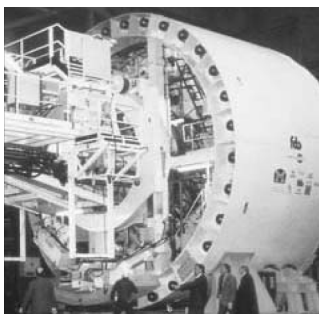


Frequency Response Function Extension Module for the Dynamix 2500 Data Collector

Catalog Number 1441-DYN25-MFRF



Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication [SGL-1.1](#) available from your local Rockwell Automation sales office or online at <http://www.rockwellautomation.com/literature/>) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.



WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence



SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.



BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

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Notes:

This manual describes the FRF Frequency Response Function Extension Module for the Dynamix 2500 data collector. You install the extension module with the FRF Secure Digital (SD) card.

See [Installing Optional Extension Modules on page 7](#) for installation instructions.

When using the Dynamix 2500 data collector and the FRF Frequency extension module, you can do the following:

- Determine natural frequencies.
- Model the way a structure reacts to forces.
- Capture information about how a machine moves when it's running.
- Illustrate high or low coherence.

Optional Extension Modules

These are the optional extension modules for the Dynamix 2500 data collector:

- 1441-DYN25-4C, 4-channel Activation ⁽¹⁾
The 4-channel activation lets you take 3 and 4 channel magnitude, time waveform, spectra, and Offroute measurements.
- 1441-DYN25-MBMP Bump Test
A bump test (or hammer test) determines the natural frequencies of a machine or a structure.
- 1441-DYN25-MBAL Balancing
Balancing application resolves single-plane, two-plane, and static-couple balances with high precision.
- 1441-DYN25-MFRF Frequency Response Function
The FRF test lets you determine the natural frequencies of a machine as well as sophisticated information about the frequency response of the structure being tested.
- 1441-DYN25-MREC Time Recorder
The Time Recorder test uses the instrument as a data recorder for real-time data acquisition and analysis.
- 1441-DYN25-MRUC Run Up Coast Down
The RUCD test records and analyzes data from intermittent events and transient vibration signals from non-steady state machines.

See [Additional Resources on page 6](#) for a listing of available publications.

(1) This is an activation license for the Dynamix 2500 data collector.

Additional Resources

These documents contain additional information concerning products from Rockwell Automation.

Resource	Description
Dynamix 2500 Data Collector User Manual, publication 1441-UM001	Describes the Dynamix 2500 data collector, which provides predictive maintenance by using noise and vibration analysis.
Dynamix 2500 Data Collector Bump Test Extension Module User Manual, publication 1441-UM002	Describes how to determine natural (or resonant) frequencies of a machine or structure.
Dynamix 2500 Data Collector Balancing Extension Module User Manual, publication 1441-UM004	Describes the direct method to balance your rotating machinery in one or two planes.
Dynamix 2500 Data Collector Time Recorder Extension Module Users Manual, publication 1441-UM005	Describes how to use the data collector as a data recorder for real-time data acquisition, post processing, and analysis.
Dynamix 2500 Data Collector Run Up Coast Down Extension Module Users Manual, publication 1441-UM006	Describes how to record and analyze data from intermittent events and transient vibration signals from non-steady state machines.
Emonitor User's Guide, publication EMONTR-UM001	Describes data management for predictive maintenance services.
Dynamix 2500 Data Collector Kit Release Notes, publication 1441-RN001	Provides important information on the latest updates, for example, firmware, certifications, warnings, and hardware changes for the data collector.
Dynamix 2500 Data Collector Optional Extension Modules Release Notes, publication 1441-RN002	Provides important information on how to install the optional extension modules on to the Dynamix 2500 data collector.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at <http://www.rockwellautomation.com/literature>. To order paper copies of technical documentation, see your Allen-Bradley distributor or Rockwell Automation sales representative.

Installing Optional Extension Modules

The data collector uses the Extension Manager to install and uninstall extension modules. These extension modules are licensed and ordered separately from the basic entry-level product.

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The installation Secure Digital (SD) cards that you receive work with any Dynamix 2500 data collector. Once you have installed an extension module, the card is locked so that it can be used only with that instrument.

IMPORTANT One installation SD card is required for each instrument that needs to be upgraded.

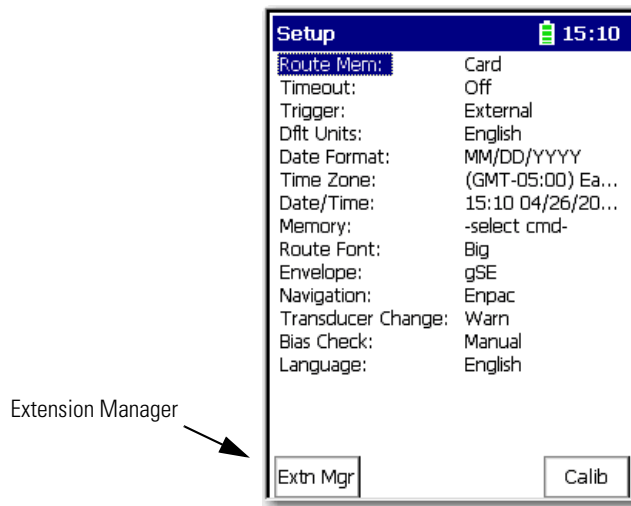
You can uninstall extension modules, if required. When uninstalling an extension module, you have the option to free up the license so you can install the extension module on another instrument. This makes the extension module available to be transferred between units.

IMPORTANT When ever you re-run the OS Loader software, you will re-load only the main OS firmware. The OS loader will backup licence files and data, but not the optional extension modules. Once you have updated the OS firmware, install the latest version of your optional extension modules. See the Dynamix 2500 Data Collector User Manual, [1441-UM001](#), for more information.

Install an Extension Module

Follow these instructions to install an extension module.

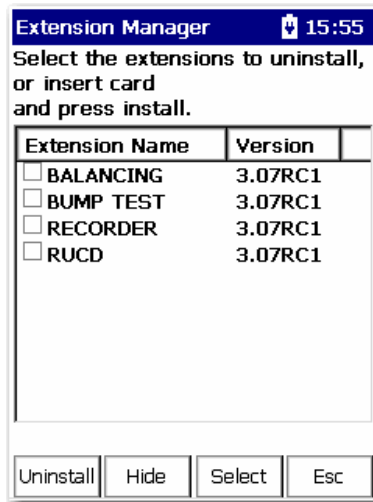
1. Open the base cover at the bottom of the Dynamix 2500 data collector.
2. Place the extension module Secure Digital (SD) card contact side-up into the unit until it is firmly seated in place.
3. Close the base cover.
4. Apply power to the data collector.
5. From the Main Menu, select Setup Utility and press Enter.
6. Press 0 (Shift) to display the second set of functions.



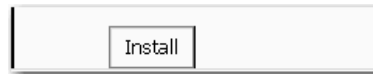
The Extension Manager function remains on the screen for about 3 seconds after releasing 0 (Shift).

7. Press F1 (Extn Mgr).

The Extension Manager screen appears showing the current extension module installations.



8. Press 0 (Shift) to display the Install Extension function.

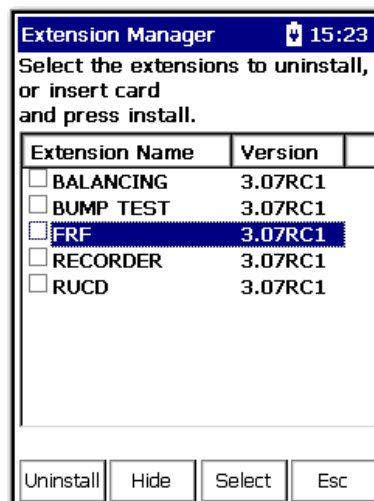


9. Press F2 (Install) to install the new extension module.

When the installation is complete, a confirmation prompt appears.

10. Press F4 (OK).

The new extension module appears in the list.



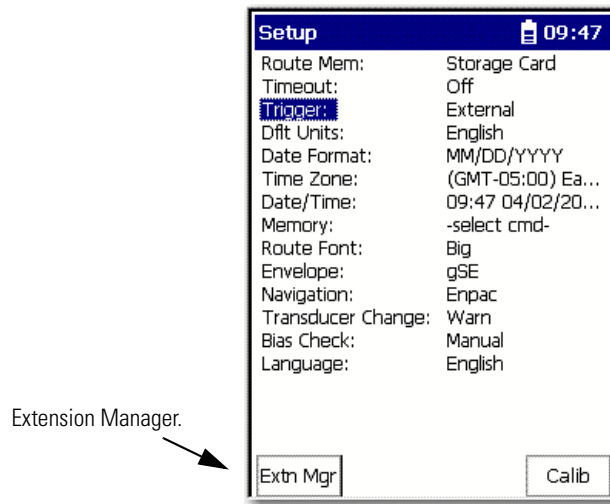
11. Press F4 (Esc) to exit the Extension Manager screen.

Uninstall an Extension Module

Follow these instructions to uninstall an extension module.

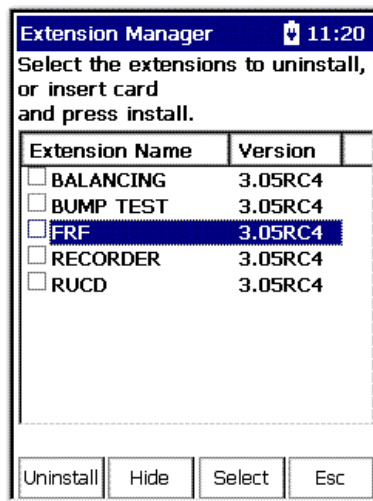
1. Press 0 (Shift) from the Setup Utility screen to display the Extension Manager function.

The Extension Manager function remains on the screen for about 3 seconds after releasing 0 (Shift).



2. Press F1 (Extn Mgr).

The Extension Manager screen appears.

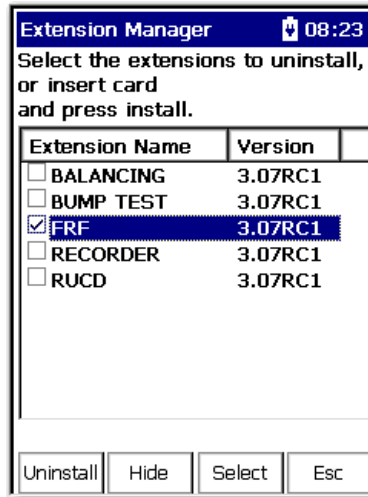


This screen lists the extension modules currently installed and the on the unit.

3. Select the extension module you want to uninstall and press F3 (Select).

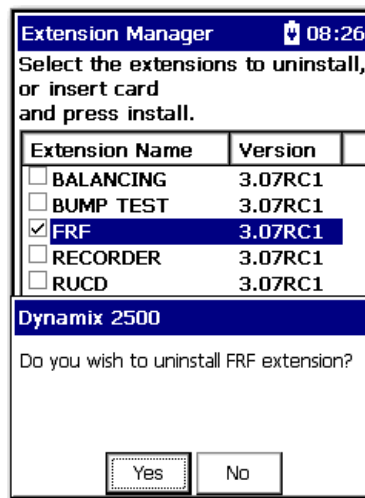
F3 (Select) toggles the selection on and off.

A checkmark appears next to that extension module.



4. Press F1 (Uninstall).

A confirmation message appears.



5. Make sure your installation card is inserted into the instrument.

IMPORTANT The extension module is uninstalled and the license on the card is released so that the card can be used to install the extension module on another Dynamix 2500 data collector.

If the installation card is not inserted in the instrument and no card, you are is found or the card does not have the extension module license for the unit, you are prompted to insert the correct installation card or continue without freeing the license.

6. Press F2 (Yes) to uninstall the extension module.
7. Press F4 (Esc) to exit the Extension Manager screen.

Manage Extension Modules

The Dynamix 2500 data collector lets you to hide installed extension modules from the Main Menu. You may need to hide an advanced extension module icon from an inexperienced user, for example, RUCD and FRF.

IMPORTANT Once an extension module is hidden, its icon is not represented on the Main Menu or displayed in the Dynamix 2500 data collector About screen.

Follow these instructions to hide or show an extension module icon on the Main Menu.

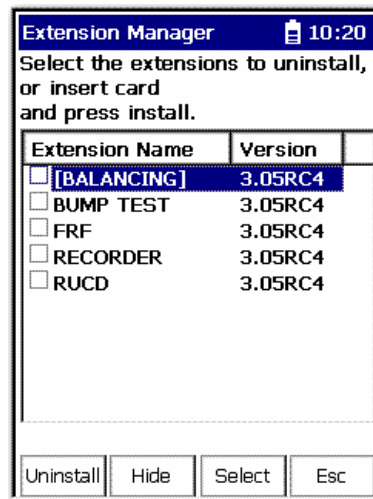
1. Press 0 (Shift) on the Setup Utility screen to display the Extension Manager function.

The Extension Manager function should remain on the screen for approximately three seconds after releasing 0 (Shift).

2. Press F1 (Extn Mgr). The Extension Manager screen appears.

The Extension Manager displays a list of installed extensions module.

The extension modules that are hidden are shown in [square brackets].



The F2 (Hide) toggles between Hide and Show depending if the selected extension module is hidden or not.

TIP You have to exit and re-enter the Extension Manager after hiding an extension module to have the Show function appear.

3. Select the extension module that you want to hide or show and press F2 (Show/Hide).

TIP

If you want to show or hide multiple extension modules simultaneously, select each extension module and press F3 (Select).





A checkmark appears next to each selected extension module. If you select multiple extension modules and some are hidden while others are shown, F2 (Show/Hide) reflects the status of the selected extension module.

4. Press F4 (Esc) to exit the Extension Manager.

Extension Module Battery Status Indicators

The battery status icons show the strength of the battery.

Table 1 - Extension Module Battery Icon Descriptions

Battery Icon	Meaning
	Battery status is good: >30% life remaining.
	Battery status is low: >10% life remaining.
	Battery status is very low: <10% life remaining.
	Battery is charging.

Notes:

FRF Frequency Response Function Extension Module

The Frequency Response Function (FRF) extension module is an optional module for the Dynamix 2500 data collector. You install the extension module with the FRF Frequency Response Secure Digital (SD) storage card.

See [Install an Extension Module on page 8](#) for installation instructions.

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Setting Up an FRF Measurement	16
FRF Module Setup	18
Collect FRF Data	22
Field Calibration	25
Saving, Reviewing, and Deleting FRF Measurements	27

The Dynamix 2500 data collector FRF extension module lets you determine the natural frequencies of a machine or structure in a more sophisticated manner than the Bump Test module. Rather than simply detecting the frequencies where resonances occur, it captures information about the frequency response of the structure being tested.

- You can use the FRF data in conjunction with a modal analysis software package to model the way the structure reacts to forces applied to it.
- You can use the FRF module to capture information about how a machine moves when it is running. You can use this information with the Operation Deflection Shape (ODS) analysis software.

IMPORTANT The FRF extension module is for Offroute/unscheduled measurements only. The Emonitor software does not import this type of data.

The FRF module includes the following features:

- Simple selection of measurement type from a list of predefined options, for example, mobility, stiffness, and apparent mass.
- FRF trace colored green or red to illustrate high or low coherence.
- Optional automatic parameter setting for input ranges, number of lines, and windowing.
- Compatibility with ODS analysis software.

Newton's Law and Apparent Mass

Newton's Law states that force equals mass x acceleration:

$$F = ma$$

Rearranging this gives:

$$m = F/a$$

The units for this are N/m/s². The definition of a Newton:

$$N = kg \times m/s^2$$

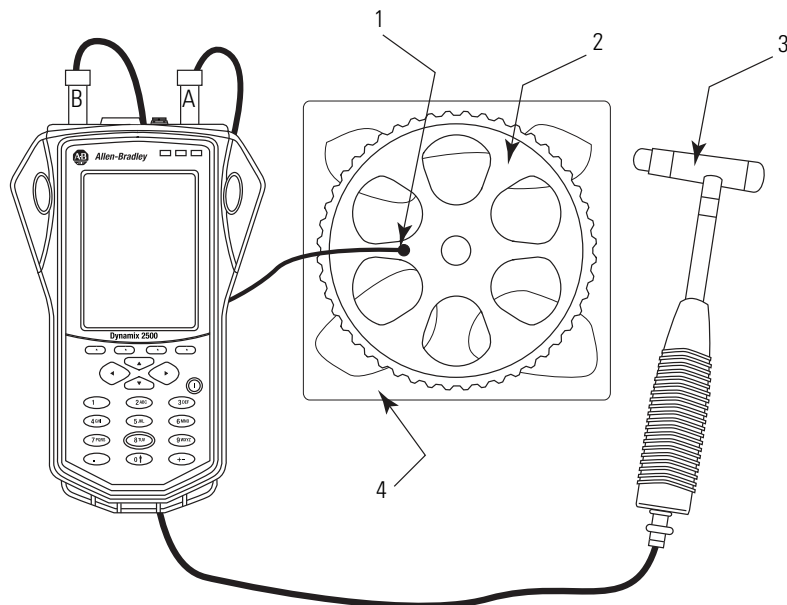
So we can see that:

$$N/m/s^2 = kg$$

Setting Up an FRF Measurement

When setting up an FRF measurement, first set up the test hardware before you configure the parameters for the FRF Module.

Figure 1 - Example FRF Measurement Setup



- 1 Accelerometer connected to connector B
- 2 Hardware being tested
- 3 Modally tuned hammer fitted with correct tip connected to connector A
- 4 Foam support to allow free movement

32159-M

Test Hardware Setup

When setting up an FRF test, you need this equipment:

- Accelerometer
- Hammer
- Object whose FRF measurement you are collecting
- Support for the object that provides free movement when the object is struck with the hammer, for example, as a foam support

Follow these instructions to set up the FRF test apparatus.

1. Fit the correct tip to a modally tuned hammer.

The hammer is used to create the force that is to be measured in the FRF.

TIP Use a harder tip for higher frequency and a softer tip for lower frequency measurements.

2. Connect the modally tuned hammer to Connector A of the instrument.
3. Support the object being tested, allowing free movement, for example, on a foam support.
4. Select an accelerometer of the correct mass and connect it to Connector B of the instrument.

TIP The accelerometer is used to measure the response to the hammer input of the FRF. The accelerometer mass should be low in relation to the test piece, that is, less than 10%.

5. Connect the accelerometer to one of the sides of the object you are measuring.

Avoid Bad Data

An FRF measurement involves placing an accelerometer onto the measurement position and pressing Enter the Dynamix 2500 data collector. Be aware of these items before placing the accelerometer:

- The magnet should be firmly screwed onto the accelerometer. Any looseness between the magnet and accelerometer will corrupt the measurement.
- Gently slide the accelerometer onto the measurement position. Using too much force while placing the transducer onto the machine may cause data overload.
- The magnet should be in firm contact with machine's surface. Any movement of the magnet will be falsely recorded as vibration data. Try sliding or rotating the magnet until a firm seating is achieved.
- Avoid knocking or disturbing the accelerometer while taking the measurement.

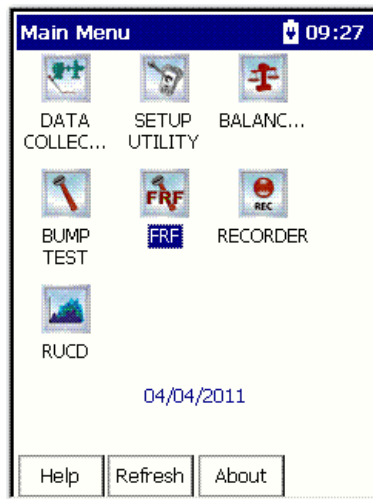
FRF Module Setup

There are three parameters that have already been configured to make the setup easier. These are the measurement parameters that are already configured for you:

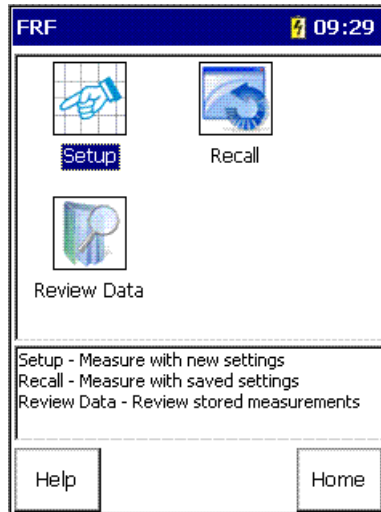
- Pre-trigger delay – set to 10% of block length
- Trigger level – set to 10% of input range
- Good Coherence- 80% threshold

All other settings can be configured on the Setup screen in the FRF extension module.

1. From the Main Menu, select the FRF icon and press Enter.



The FRF menu appears.



2. Select Setup and press Enter.

The FRF - Setup screen appears.



FRF Analysis Set-up Parameters

This table describes the FRF set-up parameters.

Table 2 - FRF Analysis Set-up Parameters

Parameter	Description	Value/Comments
Acquisition Mode	Set to Hammer for FRF acquisition and modal analysis, or set to Continuous for ODS analysis. If you are performing ODS analysis, refer to the instructions that accompanied your ODS software for additional information on settings that are required.	Hammer (default) ODS analysis
Hammer Units	This setting does not restrict the Meas Units options, for example, if Hammer Units is lbf, mobility can still be measured in mm/s/N.	N (metric default) lbf (EU)
H.Sens	Enter the sensitivity of the hammer.	5.00 (default) mV/N Vlbf
Sensor Type	Specifies the type of sensor used on Connector B, for example, an accelerometer, velocity transducer, or displacement probe. ODS analysis requires a sensor on both Connector A and B. The sensor type and sensitivity must match on both channels.	Accel G (default) m/s ² in/s mm/s mils um
Sens.	Enter transducer sensitivity in mV per sensor unit.	100.00 (default) mV/g
Measurement	Sets FRF display type.	Mobility (default) Apparent Mass Accelerance Impedance Stiffness Compliance
Meas Units	Measurement units change to correspond with the measurement display type that has been chosen, but can be set to Imperial or metric units.	ips/N (default) mm/s/N ips/lbf mm/s/lbf
Y-axis	Sets Y axis to linear, logarithmic, or decibel scale.	Linear Log (default) dB
Hammer Range	Sets the hammer input range manually to selected fixed range, or to be set automatically.	Automatic (default) 0.100...220000N
Response Range	Sets response sensor input range manually to selected fixed range, or to be set automatically. If Hammer Range or Response Range is set to Automatic, you are prompted to make three trial hits to establish the range to use.	Automatic (default) 0.100...2000g
Freq Range	Sets the frequency range for the test. The Acquisition time information box changes accordingly.	1000 (default)

Table 2 - FRF Analysis Set-up Parameters

Parameter	Description	Value/Comments
Num of Lines	Sets the number of lines of resolution for the FFT. The Acquisition time information box changes accordingly. When set to Automatic, the FRF module automatically chooses the number of lines after three trial hits. This uses a Uniform window if possible and automatically increases the lines of resolution to accommodate the decay time. If this cannot be achieved, then Force/Exponential is automatically selected. This function is optimized to work for frequency ranges between 200 Hz and 4 kHz. If you select Automatic at a frequency range outside this band, the algorithm attempts to auto select, but may not achieve good results.	400 (default)
Windowing	Sets the FFT window type to Uniform or Force/Exponential.	Force-Exp (default) Uniform
Num of Averages	Sets the number of FFT averages.	5 (default)
Accept/Reject	When performing a hammer test, the setting Accept/Reject to Manual displays a dual time trace and presents the choice to accept or reject control. Setting it to Automatic, automatically rejects overloaded data and double impacts.	Manual (default) Automatic
Invert Phase	Applies a 180° phase offset to the measured data. It is used when the accelerometer or hammer needs to be inverted at a measurement position.	Off (default) On
Save To	You can save to the Internal memory or to the Secure Digital (SD) card.	Internal (default) Card
Good Coherence	Enter the threshold at which the FRF plot changes from red (bad coherence) to green (good coherence).	80% (default)

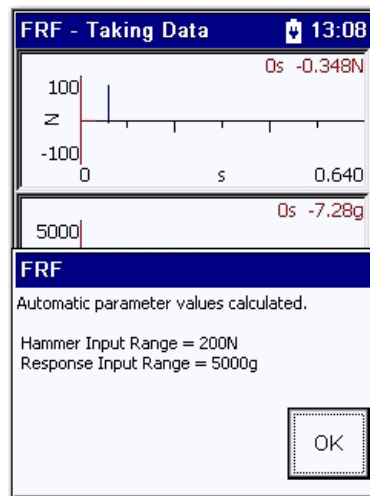
Collect FRF Data

Once the measurement is set up and the transducers are attached correctly, the next step is to start collecting data for the FRF.

Follow these instructions to collect FRF Data.

1. From the Setup screen, press Start.

If you have Hammer Range, Response Range, or Num of Lines set to automatic, a message appears advising you that you will be asked to perform three trial hits. The results of these hits are used to automatically determine the best settings for the associated options.



2. Press OK to start taking data.



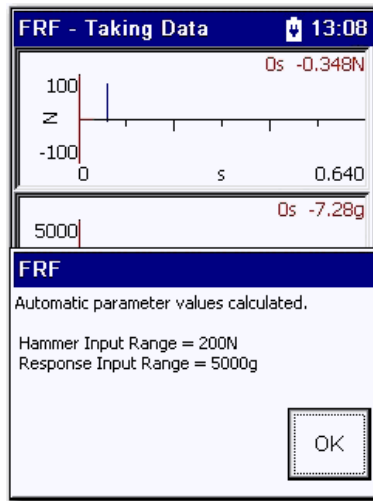
Automatic Parameter Set-up Hit Count and Number-of-hits count.

If you have been prompted to perform automatic parameter setup, hit the object being tested with the hammer at the opposite side from where the accelerometer is attached.

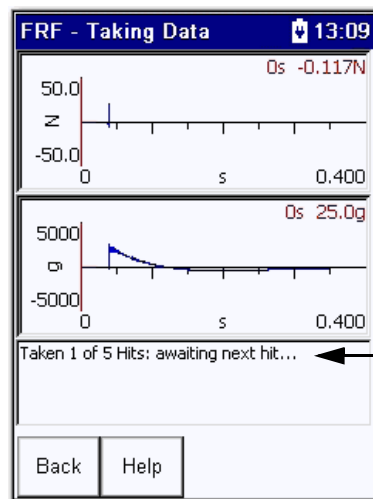
When hitting the object, try to make sure that you have one clean tap and that the hammer hits directly opposite of where the accelerometer is located on the object. If this is done correctly, the instrument registers the hit and increases the number-of-hits count displayed at the bottom of the screen.

3. Perform all three hammer strikes.

Once complete, a message box appears showing the calculated values for the applicable settings.



After the automatic parameter setup is complete, you are ready to begin capturing the FRF data.



How many hits you need to take, based on the Num of Averages setting in FRF – Setup.

The data is collected in the same way as when setting up the automatic parameters, by hitting the hammer against the object on the side opposite to the accelerometer.

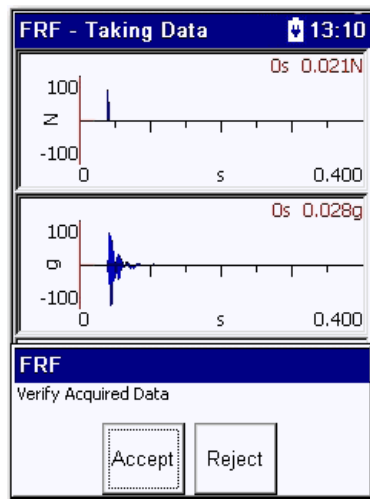
The status indicators provide feedback on the hammer hits.

Table 3 - Status Indicators

Status Indicator	Description
Red	An error, for example, input overrange, during data acquisition.
Amber	Instrument is initializing the measurement.
Green	Instrument is collecting data. In Hammer mode, it is looking for a hit.

See the Dynamix 2500 Data Collector User Manual, publication [1441-UM001](#), for more information about the status indicators:

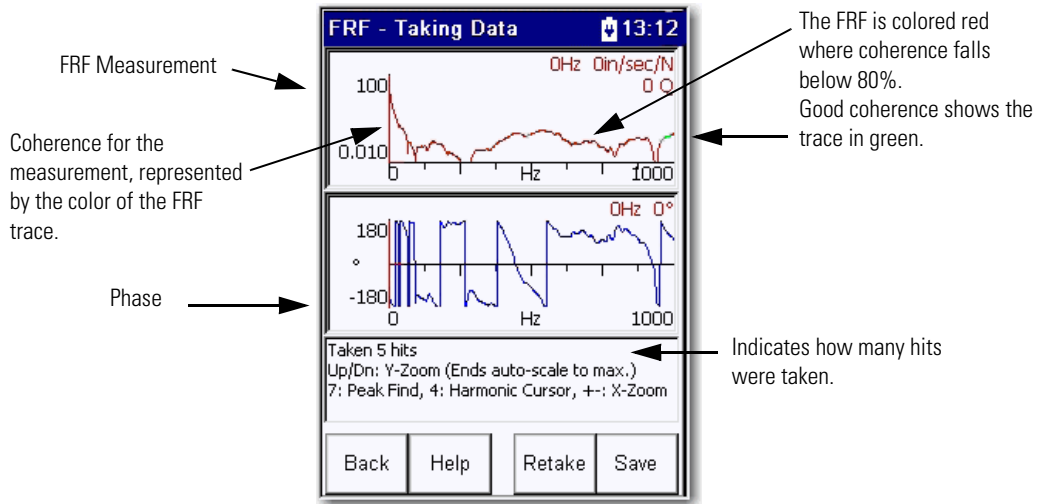
- If the Accept/Reject option in FRF - Setup was set to Automatic, each hammer hit is collected and the Dynamix 2500 data collector automatically determines if the data is correct. If it is not, a message appears with details on why the hit was rejected.
- If Accept/Reject was set to Manual, the hammer and response time waveforms display for both the hammer and accelerometer outputs, and then an Accept/Reject prompt appears.



4. Review the FRF data and either Accept or Reject the hit.

When all the averages are taken, the Taking Data screen updates to show the FRF magnitude/phase traces.

The FRF - Taking Data screen shows frequency, magnitude, phase, and Q factor (where appropriate) at the cursor position.

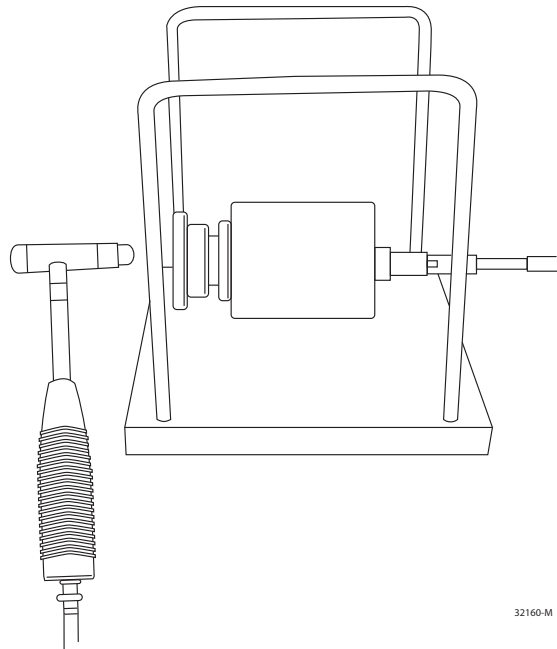


Field Calibration

Data can be checked for calibration and integrity by carrying out a test on a known mass, for example, a calibration weight or steel bar of a measured value.

Use a calibration weight of 1kg or any other known mass.

Figure 2 - Field Calibration Setup



This is an example of a set-up for Field Calibration.

1. Fit the correct tip to the modally tuned hammer.

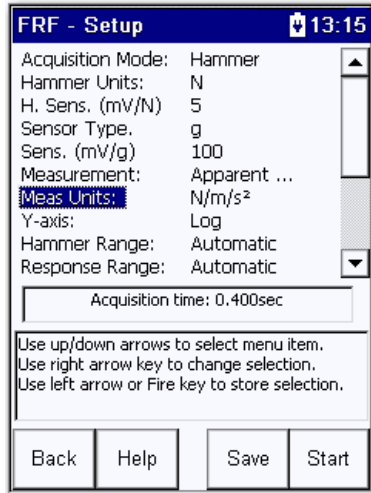
2. Connect the hammer to connector A.
3. Select an accelerometer of correct mass and connect to connector B.
4. Place the accelerometer on mass.

The mass can be hand-held. The use of foam or a supporting structure is not necessary.

5. Set the Measurement parameter to Apparent Mass.
6. Set the Meas Units parameter to N/m/s2.

The instrument displays 1 kg (or other chosen mass), plus the weight of the accelerometer:

$M = \text{calibrated mass} + \text{accelerometer mass}$
For example: $1 \text{ kg} + 10.5 \text{ g} = 1.0105 \text{ kg}$



Saving, Reviewing, and Deleting FRF Measurements

You can save measurement setups and measurement results. You can use these for reviewing and recalling stored measurements.

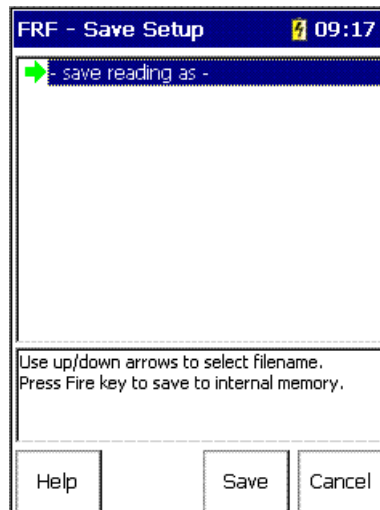
Save an FRF Test Setup and Measurement

You can save the FRF Test set-up parameters and measurements to a file that you can recall at a later time.

Follow these steps to save a file.

1. Press F3 (Save).

The Save screen appears. Depending on where you are in the measurement process, a Save Setup or Save Reading appears.



2. Save the measurement.
 - Select the file and press F3 (Save) to save the data to an existing file.
 - Press F2 (Yes) to overwrite the existing file.
 - Press F3 (No) to return to the Save screen without overwriting the file.

Follow these instructions to save the data to a new file.

1. Select 'save reading as' and press F3 (Save).
2. Enter a file name by using the keypad or accept the default file name (current date timestamp).
3. When the entry is complete, press F2 (OK).

IMPORTANT The set-up parameters are saved along with the measurement when you press F4 (Save) on the Bump Test - Save Data screen.

Importing to ODS Analysis Software.

Operating Deflection Shapes (ODS) analysis is used for determination of the vibration pattern of a structure under certain operating conditions. Vibration measurements can be performed at different locations and in different directions on a structure and the vibration pattern can be shown as an animated geometry model of the structure or listed in a shape table.

An ODS is a combination of the forcing function acting on the structure and the dynamic properties of the structure. The forcing function depends on the operating conditions, which for machinery could be influenced by, for example, engine speed, load, pressure, temperature and flow. Ambient forces from waves, wind and traffic may also apply for civil engineering structures.

You can import measurements taken by the FRF extension module into ODS analysis software such as Vibrant Technology, Inc.'s ME'scopeVESTM.

Follow these instructions to import FRF data into analysis software.

1. Collect data using the FRF extension module.
2. Create a an FRF Data folder on your computer.
3. Connect the instrument to your computer using the supplied USB cable.

For information about the USB cable and ActiveSync, see the Dynamix 2500 Data Collector User Manual, publication [144-UM001](#).

4. Start an ActiveSync session.
5. In the ActiveSync window, select Tools > Explore.
6. Browse to the \Internal Disk\FRF folder on the instrument.

This is where the Frequency Response Function module data is stored.

7. Select the appropriate data file (*.csv) readings.
8. Copy the data files into the FRF data folder you created on your computer.
9. Select all the (*.csv) files and import them into the ODS analysis software.

TIP The import function in the ODS analysis software may refer to Data Block or DI-440 FRF's (*.csv) file formats.

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Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products.

At <http://www.rockwellautomation.com/support/>, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit <http://www.rockwellautomation.com/support/>.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html , or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication [RA-DU002](#), available at <http://www.rockwellautomation.com/literature/>.

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