SHIMADZU
Excellence in Science

C225-E036

Very High Cycle Fatigue Testing System

USF-2000A

Powerful Accelerated Testing of Materials Fatigue Strength

Complete service life of 10^{10} cycles …

… within 6 days.

The USF-2000A very high cycle fatigue testing system provides the most time- and cost-efficient test procedure for reliable service life data.

Within just 6 days instead of at least 1 year, the USF-2000A gives information and certainty about the loading capacity of metallic and other materials.
Applying 20 kHz cycle frequency, it completes 10^{10} cycle tests more than 60 times faster compared to 300 Hz.

For automotive, aerospace and railway applications in particular, the reliability of materials has to be predictable to provide best quality and highest safety for consumers and peace-of-mind for manufacturers.

The USF-2000A generates stress amplitude in a specimen by resonating it with 20 kHz longitudinal wave oscillation. It measures 10^9 to 10^{10} fatigue strength, where it has been difficult or impossible to obtain data previously. Data for 10^7 can be generated in about 10 minutes.

Day 1

Set up test

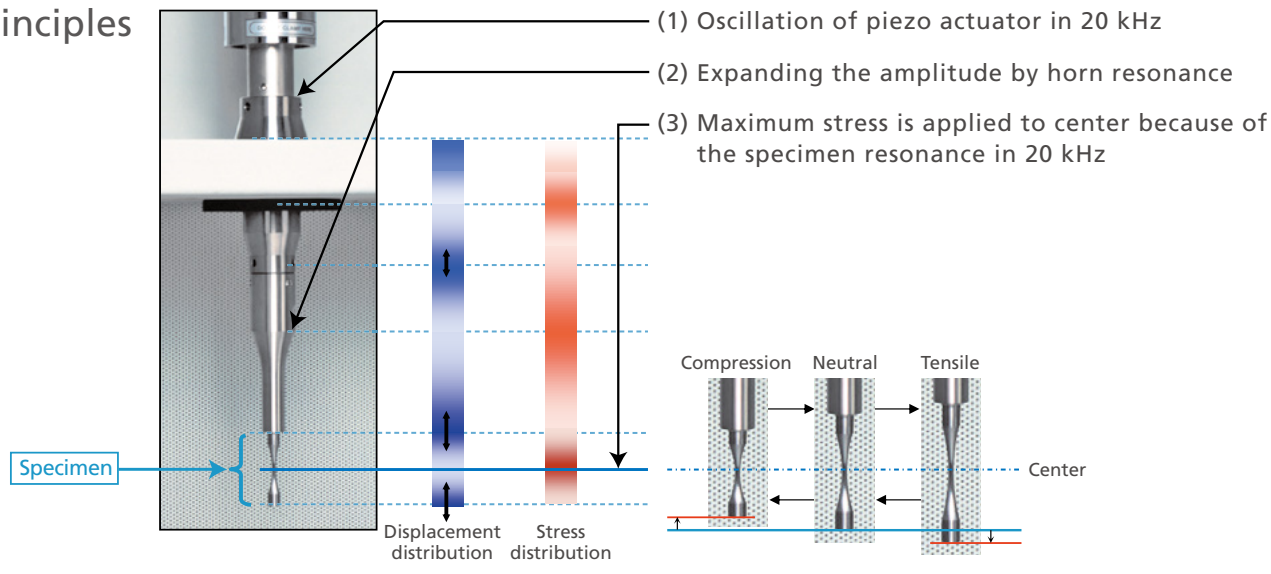
- Start material characterization by providing material name, Young's modulus and material density.
- Select specimen shape.
- Based on the settings, the software generates a technical drawing of the specimen automatically.
- FEM skills are not required.

Start test

- After selecting the test-type between normal or intermittent driving, the test can be started.
- A specified oscillation and stop time (pulse-pause) ratio can be selected in the software. Supported by an air-cooling system, it avoids overheating of the specimen.

  On reaching the specified number of cycles or exceeding of fluctuation band of test frequency due to fatigue crack initiation, the test ends automatically.

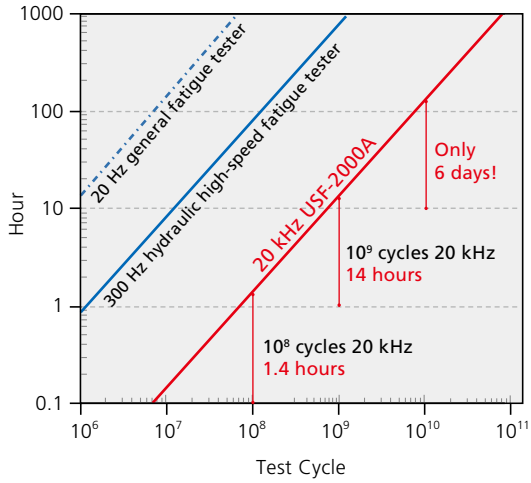
■ Principles



USF-2000A

extended features at a glance

- 20 kHz ± 500 Hz test frequency
  10^9 cycle test in 14 hours (compared to 39 days at 300 Hz)
  10^{10} cycle test in 6 days (compared to 365 days at 300 Hz)
- Range of test amplitudes 100 MPa – 1,200 MPa
  (1,000 MPa grade steel tests are possible)
- ± 50 µm amplitude in end surface of horn
- Recreates fatigue failure appearance from micro-defects and inclusions in a short time
- Resonance technique reduces power consumption to 1/100 W compared to a conventional fatigue test
- Smallest table top system available
- No oil or cooling water required
- Mean stress loading is available as an optional function

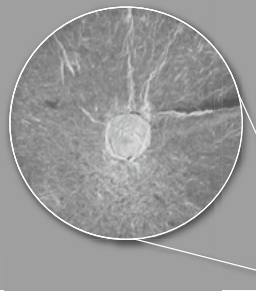


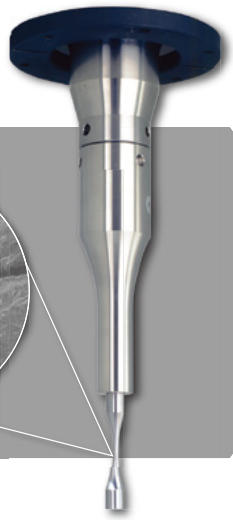
Day 6

- 10^{10} cycles fatigue test results are on hand.

Example of fatigued surface of high-strength steel from the Shimadzu very high cycle fatigue testing system USF-2000A.

Inclusions are evident which were the fatigue point of origin.



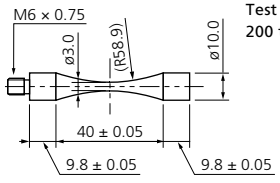


Very High Cycle Fatigue Test Specimen

- Testable materials
  Materials that can resonate at 20 kHz, and that generate little heat when resonating (such as high-strength steel, duralumin, titanium alloys, aluminum).
- Materials that cannot be tested
  Materials that do not resonate at 20 kHz, or for which specimen installation is difficult (plastics, ceramics). Also materials that generate significant heat due to hysteresis energy when resonating at 20 kHz.

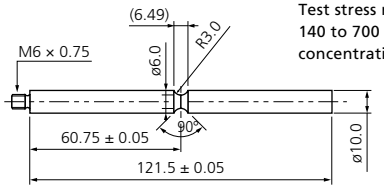
Example of specimen dimensions Young's modulus 206,000 MPa, Density 7.85 g/cm³

1) Circular tapered specimen



Test stress range (nominal stress) approx. 200 to 1,000 MPa

2) Notched specimen



Test stress range (nominal stress) approx. 140 to 700 MPa coefficient of stress concentration approx. 1.56

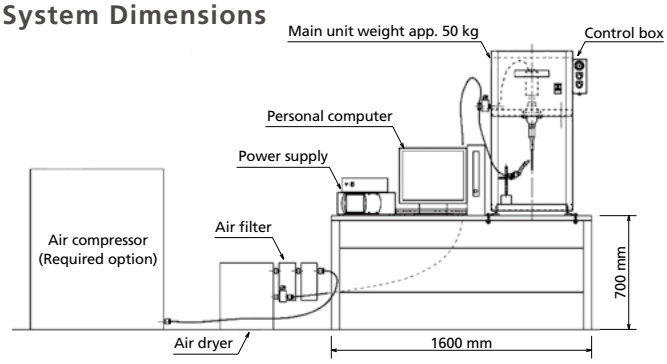
* The software can be dimensioned and stress calculation of the test specimen.

(Units: mm)

Standard Components

USF-2000A	P/N
1) Very high cycle resonance system • Main unit, • Control box, • Power supply, • Piezo actuator, • Horn, • Air dryer	S338-00016-02
2) PC system	
3) Very high cycle fatigue test control measurement software	

System Dimensions



Required Optional Equipment

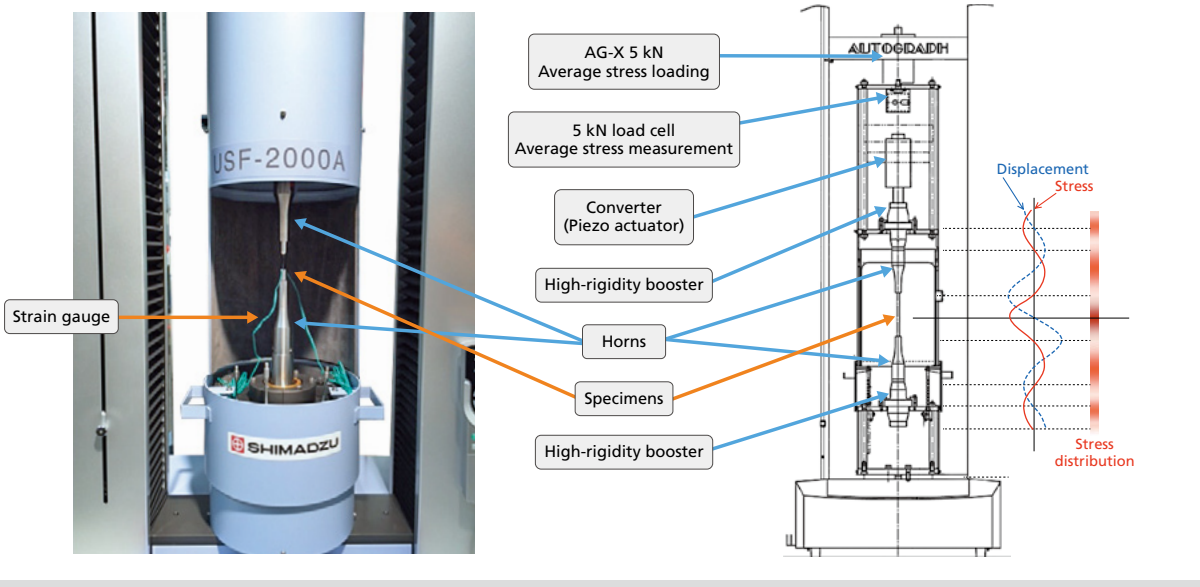
Air compressor or factory air	Flow-rate: 140 L/min or more Pressure: 0.2 MPa or more
Non-contact displacement sensor	Standard non-contact displacement sensor for Shimadzu (P/N S338-01009-01 Eddy current probe, converter, power source for converter, sensor attachment)
Displacement sensor calibrator	Standard displacement sensor calibrator for Shimadzu (P/N S346-52897-01 Displacement sensor calibrator CDE-25 model C1)
Displacement recorder	High-speed data logger for the non-contact displacement sensor Max sampling speed: 500 kHz or more

Custom Product

• Average Stress Loading Mechanism

Actual components are rarely used under conditions in which the average stress is zero. Despite this, the USF-2000A, a standard very high cycle fatigue testing system, can only perform testing under zero average stress conditions. Using a very high cycle fatigue testing system equipped with an average stress loading mechanism, gigacycle fatigue tests can be performed with average tensile stress loaded.

• System Appearance



• Average Stress Max. 1.5 kN (tensile only)

Average stress loads exceeding 1.5 kN are possible, but will have an impact on the service life of the horn.

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