

Modal Data Acquisition Using the CoCo-80/90

Introduction

The Modal Data Acquisition (MDA) function for the CoCo-80/90 allows the user to conveniently acquire modal data. It provides an interactive user interface for testing, which allows the user the flexibility to assign geometric coordinates and signal names to data files even in the middle of testing. Data files can then be transferred to the PC and exported to the UFF or Binary UFF format with only a few mouse clicks. After the data files are generated, the modal analysis software provided by other parties, such as ME'scope from Vibrant Technologies, can be used for modal analysis.

This document describes a step-by-step process of CoCo MDA function and use the ME'scope as an example for modal analysis.

System Set Up

When using the CoCo-80 to perform modal testing, 2, 4, 8 channel versions will support MDA. Even the 16 channel CoCo-90 will support MDA. In this example, we used following equipment and devices:

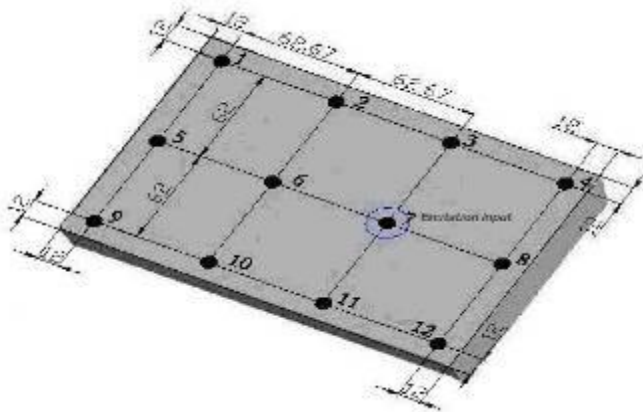
- PC with ME'scope 5.0 and Crystal Instruments EDM software
- CoCo-80 4 Channel Signal Analyzer
- Impact hammer and charge amplifier (IEPE impact hammers can be powered by CoCo)
- Two IEPE accelerometers
- Test structure: we are using a sheet of metal
- Supporting Foam (used to isolate the test structure)





Mark the Degrees of Freedom (DOFs)

First, on paper we create the following coordinates. In this test, a fixed excitation is set and the response is roving. Meaning that channel 1 will measure the impact force at a fixed location, point 7, channel 2 and channel 3 will rove across all other coordinates and measure the response.



Select Appropriate Configurable Signal Analysis (CSA) Project

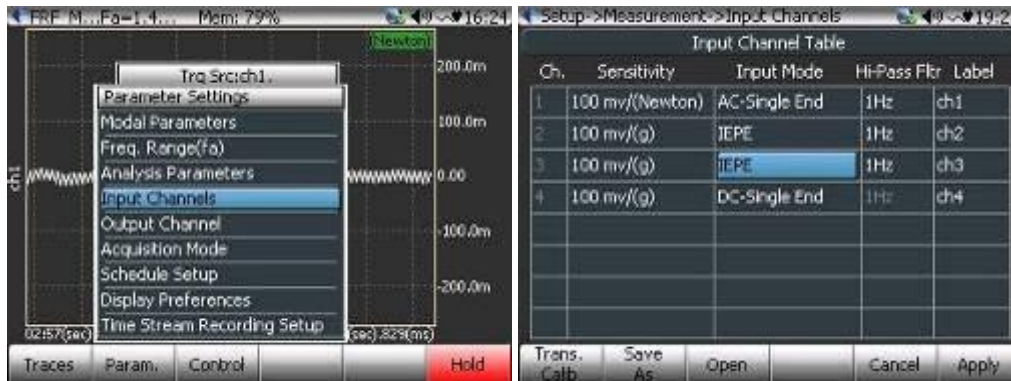
Select the appropriate CSA in the Application group, in this case select FRF_MDA(4). To do so, press Analysis button on the CoCo and enter the Modal Data Acquisition group. See the screenshot below.



Set Up the Parameters

Input Channels

To set up the input channels, select the Input Channels item under Param. Key (F2), then set the appropriate sensitivity for channel 1, channel 2 and channel 3.



Channel 1 is connected to the impact hammer therefore the sensitivity should be set to mV/Newton. Channel 2 and 3 are connected to accelerometers with IEPE power enabled.

Analysis Frequency Range

This is very important step and may take a couple of iterations to select the correct analysis frequency range and total capture points. The goal is to select the analysis frequency range so it is not too high to show too many modal modes, or too low to miss the important modes. In this test we select the analysis frequency range as 1400Hz.



Analysis Parameters

Select the Analysis Parameters under the Param. (F2) key.



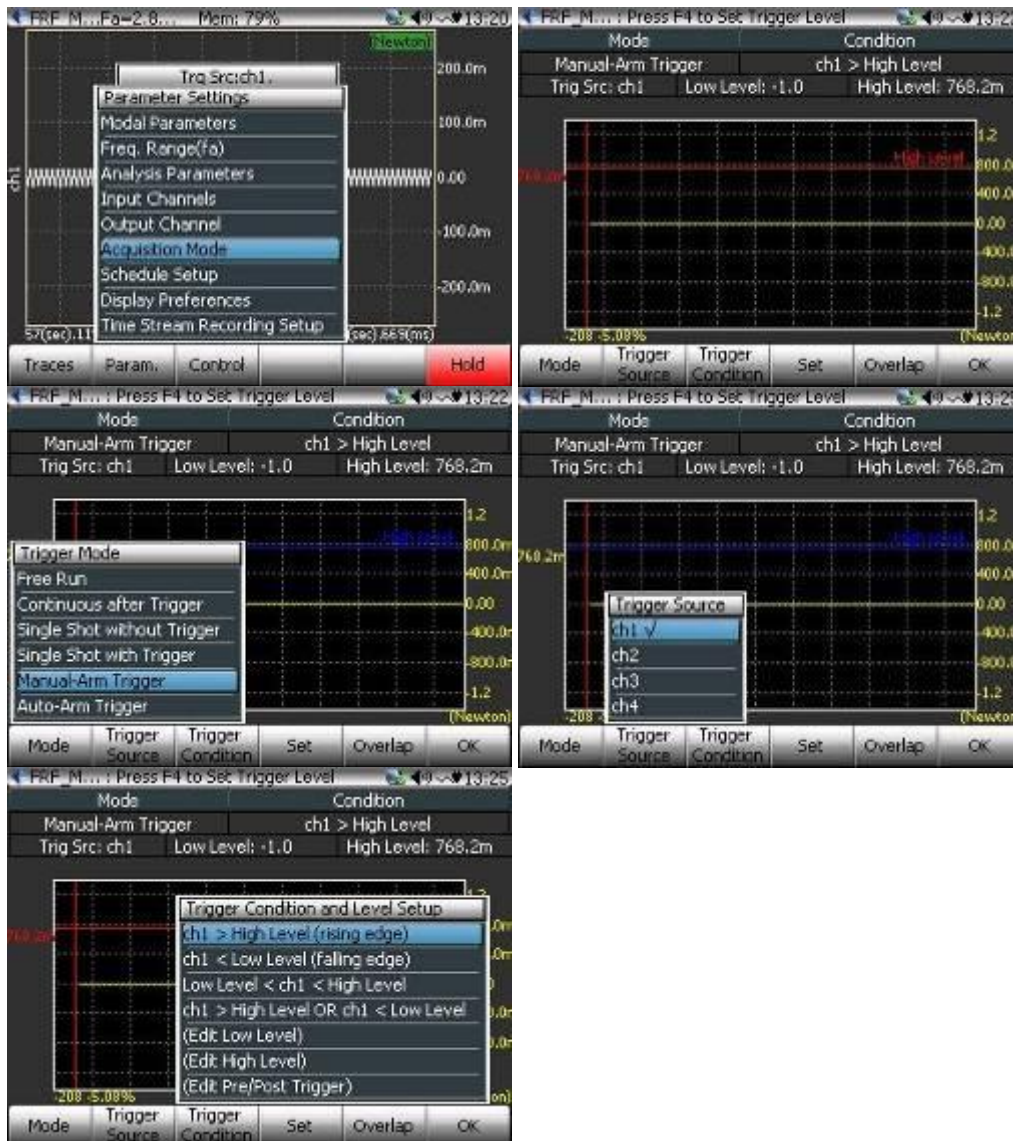
Select the appropriate block size, average mode and average number. Note that the selection of window type must be either Uniform or Force-Exponential for impact hammer testing.

Set up Trigger

Select the Acquisition Mode under Params. (F2) button.

For the impact hammer test, set the following:

- Trigger Mode: Manual Arm Trigger
- Trigger Source: channel 1
- Trigger Condition: Ch1>High Level (rising edge)
- Trigger Delay: roughly 5%
- Trigger Level: adjust to roughly half the peak value of Ch1

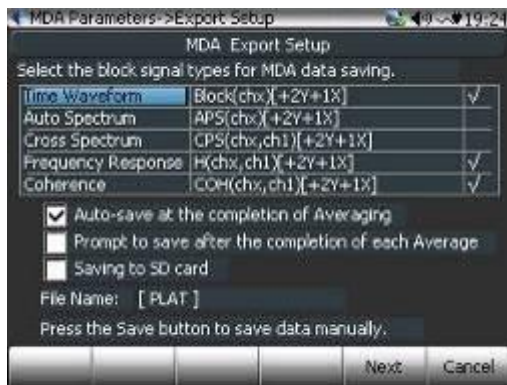


Set Up Modal Parameters

When initially entering the MDA interface, select *Modal Parameters* under the Param. button (F2).



First, enable block signals to be saved into files. Typically, modal analysis software will only need FRF signals (Frequency Response). However, other signals might also be useful. For example, coherence signals are often used for evaluating the quality of the FRF measurement.



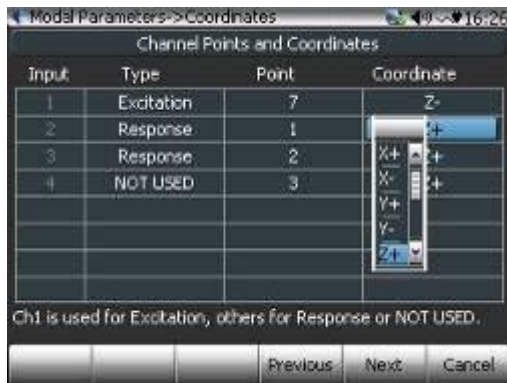
The File Name [xxx] are the file prefix. It can be assigned by the user.

If ***Auto-save at the completion of averaging*** is selected, the signals will be automatically saved when each measurement is finished. If this box is not checked, the user must manually save the data files.

If ***Prompt to save after the completion of each average*** is checked, there will be a dialog box which prompts the user to confirm the save.

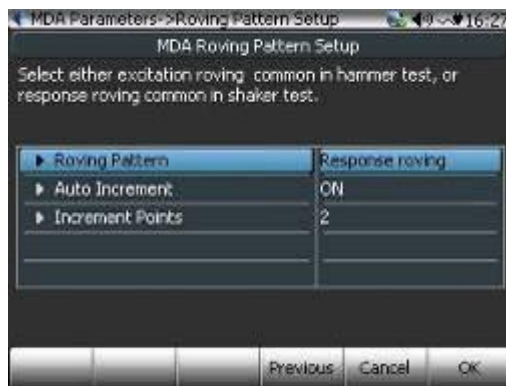
If ***Saving to SD card is checked***, data files will be saved to the SD memory card. Otherwise it will be saved to the internal flash memory. Data can always be transferred from the internal flash memory to the SD memory card at a later time.

Press Next (F5) button to go to the next page.



The above screenshot shows the mapping between input channels and the geometric coordinates. Two coordinate types are available: XYZ or RTP. Both coordinate types can be assigned positive or negative directions.

Press Next (F5) button go to the next page.



The above page allows the user to set the roving pattern. In theory, the user can set the geometric coordinates manually without automatic roving. But for most tests with hundreds of geometric points, manually entering the coordinates would be too time-consuming. The CoCo MDA provides certain ways to automate this process.

An advantage of the CoCo MDA is that the automation process can be suspended by the user at any time during testing. This is a necessity because the roving sequence may not be completely regular.

Set the roving pattern to either excitation or response roving.

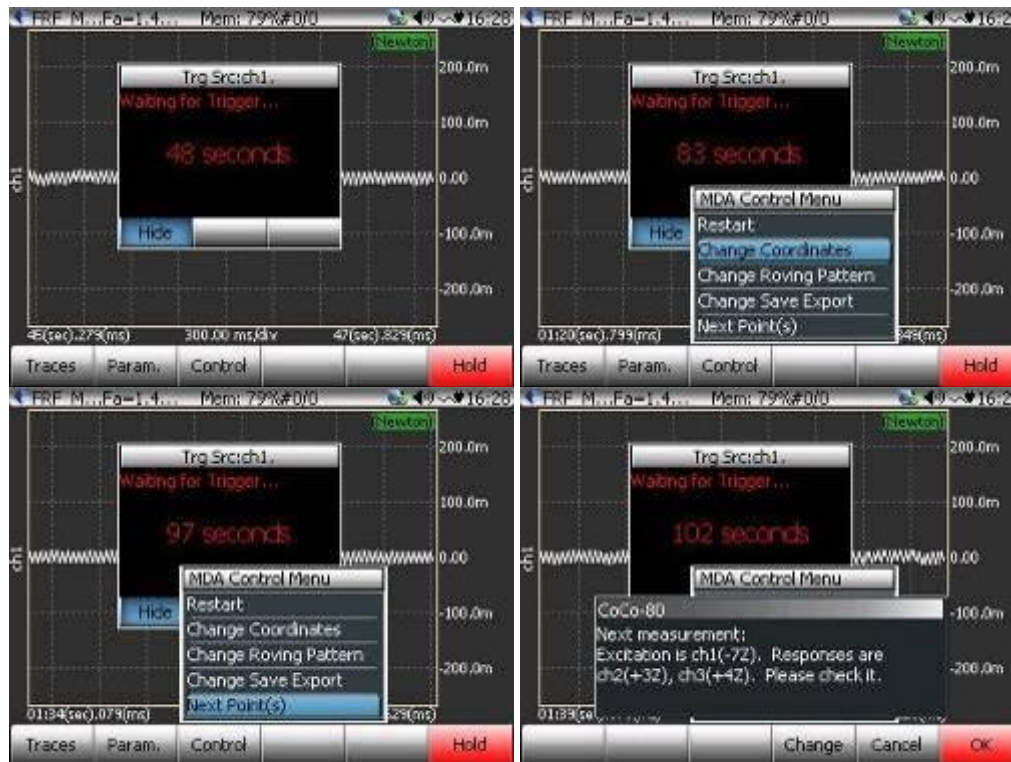
Set the Increment points. In this example, it is set to 2. Meaning that channel 2 and 3 will measure in a pattern shown below.

- Measurement 1: Channel 2= Point 1, Channel 3= Point 2
- Measurement 2: Channel 2= Point 3, Channel 3= Point 4
- Measurement 3: Channel 2= Point 5, Channel 3= Point 6
- ...

Execute the MDA Test

Now that all the parameters are set, the actual modal test can begin. If the CoCo is in the HOLD mode, press F6 to run. A trigger source window will appear waiting for trigger.

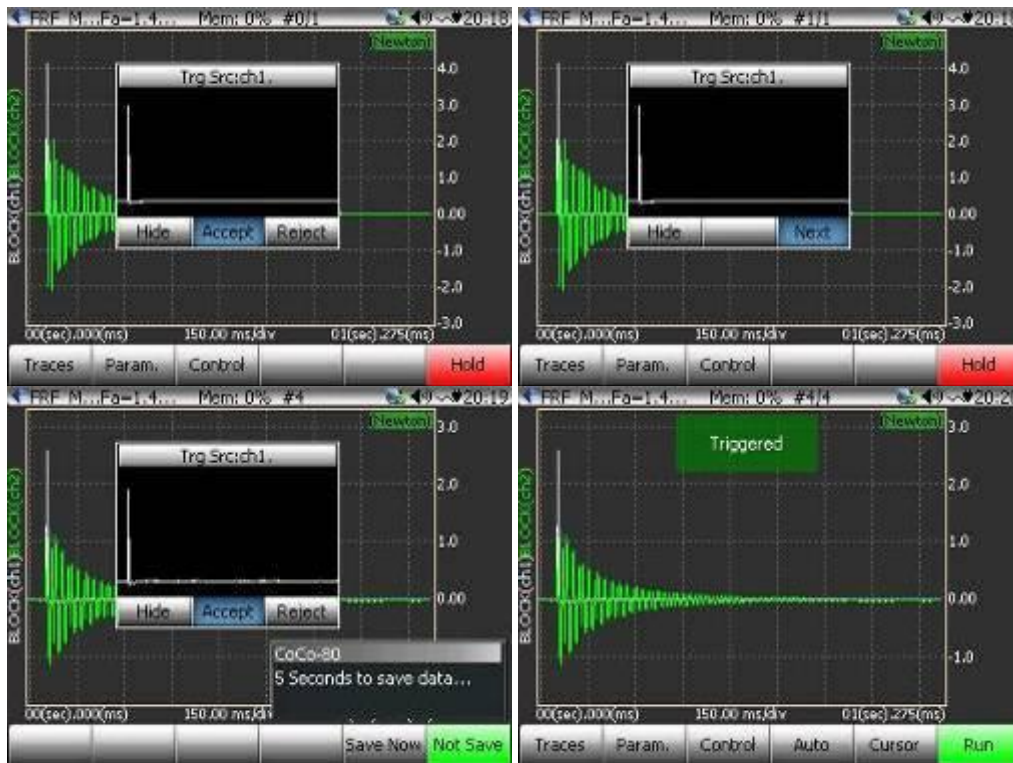
Below are four screenshots showing the control commands for this process:



Using the impact hammer, hit point 7 with an appropriate amount of force. Observe the signal qualities. You can carefully examine the signal quality by selecting each trace.

Use the Accept/Reject function to continuously average the signals until the average number is reached.

If auto save is set, the signals will be automatically saved to a file with the coordinate information. Otherwise, you must manually press the Save button to save the signals.



Notice in the above picture on the lower left, the small window showing *5 Seconds to save data...* During this five second period, the user has the choice to stop saving the data.

The FRF and Coherence signals can be viewed as below.

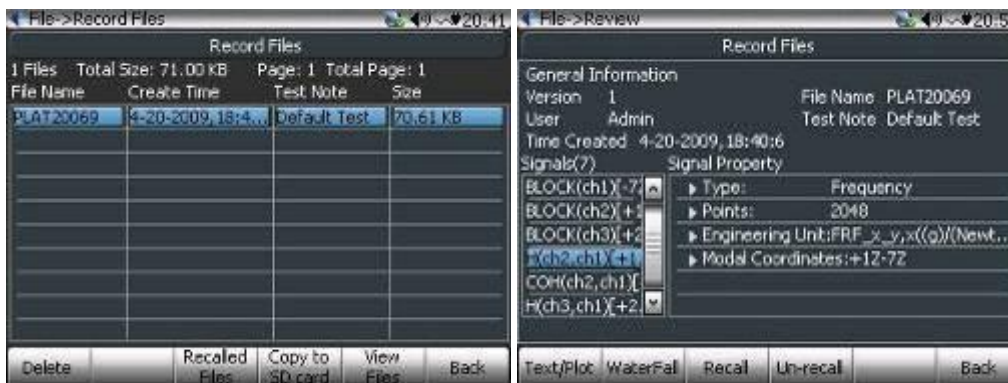


Under the Control key (F3), you can restart the measurement or manually change the coordinates. If you want to move to the next measurement point, select Next Points.



View Files on CoCo

During testing or once finished, you can always view saved data files. Press File button on CoCo to view saved files and signals.



Export Data into UFF

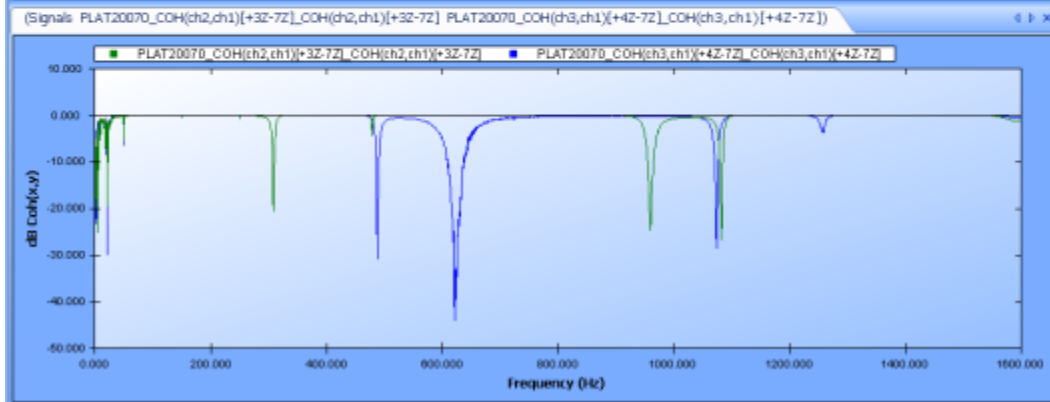
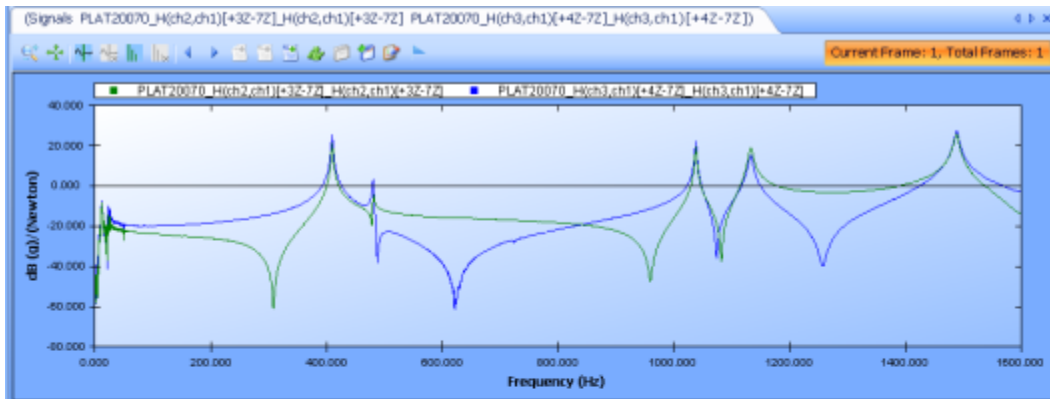
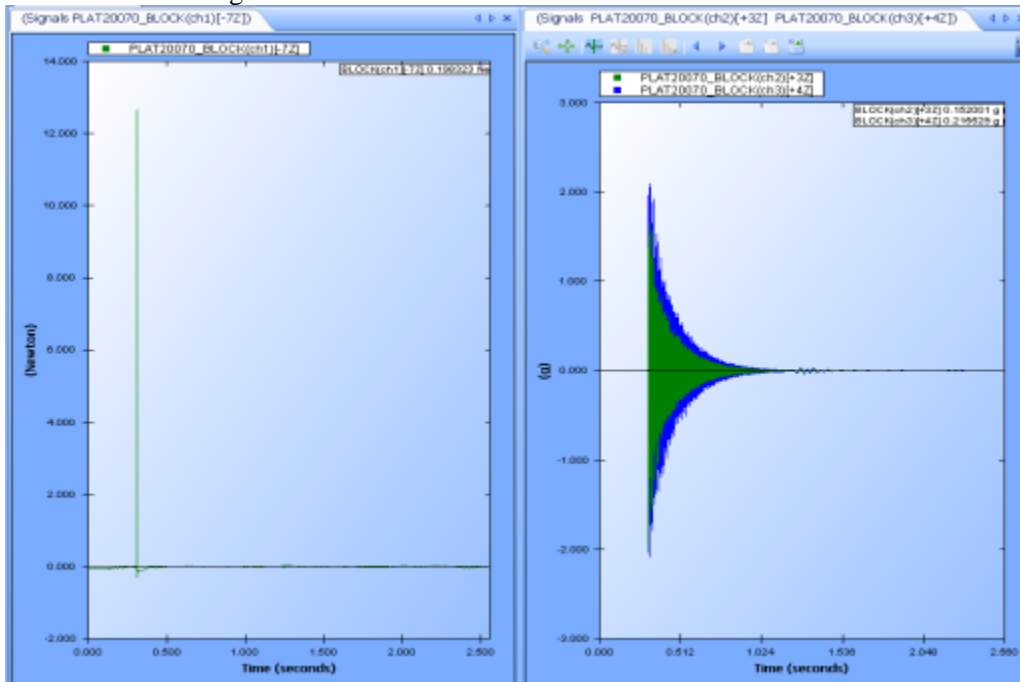
Download Files

After all the measurements are taken, connect the CoCo to a PC with EDM installed. Download data files to PC. These data files will be in the ASAM-ODS standard format.

Name	Size	Type	Date Created	Total Size
PLAT20069.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20070.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20071.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20072.atfx	75.00 KB	ATFX File	2009-4-20 17:36:49	252.00 KB
PLAT20073.atfx	95.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB
PLAT20075.atfx	95.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB

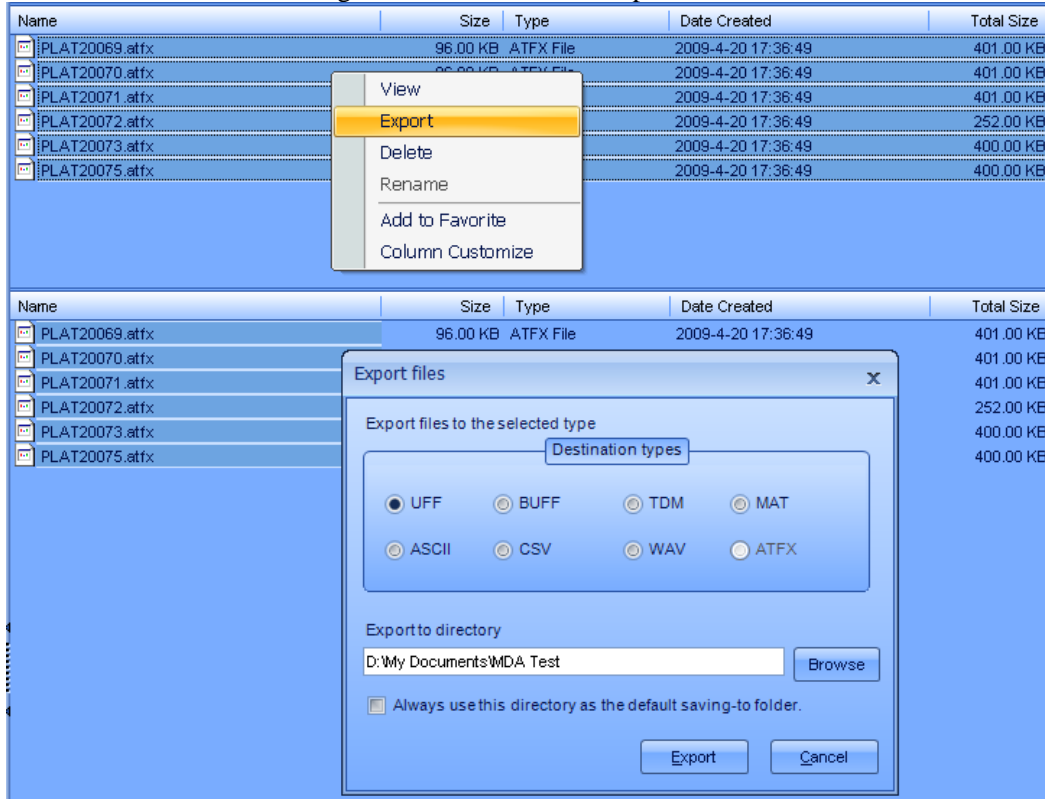
View the Signal Files

Use EDM to view signals.



Export into UFF

The EDM software supports an export command that can be simultaneously applied to multiple files. To do so, select desired files, then right click and select the Export command:



Name	Size	Type	Date Created	Total Size
PLAT20069.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20070.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20071.atfx	96.00 KB	ATFX File	2009-4-20 17:36:49	401.00 KB
PLAT20072.atfx	252.00 KB	ATFX File	2009-4-20 17:36:49	252.00 KB
PLAT20073.atfx	400.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB
PLAT20075.atfx	400.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB

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PLAT20073.atfx	400.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB
PLAT20075.atfx	400.00 KB	ATFX File	2009-4-20 17:36:49	400.00 KB

Select UFF or BUFF as export file format. A number of UFF or BUFF files will be created on your local PC.

Name	Size	Type	Date Created	Total Size
PLAT20069.uff	322.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20069_COH(ch2,ch1)[+1Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20069_COH(ch3,ch1)[+2Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20069_H(ch2,ch1)[+1Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20069_H(ch3,ch1)[+2Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20070.uff	322.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20070_COH(ch2,ch1)[+3Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20070_COH(ch3,ch1)[+4Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20070_H(ch2,ch1)[+3Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20070_H(ch3,ch1)[+4Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20071.uff	322.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20071_COH(ch2,ch1)[+5Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20071_COH(ch3,ch1)[+6Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20071_H(ch2,ch1)[+5Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20071_H(ch3,ch1)[+6Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20072.uff	215.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20072_COH(ch3,ch1)[+8Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20072_H(ch3,ch1)[+8Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20073.uff	322.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20073_COH(ch2,ch1)[+9Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20073_COH(ch3,ch1)[+10Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20073_H(ch2,ch1)[+9Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20073_H(ch3,ch1)[+10Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20075.uff	322.00 KB	UFF File	2009-4-20 19:28:10	
PLAT20075_COH(ch2,ch1)[+11Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20075_COH(ch3,ch1)[+12Z-7Z].uff	54.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20075_H(ch2,ch1)[+11Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	
PLAT20075_H(ch3,ch1)[+12Z-7Z].uff	107.00 KB	UFF File	2009-4-20 19:05:09	

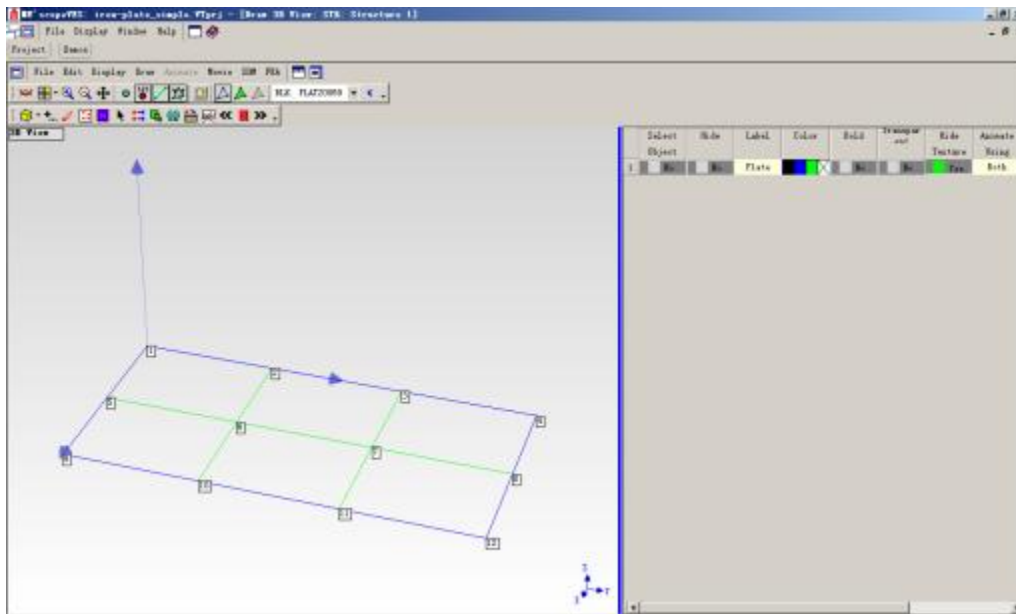
Conduct Modal Analysis using ME'scope

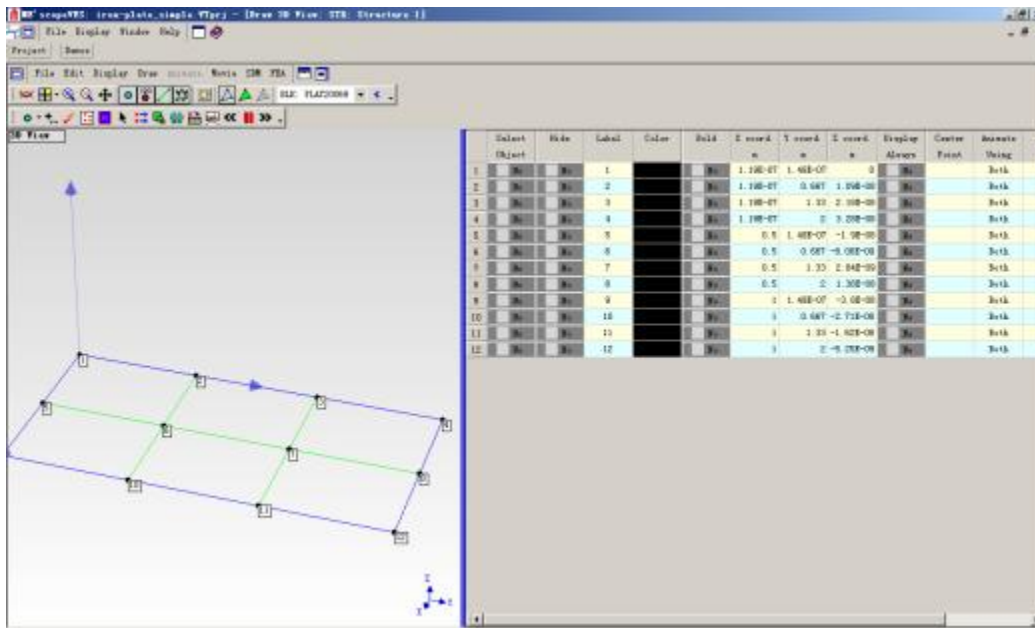
ME'scope is a popular modal analysis software from Vibrant Technology. For details of ME'scope operation please refer to its 500-page manual. Here is a very brief description:

Establish the Coordinates

For structures with simple geometries such as a flat plat, the Drawing Assistant in ME'scope can be used to quickly construct a geometric model for displaying mode shapes.

- Execute the **File | New | Structure** command in ME'scope to open a new (empty) Structure window.
- Execute **Draw | Drawing Assistant** in the Structure window to display the Drawing Assistant tab.
- On the **SubStructure** tab, double click on the Plate SubStructure.
- On the **Dimensions** tab, enter
 - Width: 188
 - Points: 4
 - Height: 124
 - Points: 3
- On the **Position** tab,
 - Repeatedly press the **Rotate Y down arrow** until the Plate structure is horizontal, as shown below.





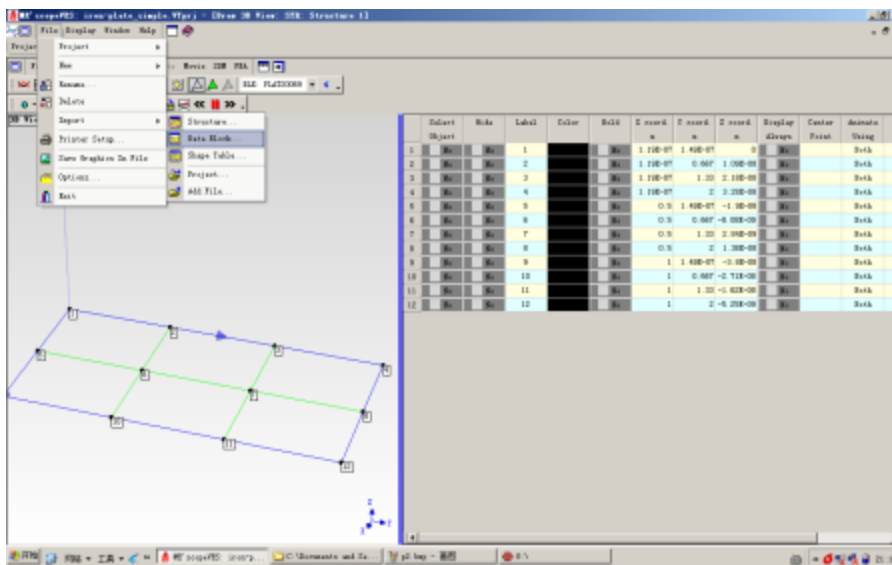
Numbering the Points

To number the Points on the model,

- Execute **Draw | Points | Number Points** in the Structure window.
- Click near each Point to number it, as shown in the figure above.
- After all Points 12 Points have been numbered, press the **Close** button in the Number Points dialog box.

Import UFF Files

Press File and select Import function to import the UFF files that are created by EDM. Because all the DOF information is embedded in the files, the import process is seamless.

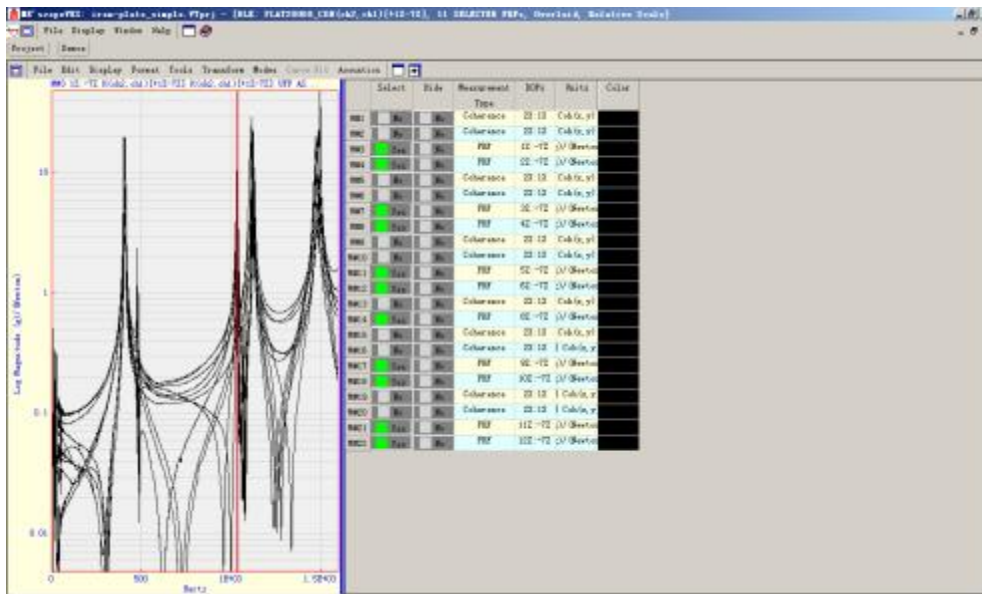


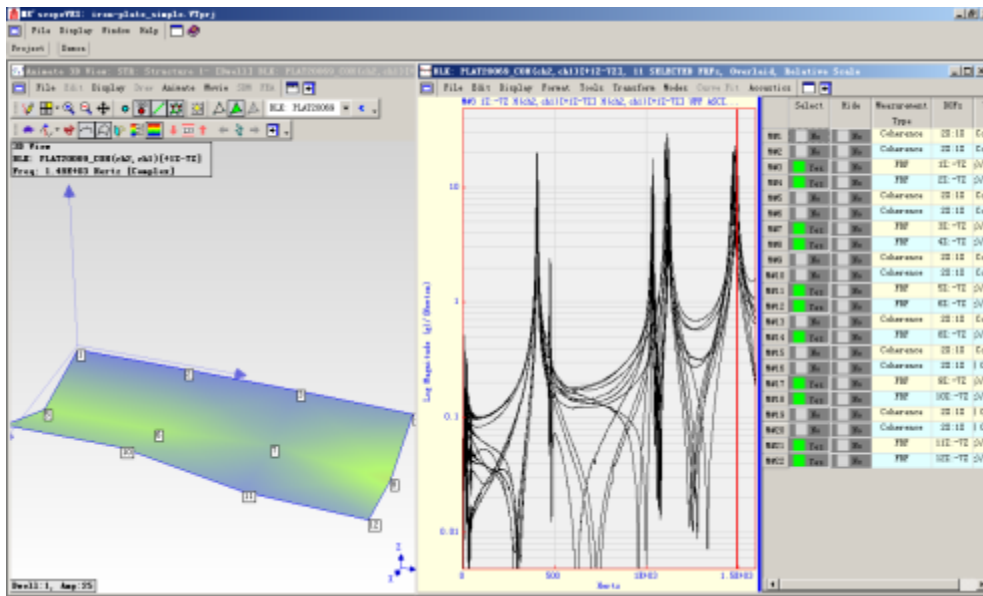
Shape Animation

After the 12 FRFs have been imported, these measurements must be assigned to the structure model in order to display mode shapes in animation.

- In the Traces spreadsheet of the Data Block window, press the **Select Trace** button of the **12 FRF** measurements, and make sure that all other Traces are deselected.
- In the Data Block window, execute **Tools | Animation Equations | Create Measured Equations (Assign M#s)**.
- Click on **Yes** and **OK** in the dialog boxes that follow to create equations for animating shapes from the Data Block window.
- Execute **Tools | Animate Shapes** in the Data Block window to initiate animation.
- Execute **Format | Overlay Traces** in the Data Block window to overlay the FRF measurements.
- Drag the **Line** cursor in the Data Block window to one of the Peaks.

The overall Deformation Shape, (or Operating Deflection Shape), at the cursor position is being displayed in animation. When the cursor is placed on or near a resonance, a mode of vibration “dominates” the response, and the ODS becomes a close approximation of the mode shape.





Curve Fitting

Modal shapes, frequencies and damping can be obtained by curve fitting the FRF measurements.

- Execute **Modes | Modal Parameters** in the Data Block window to initiate curve fitting. The curve fitting panel and tabs will open on the right side of the window.
- Execute **Curve Fit | Quick Fit** to curve fit the FRFs.
- On the **Residues & Save Shape** tab, press the **Save Shapes** button to save the mode shapes into a Shape Table.
- Execute **Tools | Animate Shapes** in the Shape Table window to initiate animation.
- **Select** each shape to display it in animation.