

# WinTest® DMA Software

## Dynamic Mechanical Analysis of Materials and Devices

Bose Corporation's WinTest® DMA application software meets the challenges of dynamic mechanical analysis. When coupled with special fixturing, such as environmental chambers and our DMA tensile grips, our ElectroForce® test instruments are the right platform for advanced viscoelastic property measurement of a variety of materials, including:

- Elastomers
- Fibers
- Biomaterials
- Gels
- Plastics
- Films
- Composites
- Foods

The WinTest DMA software allows the user to define a series of test conditions that are automatically reproduced on the test system. The user can also step through a series of conditions to explore changes in material or component properties with respect to any controlled parameter.



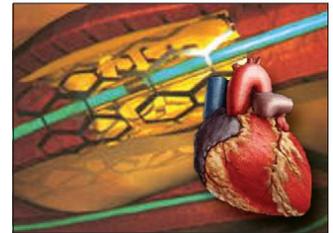
ElectroForce® 3200  
Instrument with  
Temperature Chamber



Tire Materials

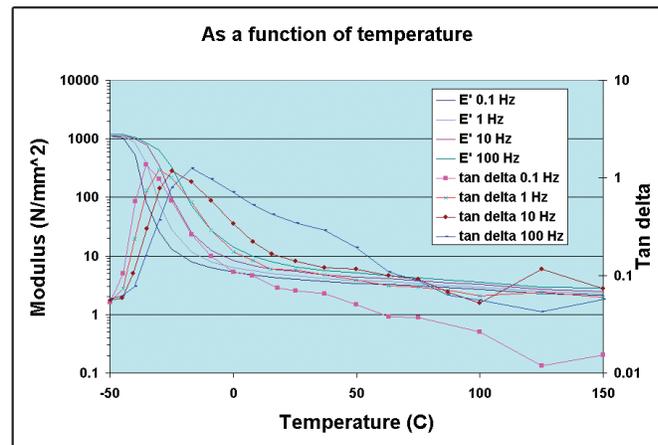


Consumer Products



Soft Tissue

The following is an example of one of the many types of tests that the WinTest DMA software can perform. In this test the dynamic properties were measured as a function of frequency at a number of various temperatures. The measured properties show how the glass transition temperature varies when the dynamic frequency of the test changes.



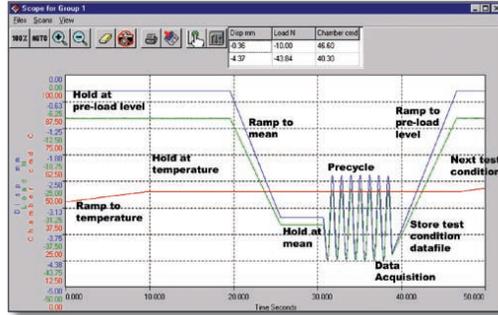
Control for the versatile ElectroForce instrument is provided by the WinTest PCI control system. This PC-based system features an intuitive interface, powerful test generation and data acquisition capabilities. WinTest software's flexible design enables the ElectroForce instruments to perform a wide range of tests.

Combine WinTest controls with the ElectroForce test instruments featuring the Bose moving-magnet linear motor, specially designed DMA accessories and application software, and you have an exceptional range of performance in our easy to use, fully integrated and automated test systems.

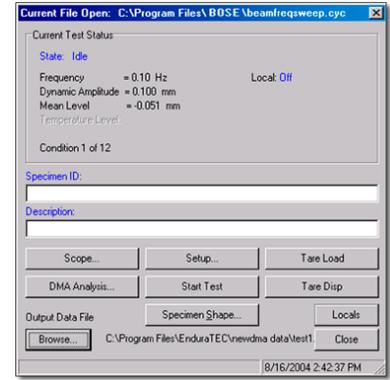
# WinTest® DMA Application Software

The software allows the user to easily define a series of test conditions that are then systematically applied to the test specimen. You can choose to step through a series of test conditions that allow you to explore the changes in material or component properties with respect to any controlled parameter, including:

- Frequency
- Dynamic amplitude
- Mean
- Hold at mean
- Hold at temperature
- Temperature

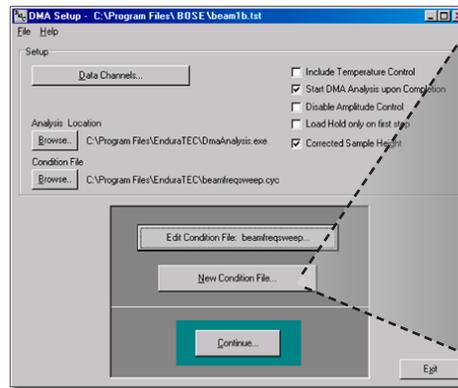


DMA Test Sequence

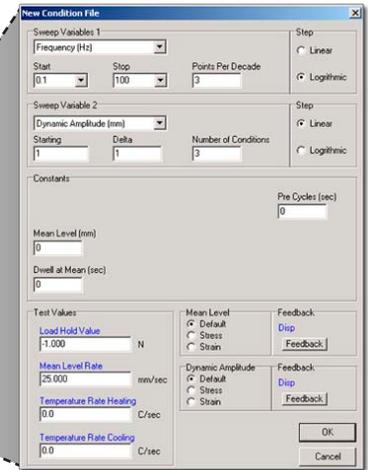


DMA Test Status Window

Designed to intelligently transition through each step of the test condition, the DMA software includes setup windows that provide what is required to define your test conditions. The Current Test Status window provides all the control needed to start a test and to provide test status and real-time loading condition information. All specimen information is entered through the Test Status window so it is fast and easy to run the same test on a number of test specimens. When one test finishes you simply enter the new specimen information, choose a new data file name and press the Start Test button.



DMA Setup Window



New Condition File Window

## Important Features and Benefits

Many features in the DMA software make your testing easier and more complete, including:

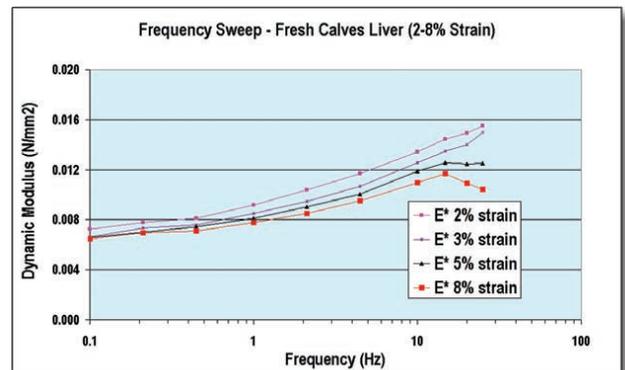
- Elimination of tuning. The software uses an advanced algorithm to provide the desired test conditions without the need for PID tuning. This is especially useful for soft samples that experience a significant modulus change with frequency.
- In one easy window you choose one parameter you would like to change (or two if you want a nested sweep) in a linear or logarithmic manner and set the other constant test parameters. The test condition matrix is automatically created.
- A DMA test file is created that includes all the necessary settings defined in the DMA test. Next time you want to run the same test you only need to open one file.
- The necessary test information is saved in the exported data file including the requested and actual test conditions, specimen information and calculated specimen properties.
- In addition to traditional force and displacement control, tests can be defined as stress or strain with independent control of the mean level and dynamic amplitude.

## Soft Tissue Example

Soft tissue represents a significant challenge for analysis because of its lack of structural integrity. Frequency sweeps were performed at very low levels on fresh calf liver in order to determine the Dynamic Modulus under different strain conditions. For this test and other applications to soft tissue, it is necessary to have very fine dynamic control at low levels of excitation.



Liver Sample in Compression



Frequency Sweep - Fresh Calves Liver (2-8% Strain)

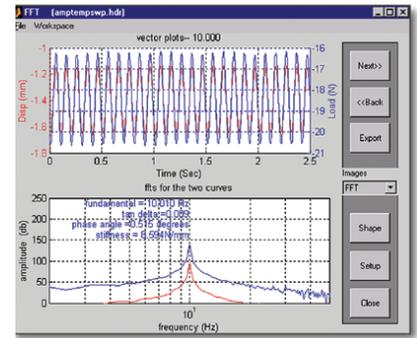
# Data Analysis Capabilities

The WinTest<sup>®</sup> DMA software provides the ability to display the collected data in a variety of ways, such as amplitude versus time or two amplitudes versus each other (hysteresis loops). Using FFT analysis, the software can calculate the viscoelastic properties of a variety of test specimens. The user selects which graph to display using the pull-down menu, or the data can be exported for analysis in a third party spreadsheet or analysis software.

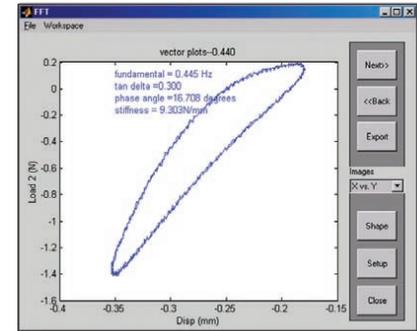
The WinTest DMA software provides numerous algorithms to characterize both component and material properties under dynamic conditions. The software uses a Fourier analysis technique, which models a measured signal as a series of sine functions of varying amplitude and phase, to analyze the timed data of a reference and measured channel. The standard analyses available are summarized in the table below for components and materials.

The DMA software optimizes the data acquisition rate, the test frequency, and the number of cycles of data taken during the test to ensure that the Fourier analysis returns phase and stiffness values that properly represent the behavior of the test specimen. The software package utilizes MATLAB<sup>®</sup> algorithms and commands to

derive the dynamic properties of the test specimen after timed data is collected by the WinTest control software. The data is available in ASCII form if there is a desire to verify or analyze specimen properties using different techniques.



Example of Timed Data and FFT Analysis



Example of Force Versus Deflection

Example of Data Exported into an Excel Database

## Component Data Analysis Properties

Description	Parameter	Definition
Dynamic Stiffness	$K^*$	The ratio of Force and Displacement amplitude
Phase	$\delta$	The phase relationship between Force and Displacement
Storage Stiffness	$K'$	$K^* (\cos \delta)$
Loss Stiffness	$K''$	$K^* (\sin \delta)$
Damping	$C$	$K^* (\sin \delta) / 2\pi (\text{frequency})$

## Material Data Analysis Properties

Description	Parameter	Definition
Tan Delta	$\text{Tan} \delta$	Tangent of $\delta (E''/E')$
Complex Modulus	$E^*$ (or $G^*$ for shear)	$K^*/\text{shape factor}$
Storage Modulus	$E'$ (or $G'$ for shear)	$K'/\text{shape factor}$
Loss Modulus	$E''$ (or $G''$ for shear)	$K''/\text{shape factor}$

## Component Data Analysis Properties

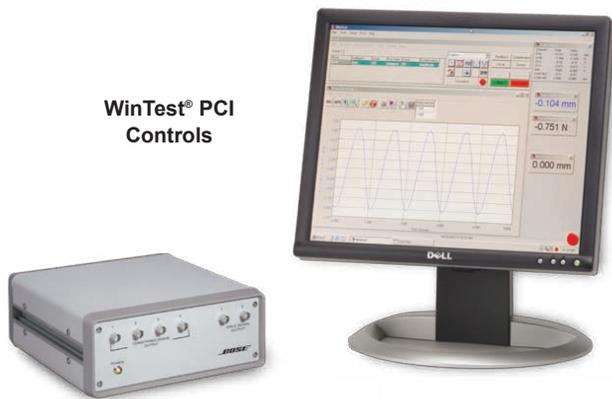
- Cylindrical and rectangular specimens
- 3-point bend specimens (free end and double cantilever)
- Single, double, or quad lap shear

# Solutions for Dynamic Mechanical Analysis of Material

Combine Bose Corporation's WinTest® DMA application software with our ElectroForce® test instruments, powerful WinTest PCI controls, and special specimen fixtures, and you're ready to determine the dynamic properties of materials and components under a wide variety of test conditions. Look to Bose for integrated test solutions that give you results quickly and accurately.

## ElectroForce® Test Instruments

ElectroForce test instruments use direct electromagnetic conversion to apply force, and as a result, provide exceptional fidelity, precision and versatility for a variety of test applications. The ElectroForce linear motor utilizes a simple and durable moving-magnet design that provides excellent dynamic performance and years of reliable operation for researchers and test engineers. In addition to being powered from a standard electrical outlet, ElectroForce instruments are air-cooled, clean room compatible and provide whisper-quiet operation in compact, space-saving packages. Thanks to their practically maintenance-free operation, ElectroForce test instruments have set a new standard for performance, simplicity and elegance in a single test system.



## WinTest® PCI Controls

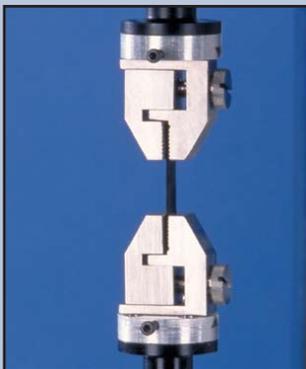
The PCI electronics are the latest version of Bose Corporation's digital control hardware featuring 32-bit digital signal processing resolution, 16-bit data acquisition, and up to a 5 kHz update rate.

The WinTest software runs under the Windows XP environment and features a fully integrated display that simplifies test operation while providing advanced testing capabilities. WinTest's intuitive design enables the user to quickly set up complex test routines with minimal training.

## Specimen Fixtures

For Dynamic Mechanical Analysis, specimen gripping and conditioning accessories are of paramount importance. The Bose line of accessories includes a variety of tension/compression fatigue grips, compression platens, 3 and 4-point bend fixtures, and numerous other solutions for small specimens. Contact Bose for customized solutions for your test applications.

### Dynamic Mechanical Analysis Grips and Fixtures



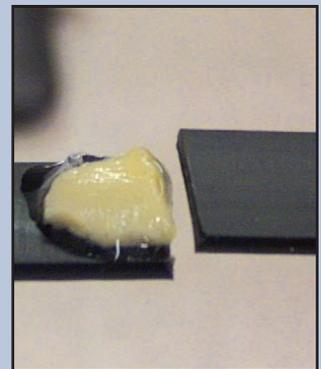
DMA Tension Grips



4-Point Bend Fixture



Compression Platens



Shear Test Fixture