

Manual

FirmTech 2 Fruit Firmness Tester

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Please read through the Setup to install the
FirmTech 2 hardware and software.

BioWorks

firmtech@bio-works.us
785.456.1287

30968 Highway K-18
Wamego, KS 66547
U.S.A.

Board Setup: PCI DAS1000 Card

The DAS1000 should be inserted in a PCI slot in your desktop computer.
Disconnect the computer power when installing this card.

FirmTech 2 Software Setup

Run Setup.exe from the BioWorks CD folder that is appropriate for your instrument.

Folder names:

INST300 is the program general fruit testing: size and firmness.

INST400 is the program for instruments testing **cherry** firmness and sizing.

During installation you may be asked if you want to replace a newer file with an older file; ***always retain the newer file.***

The program (INST300 or INST400) will be installed in the folder "C:\Program Files\BIOWORKS32" on your hard drive along with other files. Do not change the default location.

You can start the program through START-Programs-BIOWORKS32-INSTxxx
However, you must complete the remaining SETUP sections before the FirmTech will run.

Instacal Card Control (MeasurementComputing Inc)

This step installs card drivers (**Instacal32.exe**) which allow your PC to communicate with the PCIDAS1000 board. **Instacal32.exe** is a program needed by all boards and is supplied by MeasurementComputing (formerly ComputerBoards Inc.)

Updates of Instacal can be obtained from their FTP site at www.measurementcomputing.com as a single, self extracting file.

Instacal32.exe program installation is as follows:

Run Setup.exe from the Instacal folder found on the BioWorks CD.

Follow the program directions given by accepting default values observing the following points.

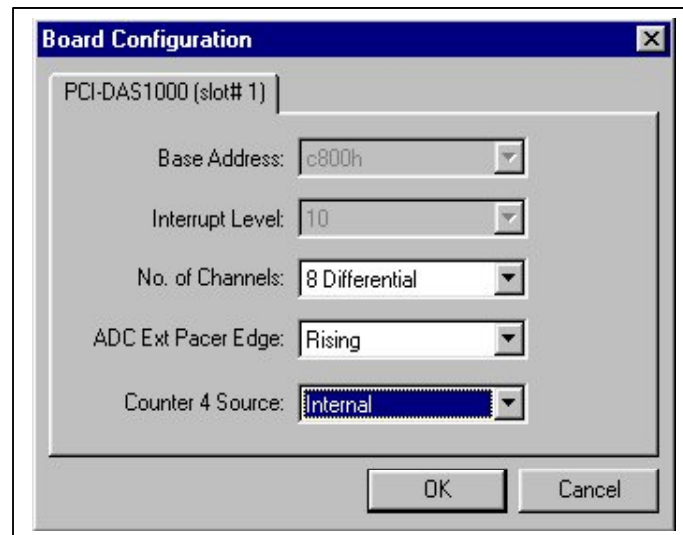
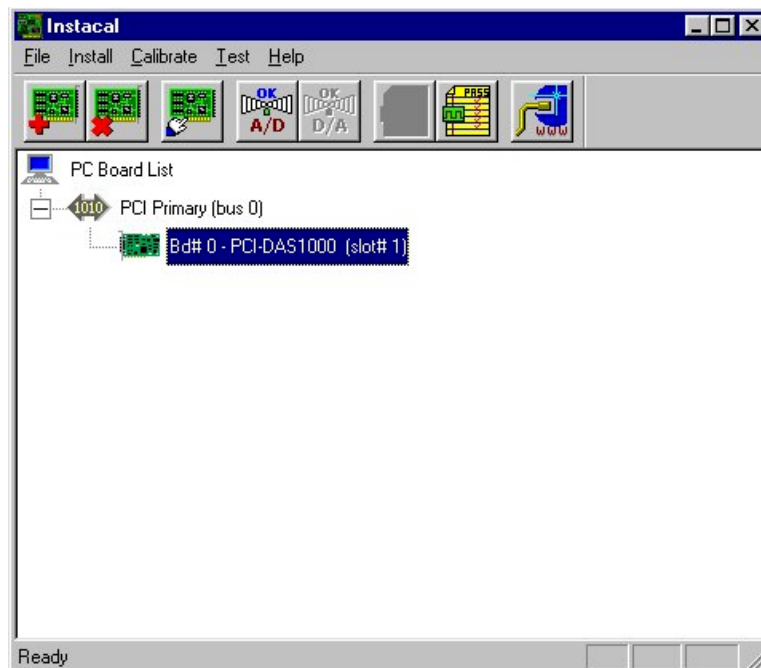
*** **Installation of Instacal requires rebooting your computer.**

A directory called C:\MCC will have been created.

PCI DAS1000 Configuration

Run **Instacal32.exe** from Windows Explorer or the program icon. This board should automatically be detected. Remove any Demo Boards that are listed in the Board List by highlighting the board and clicking **Install-Remove**. (You can also highlight and right-click).

The PCIDAS1000 must be set as board #0. Highlight the board, right click, and Change the Board # to 0. Double-clicking on the board will bring up the Board Configuration. The Counter 4 Source needs to be set to internal.



You may exit Instacal now.

INST300 is the program general fruit testing: size and firmness.
INST400 INST400.exe is a modified version of INST300 and is used exclusively for **cherry** firmness and sizing.

FirmTech.cal contains load cell calibration numbers.

CONTROL PANEL 2.00

File Configuration Calibrate Check Procedures

Current Test Files

Configuration File C:\Ainst3260MOD\Sample.cfg

Current Data File C:\Ainst3260MOD\Test

Data Base File

Test

START TEST

Sample ID 1 Sample ID 2 Procedure Time Date

Ref Size 24.5

Gap

Max Size

Min Size

Samples in Data File C:\Ainst3260MOD\Test

Sample #	Sample ID 1	Sample ID 2	Procedure	Time	Date	Sample Size	Firmness Avg	Firmness SD
3	ID1	ID2	-Com F-	10:52:48	01-11-2001	5	579.06	216.44

Data File Samples

Double-click Sample # to Graph - OR- Click, then Right Click to View Data (cut and paste to Excel). -OR- Highlight Samples and use File-Print to print.

1/11/01 10:57 AM

INST400.exe Control Panel

(Measures cherry size and firmness)

CONTROL PANEL-2.00

File Configuration Calibrate Check Procedures

Current Test Files

Configuration File C:\ASTemil\sample.cfg

Temp Data File C:\temp\Firmtech.Dat

Perm Data File

Max Size 26.821 Ref Size 24.3

Min Size 9.821 Reference Gap 4.521

Test

Grower Variety Location Target Operator Time Date Auto Inc

07:33:09 01-12-2001 305

Row Size Percentages

> 8	8	8.5	9	9.5	10	10.5	11	11.5	12	13	14	< 14
-	-	-	-	-	40.	40.	60.	100.	100.	% < Row Size		
0	-	-	-	40.	-	20.	40.	-	-	-	-	0
		100.	100.	60.	60.	40.	-	-	-	% > Row size		

Firmness Stats

Firmness Avg	Firmness STD	Min	Max	Fruit #
522.4	229.1	232.9	758.4	5

Missing Fruit

Status

Bar Chart:

Support notes for INST400:

The file **netdrive.dat** contains the location where data files will be stored and the value of the Auto increment tag.

Example of netdrive.dat contents:

C:\Data	data file location
20	auto-increment number

For security, this file has to be manually changed and saved in an ASCII editor (i.e. Notepad).

Check this before you operate the instrument.

The following files should not be changed or relocated: **CherrySizes.txt** lists the row sizes and their equivalent millimeter value. The last two numbers are correction numbers for sizing to account for indenture depth.

7	34
8	33.33
8.5	31.35
....	
....	
12	21.43
13	20.63
14	19.05
15	17
1	
2.5	

RefSizeLog.txt contains history of the reference size used. Located at the netdrive.dat spec.

CalibLog.txt contains history of calibration. Located at the netdrive.dat spec.

FirmTech.dat contains data for the most recent test (this is copied to a permanent data file at the netdrive.dat location)

Configuration

The Configuration file stores all information about how tests are to be made.

To access the **Configuration**, click Configuration from the **CONTROL PANEL**. Configurations are stored in files having an extension of ".cfg".

Note: **Test Procedures** describes the types of tests you can do. **Data Files** describes data file types.

Configuration settings can be set to sample one fruit for first time use. After you become familiar with the instrument you should change these to your desired settings. Settings are saved by clicking **Configuration File** and saving to a file. The initial default configuration file name is "sample.cfg".

INST300.exe Configuration

C:\Inst300\Sample2.cfg

Configuration File

ForceThresholds		Deflection Thresholds		Speed		Time Delay	Turntable		
Max, gms	Min, gms	Max mm	Min mm	Load Cell, mm/s	Table rps	Delay msec	Sample Size	Skip Positions	Table Positions
350	50	1.98	1.07	7	1.38	500	1	0	25

Test Procedure

☒ Compression (Force Thresholds)
☐ Compression (Defl Thresholds)
☐ Puncture
☐ Relaxation
☐ Slope Break
☒ Measure Size
☐ Continuous Test
☐ Wait After Test
☒ TurnTable


☒ Data Base
☐ Standard Data Base File Name
☒ Store Header
☐ Notebook
☒ Desktop

Auto Inc

Reference Size Table depth

Click to change Data Base Directory

Test Procedure



Load Cell Cal. Factors

Inst400.exe configuration

C:\Program Files\BIOWORKS32\FTPParameters.cfg

Configuration File

ForceThresholds		Speed		Controls Cards	
Max, gms	Min, gms	Load Cell, mm/s	Table		
350	50	15	.59	<input type="checkbox"/> PCMCIA Cards	
				<input type="checkbox"/> CIO DAS08	
				<input checked="" type="checkbox"/> PCI DAS1000	

Load Cell Cal. Factors

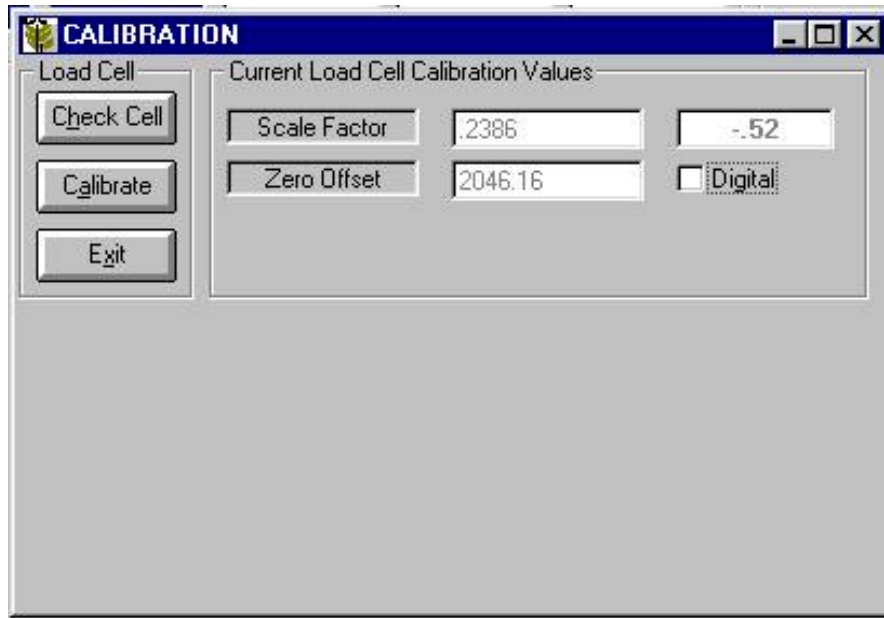
☐ Pause after each fruit

Reference size

Load Cell Speed in mm/second

Load Cell Calibration

Start the Firmtech program, then click **Calibrate** from the **CONTROL PANEL**. The Calibration Panel will appear. Click **Check Cell** and a box will appear which shows the current load cell reading in **grams** (-0.52 for example). This value should be close to zero when calibrated. If the numbers in the box are varying slightly, the load cell and PCI DAS1000 board are working. It is normal for the numbers to vary about ± 2.0 grams. If the numbers do not change at all, the load cell may not be connected.

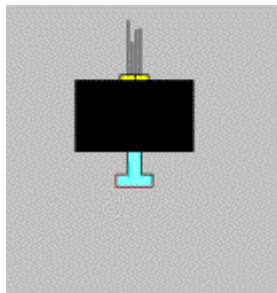


If you press very lightly on the load plate the load cell value should increase. If it does not, do not press harder! If the load cell value increases, you should be able to calibrate. This is a 2-step process which uses the 250 gram brass calibration weight and is outlined as follows:

Calibration should be checked about twice a day. Generally a 5-10 minute warm-up period provides better accuracy for calibration. If the value is close to ± 2.0 grams, the calibration is accurate.

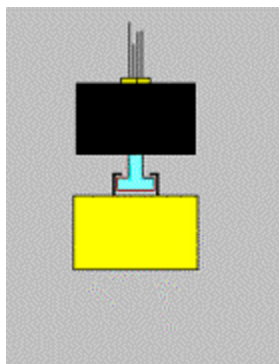
The **RED** button switch on the side of the instrument is used to zero (or tare) the load cell amplifier. Hold this in for a couple seconds before calibrating. This will improve accuracy. **If a different load cell is attached, it is necessary to do this.**

If the **Check Cell** value is varying considerably you may hold down the **RED** button to see if it comes back to ± 2.0 grams. If it does, it should not need re-calibration. The calibration procedure has been made easy enough to do, so it is better to re-calibrate periodically.



Step 1.

With no load on the load cell, click **Calibrate** on the **Calibration** Panel and follow the instructions. A measurement is made for the no-load condition in this step.



Step 2.

Carefully hang the calibration weight on the load cell and click Continue-Step2. Before taking the weight off, click **Check Cell** to see if the instrument is reading -250 grams. It will normally read -250 ± 2.0 grams. The negative reading is because it is measuring a tension force for calibration. Test forces will be positive (compression).

Exiting the calibration before either step is complete will cancel the calibration procedure and previous calibration values.

The **Digital** check box provides a way to troubleshoot any problems. If checked and Check Cell is clicked, the digitized voltage value of the load cell is displayed. This will be near 2048 with no load.

The Scale Factor and Zero Offset are the calibration values used to convert the digital values to grams Force = (Digital Value-Zero Offset) x Scale Factor.

Test Procedures

These procedures are selected in the program **Configuration** along with other variables.

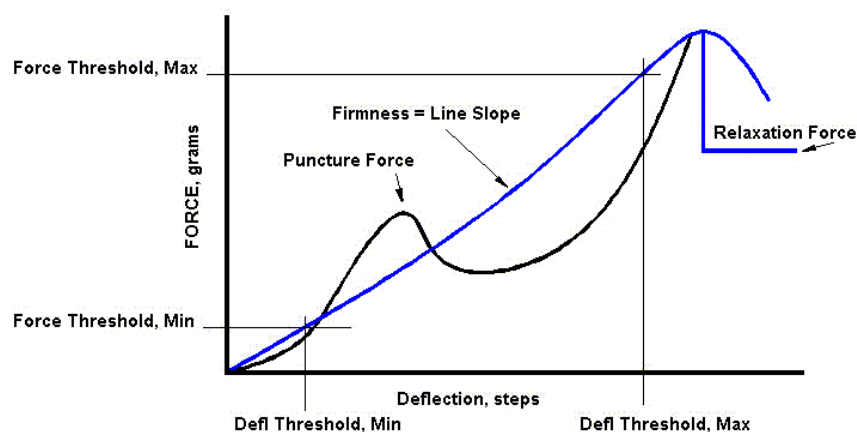
Fruit Testing gives specific recommendations for fruit.

Compression (Force Thresholds) firmness is measured by the compression of the fruit in a manner somewhat similar to squeezing it between your fingers. This type of measurement is the most common for soft fruits. A graphical representation of this is shown in the figure below which also shows the threshold measurement parameters. The slope of the line between the Minimum and Maximum Force Thresholds is defined as firmness. This line is calculated using linear regression of the data points. Firmness units are grams/mm. A firmness value of 250 grams/mm indicates that 250 grams of force would deflect or squeeze the fruit 1 mm. A higher instrument firmness value indicates greater fruit firmness. This is the only procedure available in the INST400 program.

Compression (Defl Thresholds) firmness is measured similarly to that using Force Thresholds except the thresholds are based on Deflection. The slope of the line between the Minimum and Maximum Defl. Thresholds is defined as firmness. This procedure works well for fruit with display a great range of firmness such as blackberries. Some experimentation is recommended to determine the maximum deflection as the force can exceed the load cell capacity if the maximum deflection is too high.

Puncture firmness measures the force required to rupture the skin or flesh of a fruit using a special rupture or puncture type probe. This procedure requires a puncture type probe that depends on the type of fruit you are testing. The probe is pressed into the fruit similar to the compression test up to the maximum force. Rupture force is extracted from the data and reported.

Relaxation measurements combine Compression (Force Thresholds) measurement with an additional measured value that indicates the fruits resistance after a specified time (Time Delay). Two values are reported, the normal compression firmness and the relaxation force after the time delay.



Other Configuration Options:

Wait After Test tells the instrument to wait after each individual test for user input to continue. The instrument can also be interrupted during testing by positioning the mouse pointer on the graph window and holding down the left mouse button. If you do this when the load cell is in contact with the fruit the test may yield bad results.

Measure Size Measured fruit size will be included in the firmness data only for Compression (Force Thresholds) testing. A Reference Size needs to be measured before fruit is tested from the Control Panel. A Reference Size is supplied by Bioworks. The size of the Reference needs to be entered into the Configuration as the Reference Size. Table Depth also needs to be entered.

Reference Size Contains the physical size of the reference size. (user input required.)

Table Depth The depth of the wells in the turntable are entered here to correct size measurement. Different applications use different turntables and depths. Most turntables use a standard depth of 2.54 mm. Non-standard turntable plate depths will be specified.

Continuous Sample tells the instrument to either wait after the number of Table Positions or continue uninterrupted. If checked, the instrument will not stop after 25 fruit.

Turntable disables the turning. Can be useful for puncture tests.

Data Base:

Data Base: check to use program generated file names.

Standard Data Base File: check to use standard data base file names, uncheck to use a "user" name and Auto Increment number. A "user" defined data base file name (e.g., Sample) and folder (e.g., c:\temp) can be changed by clicking on the name.

Store Header: check to store data header information.

Auto Inc: Shows current auto increment number. Clicking on the number allows it to be reset to 0.

Turntable:

Sample Size Set to how many fruit will be tested.

Skip Positions The instrument can skip over a position. "0" means all positions will be measured. Can be useful when large fruit are tested.

Table Positions This is contains the number of physical positions on the turntable.

Speed:

Load Cell Selects the speed of the load cell. Typical test values are 10-15 mm/sec.

Table Speed depends on operator preference.

Data Files

All data files are stored in ascii format so that they can be easily viewed. There are three ways to specify file names with the FirmTech 2:

1. User-Specified Data File Name

This file type can hold up to 100 samples of 100 fruit each and is the default method unless the Data Base option is checked in the **Configuration**.

These data file names are specified with the **FILES** command. A maximum of 100 samples are stored in a single file. For each sample, descriptors of the sample can be entered before data collection in the **Sample ID** boxes (Note: Time and Date and Procedure are automatically entered). This information becomes part of the header information stored in the data. If you want to store samples in the same data file make sure the correct data file is specified before you begin testing. If the data file already has samples in it you will be asked if you want to append data to this file.

2. Standard Data Base File Name

File names are automatically generated with a name **FT+"Time+Date".dat**. This creates a unique file name for each data set. Only 1 sample per file name is allowed (a sample can hold 100 fruit data though). INST400 generates file names as **FT+"Date+Time".dat**.

The current test data is stored in a temporary file called Firmtech.dat which is written to the database file. Data from the next test overwrites old data.

3. User Specified Data Base File Name (INST300 only)

File names are automatically generated with a User defined name + automatic increment.dat (eg. "Test" + "3".dat). Only 1 sample per file name (sample can hold 100 fruit data)

Data Base files are not stored in a true data base format but as ASCII files which can be imported into a database. The **Store Header** option in the **Configuration**

can be used to put the Sample ID into the database file. All data is comma delimited.

From the Control Panel you can view the most recent data by typing **ALT-F-V** keys down. You can cut and paste this data file to a Microsoft Excel spreadsheet. Previous data can be seen by clicking the Open icon (**INST300 only**). Excel macros for importing the INST300 & INST400 data formats are available on the CD. These work only for the Standard Data Base format.

Sample File Contents: (Blue denotes actual data contents)

INST300 & 200 User Specified Data File (size measurement)

Sample No 1 ID & statistics

ID1 ,ID2 ,Com F- ,08:13:37 ,06-15-2007

Sample No.1 Fruit No. Firmness Size (mm)

1, 1 ,283.376 ,23.1 ,
1, 2 ,263.576 ,24.1 ,
1, 3 ,223.872 ,26.2 ,

Sample No. 2 ID & statistics

ID1 ,ID2 ,Com F- ,08:23:12 ,06-15-2007

Sample No. 3 Fruit No. Firmness Size (mm)

2, 1 ,283.376 ,25.1 ,
2, 2 ,263.576 ,27.1 ,
2, 3 ,223.872 ,23.2 ,

INST300 & 200 Data base format (header with no size measurement)

ID1 ,ID2 ,Com F- ,08:13:37 ,06-15-2007

Sample No 1

Avg Firmness 263.38

Std Dev Firmness 23.21

1 ,283.376 , ,
2 ,263.576 , ,
3 ,223.872 , ,

INST300 Data base format (no header with size measurement)

Fruit No Firmness Size(mm)

1 ,116.939, 21.0 ,
2 ,109.065, 21.0 ,
3 ,123.881, 30.9 ,
4 ,131.360, 23.0 ,

INST400 data format (FT+"Date+Time".dat)

Fruit No Firmness Size(mm) Size(row) ID1 ID2 ID3 ID4 ID5 Time Date Auto Inc test #.

1 382.098 27.7863 10 Jones Bing WA 8 PWA 03:52:41 05-04-2007 2
2 221.848 27.7917 10 Jones Bing WA 8 PWA 03:52:44 05-04-2007 2
3 392.526 27.7855 10 Jones Bing WA 8 PWA 03:52:47 05-04-2007 2


Reference Size

The reference size is used to provide a physical size reference for the FirmTech. Once it is measured, all other size measurements are relative to this.

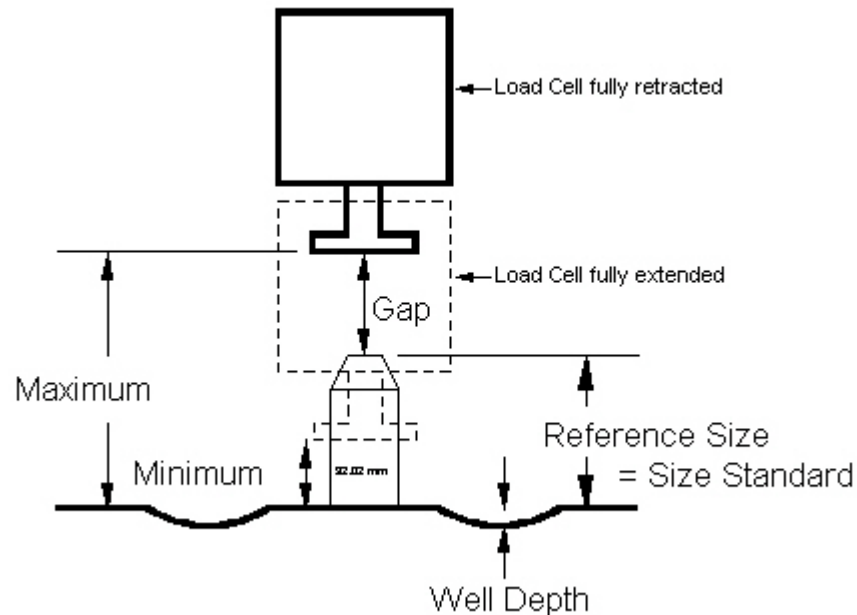
The Configuration contains a place (Reference Size) to input the physical size of the Reference. This needs to be in units of inches for the INST200 program and millimeters for the INST300 and 400 programs. The Measured Size option should be checked so the program knows to measure size. Save the configuration.

INST300 and 400 programs

The INST300 and 400 programs have a separate procedure to measure the size reference. A reference is supplied with the instrument.

The reference is placed beneath the load cell and the  icon is clicked. The load cell will come down and measure the distance between the load cell and reference. The reference needs to be measured each time the program is started.

Values showing the Max and Min size of fruit that can be measured will be displayed.



The diagram shows the values measured or calculated by the program. The reference is placed between the wells for measurement.

Ref. Size is the physical size of the reference. This value needs to be saved in the Configuration/Size Standard.

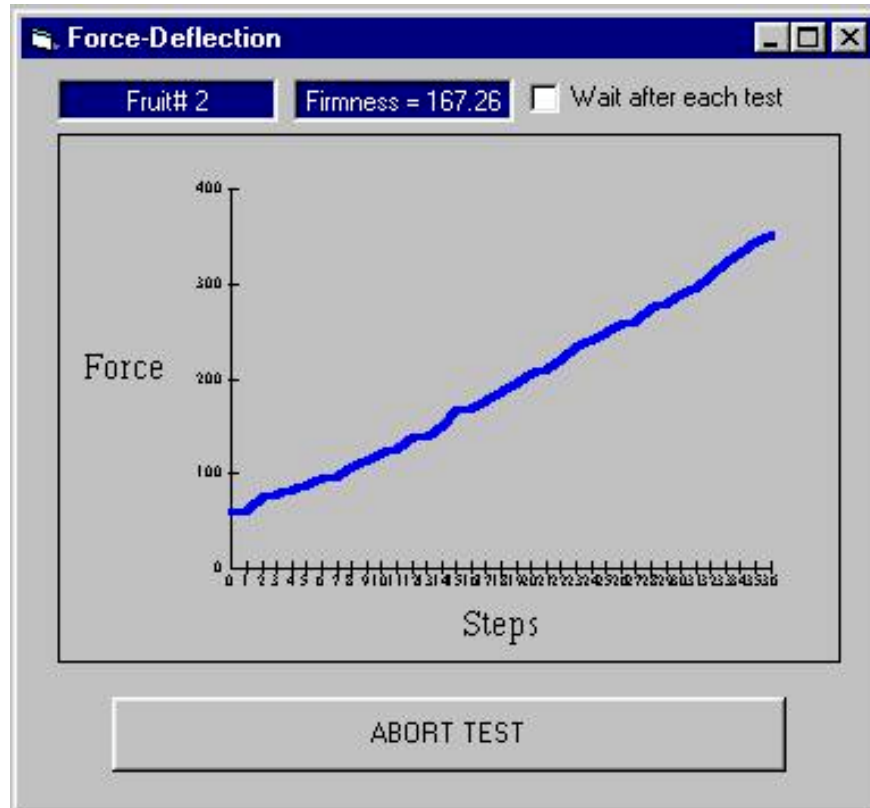
The Min force set in the Configuration should be 50 grams for accurate size measurement.

If the load cell assembly is raised or lowered the Reference Size becomes invalid; you need to re-measure it.

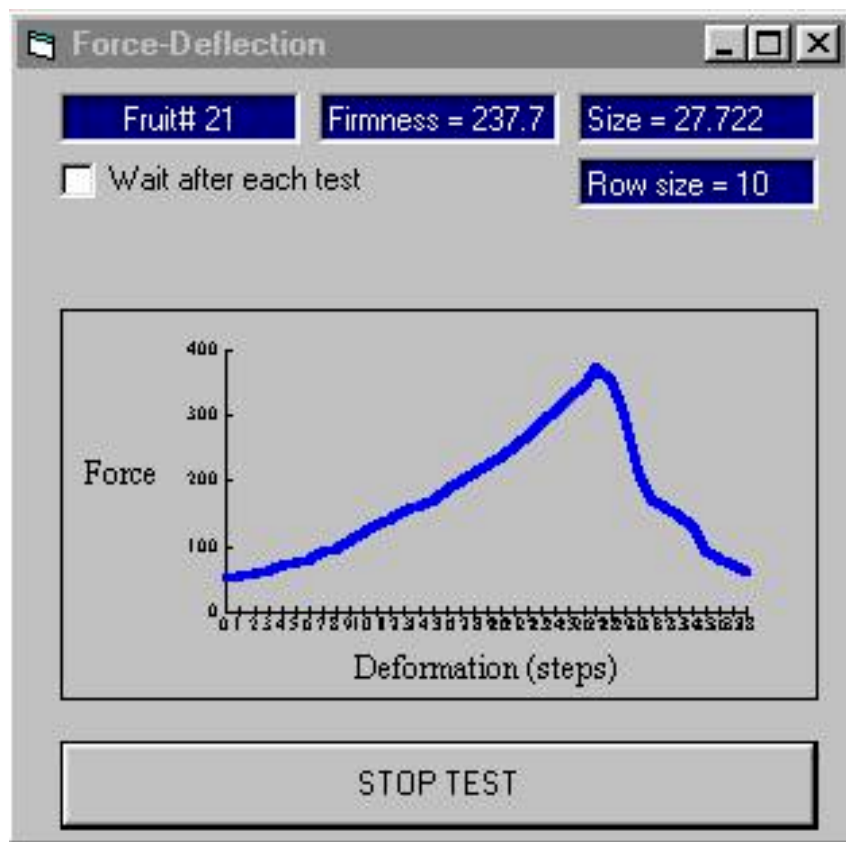
The INST400 maintains a file that logs the reference each time it is measured.

Force-Deflection

A graph of each fruit is displayed during testing showing the fruit number and firmness value. The deflection is graphed as steps of the stepping motor. Each step = 0.002". Pressing a key during testing will abort the test – no data is saved if this is done.



The INST400 program graphing is shown below. Pressing a key during testing will stop the test and the data is saved. Sample size cannot be set in this program – testing continues until the user stops it (it will stop after 400 fruit though). Fruit #, firmness and size are displayed for each cherry.



Fruit Testing

This section deals with specific procedure settings while [Test Procedures](#) gives general descriptions of the different test methods. If you have questions about the different procedures, please contact us at Bioworks: firmtech@bio-works.us

Compression (Force Thresholds) procedure is most often used for soft fruit. Cherries (and most fruit) are placed with the stem *inwards* towards the center of the turntable. The first fruit should be at the first position to the right of the Load Cell. Cherry size is measured across the large diameter of the fruit and should be placed in a table indenture accordingly if Row Size* measurements are desired.

Suggested Force Threshold values:

Cherries, Force Thresholds - Min, 50 grams, Max 350 grams

Blueberries, Force Thresholds - Min, 25 grams, Max 250 grams

Other fruit, Force Thresholds - Min, 50 grams, Max 250-350

** "Row Size" is a traditional method of measuring cherry fruit size in the USA and is based on passing a cherry through set hole sizes.*

Compression (Deflection Thresholds) is a better choice for fruit which display a large amount of variation in firmness such as blackberries and raspberries.

Suggested Deflection Threshold values:

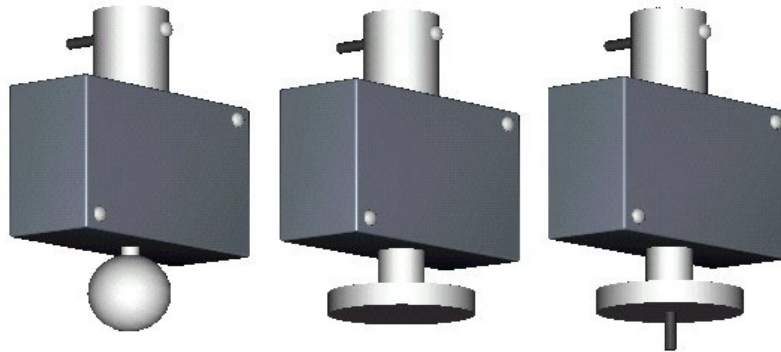
Blackberries, Deflection Thresholds - Min, 0.51 mm, Max 2.03 mm

Raspberries, Deflection Thresholds - Min, 0.51 mm, Max 2.03 mm

Puncture is used for small diameter puncture tests. A special probe is required and can be purchased from Bioworks. Puncture tests are best done with the turntable disabled. A **Maximum (Force Threshold)** needs to be specified which is greater than the puncture force - this tells the instrument when to stop pressing into the fruit. Settings are dependent on probe size

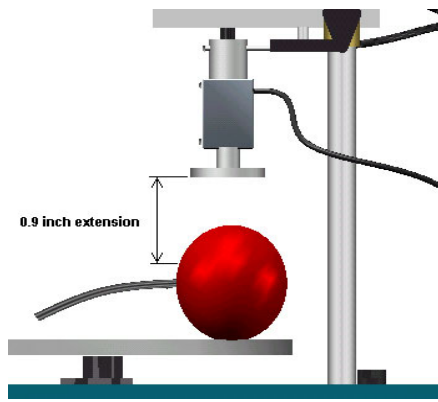
Relaxation tests combines the Compression (Force Thresholds) with an additional reading of force after a **Delay** time. This gives an indication of the fruits resilience or ability to withstand deformation.

Probe types:



Load Cell Positioning

The Load Cell can be positioned up and down the posts. The maximum extension of the linear stepper motor is 0.9 inches. The Stepper Motor Platform should be positioned so that the maximum extension of the load plate leaves a little over half of the average fruit diameter between the turntable and load plate. This will prevent the load plate from coming in contact with the turntable and generally limit the force if the load cell happens to malfunction or the calibration sequence was incorrect.



Turntable

The turntable can be hand-rotated for positioning. Before a test, position the load cell plate at the position prior to the first fruit (Turntable turns c-clockwise). **While the table is quite rugged, do not lift the instrument by the turntable.**

General Startup Procedures

This assumes all software and data acquisition boards have been installed.

1. Connect the instrument-computer cables.
2. Plug the wall transformer into a grounded wall outlet and connect to the instrument.
3. Turn on the computer
4. Start the FirmTech 2 program.
5. Check the load cell for zero load (**CALIBRATE/CHECK CELL** control). The load cell should be within 2 grams of zero. Gently pushing on the load plate will indicate it is measuring force.
6. Check the **Configuration**. (The last configuration saved will be automatically be loaded at startup).
7. The instrument is now ready for testing.

General Test Procedures

1. Adjust the load cell height as described in the diagram **Load Cell Positioning**.
2. A new data file name may need to be opened or created if the Data Base option is not checked.
3. Place fruit in the turntable indentures equal to the **Sample Size**. Rotate the turntable to the position left of Fruit 1. Enter **Sample ID** if you desire; date and time are automatically entered. Click the **START** button. If the data file already contains samples you will be asked if you want to add the data to this file. Fruit will be sequentially rotated and squeezed
4. When all fruit is tested a spreadsheet showing all the samples in the data file will appear. If you want a histogram of the data, double-click the cells that contains the sample you want to look at. Average firmness, firmness standard deviation, and minimum and maximum firmness are displayed. Use ALT-F-V to view the data file contents.

Error Messages: Software

Software errors are shown in bold and can be generated by either the Instacal (1) or Firmtech (2) program.

A/D not responding (1) (2)

- The board is not present (could also be defective).
- The base address switch on the board is not set to the same address given during installation by the Instacal program.
- The autoexec.bat file does not contain a path to the CB directory. This should have been done automatically during the Instacal installation. Check this by looking at autoexec.bat file. It should contain SET PATH=C:\CB\ and SET CBDIREC=C:\CB

Invalid Board Number (1) (2)

- Instacal has not been run to configure the board.
- The board specified in the configuration options may be incorrect.

***.DLL, *.VBX or *.OCX files not found.** These files should have been copied to the WINDOWS/SYSTEM directory from the program disks during installation. Verify that they have been copied.

Cable may not be connected. (2)

- The instrument cable may not be connected to the computer.
- The Instrument control cards may not be installed properly.

Error Messages: Mechanical

Calibration: After calibration the Zero Offset should be near 2048, the Scale factor, near 0.25, but depends on load cell type.

Load Cell does not extend smoothly during tests.

- Check cable connections.

Load Cell values have a large offset.

- May occur after long periods of no use. Press the **RED** button on the side of the instrument and recalibrate.

Turntable will not rotate, load cell will not extend and retract or calibrate.

- Make sure transformer power is connected and instrument cables are firmly attached.

Turntable will rotate, Load Cell will extend but not calibrate.

- Check Load Cell Connector.

- Load cell amplifier may need adjustment/may be damaged.

- Load cell may be damaged.

Turntable will not rotate, load cell will not extend and retract but will calibrate:

- Check cable connections.

Turntable stops or turns erratically: - Check cable connections.