuator with Servo Valve manifold
   b) Load Cell
   c) Displacement Transducer
   d) Electrical Control Panel

2. Hydraulic Power Pack with Electrical Control Cabinet

3. PC based Control System and Application Software includes
   a) Signal Conditioning and Controlling Unit
   b) Computer for Controlling and Data acquisition
   c) Control and Analysis Software

The description of the different parts of the machine is given below-

1. **LOAD FRAME WITH SIDE JACKS**

   It is a free standing load frame with two vertical columns. The frame is rigid and robust, and duly stress relieved structure capable of withstanding 1.5 times the normal developed force.

   Cross head with two hydraulic locking jacks slide over these columns and can be clamped anywhere over the entire length. Controls are provided for lifting and lowering of the middle crosshead. Arrangement is also provided for locking of the crosshead at any desired position. A suitable capacity load cell is mounted on the frame cross head or middle plate as per requirement. Manifold is provided at the base for proper distribution of oil to the actuator and hydraulic-lock. Anti vibration pads are mounted on the base.

   An operator control panel is fixed on the frame for HPS ON/Off, Manual actuator movement, emergency stop, switch for movement of the cross head etc.

   A suitable capacity Fatigue rated hydraulic actuator is mounted on the crosshead (Model-HIC) or at the lower base plate (Model-HIB) of the frame as per requirement.

### TABLE-1 LOADING FRAME (CAPACITY: 10kN – 500kN)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>HIC100.010</th>
<th>HIC100.025</th>
<th>HIC100.050</th>
<th>HIC100.100</th>
<th>HIC100.250</th>
<th>HIC100.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Capacity (kN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Minimum Vertical Clearance (C) in mm*</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Maximum Vertical Clearance (D) in mm*</td>
<td>1000</td>
<td>1000</td>
<td>1300</td>
<td>1300</td>
<td>1650</td>
<td>2200</td>
</tr>
<tr>
<td>4</td>
<td>Horizontal Clearance (E) in mm</td>
<td>550</td>
<td>550</td>
<td>550</td>
<td>550</td>
<td>650</td>
<td>775</td>
</tr>
<tr>
<td>5</td>
<td>Diameter of Column Shaft (F) in mm</td>
<td>45</td>
<td>55</td>
<td>65</td>
<td>80</td>
<td>100</td>
<td>140</td>
</tr>
<tr>
<td>6</td>
<td>Working Height (G) in mm</td>
<td>1090</td>
<td>1090</td>
<td>1090</td>
<td>1090</td>
<td>1090</td>
<td>1090</td>
</tr>
<tr>
<td>7</td>
<td>Total Height (H) in mm(Approx)</td>
<td>2290</td>
<td>2290</td>
<td>2590</td>
<td>2590</td>
<td>3000</td>
<td>4000</td>
</tr>
<tr>
<td>8</td>
<td>Base Dimension (I X J) in mm</td>
<td>920x600</td>
<td>920x600</td>
<td>1020x700</td>
<td>1050x700</td>
<td>1200x800</td>
<td>1350x900</td>
</tr>
<tr>
<td>9</td>
<td>Net Weight (Kg.)(Approx.)</td>
<td>200</td>
<td>300</td>
<td>600</td>
<td>800</td>
<td>1050</td>
<td>1750</td>
</tr>
</tbody>
</table>

* Minimum and Maximum Vertical Clearance are given keeping piston at mid position.
**Actuator with Servo valve Manifold**

Actuator is a linear motion device, which gives a controlled motion either on stress basis or strain basis. It is a precision piece of equipment which follows the command signal from the wave generator through the servo valve. It is an equal area ram and piston with surface finish of 0.2 microns. End plates have metallic seals for side thrust. A co-axially mounted displacement transducer is fitted in the actuator for precise measurement of stroke/displacement.

**TABLE-2 ACTUATOR**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HI85.10</th>
<th>HI85.25</th>
<th>HI85.50</th>
<th>HI85.100</th>
<th>HI85.250</th>
<th>HI85.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity in Compression (kN)</td>
<td>10</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Capacity in Tension (kN)</td>
<td>10</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Type</td>
<td>Double Acting (Single/Double Ended depending upon requirement)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Total Stroke (mm)</td>
<td>100</td>
<td>100/200</td>
<td>150/250</td>
<td>150/250</td>
<td>150/250</td>
<td>150/250</td>
</tr>
<tr>
<td>Max. Working Pressure (kg/ cm²)</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Servo Valve (LPM)</td>
<td>4/20/40</td>
<td>4/20/40</td>
<td>40/60</td>
<td>40/60/80</td>
<td>40/60/80</td>
<td>40/60/80</td>
</tr>
<tr>
<td><strong>Minimum Frequency (Hz)</strong></td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Frequency (Hz)</strong></td>
<td></td>
<td></td>
<td></td>
<td>100 or even more</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Stroke length up to 500mm can also be provided as per customer requirement

**The test stroke length depends upon the frequency of operation i.e. it decreases with increase in frequency and vice versa. Therefore, test stroke is to be calculated from the Performance curve of the actuator operated through given hydraulic power pack.**
**SERVO VALVE MANIFOLD**

A servo valve with Pressure Line filter & Accumulators is fitted on the manifold block that controls the movement of the ram as per given command signal from controlled electronics.

**Servo Valve**

The servo control valves are throttle valve for 4 way applications. It is two or three stage valve that is suitable for a rated with a pressure drop of 1000 P.S.I (70 Kg/cm²). The output stage is a closed center four way sliding spool.

Make of Servo Valve - MOOG/STAR

Flow - 4LPM/20LPM/40LPM/60LPM/95LPM (Depending upon requirement)

Some of the salient features of the valve are

- 2 stage design with dry torque motor
- Low friction double nozzle pilot stage
- High Spool control force
- High dynamics
- Long life and rugged design
- Low hysteresis
- Field replaceable first stage disc filter

**Pressure Line Filter**

It is an interface between hydraulic pump and servo valve. Pressure line filter is attached next to the servo valve. Servo valve is a very sensitive controlling gadget. It has very fine nozzles. If any particle gets into these nozzles, the possibility is that the system will not respond at all. For maintenance the valve has to be sent to the manufacturer. Filtration in the high pressure filter is 3 µ absolute. The position of the filter is such that the cartridge can be replaced without opening any pipe line.

Make - EPE/ Hydroline/ Hydac

Capacity - 3 µ

**Accumulators**

Diaphragm type accumulators have been used in the system for -

- Fluid Power Storage
- Counter Balance
- Pulsation Dampner
- Hydraulic Semi Shock Damper
- Emergency energy reserve
- Shock absorber
- Volume compensator
- Hydraulic Spring
- Fluid Separator

For appropriate efficiency of the system suitable accumulators are used for both the ‘A’ and ‘B’ port.

Make - EPE/ Hydroline/ Hydac

Capacity - 0.16/0.32/0.5Litres (Depending upon the capacity of actuator and application)
b) Load Cell

It is a strain gauge based type load cell with full wheat-stone bridge configuration. Structure of the load cell is such that it can be loaded in compression over few million numbers of times. It has Alloy tool steel, electro less nickel plated structure for outstanding corrosion resistance.

**Technical Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>+/-10kN to +/-1000 kN</td>
</tr>
<tr>
<td>Make</td>
<td>Adi-Artech/ Sensotronics</td>
</tr>
<tr>
<td>Full Scale Output</td>
<td>2.0 mV/V</td>
</tr>
<tr>
<td>Non-Linearity</td>
<td>&lt; + 0.05% FSO</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>&lt; + 0.05% FSO</td>
</tr>
<tr>
<td>Non-Repeatability</td>
<td>&lt; + 0.05% FSO</td>
</tr>
<tr>
<td>Creep (30 minutes)</td>
<td>&lt; + 0.03% FSO</td>
</tr>
<tr>
<td>Excitation Voltage</td>
<td>10 Volts DC</td>
</tr>
<tr>
<td>Safe overload</td>
<td>150%</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>0° C to +60° C</td>
</tr>
<tr>
<td>Protection Class</td>
<td>IP68</td>
</tr>
</tbody>
</table>

c) Displacement Transducer

Actuator has integral displacement sensor which is co-axially fitted to the lower part of the actuator. Magnetic ring is fixed to the ram of the actuator. It is contact less linear position transducer with magnetostrictive technology. The absence of Electrical contact on the cursor eliminates all wear and guarantee almost unlimited life.

**Salient feature of Linear Transducer:**

- ONDA technology
- Optimized mechanical structure
- Strokes from 50 to 4000 mm
- Wide range of connectors for the electrical connection
- Rod, nipple, Hexagonal flange AISI 316
- Work temperature: -30° to +75°C
- Resistance to vibrations (DIN IEC68T2/6 12g)
- Power supply 24Vdc ± 20%
- Immunity to shock, vibration, contamination and electrical noise.
- An absolute output signal

**Technical Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>100mm to 500mm</td>
</tr>
<tr>
<td>Make</td>
<td>Gefran/Balluff</td>
</tr>
<tr>
<td>Full Scale Output</td>
<td>10.0 Volts</td>
</tr>
<tr>
<td>Independent Linearity</td>
<td>+ 0.02% of FS</td>
</tr>
<tr>
<td>Repeatability</td>
<td>&lt;0.01mm</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>&lt;0.01mm</td>
</tr>
<tr>
<td>Pressure Withstand</td>
<td>Up to 600 Bars</td>
</tr>
<tr>
<td>Excitation Voltage</td>
<td>24 Volts DC</td>
</tr>
<tr>
<td>Sampling Rate fStandard</td>
<td>2kHz</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-30° to +75° C</td>
</tr>
<tr>
<td>Protection Class</td>
<td>IP67</td>
</tr>
</tbody>
</table>
2. HYDRAULIC POWER PACK (HPS UNIT)

Hydraulic power supplies are compact in design and are suitable for the supply of required flow and pressure for the actuation of the actuator to carry out various tests as per different standard for dynamic/static tests. It has an oil tank of adequate capacity, a pump powered by a single/three phase motor. It includes all the accessories like return line filter, oil level, relief valve, pressure gauge, Bye pass valve in case of clogging of the filter etc. Anti vibration mountings are provided as standard along with the HPS.

Features

- Provided with a large reservoir nearly 3 – 4 times the capacity of the pressure pump
- Vane/Gear type pump for better life
- Filtration of 3 microns absolute for the protection of servo valve and also for the smooth functioning of the valve.
- Inter locking at each stage for the protection of the components as well as oil
- Starting at almost zero pressure the switching over to full pressure through solenoid and timer switch provided.
- Submersed inlet with filter for pump protection.

A suitable water cooled heat exchanger or Air Cooling arrangement is provided for cooling of the hydraulic oil. Temperature controller is provided to prevent overheating of the hydraulic beyond 50°C.

Safety interlocks are also provided as standard with the HPU and trips the system, in case any of the interlock is activated.

- Over heating of the oil (Temperature Controller),
- Contamination of the oil (Clogging Filter),
- Relief Valve for pressure regulation,
- over loading of the motor,
- Phase failure,
- Low oil Level

These supplies are compatible with loading units / actuators of different sizes/capacities manufactured by HEICO.

### TABLE-3 HYDRAULIC POWER PACK

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HI 595.01</th>
<th>HI 595.05</th>
<th>HI 595.10</th>
<th>HI 595.15</th>
<th>HI 595.20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow of Pump (LPM)</td>
<td>5</td>
<td>20</td>
<td>40</td>
<td>53/64</td>
<td>95</td>
</tr>
<tr>
<td>Type of Pump</td>
<td>Vane/gear</td>
<td>Vane/gear</td>
<td>Vane/gear</td>
<td>Vane/gear</td>
<td>Vane/gear</td>
</tr>
<tr>
<td>Max. Operating Pressure (kg/cm²)</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>Make of Pump</td>
<td></td>
<td></td>
<td></td>
<td>Vickers/ Douty/ Dennison</td>
<td></td>
</tr>
<tr>
<td>Capacity of the Oil Tank (Litres)</td>
<td>100</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Motor Rating (HP)</td>
<td>2</td>
<td>10</td>
<td>20</td>
<td>25/30</td>
<td>50</td>
</tr>
<tr>
<td>Make of motor</td>
<td></td>
<td></td>
<td></td>
<td>NGEF/ABB/Kirloskar/Bharat Bijlee/Crompton</td>
<td></td>
</tr>
<tr>
<td>Return line filter (µ)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Power Supply</td>
<td></td>
<td></td>
<td></td>
<td>230V AC, 1, 50Hz or 440V, 3Phase, 50Hz</td>
<td></td>
</tr>
<tr>
<td>Noise Level</td>
<td>&lt;70dB</td>
<td></td>
<td></td>
<td></td>
<td>&lt;72dB</td>
</tr>
</tbody>
</table>

Note- Cooling Tower is to be purchased separately in case of water cooled heat exchanger.
ELECTRICAL CONTROL CABINET

This Electrical control Cabinet consisting of Electrical Components like:-

(1) Contactors
(2) Time delay relays
(3) Power inlet points
(4) Indicating lamps (RYB)
(5) Temperature Controller

and other electrical accessories are fixed inside the Electrical Control cabinet having protection class IP65.

System will be supplied with necessary cable and fittings for the operation of the machine.

C. PC BASED CONTROL SYSTEM AND CONTROL SOFTWARE

Control system provides the digital servo control, Wave generation for the actuator, data acquisition, hydraulic control etc. for the continuous operation of the system.

(a) Signal Conditioning & Controlling Unit

HEICO Servo controller basically consists of signal conditioning unit and controlling unit. Signal conditioning unit consists of conditioning modules for various transducers (e.g. Load Cell, Displacement Transducers, Extensometer, COD gauges etc.) that receives the output signal from these sensors and amplifies and process that signal as per the requirement and transfer it to computer through dedicated cables where it is accepted by the data acquisition system. The controlling unit controls the movement of the RAM with respect to the signal input on feedback basis either from LOAD CELL or DISPLACEMENT sensor (or through an external sensor optional).

It consists of dedicated Servo-controller card that gives the desired processed signal through the Automatic P.I.D controller to the servo valve to operate either of the control modes i.e. Load mode or Displacement mode. It also sends the signal to computer and accepts the command from the software to operate in desired manner. The parameters like rate of loading for machine, safety limits for load & displacement can initially be programmed through the software. The programming facility is given to operate the system in STATIC MODE at programmed rate of loading in both Load and Displacement controls. In DYNAMIC MODE the cycling can be done at a frequency from 0.01Hz-100Hz or even higher.

Specifications of Controller

- 32-bit Auto PID operation with auto zeroing, auto tuning and auto-adjustment feature servo operation
- Closed loop update rate is 10 kHz
- Facility to expand up to 4 Independent Control modules with independent wave generator
- No. of control channels- 3 (Load/Displacement/External Transducer (COD))
- 12-Additional Analog Input channels to accept analog input signals from different sources such as strain gauge, LVDT, load cells, temperature sensors etc. (To be specified by customer)
- Demand Wave generation - Sine, Triangular, Square, Random wave forms and Ramp signal
• Standalone operation to Start, Stop & Hold the test system
• High speed Data Acquisition card with 100 kHz sampling rate and 16-bit/24-bit/32-bit resolution acquires data from the signal conditioning and controlling unit
• System accuracy: Load accuracy: ± 0.5% of indicated value of load
  Displacement accuracy: ± 0.5% of indicated value of displacement
• Two types of Loading- Dynamic (for fatigue test) and Static (Ramp)
• Dynamic Frequency Range- 0.01Hz to 100Hz or even higher (Note: The stroke of actuator depends upon the frequency of operation. Performance curve will be provided along with the offer)
• Static Ramp rate: Load control mode – Refer Table.
  Displacement control mode- Refer Table.
• Event Detector
• Environmental Temperature- 0° C to +50° C
• Relative Humidity- 10% to 85% non-condensing
• Supply Input- 220-240 VAC, 50 Hz

(b) Computer for Controlling and Data acquisition
System is provided with dedicated computer of latest available configuration with built in data acquisition card and wave generator.

(Note- Latest available model of the computer will be supplied at the time of delivery)

CONTROL SOFTWARE
Control software provides flexibility to user to conduct the various tests as per related standards and to do statistical analysis of test results and report generation. Control software is the integral part of the system for precise controlling & Data Acquisition and analysis.

Salient Features
• Windows based user friendly software
• High speed Data Acquisition card with 100 kHz sampling rate and 16-bit/24-bit/32-bit resolution acquires data from the signal conditioning and controlling unit
• Create and define test set-ups and data acquisition
• Suitable for Simple Tension, Compression & Flexural test in static mode
• Suitable to carry out Low cyclic fatigue tests, Fracture toughness, fatigue crack growth etc.
• Test control options: Load/ Stress, Total Strain and incremental strain
• Different types of loading can be given to the sample- Sine, Triangular, Square, Random waveform, Ramp signal etc. with frequency 0.01 to 100 Hz.
• Programmable Loading parameters – Frequency, Base, Amplitude etc.
• Programmable rate of loading in static mode
• Two types of Tests- Dynamic (for fatigue test) and Static (Ramp).
• Defining test sequences
• Computer/Software programmable Safety Limits for each load & displacement
• Independent Taring of each channel
• Facility to hold the actuator and restart the loading during the test.
• Facility to increase the Base load, frequency and amplitude during the test
• Facility to save the data after the test
• Displays and Store the number of cycles in Dynamic test
• On-line graphic display of load, displacement, extensometer, COD gauge data along with numerical readings
• Data display and storage of additional channels
• Auto adjustment of graph scales
• Storing of data of each channel in user defined file/directory that can be directly opened in Excel and Analysis Software

ANALYSIS SOFTWARE

Analysis software provides flexibility to user to do statistical analysis of test results and report generation.

Salient features

• Plotting of following graphs-
  a) Load v/s Time
  b) Displacement v/s Time
  c) Load v/s Displacement
  d) Stress v/s Strain
• Calculation of various parameters depending upon the test conducted on the polymer composite material—Peak Load, Tensile Strength, Yield Point Elongation (YPE), 0.2% proof stress, Maximum deformation/extension at peak load, Compressive Strength, Modulus of Elasticity, Flexural Strength, Absorbed energy by specimen from the start of test through to the end of test etc.
• Facility to print the data and all the graphs
• Statistical analysis of the test results
• Batch Summary Report with statistical data & print facility
• Detailed Summary Report with print of all graphs
• Facility to export data to excel
**TABLE 4 - ELECTRONIC CONTROLLER & DATA ACQUISITION SYSTEM**

<table>
<thead>
<tr>
<th>MODEL</th>
<th>HI85.10</th>
<th>HI85.25</th>
<th>HI85.50</th>
<th>HI85.100</th>
<th>HI85.250</th>
<th>HI85.500</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ELECTRONIC CONTROLLER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closed Loop Update Rate (KHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>No. of system</td>
<td>4 Independent control module with independent wave generator</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Control Channels</td>
<td>3 (Each control module has 3 control channels)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Parameters</td>
<td>Load/Displacement/External Transducer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waveform Generation</td>
<td>Sine/Haversine/Square/Triangular/Random/Ramp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of Loading</td>
<td>Dynamic/Static</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Closed Frequency (Min.)</strong></td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Closed Frequency (Max.)</strong></td>
<td>≥100</td>
<td>≥100</td>
<td>≥100</td>
<td>≥50</td>
<td>≥50</td>
<td>≥50</td>
</tr>
<tr>
<td>No. of Data Points per cycle</td>
<td>128 up 10Hz frequency and 64 above 10Hz</td>
<td></td>
<td></td>
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<tr>
<td><strong>DATA ACQUISITION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>No. of Additional channels</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
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</tr>
<tr>
<td>Resolution</td>
<td>16/24/32-bit</td>
<td>16/24/32-bit</td>
<td>16/24/32-bit</td>
<td>16/24/32-bit</td>
<td>16/24/32-bit</td>
<td>16/24/32-bit</td>
</tr>
<tr>
<td>Sampling Rate (kHz)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Digital Inputs &amp; Outputs</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>No. of Data Points per cycle</td>
<td>128 up 10Hz frequency and 64 above 10Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Temperature (°C)</td>
<td>0-50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Input</td>
<td>220-240 VAC, 50 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The test stroke length depends upon the frequency of operation i.e. it decreases with increase in frequency and vice versa. Therefore, test stroke is to be calculated from the Performance curve of the actuator determined with given hydraulic power pack.
ACCESSORIES

A. GRIPS & FIXTURES

Grips and fixtures are supplied with the system to conduct Tension, Compression and Bend tests on the specimen of different sizes.

1. Tension Test Grips

Room Temperature Fatigue rated hydraulically operated wedge action grips have been designed to grip various sizes and shapes of ferrous or non-ferrous specimens suitable for tensile test applications in both static and dynamic loading. These grips are ideal for testing of the round or flat specimens. Outer housing remains the same where as the inserts for tension tests can be changed from the side to suit round or flat specimens.

   a. Clamping jaws for Round specimens (mm): 5-25
   b. Clamping jaws for Round specimens (mm): 25-45
   c. Clamping jaws for Flat specimens (mm) : 0-10
   : 10-20
   : 20-40
   (Maximum Width of specimen) : 50mm

Note: Different clamping jaws sizes can be supplied as per customer requirement.

2. Low Cyclic fatigue grips

This room temperature self aligning type low cycle fatigue grips are suitable for testing sample of different diameter as per ASTM E606

3. High Cyclic fatigue grips

This self aligning type high cycle fatigue grips are suitable for testing sample of different diameter as per ASTM E466

4. Compact Tension Grips

These Room Temperature CT grips are suitable for fatigue crack growth rate, K1c and J1c tests for CT samples of width 50mm/25mm & thickness 25mm/12.5mm as per ASTM E647, ASTM E399, ASTM E813, ASTM E1820.

5. Compression Test Platens

A set of compression platens made from hardened steel with chrome plating will be supplied.

Diameter of Compression Platen - 100mm/150mm/250mm/300mm

6. Bend Test fixture

A suitable room temperature fatigue rated 3 Point or 4 Point Bend fixture suitable to conduct bend test as per ASTM E855 and other relevant standard

   Adjustable Span Length - 10-500mm
   Diameter of the rollers - 10mm
   Width of the rollers - 100mm
7. Shear Test Fixture
This room temperature fixture is suitable to conduct shear test as per ASTM D5379

B. EXTENSOMETERS & COD GAUGE

1. Axial Extensometer for Tensile Test
General Purpose full bridge strain gauged (350ohm) based axial extensometer suitable for tensile tests at room temperature

- **Gauge length**: 12.5mm/ 25mm/ 50mm/ 100mm (Depending upon requirement)
- **Travel**: 10% /20% /50% of gauge length (Depending upon requirement)
- **Temperature range**: 0°C to 50°C
- **Resolution**: 0.001mm
- **Accuracy**: +0.5% of readout value as per ASTM E 83

2. COD Gauge for Fracture mechanics tests
For fracture mechanics studies, these gauges are in compliance with standardized test methods, such as ASTM E 1820 for determination fracture toughness properties of metallic materials. These gauges conform to the requirements of ASTM E399 for fracture toughness and E1820 and E813 for JIC and R-curve determination. This is full bridge strain gauged (350ohm) based COD gauge suitable for Fracture mechanics tests at room temperature

- **Gauge length**: 5mm or 10mm
- **Travel**: +2.5mm/-1.0mm or +4.0mm/-1.0mm
- **Temperature range**: 0°C to 50°C
- **Resolution**: 0.001mm
- **Accuracy**: +0.5% of readout value as per ASTM E 83
- **Linearity**: 0.15% of FSO
- **Operating Force**: 9 to 14N

C. APPLICATION SOFTWARE MODULES FOR METAL TESTING

Application software provides flexibility to user to conduct the various tests as per related standards and to do statistical analysis of test results and report generation. The software provides following different application profiles/modules:-

1. Tension Tests as per ASTM E-8M
The application used for the determination of the following parameters:
   a) Ultimate Tensile Strength
   b) Upper yield stress
   c) Yield Point Elongation (YPE)
   d) Uniform Elongation
   e) 0.2% proof stress
   f) Total elongation
   g) Extension at peak load etc.
2. **Compression Tests as per ASTM E9**

The application used for the determination of the following parameters:

a) Compressive Strength  
   a) Yield Point  
   b) Yield Strength  
   c) Modulus of Elasticity etc.

3. **Fracture Mechanics application for fully automated crack growth testing as per ASTM E647.**

- Crack Length measurement from unloading compliance  
- Works with standard geometries including C(T), SE(T), D(T) etc.  
- Enables total description of tens of steps including pre-cracking, decreasing-K, constant stress ratio etc.  
- Test termination conditions includes limit on crack length, crack increment, Kmax, crack growth rate or number of cycles.  
- Includes post processing software for the computation and graphical display of da/dN Vs Delta K, Crack length Vs No of cycles and other required parameter J1c, K1c & CTOD application software as per ASTM E1820  
- Includes post processing software for E1820 package.  
- Validation of K1c, J1c, CTOD, and JR tests according to ASTM E399, ASTM E813, ASTM E1820.

4. **Low cycle fatigue testing application software as per ASTM E606**

- Loading under constant amplitude load/strain control / plastic strain control.  
- Continuous peak-trough monitoring.  
- Test termination option: drop in unloading modulus, ratio of loading / unloading modulus, number of cycles etc.  
- Test specimen temperature logging as an auxiliary input to test controls.  
- Three test control options: stress, total strain and incremental strain.  
- Frequency 0.01 to 100Hz.  
- Auto-triggered or user triggered data acquisition in all active modes.

**D. COOLING SYSTEM**

Air Cooling system for cooling of Hydraulic oil  

or

Water Cooled heat exchanger with cooling tower for cooling of Hydraulic oil

**E. ENVIRONMENTAL CHAMBER**

Suitable for controlled temperature testing between Ambient to 100°C as per customer requirement.

*** User Specification, if differ from the standard ones will be incorporated in the nearest model to suit the user’s requirement. Also, the combination of Load Frame/Actuator and Hydraulic Power Pack can be altered depending upon the user’s requirements/applications
TABLE- LOADING FRAME (CAPACITY: 10kN – 500kN)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>HIC100.010</th>
<th>HIC100.025</th>
<th>HIC100.050</th>
<th>HIC100.100</th>
<th>HIC100.250</th>
<th>HIC100.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Capacity (kN)</td>
<td>10</td>
<td>25</td>
<td>50</td>
<td>100</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>Minimum Vertical Clearance in mm*</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
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<tr>
<td>3</td>
<td>Maximum Vertical Clearance in mm*</td>
<td>1100</td>
<td>1200</td>
<td>1300</td>
<td>1300</td>
<td>1650</td>
<td>2200</td>
</tr>
<tr>
<td>4</td>
<td>Horizontal Clearance in mm</td>
<td>550</td>
<td>550</td>
<td>550</td>
<td>550</td>
<td>650</td>
<td>775</td>
</tr>
<tr>
<td>5</td>
<td>Bottom Bed Length in mm</td>
<td>1000</td>
<td>1250</td>
<td>1500</td>
<td>1500</td>
<td>2000</td>
<td>3000</td>
</tr>
<tr>
<td>6</td>
<td>Total Height in mm (Approx.)</td>
<td>2390</td>
<td>2490</td>
<td>2590</td>
<td>2590</td>
<td>3000</td>
<td>4000</td>
</tr>
</tbody>
</table>

* Minimum and Maximum Vertical Clearance are given keeping piston at mid position.

Note: The above mentioned load frames are with standard dimensions. However the clearances (Horizontal and Vertical) and other dimensions can varied as per customer requirements.