Fatigue and Endurance Testing Systems

Shimadzu Servopulser
Servo-hydraulic Fatigue and Endurance Tester
Servopulser Series

The evaluation of strength, which relates to safety and durability will affect the product life. It has become increasingly important in areas such as product development, quality control and failure analysis. The Servopulser Series of high-performance, high-accuracy strength testing machines can accommodate this diverse range of requirements. The comprehensive lineup allows configuration of the optimal system for each user’s requirements.

Features of the Servopulser

Compact but Powerful
Hydraulically operated to generate large test forces in a compact design.

Continuously Variable Force and Speed
The high-performance servo valve allows instant variation of test force and speed.

Rigid Construction
The highly rigid frame prevents buckling of specimens.

Full Safety Features
Alarm functions and post-alarm operations allow safe unmanned operation.

Wide-ranging Test Applications
Extensive ranges of test jigs, detectors, and environment control devices permit testing for a wide range of applications.

Servopulser Basic Configuration

The Servopulser is a hydraulically operated testing machine.

The customer chooses the main frame, controller, actuators, and hydraulic power supply unit to achieve the required test forces and test rates.

An extensive range of extensometers and other detectors, test jigs, and environment control devices can be added to permit a variety of tests.

2 Controller ➔ P6/7
The controller feeds back the measured signals to achieve the target control.

Controller 4830 (Type V)
General-purpose, stand-alone type
Controller 4890 (Type M)
High-performance, PC type

5 Hydraulic power supply ➔ P10/11
Generates the hydraulic power.
4, 10, 20, 40, 70, 110, or 140 L/min max. discharge capacity

* Item supplied varies according to the combination of actuator and hydraulic power supply.
Selecting A Testing System

Select your ideal combination of main unit, controller, and hydraulic power supply to meet the test aims (force capacity, loading speed, etc.). Consult your Shimadzu representative about extra large or small machines or for custom specifications. Shimadzu will apply its extensive experience in the industry to provide the optimal system for every need.

Key to Model Codes

```
EHF - E V 5 1 k - 0 2 0 - A
```

1. **Select the Main Unit Frame Type** (See pages 4 and 5 for details.)

   Select the most applicable of the following three frame types.
   - **L** L-type Loading Frame
   - **E** E-type Loading Frame
   - **U** U-type Loading Frame

   **L-type Loading Frame**
   - Tabletop frame with overhead actuator
   - This frame is suited to testing parts and formed specimens with a test force up to 20 kN.
   - Sample application: bearing components

   **E-type Loading Frame**
   - Standard frame with bottom actuator
   - This frame is suited to testing small parts and formed specimens with a test force up to 200 kN.
   - Sample application: standard specimens

   **U-type Loading Frame**
   - Standard frame with overhead actuator
   - This frame is suited to testing structural materials and large specimens with a test force up to 200 kN.
   - Sample application: large parts

2. **Select the Controller** (See pages 6 and 7 for details.)

   Select one of the following two controller types that provides the functions required.
   - **V** Controller 4830
   - **M** Controller 4890

   **Controller 4830**
   - Compact controller with color LCD and touchpanel
   - Generates a comprehensive variety of loading waveforms. Handles measurement and control, and displays the waveforms.
   - Optional software provides waveform combinations and permits testing using actual waves.

   **Controller 4890**
   - All-purpose, high-performance controller
   - Generates six different loading waveforms and combinations of them. Handles measurement, control, hydraulic power supply operation, data acquisition, and data processing.
   - Requires a PC and dedicated GLUON software.

3. **Select the Actuator Capacity** (Select an actuator that matches the frame capacity.)

   Select the maximum test force from the list below.
   - **A10** 050 : 5 kN
   - **A20** 050 : 10 kN
   - **A30** 050 : 20 kN
   - **A40** 050 : 50 kN (U-type)
   - **A50** 050 : 100 kN (U-type)
   - **A60** 050 : 200 kN
   - **A110** 050 : 50 kN (E-type)
   - **A210** 050 : 100 kN (E-type)
   - **A310** 050 : 200 kN

4. **Select the Stroke**

   Select the stroke from the following alternatives.
   - **1** ±25 mm
   - **2** ±50 mm

5. **Select the Hydraulic Power Supply Flow Rate.**

   (Select according to the required test ranges (frequency and amplitude). (See pages 14 and 15 for details.)

   Select the appropriate model from the table of amplitude characteristics on pages 14 and 15.
   - **A20** 050 : AF-10B
   - **A30** 050 : QF-70B
   - **A40** 050 : AF-20B
   - **A50** 050 : AF-10B
   - **A60** 050 : QF-70B
   - **A110** 050 : AF-20B
   - **A210** 050 : AF-20B
   - **A310** 050 : AF-20B

   *Model QF-110 differs according to the power supply frequency.

6. **Select the column length of loading frame**

   - **A** Standard
   - **B** Standard + 400 mm

See page 18 for typical combinations.
Servopulser Series

Servo-hydraulic Testing Machines

**L-type Loading Frame**

Tabletop testing machine with overhead actuator. Despite its low capacity, the overhead actuator allows testing of actual parts and comparatively large specimens.

- An environment control device can be attached, despite the compact frame size.
- The optional T-grooved base plate (346-78491) permits evaluation testing of actual parts and components.

### Major Specifications

<table>
<thead>
<tr>
<th>Main Unit Model</th>
<th>Stroke</th>
<th>Max. test force</th>
<th>Dynamic/static (kN)</th>
<th>Frame rigidity</th>
<th>Crosshead drive mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>L5 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±5/±6</td>
<td></td>
<td>Hydraulic drive (with hydraulic clamp)</td>
</tr>
<tr>
<td>L10 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±10/±12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L20 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±20/±26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note1 Loading frame with ±100 mm maximum stroke is also available.

*Note2 At 300 mm clearance between crosshead and table.

*Note3 version with no vertical jack is available as an option.

### Major Dimensions

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Actuator stroke</th>
<th>Testing space (mm)</th>
<th>Main unit dimensions (mm)</th>
<th>Approx. weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 kN</td>
<td>±25 mm</td>
<td>±25 mm</td>
<td>135 - 835</td>
<td>Approx. 1780</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±25 mm</td>
<td>460 - 600</td>
<td>300</td>
</tr>
<tr>
<td>10 kN</td>
<td>±25 mm</td>
<td>±25 mm</td>
<td>800 - 600</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±25 mm</td>
<td>1250</td>
<td></td>
</tr>
<tr>
<td>20 kN</td>
<td>±25 mm</td>
<td>±25 mm</td>
<td>1750</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±25 mm</td>
<td>2250</td>
<td></td>
</tr>
</tbody>
</table>

**E-type Loading Frame**

This is the most standard frame type. It requires a small installation space and is suited to the testing of formed specimens and small parts.

- The highly rigid frame prevents buckling of specimens and saves losses in hydraulic energy due to frame deformation.
- The crosshead hydraulic drive mechanism simplifies crosshead vertical movement and clamping.
- Various test jigs and environment control devices can be attached. Major test applications:
  - evaluation of metal and plastic specimens, fracture toughness testing, testing of standard specimens and small parts.

### Major Specifications

<table>
<thead>
<tr>
<th>Main Unit Model</th>
<th>Stroke</th>
<th>Max. test force</th>
<th>Dynamic/static (kN)</th>
<th>Frame rigidity</th>
<th>Crosshead drive mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>E051 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±50/±60</td>
<td>0.0012</td>
<td>Hydraulic drive (with hydraulic clamp)</td>
</tr>
<tr>
<td>E101 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±100/±120</td>
<td>0.0012</td>
<td></td>
</tr>
<tr>
<td>E200 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>±200/±240</td>
<td>0.00065</td>
<td></td>
</tr>
</tbody>
</table>

*Note1 At 500 mm clearance between crosshead and table.

*Note2 Fixed crosshead type also available (without drive mechanism or hydraulic clamp).

### Major Dimensions

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Actuator stroke</th>
<th>Column length (mm)</th>
<th>Testing space (mm)</th>
<th>Main unit dimensions (mm)</th>
<th>Approx. weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kN</td>
<td>±25 mm</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>162 - 694</td>
<td>980 750</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±50 mm</td>
<td>Standard + 400</td>
<td>137 - 797</td>
<td>Approx. 2155</td>
</tr>
<tr>
<td>100 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>Standard + 400</td>
<td>138 - 798</td>
<td>Approx. 2555</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±50 mm</td>
<td>Standard + 400</td>
<td>137 - 797</td>
<td>Approx. 2555</td>
</tr>
<tr>
<td>200 kN</td>
<td>±25 mm</td>
<td>±50 mm</td>
<td>Standard + 400</td>
<td>133 - 1313</td>
<td>Approx. 2805</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±50 mm</td>
<td>Standard + 400</td>
<td>175 - 1375</td>
<td>Approx. 2805</td>
</tr>
</tbody>
</table>

Hydraulic drive mechanism *2 *3

*Note3 version with no vertical jack is available as an option.
Hydraulic Power Supply Unit

U-type Loading Frame

The large testing table below and crosshead-mounted actuator above create a large testing space for testing construction materials and large specimens.

- The large testing space accommodates large specimens and allows the attachment of various test jigs and environment control devices.
- The highly rigid frame prevents buckling of specimens and saves losses in hydraulic energy due to frame deformation.
- Various test jigs can be attached.
- Major test applications: testing of automobile parts and frames

### Major Specifications

<table>
<thead>
<tr>
<th>Main Unit Model</th>
<th>Stroke</th>
<th>Max. test force Dynamic/static (kN)</th>
<th>Frame rigidity *1 (mm/kN)</th>
<th>Crosshead drive mechanism *2</th>
</tr>
</thead>
<tbody>
<tr>
<td>U50 kN</td>
<td>±25 mm</td>
<td>±50 kN</td>
<td>0.0025</td>
<td>Hydraulic drive (with hydraulic clamp)</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±100 kN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U100 kN</td>
<td>±25 mm</td>
<td>±100 kN</td>
<td>0.0019</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±200 kN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U200 kN</td>
<td>±25 mm</td>
<td>±200 kN</td>
<td>0.0009</td>
<td></td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>±400 kN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note1: At 500 mm clearance between crosshead and table.
*Note2: Separate crosshead drive and clamp operation stand.

### Major Dimensions

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Testing space (mm)</th>
<th>Main unit dimensions (mm)</th>
<th>Approx. weight(kg) *4</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kN</td>
<td>±25 mm</td>
<td>Standard 179 ~ 789</td>
<td>1610</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>Standard + 400 379 ~ 1189</td>
<td>2010</td>
</tr>
<tr>
<td>100 kN</td>
<td>±25 mm</td>
<td>Standard 154 ~ 764</td>
<td>1710</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>Standard + 400 354 ~ 1164</td>
<td>2110</td>
</tr>
<tr>
<td>200 kN</td>
<td>±25 mm</td>
<td>Standard 175 ~ 740</td>
<td>1655</td>
</tr>
<tr>
<td></td>
<td>±50 mm</td>
<td>Standard + 400 375 ~ 1140</td>
<td>2055</td>
</tr>
</tbody>
</table>

*Note4: Unit weight includes hydraulic drive and clamp mechanisms.
Controller 4830

Easy-to-use and multi-functional!
The next generation of controller...
Extremely simple operation using a color LCD and touchpanel

- **Waveform generation with excellent reproducibility**
  Fully digital control with control parameter autotuning and waveform distortion correction functions achieves faithful load waveform reproducibility.

- **Push test function for testing actual objects**
  Achieves stable peak-value control using the test force, even for specimens with "play" (areas where no test force is applied).

- **World-class basic performance**
  The 24-bit high-resolution AD converter and detector-output linearization achieve Class 0.5 test force accuracy (0.5% indicated value) with a standard system.

- **Waveform display functions**
  Test waveform display functions installed as standard permit the realtime display of time graphs, X-Y graphs, and peak graphs.

### Major Specifications

<table>
<thead>
<tr>
<th>Part No.</th>
<th>347-39536-40</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loading waveform</strong></td>
<td>Standard types: Sine, triangular, rectangular, haversine, havertangular, haver-rectangular, trapezoidal, 1/2 haversine, ramp, step, sweep, random, external input, combination<strong>1</strong> and file waveforms (any wave)<strong>1</strong></td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>0.00001 to 1000Hz</td>
</tr>
<tr>
<td><strong>Measurement amplifiers</strong></td>
<td>Type: Test force, stroke amplifiers (2 additional optional amplifiers can be added)</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>24-bit, rangeless</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Type: Fully digital closed-loop control (two-degree-of-freedom PID)</td>
</tr>
<tr>
<td><strong>Correction</strong></td>
<td>Automatic amplitude/mean-value correction (AGC), autotuning, shockless control switching, touch-load function, waveform distortion correction<strong>1</strong>, push test function</td>
</tr>
<tr>
<td><strong>Synchronous control</strong></td>
<td>Up to 4 units</td>
</tr>
<tr>
<td><strong>Signal I/O</strong></td>
<td>Analog: 4 CH (±10 V) output; 1 CH (±10 V) input</td>
</tr>
<tr>
<td><strong>Digital</strong></td>
<td>8CH output; 8CH input</td>
</tr>
<tr>
<td><strong>Safety features</strong></td>
<td>Types: 4-point limiter, power unit alarm, counter, external alarm</td>
</tr>
<tr>
<td><strong>Stop modes</strong></td>
<td>Power unit stop, waveform stop, waveform zero, waveform mean-value stop, unload, position hold</td>
</tr>
<tr>
<td><strong>Required power supply</strong></td>
<td>Single-phase, 100 to 230 VAC, 50/60 Hz, 300 VA</td>
</tr>
</tbody>
</table>

*1 Using software. *2 Standard power cable supplied is for 100 V AC only.

### Option
Windows Software for 4830

- **Software Configuration**
  - Program function testing
  - Durability testing
  - Static properties testing
  - Combined testing

- **Other Optional Software**
  - Static test software
  - Resonance tracking test software
  - Multi-Axis Sine Wave test software
  - Multi-Axis Actual Wave test software

### Standard Contents
- Media CD-ROM
- Instruction manual
- USB cable

### PC Operation Environment

| OS | Windows® 32 bit (Japanese/English), Windows® 7 32 bit (Japanese/English) |
| CPU | 1 GHz min. |
| Memory capacity | 1 GB min. |
| HDD capacity | 8 GB min. |
| Screen resolution and displayed colors | 1024 x 768 pixels, 65535 colors min. |
Controller 4890

High-performance controller packed with state-of-the-art technologies

The 4890 is a highly functional controller that offers test operations, data acquisition, and data processing. It incorporates state-of-the-art technologies to achieve highly accurate control and measurements. The Windows-based GLUON software packages offer comprehensive customization wizards and online help functions, which can be selected according to the application. (See pages 8 to 9.)

- **2-degree-of-freedom PID Control**
  The 4890 is the first controller to offer 2-degree-of-freedom PID control for testing machines. Conventional control methods suffered from excessive response to external factors when response with respect to the target waveform was improved. The controller 4890 enhances both the response to the target waveform and minimizes the effects due to external forces.

- **Highly Accurate Measurement**
  The world’s first 20-bit high resolution* achieves “rangeless” performance. Non-linear sensor outputs are linearized for high-accuracy measurement. High resolution is achieved across the entire measuring range without discontinuity due to range switching.

  (*As of August 2004)

- **Automatic Sensor Recognition and Calibration**
  The detector rating, units, and calibration information (zero, span) are read automatically to eliminate complicated settings of ratings and units calibration operations. Ensures safe operation when multiple load cells or extensometers are used.

- **Remote Subcontroller**
  The subcontroller box supplied as standard allows the actuator to be operated near the testing machine. The Digital Load Limiter ensures safe removal of the specimen.

- **Digital Load Limiter**
  Digitally monitors the test forces to restrict overloads. The degree of overload can be adjusted to several percent of full-scale. This device uses digital technology to prevent overloading reliably.

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**Major Specifications**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>346-99845-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading waveform</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Type</td>
</tr>
<tr>
<td>Measurement amplifier</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Range</td>
</tr>
<tr>
<td>Control</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Functions for inputting external loading waveforms and external feedback signals</td>
</tr>
<tr>
<td></td>
<td>Virtual transducer (VTD) function</td>
</tr>
<tr>
<td>Monitor outputs</td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
</tr>
<tr>
<td>Safety features</td>
<td>Item</td>
</tr>
<tr>
<td></td>
<td>Action</td>
</tr>
<tr>
<td>Required power supply</td>
<td>100 V, 1 kVA, single phase</td>
</tr>
</tbody>
</table>

*At least one GLUON software package is required to use the Controller 4890.

*The standard package includes an uninterruptible power supply, test-force amplifier, stroke amplifier, CAL cables (one each for test force and stroke), and sub-controller box.

*See the separate controller catalog for details.
The GLUON software packages run on a PC to control the Controller 4890. Nine GLUON software packages are available for different test aims.

**PC Environment**

- **OS**: Windows XP / 7 (English) 32bit
- **CPU**: 800 MHz min. (1 GHz min. recommended)
- **Memory capacity**: 1 GB min.
- **Hard disk capacity**: 8 GB min.
- **Screen resolution**: 1024 x 768, 65535 colors
- **Network**: 100Base-T compatible

The *gluon* is the elementary particle that imparts the strong force in physics. Gluons trap quarks inside protons and neutrons and hold together the atomic nucleus. The name *GLUON* was chosen to suggest a powerful force.

* See the separate GLUON catalog for details.

**GLUON Features**

### Mail Notification Function

The mail notification function can reduce the daily monitoring workload. It sends mail notifications at fixed intervals or when the status changes during testing. It allows immediate action on specimen failure or when an alarm occurs.

**Wizards**

GLUON offers a variety of Windows-compatible wizards. Even first-time users can intuitively make all settings.

### Autotuning

Autotuning automatically determines the optimal parameters for control. Simply mount the specimen in a status similar to the actual test status and set the preload. This function assures safe operation when a new material is tested or when the detector changes.

### Virtual Transducer Function

The measured signal with added primary signal processing can be registered as a new virtual transducer. This function allows easy direct control of stress and strain or control using the mean value from multiple extensometers.

**GLUON software set**

<table>
<thead>
<tr>
<th>Software Set</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLUON M.P. (multipurpose) test package</td>
<td>346-99918</td>
</tr>
<tr>
<td>GLUON Fatigue test package</td>
<td>346-99919</td>
</tr>
<tr>
<td>GLUON Static test package</td>
<td>346-99920</td>
</tr>
<tr>
<td>GLUON Crack growth test package</td>
<td>346-99921</td>
</tr>
<tr>
<td>GLUON Kc / COD test package</td>
<td>346-99922</td>
</tr>
<tr>
<td>GLUON Jic test package</td>
<td>346-99923</td>
</tr>
<tr>
<td>GLUON Dynamic characteristics test package</td>
<td>346-99314</td>
</tr>
<tr>
<td>GLUON Thermal fatigue test package</td>
<td>346-99313</td>
</tr>
<tr>
<td>GLUON Pseudo-dynamic test package</td>
<td>346-99315</td>
</tr>
</tbody>
</table>

**Compliant with:**

- ASTM E1820-99 *3
- ASTM E647-00 *1
- JIS K6394-98 *5
- JIS Z 2284-98
- ISO 12737-96
The GLUON software packages run on a PC to control the Controller 4890. GLUON offers a variety of Windows-compatible wizards. Even first-time users will find GLUON easy to use.

The “gluon” is the elementary particle that imparts the strong force in physics. Gluons trap quarks inside protons and neutrons and hold together the atomic nucleus.

GLUON Features

- Mail Notification Function
- Wizards
- Screen resolution
- Hard disk capacity
- Memory capacity
- CPU: 800 MHz min. (1 GHz min. recommended)

Immediate action on specimen failure or mail notifications at fixed intervals or when the detector changes.

Servo-hydraulic Testing Machines

The measured signal with added primary signal processing can be registered as a waveform before tuning Waveform after tuning

1 GLUON M.P. (Multipurpose) Test Package

Combined-load control and multi-axis control. Easy generation of complex simulation loads.

By permitting the synchronized operation of up to 16 controllers*, this package can handle almost any type of testing. Control and measurement commands can be flexibly combined to permit complex measurement and control, including programmed loading using combinations of different waveforms and multi-axis control. Measured data can be handled by commercial spreadsheet software for simple analysis by the user.

2 GLUON Fatigue Test Package

Handles all fatigue testing from low to high cycles. Easily plots S-N curves and calculates hysteresis energy.

This package can create the S-N curves of stress amplitude (S) versus number of cycles to failure (N) for high-cycle fatigue testing. Additionally, it can calculate the hysteresis energy and plastic strain from the stress-strain relationship for low-cycle fatigue testing.

3 GLUON Static Test Package

For fundamental strength evaluation. Handles tensile, compression, and bending static testing.

Determines the static characteristics of a material from the relationship between test force (or stress/bending stress) and displacement (or strain) when a constant loading rate is applied to the specimen. It calculates the characteristic values: maximum test force, displacement at failure, Young’s modulus, 0.2% yield stress, and absorbed energy.

4 GLUON Crack Growth Test Package

Evaluates the crack growth properties of notched specimens. Ideal to pre-crack specimens for KIC and JIC tests.

Calculation functions provide smooth control of ∆K. Can evaluate the relationship between the crack growth rate (da/dN) and change in stress intensity factor (DK). Various loading modes (constant test force, K value smooth increase/decrease, K value step increase/decrease) allow pre-cracking of specimens in compliance with all fracture toughness standards.

5 GLUON Kic/COD Test Package

For fracture toughness evaluation. Calculates the CTOD value for the failure mode and evaluates the validity of the KIC value.

Evaluates the fracture resistance, namely the fracture toughness, when a load is applied to notched specimens so that the K value increases at a constant rate. Can determine the plane-strain fracture toughness Kc (valid in the applicable range of linear fracture mechanics) and crack opening displacement (COD) (valid for materials generating high yield).

6 GLUON Jic Test Package

For elastic-plastic fracture toughness (Jic) evaluation. Easy Jic testing with complex procedures.

Testing is conducted with test force control or opening displacement control at a constant loading rate, and the specimen is then unloaded to calculate the crack length. The data obtained is used to plot graphs of increment in crack length (Δa) against crack growth resistance (J value), and to calculate the Jic value and its effectiveness.

7 GLUON Dynamic Characteristics Test Package

For fundamental evaluation of rubber. Simplifies evaluation of anti-vibration characteristics.

Static Characteristics Testing Applies a constant loading rate to plot test force – displacement (deflection) curves and to calculate the static spring constant.

Dynamic Characteristics Testing Applies a constant frequency or stepped frequency to calculate dynamic characteristics based on the number of repeated cycles and the frequency.

8 GLUON Thermal Fatigue Test Package

For compound loads of heat and strain. Permits strain constraint testing under constant strain.

A temperature pattern synchronized with the load is applied to provide mechanical strain control and constant constraint control after correction for thermal expansion. Additionally, it can calculate the hysteresis energy and plastic strain from the acquired data.

9 GLUON Pseudo-dynamic Test Package

Conducts earthquake-response testing on construction materials. Provides accurate control of earthquake-response displacements under seismic vibrations.

Elastic-plastic response displacement for each input seismic-wave step is taken as the target values and is controlled to reach each layer simultaneously. The Newmark b method is used for the response calculations, but user’s individual response calculations can be handled in an external PC. Vertical jacks can be used in addition to the horizontal jacks (in up to four layers).

*1 The correspondence specimens are CT and 3-bend. Only the compliance method is supported for crack-size monitoring. The force constant, K linear smooth, and K step are selectable for K control. The K control by exponent is noncompliant.

*2 The correspondence specimens are CT and 3-bend.

*3 The correspondence specimen is only CT. The calculation of KIC, Jc, CTOD, and BIC are not supported. The method for rapid loading KIC test and rapid load J-integral fracture toughness test are noncompliant.

*4 The static characteristic test and dynamic characteristic test by nonresonant method are supported.

*5 The forced oscillation nonresonant method is supported. The free oscillation method and temperature characteristic test are not supported.
Servopulser Series

QF Series Hydraulic Power Supply Unit (Water-cooled)

This hydraulic power supply unit was specially designed for use with materials strength testing machines using electrohydraulic-servo systems. It comprises a hydraulic pump, oil reservoir, filter, cooler, pressure regulator valve, and other components.

- The hydraulic power supply uses a low-noise, low-pulse gear pump.
- The 3-micron filter element eliminates wear in the servo valve and other equipment.
- The vertical pump and motor reduce installation space (QF-10B to 70B, AF-4, AF10B to 20B).

Specifications

<table>
<thead>
<tr>
<th>model</th>
<th>QF-10B</th>
<th>QF-20B</th>
<th>QF-40B</th>
<th>QF-70B</th>
<th>QF-110*</th>
<th>QF-140</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part No.</td>
<td>346-75200</td>
<td>346-75201</td>
<td>346-75245</td>
<td>346-75246</td>
<td>346-75401-01(50 Hz)</td>
<td>346-75402</td>
</tr>
<tr>
<td>Applicable testing machine</td>
<td>E-type</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>L-type</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Approx. pumping rate</td>
<td>50 Hz (L/min.)</td>
<td>9</td>
<td>19</td>
<td>42</td>
<td>68</td>
<td>108</td>
</tr>
<tr>
<td>60 Hz (L/min.)</td>
<td>11</td>
<td>24</td>
<td>51</td>
<td>81</td>
<td>104</td>
<td>162</td>
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<tr>
<td>Normal oil pressure (MPa)</td>
<td>600 V, 3-phase</td>
<td>5.5</td>
<td>11</td>
<td>22</td>
<td>37</td>
<td>45</td>
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<tr>
<td>Hydraulic fluid</td>
<td>Model</td>
<td>MOBILE DTE25</td>
<td>Qty</td>
<td>1</td>
<td>2</td>
<td></td>
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<tr>
<td>Motor capacity (kW)</td>
<td>150 V, single-phase</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Oil filter</td>
<td>160 V, 3-phase</td>
<td>8 kVA</td>
<td>16 kVA</td>
<td>32 kVA</td>
<td>47 kVA</td>
<td>57 kVA</td>
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<tr>
<td>Tank capacity (L)</td>
<td>100 V, single-phase</td>
<td>20 kVA</td>
<td>65</td>
<td>80</td>
<td>110</td>
<td>150/180/200/250/60 Hz</td>
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<tr>
<td>Noise (at 21MPa) (dBA)</td>
<td>300</td>
<td>500</td>
<td>590</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Required cooling water capacity (L/min.) at 32°C</td>
<td>104</td>
<td>108</td>
<td>107</td>
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<td></td>
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</tr>
<tr>
<td>Cooling tower capacity (cooling tons)</td>
<td>5.5</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Approx. unit dimensions</td>
<td>830</td>
<td>920</td>
<td>1100</td>
<td>1200</td>
<td>1730</td>
<td>1950</td>
</tr>
<tr>
<td>width (mm)</td>
<td>750</td>
<td>860</td>
<td>1000</td>
<td>1290</td>
<td>1500</td>
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<tr>
<td>depth (mm)</td>
<td>1235</td>
<td>1400</td>
<td>1515</td>
<td>1370</td>
<td>1550</td>
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<tr>
<td>height (mm)</td>
<td>720</td>
<td>920</td>
<td>1500</td>
<td>2200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit weight (including fluid) (kg)</td>
<td>530</td>
<td>530</td>
<td>720</td>
<td>920</td>
<td>1500</td>
<td>2200</td>
</tr>
</tbody>
</table>

* Model QF-110 differs according to the (50 Hz/60 Hz) power supply frequency.
** Please contact us to modify the power supply voltage. (option)
AF Series Hydraulic Power Supply Unit (Air-cooled)

- The hydraulic power supply uses a low-noise, low-pulse gear pump.
- No cooling water is required.

### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>AF-4</th>
<th>AF-10B</th>
<th>AF-20B</th>
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<tbody>
<tr>
<td>Part No.</td>
<td>339-88838</td>
<td>346-75202</td>
<td>346-75203</td>
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<tr>
<td>Applicable testing machine</td>
<td>E-type</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>U-type</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>L-type</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Approx. pumping rate 50 Hz (L/min.)</td>
<td>3.7</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>60 Hz (L/min.)</td>
<td>4.5</td>
<td>11</td>
</tr>
<tr>
<td>Normal oil pressure (MPa)</td>
<td>MOBILE DTE25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump</td>
<td>Constant-rate gear pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor capacity (kW)</td>
<td>2.2</td>
<td>5.5</td>
<td>11</td>
</tr>
<tr>
<td>Cooling fan (kW)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Oil filter</td>
<td>3 µm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tank capacity (L)</td>
<td>24</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Noise* (dBA)</td>
<td>56</td>
<td>64</td>
<td>71</td>
</tr>
<tr>
<td>Required power supply ** 100 V, single-phase</td>
<td>1.5 kVA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200 V, 3-phase</td>
<td>3.5 kVA</td>
<td>8 kVA</td>
</tr>
<tr>
<td>Approx. unit dimensions</td>
<td>width (mm)</td>
<td>800</td>
<td>870</td>
</tr>
<tr>
<td></td>
<td>depth (mm)</td>
<td>770</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>height (mm)</td>
<td>700</td>
<td>1700</td>
</tr>
<tr>
<td>Unit weight (including fluid) (kg)</td>
<td>185</td>
<td>630</td>
<td>630</td>
</tr>
</tbody>
</table>

* Noise value for AF-4 applies to unit installed in special AF-4 base.
** Please contact us to modify the power supply voltage. (option)
*** Please keep the room temperature at 25°C or less.
The servo valve lies at the heart of the servo-hydraulic testing system. It allows small electric signals to control the flow rate of high-pressure hydraulic fluid over a wide range of speeds.

- The servo valves incorporate special Shimadzu features for electrohydraulic-servo testing machines.
- Excellent response
- Long service life and able to withstand long-term fatigue testing
- Good resolution and threshold for precise control

The Servopulser units can be configured to meet specific test requirements. A variety of test jigs, detectors, and environment control devices are available for many test applications. A range of these optional accessories is described below. See the separate optional accessories catalog for details.

The servo valves incorporate special Shimadzu features for electrohydraulic-servo testing machines.

Excellent response
Long service life and able to withstand long-term fatigue testing
Good resolution and threshold for precise control

### Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Part No.</th>
<th>Rated flow rate (L/min)</th>
<th>Supply pressure range (MPa)</th>
<th>Applicable hydraulic power supply</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>761-4015</td>
<td>339-89458-01</td>
<td>3.8</td>
<td>1.4 to 21</td>
<td>AF-4</td>
<td>For low-cycle testing</td>
</tr>
<tr>
<td>761-4016</td>
<td>339-89458-02</td>
<td>9.5</td>
<td></td>
<td>QF-10B, AF-10B</td>
<td></td>
</tr>
<tr>
<td>761-4018</td>
<td>339-89458-04</td>
<td>38</td>
<td></td>
<td>QF-20B, AF-20B</td>
<td></td>
</tr>
<tr>
<td>761-4019</td>
<td>339-89458-05</td>
<td>57</td>
<td></td>
<td>QF-40B</td>
<td>2 valves used</td>
</tr>
<tr>
<td>72-023</td>
<td>340-01917-03</td>
<td>228</td>
<td></td>
<td>QF-70B, QF-110, QF-140</td>
<td>2 valves used</td>
</tr>
</tbody>
</table>

*1 Flow rate when pressure drops through 7 MPa

### Load Cell

The flat load cells used with the Servopulser series are strain gauge-type shear load cells developed by Shimadzu for fatigue testing machines. They are ideal for fatigue testing due to their endurance under tensile, compression, and bending loads. They feature low deformation under load and a high natural frequency.

All types permit stable testing up to 10⁹ cycles.

### Stroke Detector

A differential-transformer type stroke detector is installed as standard at the tip of the actuator. It controls the piston displacement during testing and controls the actuator when mounting or removing the specimen (subcontroller control).
Servo Valves

The servo valve lies at the heart of the servo-hydraulic testing system. It allows small electric signals to control the flow rate of high-pressure hydraulic fluid over a wide range of speeds.

The Servopulser units can be configured to meet specific test requirements. A variety of test jigs, detectors, and environment control devices are available for many test applications. A range of these optional accessories is described below. See the separate optional accessories catalog for details.

The servo valves incorporate special Shimadzu features for electrohydraulic-servo testing machines.

- Excellent response
- Long service life and able to withstand long-term fatigue testing
- Good resolution and threshold for precise control

Tensile Test Jigs

- Static tensile test jigs with extensometer
- Pin-type grips for flat specimens with Dynastrain
- Split-flange type grips for round specimens
- Manual non-shift grips for flat specimens
- Front-opening hydraulic grips

Compression Test Jig

- Compression plates
- 3-point bending jig for fatigue testing (pulsating)

Bending Test Jigs

- Uniform bending jig for fatigue testing (reversed)
- Tensile test jig for fatigue testing of bolts
- Thread-loosening test jig

Thread-loosening test jig

- Split-flange type grips for round specimens
- Manual non-shift grips for flat specimens
- Front-opening hydraulic grips

Bolt Test Jigs

- Static tensile test jigs with extensometer
- Pin-type grips for flat specimens with Dynastrain
- Split-flange type grips for round specimens
- Manual non-shift grips for flat specimens
- Front-opening hydraulic grips

Fracture Toughness Test Jigs

- Grip for CT specimens with clip gauge
- COD test jig

Extensometers

- Clip gauge
- Dynastrain (measures displacement between gauge marks)
The characteristics of the amplitude curves graphically represent the system testing range. For the Servopulser, these characteristics are determined from the capacities of the actuator and hydraulic power supply and the rated flow rate and frequency characteristics of the servo valve. To select the optimal system, confirm that the amplitude characteristics comply with the test conditions. Testing is also possible at a frequency of 0.1 Hz, or below, which does not appear in the diagrams.

- The diagrams show the relationship between the single amplitude and frequency for a sinewave drive at rated load.
- The testing range is indicated by the region to the bottom-left of each characteristics curve for the capacity and stroke of the selected actuator and the capacity of the hydraulic power supply.
- The diagrams below show amplitude characteristic curves for a 60 Hz power supply. The amplitude characteristics for a 50 Hz supply are approximately 5/6 of those shown.
- These characteristics do not incorporate the frame and load cell characteristics. Subtract these characteristics to determine the actual amplitude characteristic values.
- These amplitude characteristics were calculated using typical servo-valve characteristics. Differences of approximately 10% may occur along the frequency axis.
- The frequency may be limited by the characteristics of the jig and specimen.

**How to Read Amplitude Characteristics**

To conduct fatigue testing at 10 Hz...

<table>
<thead>
<tr>
<th>L-type</th>
</tr>
</thead>
</table>

**AF-4**
**QF-10B**
**QF-20B**

(25 mm stroke)

(50 mm stroke)

**60 Hz amplitude characteristics at 5 kN**

**60 Hz amplitude characteristics at 10 kN**

**60 Hz amplitude characteristics at 20 kN**
**E-type, U-type**

- **QF-10B**
- **QF-20B**
- **QF-40B**
- **QF-70B**
- **QF-140**

*The servo-valve characteristics prevent operation in the high-frequency region with the standard configuration of QF-70B, or above. However, the servo valve can be replaced to permit operation in the high-frequency region. Consult your Shimadzu representative for details.*

60 Hz amplitude characteristics at 50 kN, ±25 mm

60 Hz amplitude characteristics at 50 kN, ±50 mm

60 Hz amplitude characteristics at 100 kN, ±25 mm

60 Hz amplitude characteristics at 100 kN, ±50 mm

60 Hz amplitude characteristics at 200 kN, ±25 mm

60 Hz amplitude characteristics at 200 kN, ±50 mm
Servopulser Series  Servo-hydraulic Testing Machines

Installation

- No foundation work is required if a 150 mm-thick concrete floor is available.
- However, foundation work is required for the QF-70B hydraulic power supply (or larger) or in locations where vibrations cannot be tolerated.

1 Location

Install in a location that satisfies the following conditions:
- small ambient temperature fluctuations (+10 to +35°C recommended);
- low humidity (10 to 75% recommended);
- not subject to air flows from air conditioning equipment;
- no direct sunlight;
- low dust levels;
- no contamination by corrosive gases; and
- no vibrations (0.1 G max. recommended).
- Keep the room temperature at 25°C or less.

2 Power Supply Requirements

- 100 – 220 V ±10%, 50/60 Hz, single-phase
- 200 – 400 V ±10%, 50/60 Hz, 3-phase

The required power supply capacity depends on the hydraulic power supply capacity.
- Use a clean grounding wire (D-type grounding recommended)
- Avoid power supplies with extreme voltage fluctuations. If unavoidable, use a voltage stabilizer and noise-cut transformer.
- The customer is responsible for electrical wiring installation up to the terminals on the power control board of the hydraulic power supply unit.

Provide separate power supplies for accessories that require separate power supplies.
- Check the power supply voltage and inform Shimadzu when ordering a system.

3 Cooling Water

- The customer is responsible for cooling water pipe connections to the cooling water connector on the hydraulic power supply unit.
- Provide separate cooling water supplies for accessories that require separate cooling water.
- Use tap water up to 32°C as the cooling water.

Standard Configurations

*The diagrams show the area occupied by the equipment. The shape and installation orientation of the hydraulic power supply may differ according to the unit capacity.
*If necessary consult your Shimadzu representative for more detailed layout drawings.
*PC and table are not included in the standard configuration.

L-type

*To allow operation and maintenance, reserve an additional 500 mm-wide space around the area shown in the diagram.

Model LV

Space required for Model LV (mm)

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Hydraulic power supply</th>
<th>Space required (W × D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kN</td>
<td>QF-10B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>10 kN</td>
<td>QF-20B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>5 kN</td>
<td>QF-70B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>2 kN</td>
<td>AF-20B</td>
<td>2000 x 2400</td>
</tr>
</tbody>
</table>

Using AF-4 hydraulic power supply

Model LV

Space required for Model LV (mm)

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Hydraulic power supply</th>
<th>Space required (W × D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kN</td>
<td>QF-10B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>10 kN</td>
<td>QF-20B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>5 kN</td>
<td>QF-70B</td>
<td>2000 x 2400</td>
</tr>
<tr>
<td>2 kN</td>
<td>AF-20B</td>
<td>2000 x 2400</td>
</tr>
</tbody>
</table>

Model LM

Space required for Model LM (mm)

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Hydraulic power supply</th>
<th>Space required (W × D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 kN</td>
<td>QF-10B</td>
<td>2500 x 2400</td>
</tr>
<tr>
<td>10 kN</td>
<td>QF-20B</td>
<td>2500 x 2400</td>
</tr>
<tr>
<td>5 kN</td>
<td>QF-70B</td>
<td>2500 x 2400</td>
</tr>
<tr>
<td>2 kN</td>
<td>AF-20B</td>
<td>2500 x 2400</td>
</tr>
</tbody>
</table>
Standard Configurations

• Use these diagrams as a reference if a special layout arrangement is required to suit the location.

E-type (common for Model EV and EM)

![E-type Layout]

*To allow operation and maintenance, reserve an additional 500 mm-wide space around the area shown in the diagram.

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Hydraulic power supply</th>
<th>Space required (W x D)</th>
</tr>
</thead>
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<td>E51 kN</td>
<td>QF-10B</td>
<td>2300 x 2100</td>
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<tr>
<td></td>
<td>QF-20B</td>
<td>2300 x 2700</td>
</tr>
<tr>
<td></td>
<td>QF-40B</td>
<td>2300 x 2600</td>
</tr>
<tr>
<td>E101 kN</td>
<td>QF-70B</td>
<td>2300 x 2800</td>
</tr>
<tr>
<td></td>
<td>AF-10B</td>
<td>2300 x 2200</td>
</tr>
<tr>
<td></td>
<td>AF-20B</td>
<td>2300 x 2700</td>
</tr>
<tr>
<td>E200 kN</td>
<td>QF-10B</td>
<td>2500 x 2100</td>
</tr>
<tr>
<td></td>
<td>QF-20B</td>
<td>2500 x 2200</td>
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<tr>
<td></td>
<td>QF-40B</td>
<td>2500 x 2600</td>
</tr>
<tr>
<td></td>
<td>QF-70B</td>
<td>2500 x 2800</td>
</tr>
<tr>
<td></td>
<td>AF-10B</td>
<td>2500 x 2200</td>
</tr>
<tr>
<td></td>
<td>AF-20B</td>
<td>2500 x 2700</td>
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</table>

U-type (common for Model UV and UM)

![U-type Layout]

*To allow operation and maintenance, reserve an additional 500 mm-wide space around the area shown in the diagram.

<table>
<thead>
<tr>
<th>Main unit</th>
<th>Hydraulic power supply</th>
<th>Space required (W x D)</th>
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</thead>
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<td>U50 kN</td>
<td>QF-10B</td>
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<tr>
<td></td>
<td>QF-20B</td>
<td>2500 x 2200</td>
</tr>
<tr>
<td></td>
<td>QF-40B</td>
<td>2500 x 2600</td>
</tr>
<tr>
<td></td>
<td>QF-70B</td>
<td>2500 x 2800</td>
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<tr>
<td></td>
<td>AF-10B</td>
<td>2500 x 2200</td>
</tr>
<tr>
<td></td>
<td>AF-20B</td>
<td>2500 x 2700</td>
</tr>
<tr>
<td>U100 kN</td>
<td>QF-10B</td>
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</tr>
<tr>
<td></td>
<td>QF-20B</td>
<td>2600 x 2200</td>
</tr>
<tr>
<td></td>
<td>QF-40B</td>
<td>2600 x 2600</td>
</tr>
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<td></td>
<td>QF-70B</td>
<td>2600 x 2800</td>
</tr>
<tr>
<td></td>
<td>AF-10B</td>
<td>2600 x 2200</td>
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<td>QF-10B</td>
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<td>2600 x 2700</td>
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</table>
Some typical configurations are listed below. These are the most fundamental configurations that are well tried and tested.

### L-type Series

<table>
<thead>
<tr>
<th>Model</th>
<th>Part No.</th>
<th>Main frame</th>
<th>Actuator</th>
<th>Controller</th>
<th>Hydraulic power supply</th>
<th>Load cell</th>
<th>Servo valve</th>
<th>Accumulator</th>
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<tbody>
<tr>
<td>EHF-LV005k1-004</td>
<td>348-20610-01</td>
<td>L5kn</td>
<td>5 kN, ±25 mm</td>
<td>4830</td>
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<td>SCL-5kn</td>
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<td>4890</td>
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<td>QF-20B</td>
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### E-type Series

<table>
<thead>
<tr>
<th>Model</th>
<th>Part No.</th>
<th>Main frame</th>
<th>Actuator</th>
<th>Controller</th>
<th>Hydraulic power supply</th>
<th>Load cell</th>
<th>Servo valve</th>
<th>Accumulator</th>
</tr>
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<tbody>
<tr>
<td>EHF-EV050k1-010-0A</td>
<td>348-21060-01</td>
<td>E50kN</td>
<td>50 kN, ±25 mm</td>
<td>4830</td>
<td>AF-4</td>
<td>SFL-50kN</td>
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<tr>
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<td>200 kN, ±25 mm</td>
<td>4830</td>
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### U-type Series

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<thead>
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<th>Model</th>
<th>Part No.</th>
<th>Main frame</th>
<th>Actuator</th>
<th>Controller</th>
<th>Hydraulic power supply</th>
<th>Load cell</th>
<th>Servo valve</th>
<th>Accumulator</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHF-LV050k1-010-0A</td>
<td>348-20511-01</td>
<td>E50kN</td>
<td>50 kN, ±25 mm</td>
<td>4830</td>
<td>AF-4</td>
<td>SFL-50kN</td>
<td>761-4018</td>
<td>1 L x 1 L</td>
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<td>E200kN</td>
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<td>4830</td>
<td>AF-4</td>
<td>SFL-200kN</td>
<td>761-4019</td>
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<td>EHF-LU200k1-040-0A</td>
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<td></td>
<td>72-023</td>
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</tr>
</tbody>
</table>

*Other combinations are also possible.* "±50 mm stroke is available as an option. *±400 mm column extension is available as an option. *±500/±1000 mm table expansion is available as an option.*

*CE marked models are available as options (EVL/LV/UV Series)*
Some typical configurations are listed below. These are the most fundamental configurations that are well tried and tested.

- EHF-UM200k1-040-0A
- EHF-UV200k1-070-0A
- EHF-UM100k1-020-0A
- EHF-UV050k1-020-0A
- EHF-UV050k1-010-0A
- EHF-EM200k1-070-0A
- EHF-EM200k1-040-0A
- EHF-EV200k1-070-0A
- EHF-EV200k1-040-0A
- EHF-EM101k1-040-0A
- EHF-EM101k1-020-0A
- EHF-EV101k1-040-0A
- EHF-EM051k1-020-0A
- EHF-LM020k1-020
- EHF-LM020k1-010
- EHF-LM020k1-A04
- EHF-LV020k1-020
- EHF-LV020k1-A04
- EHF-LM010k1-020
- EHF-LM010k1-010
- EHF-LM010k1-A04
- EHF-LV010k1-020
- EHF-LV010k1-010
- EHF-LM005k1-020
- EHF-LV005k1-020
- EHF-LV005k1-010
- EHF-LV005k1-A04

Servopulser Retrofit

Controller

Retrofit your controller to the latest model to resurrect your servo-hydraulic testing machine.

Controller 4890 (P7)

Highly functioned model using fully digital technology

- Fully digital control (2-degree-of-freedom PID control, realtime gain adjustment, autotuning, AGC) allows anyone to conduct highly accurate testing.
- Digital Load Limiter restricts overloads.
- Mail notification function and remote monitoring.
- Automatic sensor recognition, rangeless performance, and sensor linearization
- The nine GLUON software packages can be selected according to the target application. (P8 – 9)

Controller 4830 (P6)

A compact, high-performance, general-purpose controller offering extremely simple operation

- Fully digital control with autotuning, waveform distortion correction, and AGC achieves faithful load waveform reproducibility.
- Test force control for specimens with clearance. (push test function)
- ±0.5% indicated force value accuracy
- Extremely simple operation using a color LCD and touchpanel
- Comprehensive waveform generation functions and realtime graphic functions
- Optional Windows software available

*Photo shows a typical system configuration.
Compact Hydraulic Actuator
Shimadzu JF Series Force Simulator

Applies repeated loads to products such as automobile components, furniture, and structural parts to evaluate their durability. Force Simulator is a lightweight, compact, easy-to-use hydraulic actuator for these applications.

Lightweight, Compact, Easy-to-use
20 kN force and 100 mm stroke from a 25 kg actuator. Lightweight and compact actuator is portable and easy to install. Hydraulic hoses are easy to connect using one-touch couplings.

The AF Series portable air-cooled hydraulic power supply unit requires no cooling water. The casters make it easy to move.

Free Mounting
The optional brackets allow the actuator to be mounted in a variety of ways.

Actuator Size and Weight

<table>
<thead>
<tr>
<th>Model</th>
<th>Stroke</th>
<th>a50 mm</th>
<th>a100 mm</th>
<th>a150 mm</th>
</tr>
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<tbody>
<tr>
<td>JF 5 kN</td>
<td>weight</td>
<td>17 kg</td>
<td>20 kg</td>
<td>25 kg</td>
</tr>
<tr>
<td>JF 10 kN</td>
<td>overall length</td>
<td>565 mm</td>
<td>815 mm</td>
<td>1065 mm</td>
</tr>
<tr>
<td>JF 20 kN</td>
<td>weight</td>
<td>21 kg</td>
<td>25 kg</td>
<td>28 kg</td>
</tr>
<tr>
<td>JF 30 kN</td>
<td>overall length</td>
<td>570 mm</td>
<td>820 mm</td>
<td>1070 mm</td>
</tr>
</tbody>
</table>

*1 The weight includes the load cell and servo valve.
*2 The overall length is the dimension at the central position, with the load cell attached.

System Configuration Example

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Model</th>
<th>JF-5 kN</th>
<th>JF-10 kN</th>
<th>JF-20 kN</th>
<th>JF-30 kN</th>
</tr>
</thead>
</table>

Servo valve
- Model: 4830
- Rated pressure: 213 MPa
- Flow rate: 19 l/min
- Load cell: 5 kN

Controller
- Model: 4830
- Motor: 5.5 kW, 4 pole (drip-proof)
- Constant-rate gear pump
- Tank capacity: 90 L
- Cooling method: air cooled
- With casters

Hydraulic power supply unit
-Rated pressure: 761-4017
-Rated flow rate: 9 l/min
-Supply unit capacity: AF-10B

Amplitude Characteristics
- The diagram shows the relationship between the single amplitude and frequency for a sinewave drive at rated load.
- These characteristics do not incorporate the frame and load cell characteristics. Subtract these characteristics to determine the actual amplitude characteristic values.
- These amplitude characteristics were calculated using typical servo-valve characteristics.
- Differences of approximately 10% may occur along the frequency axis.
- The amplitude characteristics for a 50 Hz supply are approximately 1/6 of those shown. Consult your Shimadzu representative for details.

<table>
<thead>
<tr>
<th>Servo valve</th>
<th>Model</th>
<th>761-4017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated flow rate</td>
<td>19 x 1 l/min</td>
<td></td>
</tr>
<tr>
<td>Hydraulic power supply unit</td>
<td>Model</td>
<td>AF-10B</td>
</tr>
<tr>
<td>Power supply frequency</td>
<td>50 Hz</td>
<td></td>
</tr>
<tr>
<td>Accumulator</td>
<td>1 L</td>
<td></td>
</tr>
</tbody>
</table>

* Other combinations of hydraulic power supply, controller, etc. are possible. Consult your Shimadzu representative for details.
Simulator is a lightweight, compact, easy-to-use automobile components, furniture, and Shimadzu Series Force Simulator. The AF Series portable air-cooled hydraulic power supply unit requires no cooling water. The casters make it easy to move. Hydraulic hoses are easy to connect using one-touch couplings. 20 kN force and 100 mm stroke from a 25 kg actuator.

Optional Bracket
Combinations of a front bracket, trunnion bracket, swivel base/head, can be used at three positions: front flange, center trunnion, and tail flange.

JF30KN Optional Brackets

<table>
<thead>
<tr>
<th>Name</th>
<th>Model</th>
<th>Part No.</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swivel base/head</td>
<td>JF-50</td>
<td>346-74159</td>
<td>Used with base head</td>
</tr>
<tr>
<td>Front bracket</td>
<td>JF-50</td>
<td>346-77042</td>
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</tr>
<tr>
<td>Trunnion bracket</td>
<td>JF-50</td>
<td>346-76901</td>
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</tr>
</tbody>
</table>

* Purchase two units for combination with base head.

JF30KN to JF20KN Optional Brackets

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<th>Model</th>
<th>Part No.</th>
<th>Comments</th>
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</thead>
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</tr>
<tr>
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<td>Front</td>
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<tr>
<td>Head</td>
<td>50/20</td>
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</tr>
<tr>
<td>Front bracket</td>
<td>JF-50</td>
<td>346-74113</td>
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<tr>
<td>Trunnion bracket</td>
<td>JF-50</td>
<td>346-74115</td>
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<tr>
<td>Angle set bracket</td>
<td>JA-20</td>
<td>346-74117</td>
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</tbody>
</table>

Front View

Tail View

Swivel head

Swivel base

System Customization
Consult your Shimadzu representative for customized systems with modifications to all or part of the system.

<Precautions on changing the hydraulic power supply unit>
1. A separate accumulator stand and hydraulic pipes are required to use a QF Series hydraulic power supply unit. (Specify the distance between the hydraulic power supply unit and accumulator stand and between the accumulator and actuator.)
2. Select servo valve 761-4018 when changing to a QF-40 hydraulic power supply unit. (For JF10KN to JF20KN.)
3. Select servo valve 761-4019 when changing to a QF-40 hydraulic power supply unit. (For JF20KN to JF30KN.)

<Branch divider>
Consult your Shimadzu representative, quoting the information below, to use a system incorporating a branch divider after the hydraulic power supply unit to drive multiple actuators.

Hydraulic power supply unit capacity
- If a hydraulic power supply unit has a maximum capacity of the hydraulic power supply unit or if the hydraulic power divided equally between them? (Select servo valve or select piping.)
- Distance between the hydraulic power supply unit and accumulator stand and between the accumulator and actuator. (Select piping.)
- On an alarm, does the entire system stop, or do individual actuators stop? (To stop individual actuators, a solenoid valve must be installed for each actuator to cut off the hydraulic pressure to that actuator while the hydraulic power supply unit continues operating.)

<Changing the length of hydraulic pipes or electrical wires> Consult your Shimadzu representative.

<Changing the controller> The controller can be changed to Controller 480.

<Hydraulic Power Supply Unit and Controller Specifications> See pages 6, 7, 10, and 11 for details.

<Frame for Reaction Force> Shimadzu designs and manufactures various frames to use with the F Series. Consult your Shimadzu representative for details.
In recent years, we have seen the demand for the strength testing of minute materials and parts across a range of fields, such as materials like composite and superconductors. Practical micro machines including micro actuators and micro sensors can be used on electronics and communications industries (which are achieving greater compactness and higher functionality), which can be used in lead-free soldered joint technologies developed due to increasing concerns about environmental problems and biotechnologies.

The Microservo MMT Series employs an electromagnetic actuator with extremely high frequency response characteristics as the loading mechanism. The combination with closed-loop control achieves rapid and accurate control of minutes test forces and microdeflections.

Features of the Micro-servo MMT Series

- **Compact testing system**
  - Light and compact for easy installation.

- **Requires no utilities, except AC 100 V**
  - No water or air supply equipment is needed.

- **Quiet enough to install anywhere**
  - Quieter than hydraulic machines.

- **Easy to operate**
  - Simple and easy to use.

Basic Construction of the Microservo MMT Series

- Quiet actuator operation
- High-speed tests to 100 Hz
- Mount actuator above or below, according to the application. Test method not fixed.
- Easy crosshead positioning. Clamp and rack system.
- Compact but highly rigid frame

- Controller is tried and tested with servo-hydraulic systems. Handles both static and dynamic testing. Select the waveform required for the test.
- Great operability, as power amplifier operations are controlled at the Controller.
- Shockless circuits when ACT power turned ON/OFF
- Alarm circuits as standard for safe operation
- Highly efficient cooling
- Requires only AC 100 V. No other equipment needed.
- Large test space. Easy installation of environment control devices or microscopes.

* See the separate MMT catalog for details.
Principle of Micro Test Force Control

As shown in the diagram below, the component that generates the test forces comprises a permanent magnet and force coil. The permanent magnet is fixed and the moveable coil moves vertically. When a current flows in the coil, an electromagnetic force $F$ is generated in proportion to the current, according to the following expression:

$$F = 2 \pi nBI$$

Where,
- $r$ is the coil radius;
- $n$ is the number of coil windings;
- $B$ is the magnet flux density; and
- $I$ is the coil current.

To achieve accurate micro test force control, the coil current $I$ is controlled by a closed-loop control method when electromagnetic forces are generated.

Major Specifications

In combination with Controller 4830

<table>
<thead>
<tr>
<th>Main Unit Model</th>
<th>Part No.</th>
<th>Test force</th>
<th>Piston stroke</th>
<th>Frequency</th>
<th>Controlled items</th>
<th>Load cell (standard accessory*)</th>
<th>Jigs and test devices</th>
<th>Indication accuracy</th>
<th>Installation space (W × D × H)</th>
<th>Total weight</th>
<th>Power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMT-500NV-10</td>
<td>348-20803-00</td>
<td>Max. ±500 N</td>
<td>Max. ±10 mm</td>
<td>Max. 100 Hz</td>
<td>Test force, piston stroke (can be expanded by adding options)</td>
<td>±500 N</td>
<td>Not included in standard configuration (standard specification). (Select options or consult Shimadzu.)</td>
<td>Test force: within ±0.5% indicated value or within ±0.02% dynamic max. test force, whichever is larger*1 Stroke: within ±1% indicated value or within ±0.1% dynamic max. stroke, whichever is larger</td>
<td>1000 × 500 × 1200mm (approx.)</td>
<td>approx. 150 kg</td>
<td>100 V 1 kVA</td>
</tr>
<tr>
<td>MMT-250NV-10</td>
<td>348-20802-00</td>
<td>Max. ±250 N</td>
<td>Max. ±2 mm</td>
<td></td>
<td></td>
<td>±250 N</td>
<td></td>
<td></td>
<td></td>
<td>approx. 120 kg</td>
<td>100 V 500 VA</td>
</tr>
<tr>
<td>MMT-101NV-10</td>
<td>348-20801-00</td>
<td>Max. ±100 N</td>
<td></td>
<td>Max. 60 Hz</td>
<td></td>
<td>±100 N</td>
<td></td>
<td></td>
<td></td>
<td>approx. 100 kg</td>
<td></td>
</tr>
<tr>
<td>MMT-101NV-2</td>
<td>348-20800-01</td>
<td>Max. ±10 N</td>
<td></td>
<td></td>
<td></td>
<td>±10 N</td>
<td></td>
<td></td>
<td></td>
<td>approx. 80 kg</td>
<td></td>
</tr>
</tbody>
</table>

* Various capacity load cells are available as options.
*1 For MMT-11NV-2, this becomes “within ±1% indicated value or within ±0.02% dynamic max. test force, whichever is larger.”
* CE marked models are available as options (NV Series)

In combination with Controller 4890

<table>
<thead>
<tr>
<th>Main Unit Model</th>
<th>Part No.</th>
<th>Test force</th>
<th>Piston stroke</th>
<th>Frequency</th>
<th>Controlled items</th>
<th>Load cell (standard accessory*)</th>
<th>Jigs and test devices</th>
<th>Indication accuracy</th>
<th>Installation space (W × D × H)</th>
<th>Total weight</th>
<th>Power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMT-500NM-10</td>
<td>346-72813-11</td>
<td>Max. ±2 mm</td>
<td></td>
<td>Max. 100 Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>approx. 150 kg</td>
<td>100 V 1 kVA</td>
</tr>
<tr>
<td>MMT-250NM-10</td>
<td>346-72155-11</td>
<td>Max. ±10 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>approx. 120 kg</td>
<td>100 V 500 VA</td>
</tr>
<tr>
<td>MMT-101NM-10</td>
<td>346-71624-04</td>
<td>Max. ±100 N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>approx. 100 kg</td>
<td></td>
</tr>
<tr>
<td>MMT-101NM-2</td>
<td>346-71624-05</td>
<td>Max. ±250 N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>approx. 80 kg</td>
<td></td>
</tr>
<tr>
<td>MMT-11NM-2</td>
<td>346-71624-06</td>
<td>Max. ±10 N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>approx. 10 kg</td>
<td></td>
</tr>
</tbody>
</table>

* See Servopulsers pages 18 to 21 for details about the controllers and software.

External Dimensional Drawings

- 250 N to 10 N

- 500 N
Guarantees High Data Reliability
The T Series torsional fatigue testing machines test the torsional strength characteristics of engines, turbines, and motors, and of shafts, couplings, clutches that transmit rotational torque used in automobiles, aircraft, carriages, electric motors, and machines.

T Series Torsional Fatigue Testing Machines

Fatigue testing for pipe materials
- With axial slide guide (mechanism to alleviate axial loads)
- Hydraulic chuck simplifies specimen clamping

System Configuration Example
- Loading Frame (TSKKNM)
- Torque actuator (TQ-5KNM)
- Controller 4830
- QF-408 hydraulic power supply unit
- Hydraulic grips

The controller can be changed to Controller 4890.
The optional thermostatic chamber permits controlled-temperature environmental testing.

* Contact your Shimadzu representative for details.

300Hz High-cycle Fatigue and Endurance Testing Machine

For service life evaluation and 10⁶-order fatigue testing on parts and materials
- Test frequency up to 300 Hz
- Servo-hydraulic actuator achieves 300 Hz, ±20 kN loading.

System Configuration Example
- Highly rigid frame
  - ±20 kN, ±10 mm actuator
  - QF-408 hydraulic power supply unit
  - Controller 4830
  - Windows software for 4830

Major Specifications
- Test frequency : 0.001 to 300 Hz (max.)
- Test force capacity : ±20 kN
- Piston stroke : ±10 mm

* Contact your Shimadzu representative for details.

Shock Absorber Testing Machine

Damping characteristic evaluations on automobile and motorcycle shock absorbers
- Measures the damping force with respect to the shock-absorber piston speed.
- Plots graphs, including speed-damping force curves and displacement-damping force Lissajous curves.

System Configuration Example
- E-type frame
  - Controller 4830
  - Hydraulic power supply unit
  - Dedicated software

* Contact your Shimadzu representative for details.

Axial Force (Tensile/Compression) and Torsion Testing Machine

Evaluates materials and parts under conditions similar to actual use.
- Loading approximates actual use
- Simultaneously applies axial and torsional loads to specimen.

System Configuration Example
- Special frame
  - Actuator combinations
    - 50kN axial and 0.5 kN.m torsional
    - 100kN axial and 1 kN.m torsional
  - Hydraulic power supply unit
  - Controller 4830 (two units)
  - Windows software for 4830

* Contact your Shimadzu representative for details.
Dynamic Characteristics Testing Machine for Rubber Vibration Isolators

For R&D into rubber vibration isolators
- Can calculate the static characteristics and high-cycle dynamic characteristics (to 300 Hz) of viscoelastic materials.
- Simple measurement of spring constants, damping coefficients, and loss factors.
- Thermostatic chamber permits testing in controlled temperature environments.

System Configuration Example
- Special frame
- 100 kN actuator
- QF-40 hydraulic power supply unit
- Controller 4830
- Windows software for 4830

Options
- Max. test force : ±100 kN
- Max. displacement : ±10 mm
- Frequency : 5 to 300 Hz
- Amplitude characteristics : 50 Hz ±2 mm, 100 Hz ±0.9 mm, 200 Hz ±0.36 mm, 300 Hz ±0.18 mm

* Contact your Shimadzu representative for details.

Thermostatic Environment Control Device

For fatigue and durability testing of materials and small parts in a temperature-controlled environment
- Forced circulation of hot or cold air from heater or chiller
- Extremely safe during long-periods of continuous operation

Applicable Systems
- E-type, U-type, L-type Servopulser
- Micro-servo MMT Series

Temperature Range
- -65°C to 250°C
- -35°C to 250°C
- (Room temperature +10°C) to 300°C

* Contact your Shimadzu representative for details.

Resistance-heated High-temperature Testing Machine

High-temperature low- and high-cycle testing of all materials
- A cooling jacket around the furnace minimizes the thermal effects on the extensometer.
- Highly accurate temperature control from Shimadzu’s unique PID circuit simultaneous control method.

Applicable Systems
- E-type Servopulser
- Micro-servo MMT Series

Temperature Range
- Temperature distribution : ±3°C (300°C to 800°C), ±5°C (800°C to 1000°C)

* Contact your Shimadzu representative for details.

High-frequency Induction-heated Thermal Fatigue Testing Machine

For thermal fatigue testing and high-temperature, low-cycle testing on all materials
- High-frequency heating device achieves rapid heating and the servo-operated coolant gas injection device achieves rapid cooling.
- Permits highly accurate temperature cycle testing.

Applicable Systems
- E-type Servopulser

Temperature Range
- Temperature range : 100°C to 1200°C
- Max. heating rate : Room temperature to 1000°C within 70s

* Contact your Shimadzu representative for details.
Other Testing and Evaluation Machines

UH-FX
Universal Testing Machine

AG-X plus Series
Precision Universal Tester

MST-I
Micro-Autograph Micro Strength Tester

MCT-W Series
Micro Compression Testers

DUH-211/211S
Dynamic Ultra Micro Hardness Tester

HMV-G
Micro Hardness Tester

CFT-500D
Flow Tester (Capillary Rheometer)

* Windows® is a trademark of the Microsoft Corporation.