High Speed Impact Testing Machines

HITS-X Series

- Heating/cooling unit (optional)
- Test chamber (optional)
- Main testing machine unit
- Air inlet (puncture impact testing machine)
- Measurement/Control Unit

Power Supply: three-phase 200 V, 6 kVA
Single-phase 100 V, 1.5 kVA
Cooling water: 50 L/min.

Approx. 700 x 700 x 1200 mm

Units: mm

1) Locations subject to large fluctuations in temperature (Recommended: +10 °C to +35 °C)
2) Locations with high humidity, where dew condensation may form (Recommended: 20 % to 80 %)
3) Locations exposed to the direct air flow from heating/cooling systems
4) Locations exposed to direct sunlight
5) Locations with large amounts of dust
6) Locations with significant amounts of corrosive gases
7) Locations subject to strong vibrations (Recommended: 0.1 G max.)
8) Locations subject to large voltage fluctuations (Recommended: Single phase 100 V ±5 % max., Three-phase 200 V ±10 % max.)

Note: Avoid installing devices that can be negatively impacted by vibrations (such as balances) in the vicinity of the testing machine.

Related Products:
- NJ-SERVO Series
  - Electric Motor Driven Actuator
- CFT-EX Series
  - Capillary Rheometer Flowtester
  - L-Series Servopulser
  - Benchtop Hydraulic Servo Strength Testing Machine
- EMT Series
  - Electromagnetic Force Fatigue / Endurance Testing System
- MMT Series Micro-Servo
  - Electromagnetic Micro Testing Machine

Note: The main unit of the testing machine must be installed on the first floor of a building, on a concrete floor that has a thickness of at least 250 mm (capable of withstanding the own weight of 1,500 kg). The foundation needs to be constructed by the user. Avoid installing the machine on an upper or hollow floor, due to the impacts and vibration generated during high-speed testing. Although the machine is equipped with vibration-damping springs, care should be taken when selecting an installation location where vibrations could be easily transmitted. Note that the weight of the thermostatic chamber is approximately 800 kg.

Caution: Avoid locations with unsuitable conditions such as those listed below.
To reduce weight and fuel costs in the automotive industry and other transportation equipment markets, the use of plastics and composite materials has increased. Due to the superior workability of plastics compared to metals, many parts that were made of metal are now being made of plastics. However, plastics are not as resistant as metals to heat and shock. For this reason, new materials are continually being developed and these materials need to be tested.

Additionally, in order to improve the efficiency of development, the manufacturing technique is simulated during the design stage, so the accuracy of these processes is very important. An improvement in the simulation accuracy can be expected by making use of yield stress, maximum test force, and energy obtained through high-speed tensile testing.

The HITS-X high-speed tensile testing machine is capable of control at speeds up to a maximum of 20 m/s (72 km/h). By combining a high-response force detector, a volumetric displacement gauge resistant to vibration and impacts, and software that minimizes vibrational noise, sophisticated data with very little noise can be obtained.

The HITS-TX model allows obtaining baseline high speed deformation behavioral data for materials by tensile testing materials at freely selectable tensile speeds. It incorporates a newly developed high response detector and a vibration resistant volumetric displacement meter, which allow obtaining highly accurate data with minimal vibration noise.

The HITS-PX model allows puncture testing materials using impact speeds that are freely selectable. Puncture impact testing involves puncturing a flat plate specimen with a striker that has a semi-spherical tip. This testing machine allows various data, such as test force vs. displacement curves, max. test force values, energy, and displacement to be obtained easily.

**Testing Standards**
- Complies with ISO 6603-2 (JIS is expected to adopt this standard)
- ASTM D3763
Equipped with State-of-the-Art Technology

High test speeds
The hydraulic operation allows impact tests to be conducted at any speed between 0.0001 m/s and 20 m/s (72 km/h). It allows a wide range of testing speeds using a single machine.

Design to minimize the effects of impacts
The HITS Series incorporates various features to minimize the effects of impacts, including metal springs with superior vibration absorption capacity, the displacement detector resistant to vibration and shock, a striker integrated with a load detector (HITS-PX), a load detector integrated with grips (HITS-TX), and a speed reduction and stopping function that combines braking control with hydraulic cushioning (patent pending).

Specialized approach jig (HITS-TX)
Allows target speed to be reached rapidly.

State-of-the-art software
The software uses standard Windows 10 wizard format to allow intuitive and simple operation even for beginners. The software provides information such as load-displacement curve, maximum test force, displacement, energy, and inclination. Advanced processing, such as overlaying results from multiple tests or statistical analysis are standard functions.

Environmentally friendly energy-saving design
The HITS Series employs an energy-saving operation system that changes the motor speed and supply pressure for the hydraulic power unit depending on the operating status of the testing machine (patent pending). In addition, the hydraulic power unit is air cooled, so water is not necessary for cooling.

Comprehensive safety features
The HITS Series is equipped with comprehensive safety features, such as a safety cover, safety mat, and dual switch system for starting tests. In addition, for extra safety, the piston uses a mechanism that allows high-speed travel only in the test direction.

Temperature dependency for high-speed behavior (optional)
Information on the temperature dependency for specimens’ high-speed behavior can be obtained using the optional thermostatic chamber (-40 to +150°C).
High Speed Tensile Testing Machine HITS-TX

High Rate Tensile Testing Machine

Vibration Resistant Design Reduces Vibration Noise

* The standard configuration does not include a computer, monitor and printer. Please procure them separately.
(Optional) Force Detectors and Applicable Grips

Force Detector and Grip for Flat Plate Samples

<table>
<thead>
<tr>
<th>Model</th>
<th>SHL-10 kN-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>346-77909-01</td>
</tr>
<tr>
<td>Capacity</td>
<td>Maximum 10 kN (tensile)</td>
</tr>
</tbody>
</table>

High-Speed Grip for Flat Plate Samples

<table>
<thead>
<tr>
<th>Model</th>
<th>High-speed grip for flat plate samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>346-77160-02</td>
</tr>
<tr>
<td>Capacity</td>
<td>Maximum 10 kN (tensile)</td>
</tr>
<tr>
<td>Shape of Grip</td>
<td>Wedge shape: W 13 mm, H 15 mm, file teeth</td>
</tr>
<tr>
<td>Applicable Sample</td>
<td>Flat plate: Width max. 13 mm, thickness 0.5 to 3 mm</td>
</tr>
</tbody>
</table>

Load detector and grips for round rods

<table>
<thead>
<tr>
<th>Model</th>
<th>Round rod grips for high-speed tensile testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>346-77164-01</td>
</tr>
<tr>
<td>Capacity</td>
<td>Maximum 10 kN (tension)</td>
</tr>
<tr>
<td>Shape of Grip</td>
<td>M12 x 1.5 female threads</td>
</tr>
<tr>
<td>Applicable Sample</td>
<td>Round rod specimens with M12 x 1.5 threaded ends (threaded length of 20 mm or more)</td>
</tr>
</tbody>
</table>

System Functions

The hydraulic energy is temporarily stored in an accumulator, and the piston speed is controlled using a high-speed servo valve.

Accelerating mechanism for efficient tensile testing
An acceleration mechanism is required to load the specimen at a specified rate. The tapered section of the acceleration rod incorporated in the space inside the piston engages with the tapered surface of the acceleration guide, ensuring a stable speed during testing.

Approach mechanism that heightens acceleration capability
In order to apply the load at the speed that is set for the sample, an approach mechanism is required. The tapered portion of the approach rod, which is stored within the space inside the piston, engages with the tapered surface of the approach guide, and applies the load. This mechanism enables testing at a stable speed.

Safety considerations for piston movements
Comprehensive safety features such as a safety cover interlock switch, safety mat interlock switch, and two-switch start procedure ensure operator safety during high-speed piston operation.

Lightweight unitized load detector
The striker is equipped with a load detector near its tip to increase the resonant frequency of the detector and minimize the effects of vibration noise.
High Speed Puncture Impact Testing Machine HITS-PX

High Speed Puncture Impact Testing Machine

Complies with ISO 6603-2 and ASTM D 3763-93 Testing Standards (see note)

Note:
- ISO 6603-2
  Plastics – Determination of puncture impact behaviour of rigid plastics –
  Part 2:
  Instrumented impact testing
- ASTM D 3763-93
  High Speed Puncture Properties of Plastics Using Load and Displacement Sensors

* The standard configuration does not include a computer, monitor and printer. Please procure them separately.
High Speed Impact Testing Machines

**Optional Accessories** Striker, Clamping Plates

**Striker (with load detector)**

Main striker unit and tip

<table>
<thead>
<tr>
<th>Model name</th>
<th>Striker ø12.7</th>
<th>Striker ø20</th>
<th>Striker ø10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part No. for main unit</td>
<td>339-83665-02</td>
<td>339-83665-03</td>
<td>339-83665-01</td>
</tr>
<tr>
<td>Part No. for tip</td>
<td>347-40060-06</td>
<td>347-40062-09</td>
<td>347-41604-00</td>
</tr>
<tr>
<td>Capacity (puncture)</td>
<td>10 kN</td>
<td>10 kN</td>
<td>10 kN</td>
</tr>
<tr>
<td>Striker diameter</td>
<td>ø12.7 mm</td>
<td>ø20 mm</td>
<td>ø10 mm</td>
</tr>
<tr>
<td>Compatible with</td>
<td>ASTM D 7363</td>
<td>ISO 6603-2</td>
<td>ISO 6603-2</td>
</tr>
</tbody>
</table>

Note: Striker units with other load capacities and shapes are supplied as options.

**Clamping Plates**

<table>
<thead>
<tr>
<th>Part number</th>
<th>346-77213-02</th>
<th>346-77213-01</th>
<th>346-77213-03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hole diameter</td>
<td>ø76 mm</td>
<td>ø40 mm</td>
<td>ø100 mm</td>
</tr>
<tr>
<td>Compatible with</td>
<td>ASTM</td>
<td>ISO</td>
<td>ISO</td>
</tr>
<tr>
<td>Applicable specimen size</td>
<td>t = 1 to 3 mm</td>
<td>t = 1 to 3 mm</td>
<td>t = 1 to 3 mm</td>
</tr>
</tbody>
</table>

**Examples of striker-clamp combinations for specific standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Striker diameter</th>
<th>Clamping plates</th>
<th>Standard combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 6603-2</td>
<td>ø20.0 mm</td>
<td>ø140 mm</td>
<td>Remarks</td>
</tr>
<tr>
<td>ISO 6603-2</td>
<td>ø10.0 mm</td>
<td>ø100 mm</td>
<td>For fragile materials or low fracture strain</td>
</tr>
<tr>
<td>ASTM D 3763</td>
<td>ø12.7 mm</td>
<td>ø176 mm</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: Non-standards combinations are supplied as options.

**System Functions**

The hydraulic energy is temporarily stored in an accumulator, and the piston speed is controlled using a high-speed servo valve.

Vibration and shock-resistant displacement detection mechanism

This volumetric displacement detector uses the moveable piston rod of the accumulator as an electrode. The simple mechanism that is resistant to vibration and shock provides highly precise displacement detection.

Specimen Holder

The mounting and fixing plates can be easily replaced, complying with various standards. Specimens are secured pneumatically with one-touch operation.

**Safety considerations for piston movements**

Comprehensive safety features such as a safety cover interlock switch, safety mat interlock switch, and two-switch start procedure ensure operator safety during high-speed piston operation.

Striker (with load detector)

The highly responsive load detector incorporates the grips and detector to reduce weight and increase resonant frequency, thus minimizing the effects of vibration noise.
High-Speed Impact Testing Software

Dedicated High-Speed impact testing software for outstanding user friendliness

The software, which is specially designed for High-Speed impact testing, uses standard Windows 10 wizard format to allow intuitive and simple operation even for beginners. The software provides information such as load-displacement curve, maximum test force, displacement, energy, and inclination. Advanced processing, such as overlaying results from multiple tests or statistical analysis are standard functions. The software consists of two parts: the “Testing” and “Data Processing” components. Since both software components can be opened simultaneously, data can be processed while tests are being performed, allowing testing to be executed efficiently.

Testing software

1. Setting parameters
   Test parameters are set via a wizard-style interface. Parameters can be entered via a dialog format.

2. Testing
   The testing screen shows measurement values with actually used and, online graphical displays of test results, and includes a measurement start button.

Data Processing Software

1. Data processing functions
   The software displays summary data for the maximum test force, corresponding energy and displacement, at specified points, as well as inclination. It also provides graphs, which include a smoothing feature.

2. Multiple data overlaying and statistical processing functions
   Up to ten test data curves can be overlaid. Statistical data for multiple data sets, such as mean values and standard deviation, can be obtained.

3. Report printing functions
   Numerous printing functions, such as overlaying graphs or indicating characteristic values at the point of maximum test force or specimen fracture, are available.
Controller 4870

A specialized control system equipped with an internal highly responsive amplifier and start interlock system. The controller is specifically designed for High-Speed impact testing systems. In order to assure safety, manual piston operations and test start/stop operations are performed via hardware controls.

High-Speed Tensile Test Measurement Data

Data example for plastics

Material: Polycarbonate / Flat plate: 5 mm wide x 2 mm thick
Tensile rate: 20 m/s

Data example for aluminum

Round rod: 5 mm radius
Tensile rate: 5 m/s

Puncture Impact Measurement Data

Data example for plastics

Material: Polycarbonate (t = 2 mm)
Speed: 10 m/s

Data example for aluminum

Material: Aluminum (t = 0.75 mm)
Speed: 20 m/s
High Speed Impact Testing Machines
Standard Specifications

HPV-X2 & HITS X Series  Visualization and Strain Measurement

Analyzing Strain Distribution Using a 10 Million Frame-per-Second Ultra High-Speed Camera and a DIC Data Analysis System

Verifying material characteristics to ensure dynamic safety during composite material development requires not only static strength testing, but also understanding the impact fracture strength and the fracture process. Using an HPV-X2 high-speed video camera in combination with a Hydrosio HITS series high-speed tensile impact testing machine allows observation of the high-speed failure behavior with high time resolution.

To start the high-speed video recording, the system uses an external trigger mechanism, where the testing machine sends a video start signal synchronized with the tensile load to the camera. Strobe lighting is also synchronized with the video timing. Combining a high-speed video camera and impact testing machine makes it possible to evaluate material impact properties and observe fracture behavior at the same time. This allows a multifaceted evaluation of the complicated failure behavior of composite materials.

Example of High-Speed Tensile Testing of Multilayered Porous CFRP Material

This shows a series of representative fracture images, arranged in chronological order. The images were acquired at 500,000 frames per second, from the start of the test until the sample failed. The acquired fracture images were processed by digital image correction (DIC) data processing to generate a 2D map of the strain distribution generated across the sample. The strain magnitude is represented with colors ranging from blue to red, where the warmer the color the greater the sample strain level.

References: H.Kusano, et al., “The experimental comparison of the strain measurement techniques on tensile test”, ECCM-15, We.2.8.3, Venice; Italy, 24-28 June 2012
Standard Specifications

Main Unit, Controller and Software

<table>
<thead>
<tr>
<th>Model Name</th>
<th>High Speed Tensile Testing Machine HITS-TX</th>
<th>High Speed Puncture Impact Testing Machine HITS-PX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Number</td>
<td>346-72545</td>
<td>346-72457</td>
</tr>
<tr>
<td>Impact Test Force</td>
<td>10 kN</td>
<td></td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>20 m/s</td>
<td></td>
</tr>
<tr>
<td>Range Of Speed Settings</td>
<td>0.0001 m/s to 20 m/s</td>
<td>1 m/s to 20 m/s</td>
</tr>
<tr>
<td>Piston Stroke</td>
<td>300 mm</td>
<td></td>
</tr>
<tr>
<td>Force Amplifier</td>
<td>Range: 20%, 50% or 100% of load detector rating / Accuracy: Within 1.0% of full scale</td>
<td></td>
</tr>
<tr>
<td>Displacement Amplifier</td>
<td>Range: 10%, 20%, 50% or 100% of 150 mm / Accuracy: Within 1.0% of full scale</td>
<td></td>
</tr>
<tr>
<td>AD Converter</td>
<td>Sampling rate: Max. 2 MHz with 12-bit resolution</td>
<td></td>
</tr>
<tr>
<td>Specimen Holder</td>
<td>—</td>
<td>Pneumatic clamping</td>
</tr>
<tr>
<td>Acceleration Jig</td>
<td>Tapered acceleration mechanism</td>
<td>—</td>
</tr>
<tr>
<td>Hydraulic Pressure Supply</td>
<td>Model AF-7H, 7 L/min, air cooled, installed below main unit</td>
<td></td>
</tr>
<tr>
<td>Safety Devices</td>
<td>Door open/close interlock switch / Safety mat interlock switch / Two-switch start operation / Start timer, etc.</td>
<td></td>
</tr>
<tr>
<td>Controller</td>
<td>Model 4870 controller (specialized for high-speed impact testing)</td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>High-speed impact testing software</td>
<td></td>
</tr>
<tr>
<td>PC Environment Required for Operation*2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply Requirements</td>
<td>200 V 3-phase 6 kVA, 100 V single-phase 1.5 kVA</td>
<td></td>
</tr>
<tr>
<td>Air Supply Requirements</td>
<td>Not required</td>
<td></td>
</tr>
<tr>
<td>Dimensions (Main Testing Unit)</td>
<td>Approx. W1,100 x D700 x H2,850 mm</td>
<td>Approx. W1,100 x D900 x H2850 mm</td>
</tr>
<tr>
<td>Weight (Main Testing Unit)</td>
<td>Approx. 1,500 kg</td>
<td></td>
</tr>
</tbody>
</table>

*1: Duration of one test must be within five minutes.
*2: The computer and operating system are not included in the standard system configuration. Please acquire them separately.

Standard System Configuration

The standard HITS-TX system is configured as follows.

- The griptype, force detector (either for round rods or flat plates) are selected and combined with the main high-speed tensile testing machine.
- The heating/cooling unit is separated from the main testing machine so it is not affected by impact testing.

For HITS-TX (High Rate Tensile Testing)

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Thermostatic chamber for HITS-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Name</td>
<td>346-72457-31</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°C to +150°C with two refrigerating sources</td>
</tr>
<tr>
<td>Power Supply Requirements</td>
<td>200 V 3-phase 12 kVA</td>
</tr>
<tr>
<td>Cooling Water Capacity Requirements</td>
<td>50 L/min (20˚C or lower water temp)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Main unit: W1200 x D1200 x H1800 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 800 kg</td>
</tr>
</tbody>
</table>

Note: Units with other temperature ranges can also be manufactured.

The standard HITS-PX system is configured as follows.

- The striker, striker tip, specimen holder and clamp are selected and combined with the main high speed puncture impact testing machine.
- The testing chamber includes racks that can hold up to 80 specimens for preheating or precooling.

For HITS-PX (High Speed Puncture Testing)

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Thermostatic chamber for HITS-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>346-72545-31</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-40°C to +150°C with two refrigerating sources</td>
</tr>
<tr>
<td>Internal Specimen Holding Racks</td>
<td>4 racks x 20 specimens per rack</td>
</tr>
<tr>
<td>Power Supply Requirements</td>
<td>200 V 3-phase 12 kVA</td>
</tr>
<tr>
<td>Cooling Water Requirements</td>
<td>50 L/min (20˚C or lower water temp.)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Main unit: W1200 x D1200 x H1800 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 800 kg</td>
</tr>
</tbody>
</table>

Note: Units with other temperature ranges can also be manufactured.
Layout Diagram and Site Requirements (HITS-TX, HITS-PX)

Note: The main unit of the testing machine must be installed on the first floor of a building, on a concrete floor that has a thickness of at least 250 mm (capable of withstanding the own weight of 1,500 kg). The foundation needs to be constructed by the user. Avoid installing the machine on an upper or hollow floor, due to the impacts and vibration generated during high-speed testing. Although the machine is equipped with vibration-damping springs, care should be taken when selecting an installation location where vibrations could be easily transmitted. Note that the weight of the thermostatic chamber is approximately 800 kg.

Caution: Avoid locations with unsuitable conditions such as those listed below.

1) Locations subject to large fluctuations in temperature
   (Recommended: +10 °C to +35 °C)
2) Locations with high humidity, where dew condensation may form
   (Recommended: 20 % to 80 %)
3) Locations exposed to the direct air flow from heating/cooling systems
4) Locations exposed to direct sunlight
5) Locations with large amounts of dust
6) Locations with significant amounts of corrosive gases
7) Locations subject to strong vibrations
   (Recommended: 0.1 G max.)
8) Locations subject to large voltage fluctuations
   (Recommended: Single phase 100 V ±5 % max., Three-phase 200 V ±10 % max.)

Note: Avoid installing devices that can be negatively impacted by vibrations (such as balances) in the vicinity of the testing machine.

Related Products

Electromagnetic Force Fatigue / Endurance Testing System
EMT Series
- 1kN
- 5kN

Benchtop Hydraulic Servo Strength Testing Machine
L-Series Servopulser
- EHF-LM20kN-10L

Capillary Rheometer Flowtester
CFT-EX Series
- CFT-EX
  - CFT-500EX
  - CFT-100EX

Electromagnetic Micro Testing Machine
MMT Series Micro-Servo
- MMT-101NV-10

Electric Motor Driven Actuator
NJ-SERVO Series
- NJ-10kN SERVO

For Research Use Only. Not for use in diagnostic procedures.
This publication may contain references to products that are not available in your country. Please contact us to check the availability of these products in your country.

Company names, product/service names and logos used in this publication are trademarks and trade names of Shimadzu Corporation, its subsidiaries or its affiliates, whether or not they are used with trademark symbol “TM” or “®”. Third-party trademarks and trade names may be used in this publication to refer to either the entities or their products/services, whether or not they are used with trademark symbol “TM” or “®”. Shimadzu disclaims any proprietary interest in trademarks and trade names other than its own.

The contents of this publication are provided to you “as is” without warranty of any kind, and are subject to change without notice. Shimadzu does not assume any responsibility or liability for any damage, whether direct or indirect, relating to the use of this publication.