



biosyntech

MACH-1™ Micromechanical Systems

Mach-1 Motion User Manual

Version 3.2

BIOSYNTECH – MICROMECHANICAL SYSTEMS

Mach-1 Motion v3.2 – User Manual

Introduction

Thank you for buying a Mach-1™ Micromechanical System. This unique device is a small-sized universal mechanical testing system for specimens with dimensions between tens of microns and a few centimeters. Typical applications for the system are in the mechanical stimulation and characterization of biological tissues, polymers, gels, biomaterials, capsules, adhesives and food.

The instrument allows for the characterization of mechanical properties such as: stiffness, strength, modulus, viscoelasticity, plasticity, hardness, adhesion, swelling and relaxation using displacement controlled motion.

Some of the features of the Mach-1™ Micromechanical System are:

- Chambers for compression, tension, indentation, bending and other test configurations are mounted on a universal displacement actuator platform. Displacement control can be within 25 nanometers.
- Load cells are interchangeable to allow maximum loads between $\pm 150\text{g}$ to $\pm 10\text{kg}$ with load precision being 1 part in 20,000 of the maximum (7.5mg minimum at present).
- The test system can be placed in an incubator for testing at temperatures up to 37°C and for testing under sterile conditions (e.g. cell culture).
- Sophisticated and flexible software allows execution of stress relaxation, ramp and dynamic sinusoids tests in automated user-defined sequences.

The Mach-1™ Micromechanical Systems are composed of two distinct and complementary software: Mach-1 Motion and Mach-1 Analysis. There are also some device drivers used by the Mach-1 Motion program to communicate with the data acquisition hardware through the operating system.

This manual contains installation and operation instructions for the Mach-1 Motion software.

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Getting Started

System Description

Hardware

The Mach-1™ Micromechanical System is composed of a load frame, one or more actuator, one motion controller, one or more load cell, one load cell amplifier, one computer, and many accessories such as testing chambers, grips and fixtures.

The actuators are commanded to compress, stretch or bend the test sample while the load cell measures the force generated by the sample due to that deformation. The load cell amplifier energizes the load cell and converts the measured force signal to a digital value, which is transferred to the computer via a communication port. The load cell amplifier also monitors the load cell for a situation of excess load to stop the actuator motion. The actuator is commanded by the motion controller, which is in turn controlled by computer software.

Software

The Mach-1™ Micromechanical Systems are also composed of two distinct and complementary software: Mach-1 Motion and Mach-1 Analysis. There are also some device drivers used by the Mach-1 Motion program to communicate with the data acquisition hardware through the operating system.

Computer System –Recommended

- a) Pentium 4 based computer or equivalent
- b) 512MB of RAM
- c) 60MB hard disk space for system applications. 2-8GB for test data.
- d) CD-ROM drive
- e) One (1) PCI ports
- f) SVGA Video Card (1024x768 pixels minimum)
- g) SVGA Color Monitor (17" or more recommended)
- h) Mouse or other pointing device
- i) Windows 2000/XP/Vista
- j) Power requirements: 115/230 VAC, 50/60 Hz

Safety Recommendations

The use of Mach-1™ Micromechanical Systems presents some risks; precautions have to be taken to prevent injuries or damage to system and surrounding objects.

- First of all, avoid placing fingers between fixed and moving parts of the system.
- Avoid hitting the system edges forcefully.
- Take precautions when lifting the system and avoid placing it near the edges of a table, as it may fall and be damaged or cause injuries.

- Finally, to limit risks of electrocution, ensure to properly connect all wires to the system and avoid spilling liquids.

Also, the load cell is a very sensitive and fragile transducer. **Dropping it, or applying more force on it than its rated capacity, can induce permanent damage to it and compromise its performance.**

Product Disposal

There are no particular issues related to the disposal of this product.

Installing the Micromechanical System

Your system might have been properly installed by one of our qualified support representatives. Should you wish to move, stow, or reinstall the system, this section explains how to proceed.

Software Installation

Insert the Mach-1 Motion CD-ROM in your CD-ROM drive. The installation wizard should start on its own. If not, click Start/Run... from the Windows™ menu and enter X:\setup.exe, where X is the letter of the CD-ROM drive. Then follow on-screen instructions.

The Mach-1™ Motion Software will execute only on the computer where your Mach-1 Micromechanical System hardware is present. Refer to the appropriate section of this manual for details on the licensing agreement.

Starting the System

Your display screen should be set at a minimal resolution of 1024 x 768 pixels. On the desktop, or in the menu “Start/Programs/Biosyntech”, select the shortcut for “Mach1Motion”. The starting window is displayed on the computer screen (Figure 1).



Figure 1: Mach-1 Motion opening dialog box

User Log in

Select “Start” to enter the Mach-1 Motion Software. The “Select User Name” dialog box (Figure 2) will be displayed. Select the appropriate user name or create a new user name by clicking on “New...”. A maximum of 15 characters, including spaces, can be used for the user name. When

the program is started, the user name of the last person who used the system will be shown. This feature aids different users to save personal test sequences. Select “OK” in the “Select User Name” dialog box.



Figure 2: Select User Name dialog box

Hardware Initialization

The initialization sequence is an automated routine that enables the system to perform hand shaking with all of its different components. This routine sets up communications with the actuator controller and sets some software calibration parameters for the actuator. It is also the moment where the software loads the menus that you will be using during system operations. Depending on the Mach-1™ model you own, this process can take as much as 70 seconds.

We recommend letting the system heat up before performing load cell calibration and before running any significant experiment. Some components, such as load cells, are temperature dependant and can show significant load drift when exposed to temperature variations, even if they have built-in temperature compensation. Low capacity transducers are more subject to this effect. Therefore, it is recommended to let the transducers get to steady state. When the load reading is stable on the load cell amplifier or on the computer screen (after less than about 15 minutes), you can perform load cell calibration and proceed to the execution of a test sequence.

The next chapter explains how to use the Mach-1™ system to perform material characterization and stimulation. It is divided in three sections. The first two sections describe the Mach-1 Motion Software, which allows the user to interact with the hardware. This program commands the motion, performs data acquisition and writes appropriate data files for analysis. The third section describes the Configuration menu, which offers the user to define relevant settings for the different components of the Mach-1™ system.

Using the Mach-1 Motion Software

After completing system startup and hardware initialization, the main window shows up.

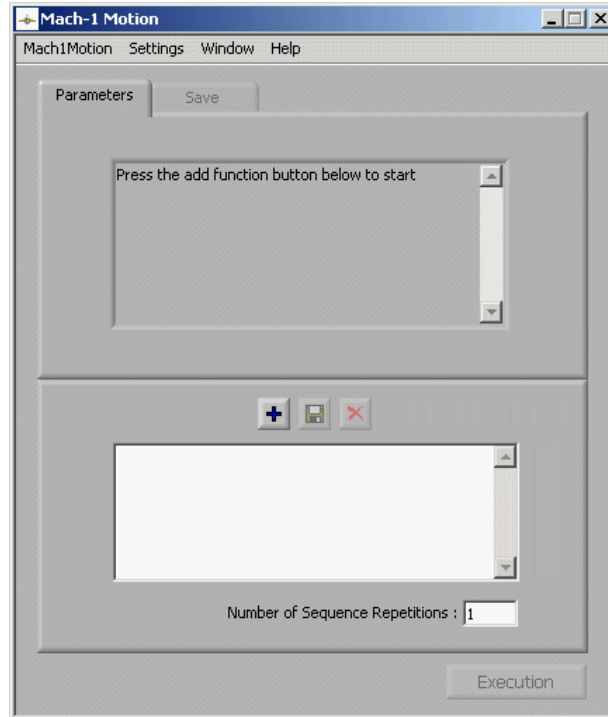


Figure 3: Mach-1 Motion Main Window

The different menu features and the three tabs “Parameters”, “Save” and “Multi-Axis” are described in the following sections.

Parameters, Save and Multi-Axis Tabs

Parameters Tab

The Parameters tab on the main window (Figure 3) is used for building a test sequence. Instructions on how to build a test sequence are given in the section: **Building a Test Sequence**.

Save Tab

To set the file used for test data storage, press the “Save” tab (Figure 4).

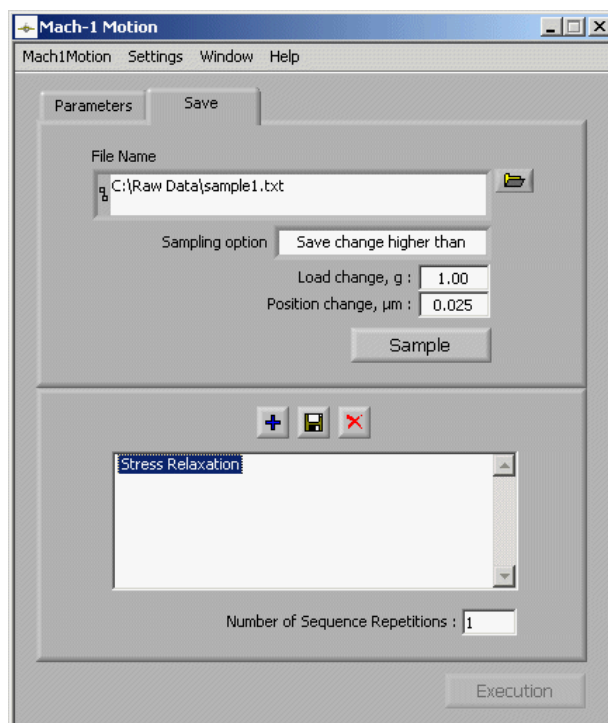


Figure 4: Save Tab

FILE NAME

To save test data into a file, select the function for which you want to save the data and enter a file name into the “File Name” field. A file name must be specified for each function of a test sequence. If no “File Name” is specified, the data acquired during this function will be displayed on the screen, but not recorded in a data file. To browse the directory structure, click on . You can select the same file for several or all functions. If the chosen file already exists, the new data will be appended to the file (without overwriting the existing data).

SAMPLING OPTION

The option “Save change higher than” is used to skip recording data triplets “time, position and load” during long-lasting tests (e.g. stress relaxation) and to avoid wasting hard drive space with redundant data. Starting with the first triplet, the system will skip recording every triplet until it finds one where the load change is higher than the specified value (“Load change, g”) **OR** the position change is higher than the specified value (“Position change, μm”). It will then take this triplet to compare to other values and so on until the end of the test.

You also have the possibility to record all test data by selecting “No option” and filter out undesired data points later.

SAMPLE DIALOG BOX

To save information on the sample or on the test to be performed, select “Sample”. You will see the dialog box shown in Figure 5.

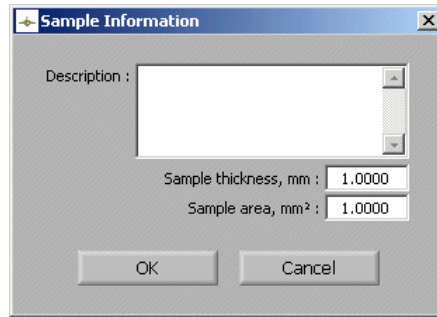


Figure 5: Sample Information

DESCRIPTION

For each function of the test sequence, you can enter a brief description of the test to be saved in the Mach-1 data file. This can be a reminder of particular details that may affect the results such as formulation, temperature, pH and others.

SAMPLE THICKNESS AND SAMPLE AREA

Enter the thickness of the sample in millimeters and its initial area in squared millimeters. This is only informative data that will not affect the execution of the program. It may be used later on for data analysis to convert, for example, displacement values (in microns) into strain (in percentage) and to convert force values into nominal Cauchy stress (force/(initial area)). This information will also be written in the data files header to remind the user of the sample characteristics during the test.

Multi-Axis Tab

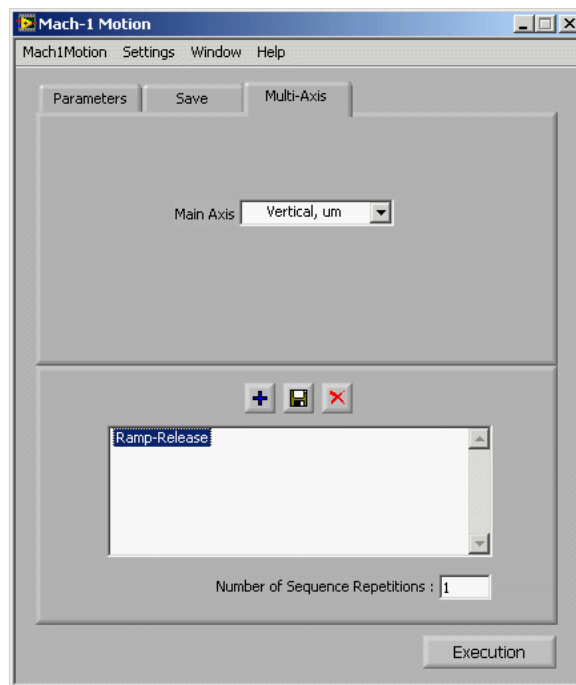


Figure 6: Multi-Axis Tab

For the V500 models, when a multi-axis system is used, it is necessary to specify which axis, “Vertical, Horizontal and/or Rotational”, will be active during each function (Figure 6).

Note: For the rotational axis, amplitudes and velocities must be specified in μm and $\mu\text{m/s}$ not in degrees. Use the convention 1° equals $1000\mu\text{m}$ to convert degrees into μm and degrees/s into $\mu\text{m/s}$.


Building a Test Sequence

Terminology

The Mach-1 Motion program allows for the controlled movement of the actuator. Motion can be either manual or programmatically specified by the user. Examples of controlled motion are routines such as stress relaxation, dynamic sinusoids, ramp-release and other type of tests. Stress relaxation refers to a constant velocity displacement imposed onto the sample and monitoring the resulting load. Dynamic sinusoids tests consist of an imposed sinusoidal displacement onto the sample and reading the resulting dynamic load. Ramp-release tests are similar to stress relaxation tests but allow for return of the actuator to its initial position and repeated cycling of this triangular displacement.

Within the Mach-1 Motion environment, a “test” is composed of one or many “repetitions” of a given number of “sequences”. In turn, one “sequence” is composed of one or many “functions”. Each function is defined by its “parameters”. Before you can run a test, you have to define all parameters of the functions composing the sequence. The next sections will show you how to do it.

Function Types

To select the functions to be included in your test sequence, press the Add function button, . The “Add Function” dialog box shows up (Figure 7), displaying the list of all the functions that may be included in a test sequence.

To add a function in a sequence, in the “Functions List” double-click on the function name. Each selected function is displayed in the “Functions Added” drop-down list box. Once the sequence is built with all the required functions, press “OK”. The functions composing the test sequence are displayed in the lower drop-down list box of the main window (Figure 3) in the order that they will be executed. To change the order of execution, drag each function to its required position of execution using the Mouse or any other pointing device.

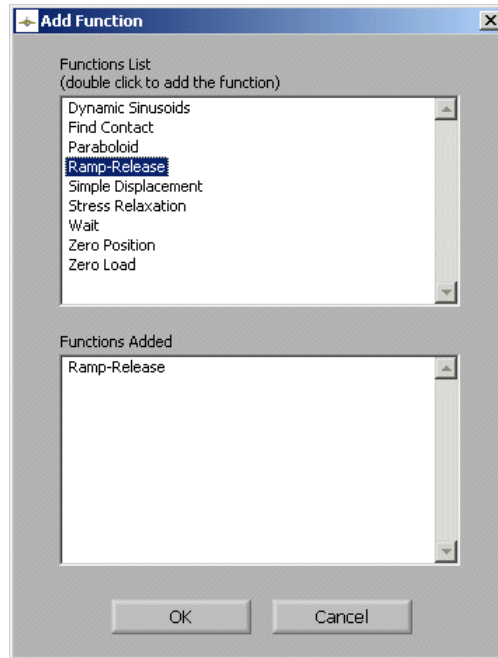



Figure 7: Add Function

Editing Parameters

Before you can execute a sequence, you must edit the parameters of the function. To edit the parameters of a function, double-click on the function name displayed in the main window (Figure 3). A dialog box, specific to the selected function, is displayed with all the required parameters. Once the parameters have been edited and the dialog box has been closed, the parameters may be viewed in the upper drop-down list box of the main window by selecting the function.

Saving a test sequence

When the same sequence has to be performed on many samples, it is convenient to save the test sequence. The user can store all the test parameters and retrieve them the next time he or she wants to run the sequence again. Those parameters include all the values entered in the three tabs, “Parameters, Save and Multi-Axis”, plus the “Number of Sequence Repetitions”. Test parameters are stored in the user’s preference file. They will be only accessible by this user.

To save a test sequence, press  in the main window. The “Save Sequence” dialog box appears (Figure 8), displaying the existing test sequences. To save a new test sequence, enter a name in the appropriate field and press “OK”. To overwrite an existing sequence, select it from the list and click “OK” (this action is irreversible). An unlimited number of sequences, all having a different name, may be saved.

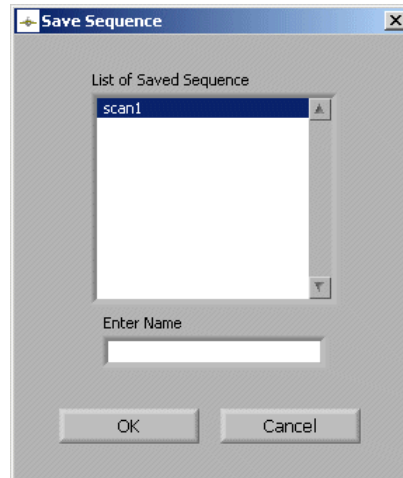



Figure 8: Save Sequence dialog box

Retrieving a test sequence

When a test sequence is saved, the sequence name is automatically added to the functions list in the “Add Function” dialog box (Figure 7). To distinguish the test sequences from the functions, an asterisk (*) precedes each sequence name. To retrieve the stored parameters, double-click on the sequence name in the list of functions.

Deleting a function

To delete a function from a test sequence, select the function to be deleted in the main window and press .

Number of Sequence Repetitions

On the bottom of the main window, you can enter the “Number of Sequence Repetitions” which is the number of times the same test sequence will be repeated.

Execution

Once your sample has been installed and your sequence has been designed, press the “Execution” button. This button will then turn red and show “Stop”. Press this button again in case you wish to abort the test sequence.

Description of Functions

This section lists and describes the different functions used to build a test sequence.

Dynamic Sinusoids

The dynamic sinusoids routine allows you to impose precise sinusoidal displacements. Limitations on the amplitude and frequency come from the displacement, velocity and accelerations specifications of the Mach-1™ model you own. Refer to System Specifications section of this manual.

The routine executes a sequence of sinusoidal displacements determined by the combinations of the three parameters “Frequency”, “Amplitude” and “Cycle”.

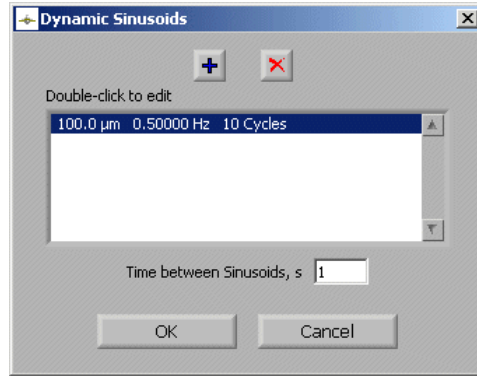



Figure 9: Dynamic Sinusoids

ADDING SINUSOIDS

To add a sinusoid, click on the  button of the “Dynamic Sinusoids” dialog box (Figure 9). Specify the amplitude of the sinusoid (in μm), the frequency (in Hz) and the number of cycles in the “Add Sinusoid” dialog box (Figure 10). Instead of a number of cycles to be performed, a time may be specified. In that case, the number of cycles will round up to the superior integer of the frequency multiplied by the time. The time should be entered in the format “h:min:s”.

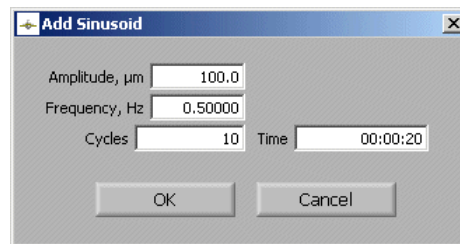



Figure 10: Add Sinusoid

Note: Amplitude value entered in the “Add Sinusoid” dialog box represent half of the peak-to-peak amplitude and is always positive.

Note: The sinusoids will be executed in the order that they appear in the Dynamic Sinusoids dialog box. To change the position of a sinusoid, drag the item to the required position.

DELETING SINUSOIDS

To delete a sinusoid, select the item in the list of the “Dynamic Sinusoids” dialog box and press .

TIME BETWEEN SINUSOIDS

When more than one sinusoid is performed, the user can indicate the waiting period that will separate two consecutive sinusoids. This can be used to let the viscous samples get back to equilibrium.

Note: At the end of the execution of the Dynamic Sinusoids function, the actuator comes back to its starting position.

Find Contact

The find contact routine can be used at the beginning or any time in a sequence to bring the vertical actuator down until it comes in contact with the sample surface. It can also be used to find the bottom of a testing chamber, but in that case, the actuator must be moved very slowly to avoid overstressing the load cell.

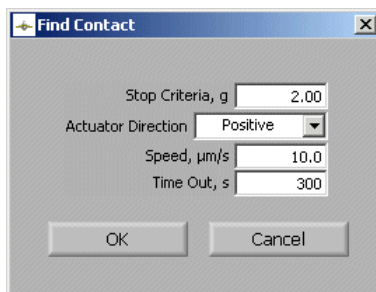


Figure 11. Find Contact dialog box

STOP CRITERIA

The user specifies the “Stop Criteria”, which is relative to the load at the beginning of the test. For instance, if the load cell indicates 10.0 g when the function “Find Contact” is called with a 2.0 g “Stop Criteria”, the actuator would move in the positive direction until the load cell reads 12.0 g, or in the negative direction until the load reads 8.0g.

ACTUATOR DIRECTION

Specify if the actuator has to start moving in the positive or negative direction or if it has to stay at rest (“No motion”). With a positive displacement, a vertical actuator would move down, a horizontal actuator would move right and a rotational actuator will move clockwise. Enter negative displacement for opposite directions.

SPEED

Specify the speed at which the actuator will move. Refer to the specifications of the Mach-1 model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

TIME OUT

If contact has not been made within the “Time Out” specified by the user, the Find Contact function will stop and the sequence will continue with the next specified function.

Paraboloid

The paraboloid routine executes a ramp followed by a release (same amplitude, opposite direction, same velocity and acceleration or not). Figure 12 presents a typical position versus time curve for a paraboloid routine.

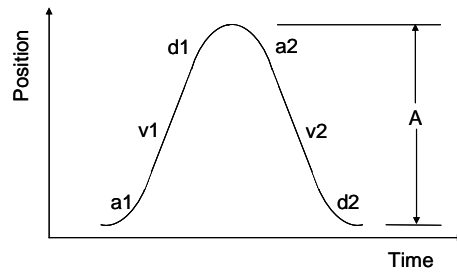


Figure 12: Typical position versus time curve for a paraboloid routine

During a Paraboloid routine, a ramp is executed with acceleration A_1 , velocity V_1 , and deceleration D_1 . Then, a return to original position with acceleration A_2 , velocity V_2 , and deceleration D_2 .

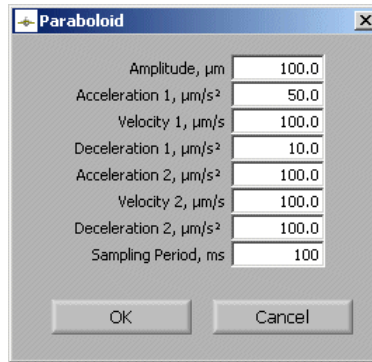


Figure 13 Paraboloid dialog box

AMPLITUDE

This is the amplitude you want the actuator to reach. Full actuator range is allowed. With positive amplitude, the vertical actuator will move down, the horizontal actuator will move right and the rotational actuator will move clockwise. Enter negative amplitude for opposite directions.

ACCELERATION 1

The loading ramp acceleration. In Mach-1 Motion, the acceleration is always specified in absolute value.

VELOCITY 1

The loading ramp velocity. Refer to the specifications of the model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

DECELERATION 1

The loading ramp deceleration. In Mach-1 Motion, the deceleration is always specified in absolute value.

ACCELERATION 2

The releasing ramp acceleration. In Mach-1 Motion, the acceleration is always specified in absolute value.

RAMP VELOCITY 2

This is the releasing ramp velocity. Refer to the specifications of the model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

DECELERATION 2

The releasing ramp deceleration. In Mach-1 Motion, the acceleration is always specified in absolute value.

SAMPLING PERIOD

This is the time between two successive readings of the triplet “time, position and load”. The fastest sampling period allowed depends on your system.

Ramp-Release

The Ramp-Release routine executes a ramp followed by a relaxation (plateau), then by a release (same amplitude, opposite direction, same velocity or not) and, if required, a second relaxation (second plateau). Figure 14 presents a typical position versus time curve for a ramp release test. This routine is particularly useful for mechanically stimulating specimens, especially in controlled environments such as cell or tissue culture incubators. It is also useful for studying fatigue and related processes during prolonged loading periods.

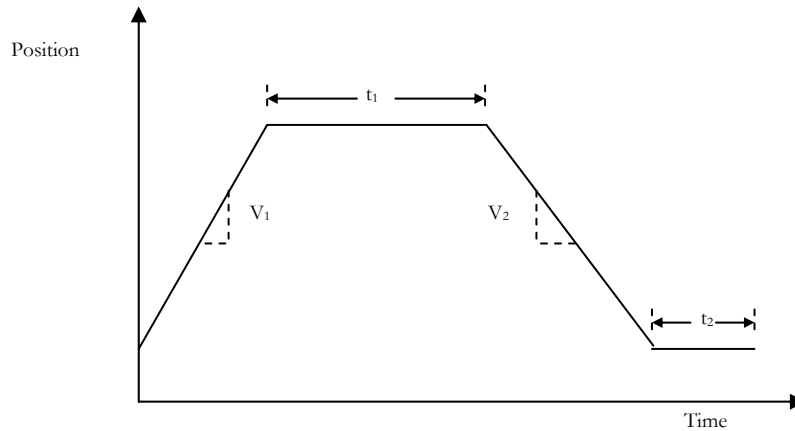


Figure 14: Typical Position versus Time curve for a Ramp-Release test

During a ramp-release function, a displacement is executed at a velocity V_1 , followed by a relaxation (plateau) of duration t_1 and a return to original position at a velocity V_2 . A second relaxation of duration t_2 is executed before the next displacement.

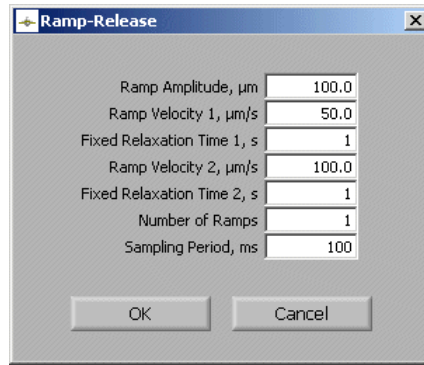


Figure 15 Ramp-Release dialog box

RAMP AMPLITUDE

This is the amplitude you want the actuator to reach. Full actuator range is allowed. With positive amplitude, the vertical actuator will move down, the horizontal actuator will move right and the rotational actuator will move clockwise. Enter negative amplitude for opposite directions.

RAMP VELOCITY 1

The loading ramp velocity. Refer to the specifications of the model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

FIXED RELAXATION TIME 1

This is the time during which the displacement is maintained at the commanded amplitude (first plateau).

RAMP VELOCITY 2

This is the releasing ramp velocity. Refer to the specifications of the model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

FIXED RELAXATION TIME 2

The commanded rest time between cycles (second plateau), that is the time between completion of releasing ramp and the start of the next loading ramp.

NUMBER OF RAMPS

This is the number of identical ramps (displacement/plateau/release/plateau) to be executed.

SAMPLING PERIOD

This is the time between two successive readings of the triplet “time, position and load”. The fastest sampling period allowed depends on your system.

Stress Relaxation

The stress relaxation routine allows for applying sequences of ramp-hold displacements (Figure 16). A sequence of ramp-hold displacements is specified by deciding on the number of ramps plus the amplitude and velocity of each ramp (the same amplitude and velocity are used for all ramps).

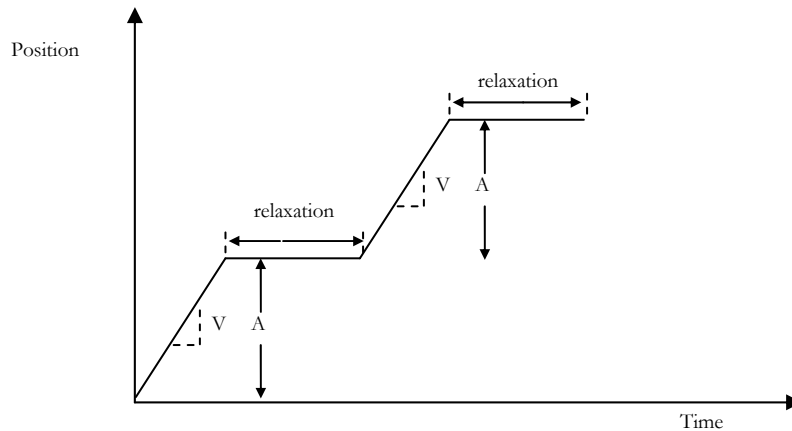


Figure 16: Typical Position vs Time curve for a Stress Relaxation test

During a stress relaxation test, a ramp is executed at a velocity V and an amplitude A , followed by a relaxation (plateau) in which a constant position is held during a time specified by the user. Several identical ramp-relaxation cycles may be executed one after the other as shown in this figure.

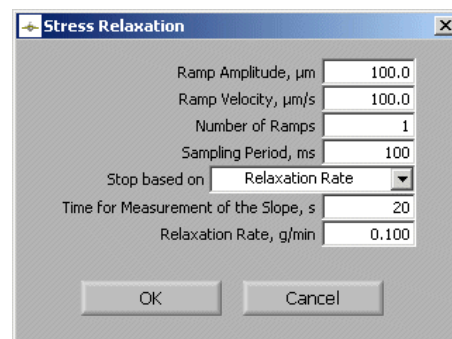


Figure 17: Stress Relaxation dialog box

RAMP AMPLITUDE

This is the amplitude that you want the actuator to reach. Full actuator range is allowed. With a positive amplitude, the vertical actuator will move down (compression), the horizontal actuator will move right and the rotational actuator will move clockwise. Enter negative amplitude for opposite directions.

RAMP VELOCITY

This is the velocity at which the actuator executes the ramp. Refer to the specifications of the model you own to know the velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

NUMBER OF RAMPS

This is the number of identical displacement/hold cycles to be executed.

SAMPLE PERIOD

This is the time between two successive readings of the triplet “time, position and load”. The fastest sampling period depends on your system.

STOP BASED ON

There are two ways of determining the end of each relaxation profile (ramp/hold cycle) before applying the next ramp. The first way, “Fixed Relaxation Time”, asks to specify the duration of each profile in the appropriate field of the dialog box. The second way, “Relaxation Rate”, is to monitor the load vs. time slope and end the profile when this slope is less than the “Relaxation Rate,” specified by the user.

With the second technique, an estimation of the condition of equilibrium is made throughout the acquisition. By using a small “Sampling Period” or a large “Time for Measurement of the Slope”, you can minimize the effect of noise by creating a low-pass filter.

Simple Displacement

This function is used to make absolute (“Move to”) or relative (“Move of”) actuator displacements. With a positive displacement, a vertical actuator will move down, a horizontal actuator will move right and a rotational actuator will move clockwise. Enter negative displacement for opposite directions.

The velocity (in $\mu\text{m/s}$) at which the motion will be executed must also be specified in the “Simple Displacement” dialog box. Refer to the specifications of the model you own to know the displacement and velocity range allowed. In Mach-1 Motion, the speed is always specified in absolute value.

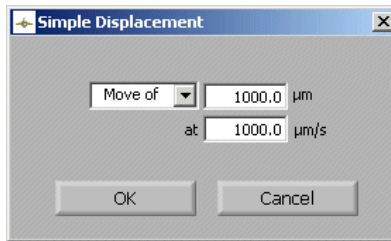


Figure 18. Simple Displacement dialog box

Wait

This function is used to acquire data from the motion controller and/or load cells without activating the motors. Specify the sampling rate in milliseconds and the duration. Once the waiting duration is reached, the next specified function of the sequence will be executed.

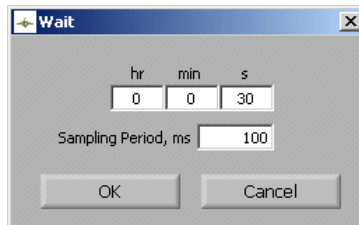



Figure 19: Wait function dialog box

Mach-1 Motion Menus

Manage Sequences...

This feature is used to delete test sequences stored by the user. To delete a sequence, select it from the list and press  in the “Manage Sequences” dialog box.

Exit

This menu item is used to terminate the Mach-1 Motion Software.

Load Cell Settings (single-axis load cells)

This feature is used to set relevant load cell parameters and perform load cell calibration.

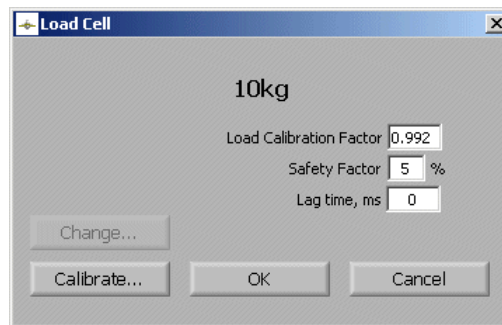


Figure 20: Load Cell Settings dialog box

LOAD CALIBRATION FACTOR

The Load Calibration Factor represents the ratio of the theoretical grams per volt of the load cell to the actual grams per volt measured through the calibration routine. This parameter should always be around 1.000. If the value of the calibration factor differs from 1.000 by more than 5%, it might indicate that your transducer is irreversibly damaged. Perform the basic verifications described in the Troubleshooting section of this manual before contacting a technical support representative.

The “Load Calibration Factor” is automatically calculated by the Load Cell Calibration routine (executed by selecting “Calibrate...”). Although you can overwrite this parameter by entering a new value in the corresponding field, it is recommended to determine the Load Calibration Factor using the Load Cell Calibration routine.

SAFETY FACTOR

This value is used to add an extra protection against overloads. It represents the percentage of the load cell capacity that is still available when the load cell sends an overload signal. For instance, if you have a ± 1 kg load cell and you enter 10% in the “Safety Factor” field, the load cell will overload when reading plus or minus 900 grams.

LAG TIME

The “Lag time” is the time that the load cell is delayed before load data are acquired. The “Lag Time” ensures that data acquisitions from the load cell and from the actuator are performed simultaneously. This value is determined in our factory in order to optimize system performance

and depends only on your configuration, such as the number of data channels you have and so forth. This value should not be changed unless you change your system hardware.

CHANGE...

If you wish to acquire data from a different set of load cells rather than the one indicated in the “Load Cell” dialog box, click on “Change...”. A dialog box will open. From the list of available load cells, select the appropriate sensor(s). Before a new load cell can be installed, it must be added through the Configuration menu. Do not forget to calibrate the new load cell.

CALIBRATE...

Load cell calibration is absolutely required when a new load cell is installed. It is also strongly recommended to calibrate the load cell prior to the beginning of an experiment.

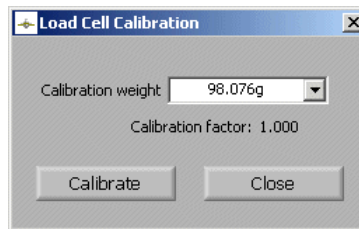


Figure 21: Load Cell Calibration

The automated routine performs load cell calibration using a known weight, which had its exact mass entered into the Configuration menu. The “Calibration Factor” field indicates the current load calibration factor. The “Offset” field indicates the current offset for this particular sensor. Every time this routine is executed, a new set of parameters is calculated.

After clicking on “Calibrate...”, the “Load Cell Calibration” dialog box shows up. Select the “Calibration weight” that you will use for calibration. Follow on-screen instructions which ask the user to install the calibration weight (the system will read the load) and to remove the weight (the system will read the load again). The “Load Calibration Factor” will be automatically calculated.

Zero Load

This option sets the current load read by the load cell as zero. On multi-axis systems, all the axes are zeroed at once.

Actuator Midpoint

This feature is used to find the midpoint of the actuator. The midpoint can be used as an absolute reference in space, because a fixed proximity switch mounted inside the actuator assures its position. On multi-axis systems, the user must specify for which axis the midpoint will be found. After reaching the midpoint, the motion controller will set this position as the zero.

Before choosing this command, make sure that the selected actuators are totally free to move along the displacement range so this action will not overstress the load cell.

Actuator Reset

This option performs manual motor initialization. It may be required after losing contact with the motion controller. This can happen after overload detection, after powering off the motion

controller or after receiving following errors from the motion controller. Also, on multi-axis systems, the user must specify which axes will be reset.

Zero Position

This option sets the current position read by the actuator as zero. On multi-axis systems, the user must specify which axes will be zeroed.

Real-Time Display

This feature is used for real-time on-screen display of the data acquired by the system.

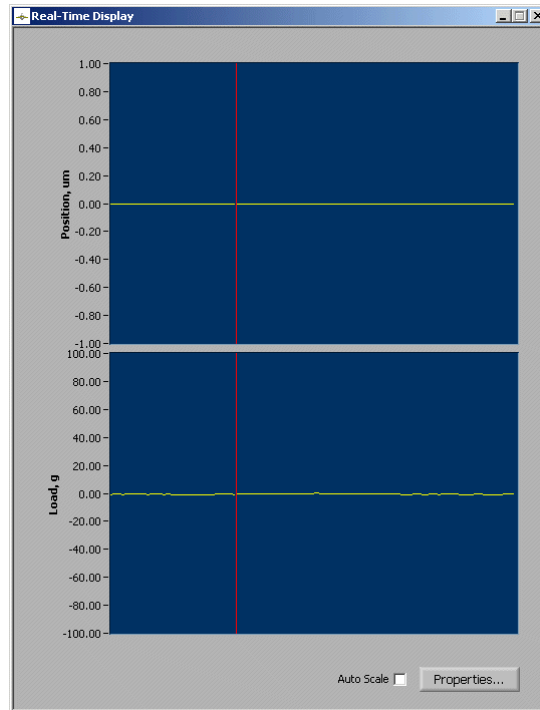


Figure 22: Real-Time Display dialog box

AUTO SCALE

You can change the graphs Y scale by disabling the “Auto Scale” option, clicking on the limits of the appropriate graph and changing the highlighted value directly on the graph.

PROPERTIES...

Select “Properties” on the lower right side of the “Real-Time Display” window to modify the graphs properties.

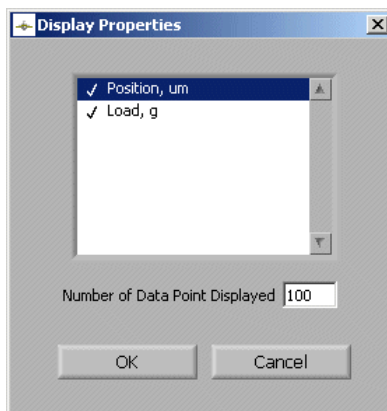


Figure 23: Display Properties dialog box

Up to eight real-time graphs may be displayed simultaneously. Select the graph(s) you wish to show in real-time by double-clicking the item(s) in the list. A check mark will be displayed beside the selected graph. To remove a graph from the “Real-Time Display” window, deselect the graph by double-clicking on it in the list.

The “Number of Data Point Displayed” is the number of data points you wish to plot on the display screen. Allowed range is from 10 to 500 data points.

Actuators Control Window

This feature allows you to manually move the actuator(s). Avoid overloading the load cell during this process.

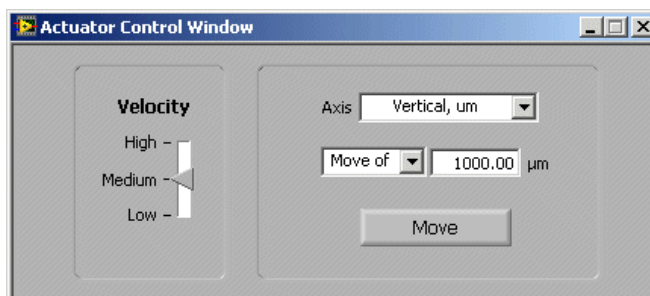


Figure 24: V500cst Actuator Control Window

On multi-axis systems, the user must first select the axis (Vertical, Horizontal or Rotational) that will be moved. The velocity at which the motion will be executed must also be specified as Low, Medium or High. Refer to the Configuration section for velocity definition.

You can enter absolute (“Move to”) or relative (“Move of”) displacement values. With a positive displacement, the vertical actuator moves down, the horizontal actuator moves right and the rotational actuator moves clockwise. Enter negative displacement for opposite directions. Once the displacement value has been entered, select “Move” to execute the motion.

User's Manual

Use this feature to access a PDF file of this User's Manual. The Adobe Acrobat Reader as to be present on your computer. Visit <http://www.adobe.com/products/acrobat/readstep2.html> for details.

Web Resources

Use this feature to access our web site at:

<http://www.biosyntech.com/en/expertise/instrumentation/?BST=Mach>

About

Use this feature to see the software version you have.

Mach 1 Motion – Configuration Menu

This section describes the configuration menu, which is accessed by selecting “Configuration” on the opening screen (Figure 1). The configuration menu allows a user to define hardware settings for the actuators, calibration weights and load cells composing the system. This menu is password protected.

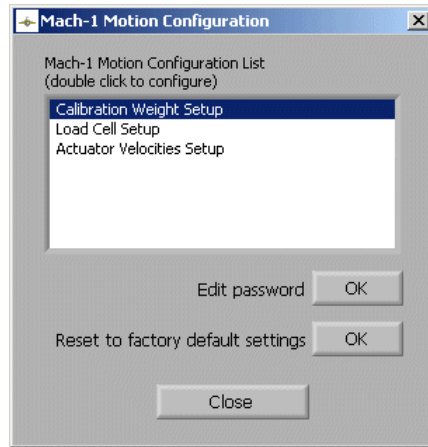


Figure 25. Configuration List

Actuator Velocity Setup

This feature allows the user to quantify for each axis the velocity corresponding to High, Medium and Low used when manually moving the actuators. Refer to the specifications of the model you own to know what is the allowed range. Always use positive values when entering velocities in Mach-1 Motion Software.

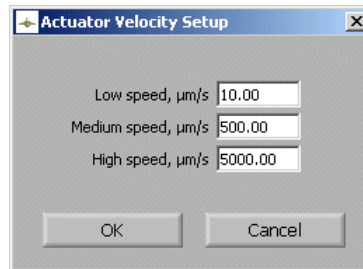


Figure 26. Actuator Velocity Setup dialog box

Calibration Weight Setup

This configuration feature is used to enter new weights used to calibrate the load cells. You may insert, edit or delete calibration weights.



Figure 27. Calibration Weight Setup

Inserting New Calibration Weights

To insert a new calibration weight, select **+** in the “Calibration Weight Setup” dialog box. A new calibration weight appears in the list with the name “<NEW>”.

Editing Calibration Weight Parameters

To set the parameters of a calibration weight, double-click on the calibration weight on the list and enter the name and the exact weight (in grams) of the calibration weight in the “Calibration Weight” dialog box.

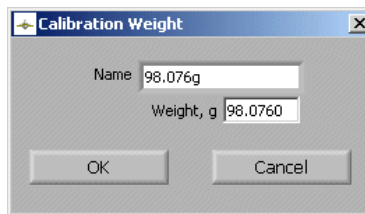


Figure 28. Dialog box to edit Calibration Weight parameters

Deleting Calibration Weights

To delete a calibration weight, select it in the list and press **-**. This action is irreversible.

Load Cell Setup (single-axis load cells)

This option, which is available only for single axis load cells, is used to enter new load cells that are easily interchangeable to get higher resolution or higher load capacity. You may insert, edit or delete load cells using the “Load Cell Setup” dialog box (**Error! Reference source not found.**).

Inserting New Load Cells

To insert a new load cell, press **+** in the “Load Cell Setup” dialog box. A new load cell appears in the list.

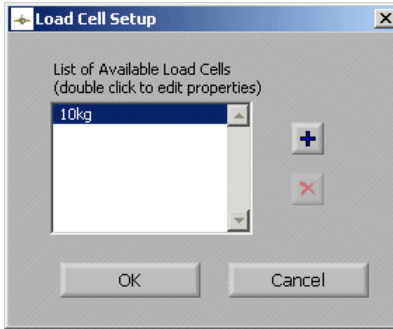


Figure 29. Load Cell setup dialog box

Editing Load Cells

To set the parameters of a load cell, double-click on the load cell on the list and enter the required parameters in the “Load Cell Parameters” dialog box. These parameters are factory settings. You should not have to edit those parameters, unless you enter a new load cell.

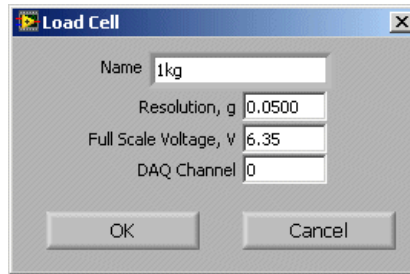


Figure 30. Load Cell Parameters

RESOLUTION

This value is the load cell capacity (in grams) divided by 20 000. It is the smallest load that can be measured by the system.


FULL SCALE VOLTAGE

This parameter is the voltage output (in V) after amplification of the load cell when strained at full capacity.

DAQ CHANNEL

This value, ranging from 0 to 7, is the address associated with the sensor in the data acquisition hardware. This setting is usually provided by the manufacturer.

Deleting Load Cells

To delete a load cell, select it in the list and press . This action is irreversible.

System Specifications

	V Class Mach-1			A Class Mach-1
	Compression / Tension	Shear	Torsion	Compression / Tension
Travel Range	100 mm	50 mm	360°	30 mm
Reproducibility	0.5 µm		0.0005°	0.05 µm
Bi-Directional Repeatability (Uni-Directional for torsion)	± 1.5 µm		± 0.002°	± 0.2 µm
Maximum Velocity	50 mm/s		80°/s	10 mm/s
Minimum Velocity	1 µm/s		0.001 °/s	0.1 µm/s
Max Capacity	± 5 kg (±50N)		(± 1 N•m)	± 4 kg (±40N)

	Single-Axis Load Cell			Multi-Axis Load Cell			
	0.150 kg	1 kg	10 kg	1.2 kg	2.5 kg	5 kg	12.5 kg
Maximal Force (x, y)	0.150 kg / 1.5 N	1 kg / 10 N	10 kg / 100 N	1.2 kg / 12 N	2.5 kg / 25 N	5 kg / 50 N	12.5 kg / 125 N
Maximal Force (z)				1.7 kg / 17 N	3.5 kg / 35 N	7 kg / 70 N	50 kg / 500 N
Maximal Torque (x, y, z)				12 kg •mm / 0.12 N•m	25 kg •mm / 0.25 N•m	50 kg •mm / 0.50 N•m	300 kg •mm / 3 N•m
Resolution Force (x, y)	7.5 mg / 7.5 x10 ⁻⁵ N	50 mg / 5 x10 ⁻⁴ N	500 mg / 5 x10 ⁻³ N	0.94 g / 9.4 x10 ⁻³ N	3.91 g / 0.039 N	15.6 g / 0.156 N	65.1 g / 0.651 N
Resolution Force (z)				1.33 g / 0.0133 N	5.47 g / 0.0547 N	21.9 g / 0.219 N	781 g / 7.81 N
Resolution Torque (x, y)				47 g•mm / 0.00047 N•m	195 g•mm / 0.00195 N•m	781 g•mm / 0.00781 N•m	57 g•mm / 0.00057 N•m
Resolution Torque (z)							28 g•mm / 0.00028 N•m

Troubleshooting

This section may help you with basic verifications before contacting our Technical Support department.

The actuator is not responding. This could be due to:
<ul style="list-style-type: none"> • The actuator is disabled. Reset the axis (Settings menu / Reset). Depending on the motion controller model, a LED should turn from yellow to green. • The actuator controller is not powered on. • The communication cable is not properly installed. • The hardware overload check cable is not properly installed (if present). • The communication port is not properly installed or configured. • A heavy object is placed on the Motion Controller.
The Load Cell Amplifier is not responding. This could be due to:
<ul style="list-style-type: none"> • The amplifier is not powered on. • The connection cable is not properly installed. • The real-time display is not opened. • The communication link is broken. Shut down the load cell amplifier and Mach-1 Motion, and then start them up again.
The Over Load message is still present without any apparent reason:
<ul style="list-style-type: none"> • The calibration factor in the load cell settings is too high. Go in the Load Cell dialog box, change the Calibration Factor manually to 1 and perform another calibration. • If the display of the load cell is also blinking check the cable connection from the load cell to the load cell amplifier.
The actuator suddenly stops responding:
<ul style="list-style-type: none"> • Check for overloads. Restart the real-time display. • An obstacle forced the motion controller to disable the actuator to prevent permanent damage to the actuator. Try to reset the axis (Settings menu / Reset Axis) • The system may have lost communications with the controller. Reboot the motion controller and restart the program. • Check connections.
The calibration factor differs from 1.0 by more than 5.0 %:
<ul style="list-style-type: none"> • Verify that the installed load cell corresponds to the load cell indicated in the “Load Cell”

dialog box.

- Verify that the connection cable from the load cell to the load cell amplifier is properly installed.
- Open the “Configuration/Load Cell Setup” menu and verify that the values for the “Resolution” and “Full Scale Voltage” are identical to the values provided by the manufacturer.
- The load cell might be damaged. Contact technical support.

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MACH-1 MOTION AND MACH-1 ANALYSIS VERSION 3.1 AND ABOVE

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Extent of Limited Warranty

Bio Syntech Canada Inc. (hereinafter called “the Company”) warrants to the end-user customer that the MACH-1 Micromechanical Systems will be free from defects in materials and workmanship within 12 months after delivery of the product to the original purchaser.

Subject to certain exceptions and conditions the Company agrees, at its option, to correct by repair, by replacement, or by credit to the purchaser any defect of materials or workmanship, which develops within 12 months after delivery of the product.

The exceptions and conditions mentioned above are the following:

The Company’s limited warranty covers only those defects which arise as a result of normal use of the product, and do not apply to any:

- Improper or inadequate maintenance;
- Unauthorized modification;
- Operation outside the product’s intended purposes;
- Operation outside the product’s specifications;
- Improper site preparation;
- Inappropriate handling.

The Company’s limited warranty does not cover load cells, which are extremely sensitive to manipulations.

The Company shall be released from all obligations under its warranty for products that have been in contact with biohazard materials and/or radioactive materials.

The Company shall be released from all obligations under its warranty in the event repairs or modifications are made by persons other than its own service personnel or authorized dealer personnel unless such repairs by others are made with written consent of the Company.

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Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the foregoing warranty shall not be binding upon the Company unless reduced to writing and signed by an officer of the Company.

Servicing and Support

The following explains Bio Syntech Canada's servicing policy.

The user should not attempt to repair, service or maintenance the system beyond the procedures described in the Troubleshooting section of the User's Manual. Bio Syntech Canada Inc. should be advised of any problems that arise with your system. Technical support should be contacted (refer to contact information below).

For all technical support, please have the following information available:

- Model number
- Serial number
- Problem description

If the technical support representative determines that the system is to be returned for repair, a copy of the Service form, which may be found on the next page, should be filled out and returned with the shipment.

Note: Customers must notify Bio Syntech Canada Inc. of any testing systems that have been exposed to any biohazard or radioactive materials. Systems that require servicing that have been exposed to biohazard or radioactive materials will have to be decontaminated before servicing. In this case, Bio Syntech Canada Inc. will decontaminate the system for the customer for a fee.

Service Request Form

Customer Name: _____
Organization: _____
System Serial Number: _____

Reason for return: _____

Please indicate possibility of exposure to the following:

- Synthetic material. Specify: _____
- Biological material. Specify: _____
- Harmful chemicals. Specify: _____
- Radioactivity. Specify: _____

For the safety of our personnel, the customer is required to ensure that the system and its parts are cleared of all biological, chemical or radioactive hazardous materials. The cost of additional cleaning or part replacement, at the discretion of Biosyntech, will not be covered under the warranty.

Name: _____ Signature: _____ Date: _____

Support and Contact Information

All requests, suggestions or reports of instrument performance should be directed to:

Bio Syntech Canada Inc.

475, Armand-Frappier Blvd.

Laval, Quebec, Canada, H7V 4B3

Telephone: +1(450) 686-2437 or (in North America) 1-866-262-5903

Fax: +1(450) 686-8952

For information about our products and services, call 1-450-686-2437 ext. 230

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