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dataPAC® 1250/1500
Data Collector User's Guide

Your manual for using the dataPAC

Entek IRD International Corporation

P/N 44853

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Chapter 1

Introduction

This chapter introduces you to using the dataPAC® data collector. It also discusses the online help system and Customer Support.

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Using the Manual *14*
Using the Online Help Systems *16*
Contacting Customer Support *16*



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Overview of the dataPAC

The information in this manual applies to all three dataPAC models (1500, 1250, and 1000). Differences in the models are noted in the text.

A predictive maintenance program helps you decide when equipment needs to be serviced or replaced. Part of a complete predictive maintenance program includes vibration monitoring. The dataPAC allows you to perform vibration analysis by collecting data samples. The dataPAC is referred to as the dataPAC or the data collector in this *User's Guide*.

With the predictive maintenance abilities of the dataPAC, you can:

- Collect magnitude, process, spectrum, time, and phase data.
- Store collected data on a memory card.
- Review collected data.
- Balancing applications are included with the 1500 model.

Using the Manual

This *Guide* is intended for people the dataPAC without host software to collect vibration data and perform vibration analysis. This manual contains step-by-step instructions for using the dataPAC. It also serves as a reference and troubleshooting guide with sections about the data collector and frequently asked questions related to the dataPAC.

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Organization

This manual is organized in chapters based on these tasks and topics:

Chapter 1 "Introduction" contains an overview of the manual, the Online Help System, and Entek IRD Customer Support Services.

Chapter 2 "The dataPAC" describes the dataPAC data collector in detail and covers the basic operations of the data collector.

Chapter 3 "Collecting and Reviewing Data" contains some of the tasks associated with collecting and reviewing data.

Chapter 4 "Off Route Analysis with the dataPAC" shows you how to collect data using the dataPAC in off route or analysis mode.

Chapter 5 "Balancing Measurements" describes methods used for performing one- or two-plane balancing using the dataPAC coupled with a speed measuring device..

Chapter 6 "Frequency Response Function (FRF)" shows you how to use the dataPAC's Frequency Response Function to determine the resonant frequency and relative dynamic stiffness of a structure.

The *Appendix* contains answers to frequently asked questions.

The *Glossary* contains definitions of terms used in this manual.

Document conventions

There are several document conventions used in this *Guide*, including the following:

- The data collector is referred to as the dataPAC or the data collector throughout this *User's Guide*.
- Keys that you press on the data collector are shown within angle brackets in <ALL CAPS>. The enter key is shown as <ENTER>. Consecutive key presses are shown as <SHIFT><F2>, which means press the shift key then press the F2 key.
- Softkeys used on the data collector are shown as the function key followed by the title of the softkey in parentheses. For example, "Press <F1> (Setup Category) to choose a setup category."
- Menu and icon choices in the dataPAC are capitalized as they appear on the dataPAC display.

WARNING: A warning indicates potential bodily harm.

Caution: A caution indicates potential loss of data.

Note: A note indicates additional information which may be helpful.

For definitions of other terms, see the Glossary at the end of this manual.

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Using the Online Help Systems

The dataPAC includes an online help system that contains information specifically about the dataPAC.

dataPAC Online Help

The dataPAC contains help files. You access these files by choosing the Help icon from the Program Manager window, or by pressing <SHIFT><HELP>. See “Using Help Windows” on page 26 for more detailed information.

Contacting Customer Support

If you are under warranty or have an active ESAFE Agreement, Entek IRD provides a variety of Customer Support services. In the United States you can reach the Technical Support Hotline by dialing 1-800-ENTEKIRD (1-800-368-3547) Monday through Friday 8:00 a.m.–5:00 p.m. eastern time. Limited extended support for users in the mountain and Pacific time zones is available until 7:00 p.m. eastern time. You can send a fax detailing your questions or comments 24 hours a day by dialing (513) 576-4213. Please address the fax to the Customer Support department. You can also reach Entek IRD from your computer.

- Send questions to support@entekird.com
- Send suggestions and comments to suggestions@entekird.com
- Visit our web site at http://www.entekird.com

For support outside of the United States, please contact your local Entek IRD representative or the nearest Entek IRD office. If your local support representative is not available, please contact the U.S. Customer Support department. You can display the worldwide Customer Support phone numbers by choosing the **About** command from the **Help** menu in EMONITOR Odyssey or Enshare.

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Chapter 2

The dataPAC

This chapter describes the dataPAC data collector in detail and covers the basic operations of the data collector. It includes the following sections:

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dataPAC Battery Pack and Charger *22*
dataPAC Windows and Screens *23*
Basic dataPAC Operations *28*
Loading the Operating System with the dataPAC Utility Program *30*
Using the dataPAC Setup Program *36*
Using Memory Cards *53*
Using the Memory Card Manager *58*
Using Security Keys *59*



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Overview of the dataPAC

The dataPAC is a portable data collector for predictive maintenance and machinery vibration diagnostics. It allows you to collect magnitude, spectrum, time, and phase data as well as process measurements. You can unload these measurements to your software program for analysis. You can collect data for locations defined in a list, or unscheduled measurements not associated with a list. The dataPAC is also called the data collector in this *User's Guide*.

This chapter discusses the basic operations of the dataPAC, including how to:

- Check and charge the batteries.
- Power the data collector on and off.
- Initialize the data collector.
- Set the date and time.
- Go through the menus and make selections.

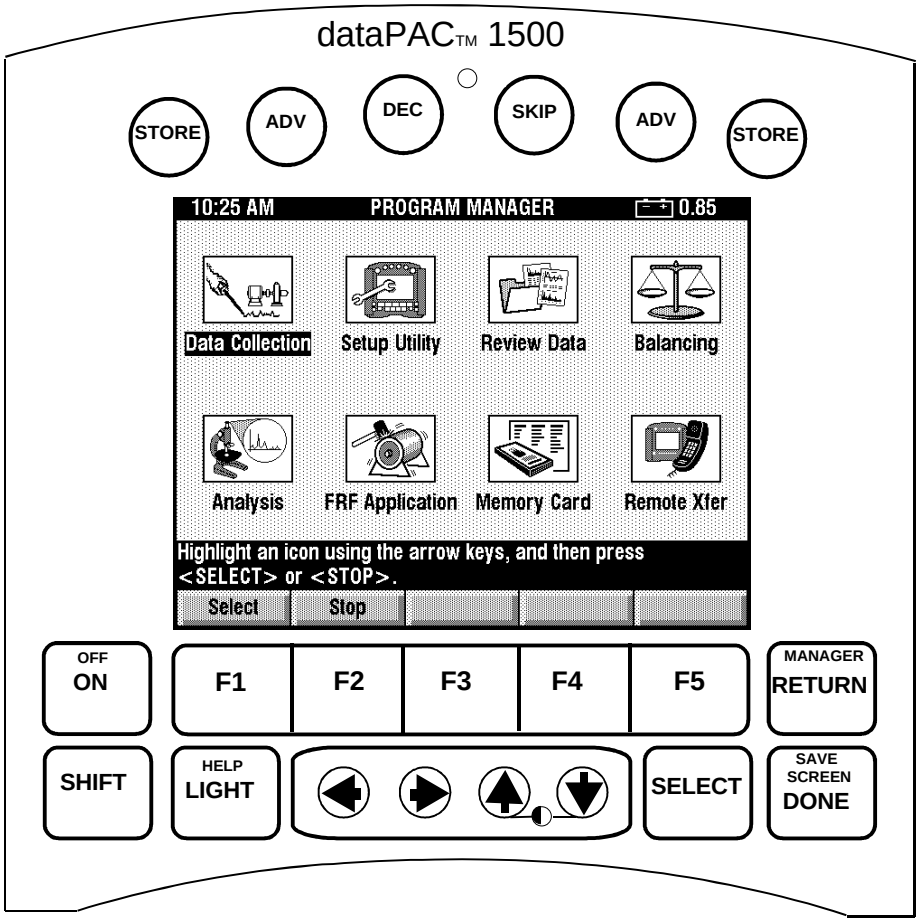
Parts of the dataPAC

This section includes a diagram of the data collector showing the hardware connections. If you are already familiar with the basic operations of the data collector, you may want to skip this section.

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Data Collector Diagram and Key Definitions

The following is a diagram of the dataPAC data collector showing the display and keys used for operation. The data collector display (LCD supertwist) displays 640 by 480 pixels and has a 5.25"x4.0" (13.3 cm x 10.1 cm) viewing area.



The dataPAC has 21 keys which can be used in combination with five softkeys for more functions. The softkey functions change depending on the current state of the data collector. The data collector displays the current function of the keys in the display above the key. The Main keys are designed for right- and left-handed operation and all keys give tactile feedback through a metal snap dome. In addition, an LED light and audible feedback (a “beep”) are available.

Note: Some dataPAC models beep intermittently, sometimes at a very low volume, for no apparent reason. This beep is harmless but can be annoying. Contact Entek IRD Customer Support to arrange for servicing. If you send the unit in, Entek IRD can eliminate this beep.

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Main keys

The round keys located above the display are the Main keys. The primary functions of these keys are:

<STORE> - The store key causes the dataPAC to begin collecting data when you are using the Data Collection Program and you have selected a route. You may press <STORE> a second time to indicate a stable signal if you did not enable the Auto Store option. There are right and left store keys for convenient right- or left-handed operation.

<ADV> - The advance key causes the dataPAC to move to the next point on the selected route. You do not have to use this key if you set the collector to Auto Advance. You can also use this key in combination with the shift key to move forward to the next point on the route for which data has not been collected. Simply press <SHIFT><ADV>.

<DEC> - The decrement key causes the dataPAC to move to the previous point on the selected route. You can also use this key in combination with the shift key to move backward to the next point on the route for which data has not been collected. Simply press <SHIFT><DEC>.

<SKIP> - The skip key allows you to skip over points, routes, or trains until you select a desired point. The active skip level is highlighted in the display, so if Plant is highlighted, you will skip to the next plant when you press <SKIP>. You can also use this key in combination with the shift key to skip backward at the active skip level. Simply press <SHIFT><SKIP>.

Menu keys

You use the Menu keys when moving through different menus and making selections within menus. Menu keys are located below the display. Press the key to activate the function in white. Press the shift key before pressing the key to activate the function in blue text.

<ON/OFF> - This power key turns the data collector on. To turn the data collector off, press <SHIFT><ON/OFF>.

<SHIFT> - The shift key accesses the second functions of other keys. After you press the shift key, the light at the top of the dataPAC between the <DEC> and <SKIP> keys remains on until you press another key. To cancel the shift key, press <SHIFT> again and the light turns off.

<SELECT/+/-> or **<SELECT/ESCAPE>**- The select key chooses the item that is highlighted. You can use the arrow keys to move up and down in a menu to select different menu choices. In many menus, pressing <SHIFT><SELECT> allows you to escape without making a selection.

<DONE/.> or **<DONE/SAVE SCREEN>**- The done key completes an action. The dataPAC sometimes gives you a message in the status bar telling you to complete the action. Generally, this causes the dataPAC to complete the action in the current window and return to the last window that was open. Pressing <SHIFT><DONE> allows you to save the screen capture, or print directly from the screen.

<RETURN/MANAGER> - The return key leaves the current program (without closing it) and returns to the previous program or to the Program Manager window. You can also use this key in combination with the shift key to return directly to the Program Manager window.

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<↑> - The up arrow has the following definitions:

- Moves to the previous menu selection.
- Moves to the previous field in a data entry screen.
- <SHIFT><↑> adjusts the screen contrast.

<↓> - The down arrow has the following definitions:

- Moves to the next menu selection.
- Moves to the next field in a data entry screen.
- <SHIFT><↓> adjusts the screen contrast.

<←> - The left arrow has the following definitions:

- Moves to the previous selection in the Program Manager.
- Moves to the left in a data entry field.
- Moves the spectrum cursor to the left.

<→> - The right arrow has the following definitions:

- Moves to the next selection in the Program Manager.
- Moves to the right in a data entry field.
- Moves the spectrum cursor to the right.

Softkeys

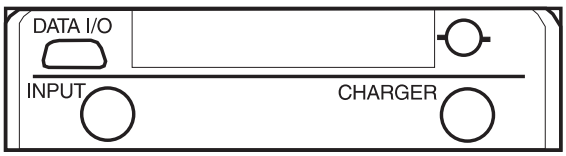
The softkeys are located above the arrow keys. They are labeled F1 through F5. The text in the display directly above a softkey describes its function at any given time. When no text appears above a softkey, the key is inactive in the current window.

Data Collector Hardware Connectors

This sections discusses the data collector hardware connections for communications and data collection.

You connect transducers to the INPUT connector on the top of the dataPAC. You connect the battery charger to the CHARGER connector on the top of the dataPAC. These are known as LEMO connections.

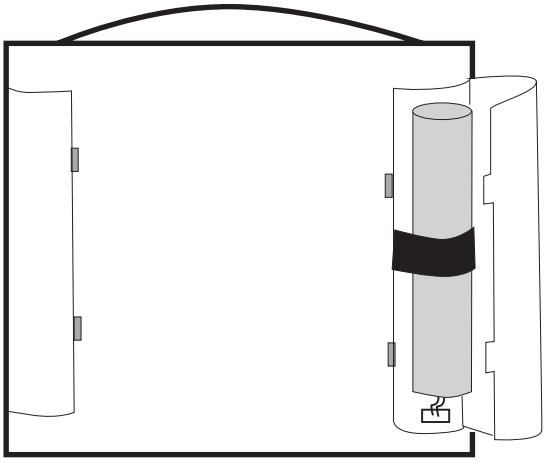
Data is transferred between the dataPAC and your computer over an RS-232 (serial) cable. The dataPAC requires a standard 9-pin connector on one end of the cable which is connected to the top of the data collector in the port labeled DATA I/O. Connect the other end of the cable to the COM port of your computer.



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dataPAC Battery Pack and Charger

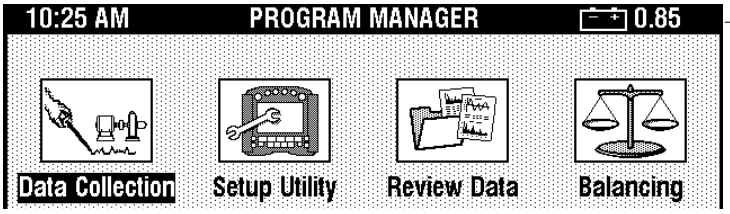
This section discusses checking and charging your battery. The dataPAC battery packs are located inside compartments in the back of the dataPAC.



With a full charge, the batteries provide over eight hours of data collection time under normal conditions. Using the backlight causes the battery to lose power more quickly.

Checking Battery Life

You can check the battery life of the battery in the data collector by noting the number in the upper right corner of the display.



The battery level indicator shows the relative strength of the batteries based on the following table.

Level	Meaning
1.3 or 1.4	Typical value immediately after charging the dataPAC.
1.0	After recharge, the level drops rapidly to 1.0, which is normal. Level drops more gradually after reaching 1.0.
0.2	Unit goes to LOW BATTERY SHUTDOWN and alerts you with a message. **When you get this message, you should charge the batteries soon.**

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Charging the Battery

The supplied battery charger is designed to charge the dataPAC Ni-Cad batteries to a safe level and to supply limited operating power when properly connected to the dataPAC. However, due to the nature of Ni-Cad batteries, you should not leave the dataPAC on the charger for more than seven days.

To charge a battery, connect the dataPAC to the charger into the connector at the top of the instrument. Do not cover or block ventilation around the charger or you risk overheating the charger. Plug the transformer adapter from the power supply socket into a standard wall outlet. Allow approximately 16 hours for complete recharging.

You can connect the battery charger to either 120 or 230 volts AC by using the voltage selector switch on the charger. Make sure you match your supply properly to avoid damage to the charger, batteries, and the data collector.

After charging, the battery pack powers the dataPAC for approximately 8 hours of normal operation.

A battery eliminator and fast charging unit is available from Entek IRD as an optional accessory to the dataPAC. It allows you to condition the Ni-Cad batteries and provides complete discharge and recharge in about four hours. In order to prolong the life of your batteries, you should periodically discharge them as completely as possible. This maintains optimum battery life.

If you will not use the instrument for more than two weeks, remove the batteries to prevent damage.

Caution: **Turn off the dataPAC before removing the batteries. Removal of batteries for more than 15 minutes erases the operating system from the internal memory of the dataPAC. If this happens, you must reload the operating system, but any lists (routes) or data stored on the memory card remain intact. If you have a bootable memory card, you can reload the operating system into internal memory with the card. See “Loading the Operating System with the dataPAC Utility Program” on page 30.**

You can leave the battery on the charger for up to seven days. If you use the dataPAC daily or once a week, you can leave it on the charger. You will get the best results if you run the batteries down all the way before charging. If you use the dataPAC less frequently than once a week, you should charge and discharge the batteries regularly in order to maintain optimum cell life.

dataPAC Windows and Screens

There are different types of displays used within the dataPAC. The Program Manager is an example of a selection menu. Data entry screens allow you to enter values in data entry fields.

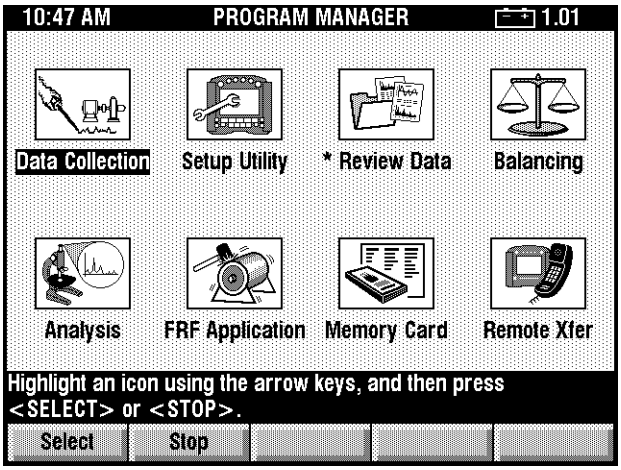
Using Selection Windows

A selection window allows you to choose the desired function by pressing the up or down arrow keys to select it, then pressing <SELECT> to choose that function. When you choose that function, the next screen appears.

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Program Manager

The Program Manager appears when you power up the data collector for the first time. Each selection in the Program Manager allows you to complete different tasks, such as collecting data, defining setup, and reviewing data. Other programs vary depending on your model of dataPAC and which features you chose to activate.



A black box around the name of the icon means the icon is selected. In the diagram, Data Collection is selected. You can press <F1> (Select) or <SELECT> to start the selected program. An asterisk by the program name means the program is still running in the background. In the diagram, Review Data is still running. You can stop a program from the Program Manager by selecting it and pressing <F2> (Stop).

Once you have entered a program, there are two methods for moving back to the Program Manger window without closing that program.

- Press <SHIFT><RETURN/MANAGER> to switch without closing the current program.
- Press <RETURN> to switch to the last program that was open without closing the current program. If no programs are running the dataPAC returns to the Program Manager.

Program Manager functions include:

Data Collection

The Data Collection program allows you to collect both route and unscheduled (off-route) data.

Setup Utility

The Setup Utility allows you to change your display and options for collecting data to best suit your needs.

Review Data

The Review Data program allows you to view various types of summary information for a point after you collect your data.

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Balancing (optional for 1250, included in 1500)

The Balancing program offers a direct method to balance your rotating machinery in one or two planes.

Analysis (1500 only)

The Analysis program allows you to observe a machine during start-up or coast-down to analyze the unusual vibration and resonance conditions that occur while you start up or shut down your machine. It also allows you to quickly collect off-route data.

Memory Card

The Memory Card Manager allows you to look at the contents of a memory card and delete files you no longer need.

FRF Application (optional for 1500)

The FRF Application provides tools to measure a mechanical system's frequency response, allowing you to determine the resonant frequency and the relative dynamic stiffness of a structure.

Help Menu (1250 only)

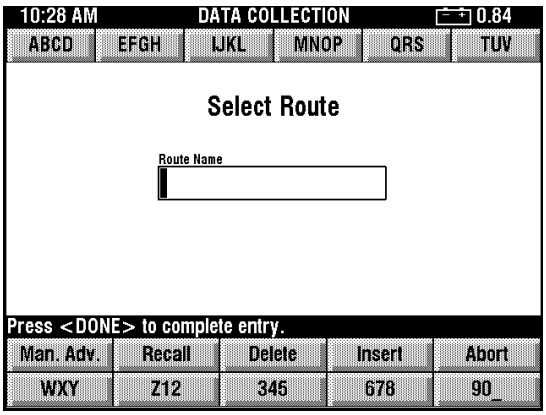
The dataPAC contains an extensive context-sensitive online help system that you can access through the Help icon in the Program Manager or by pressing <SHIFT><LIGHT/HELP> in any window. In the 1500, you must access the Help Menu by pressing <SHIFT><HELP>.

Remote Xfer (1500 only)

The dataPAC 1500 Remote Xfer program allows you to transfer route and balancing files from a remote location using an external modem.

Using Edit Windows

The dataPAC uses edit windows when you need to make alphanumeric entries. The example below shows a typical edit window.



Press <SHIFT><F1> to toggle between Manual Advance and Auto Advance

There are two modes for the edit window, either Auto Advance or Manual Advance. You can toggle between the two by pressing the <SHIFT><F1> softkey combination.

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To use Auto Adv.

To change the current value in the entry box using Auto Advance, follow these steps.

1. Press <SHIFT><F1> until Man. Adv. is display as the label for the softkey.
2. Press the key closest to the softkey on the display. For example, the left <STORE> key is assigned to ABCD. To enter a “B,” quickly press the left <STORE> key twice. The letter “B” appears in the entry box and the cursor automatically advances to the next position.
3. To add or change another character, repeat as needed. You can use the arrow keys to move the cursor within the field.
4. When you have finished the entry, press <DONE>.

To use Man. Adv.

To change the current value in the entry box using Manual Advance, follow these steps.

1. Press <SHIFT><F1> until Auto Adv. is display as the label for the softkey.
2. Press the key closest to the softkey on the display. For example, the left <STORE> key is assigned to ABCD. To enter a “B,” press the left <STORE> key until a “B” appears in the cursor position.
3. Manually advance the cursor to the next position by pressing the right arrow key.
4. To add or change another character, repeat as needed. You can use the arrow keys to move the cursor within the field.
5. When you have finished the entry, press <DONE>.

Using Help Windows

The dataPAC contains extensive context-sensitive online help which you can access from any window. This section provides an overview of opening and moving around in the Help windows.

To access help windows

To access the main help window, select the Help icon in the Program Manager and press <SELECT>. You can also access Help from any window. Press <SHIFT><HELP/LIGHT> to open a window to a related help topic. This action is similar to pressing **F1** in many Windows software applications. Press <DONE> when you are finished viewing the help topics.

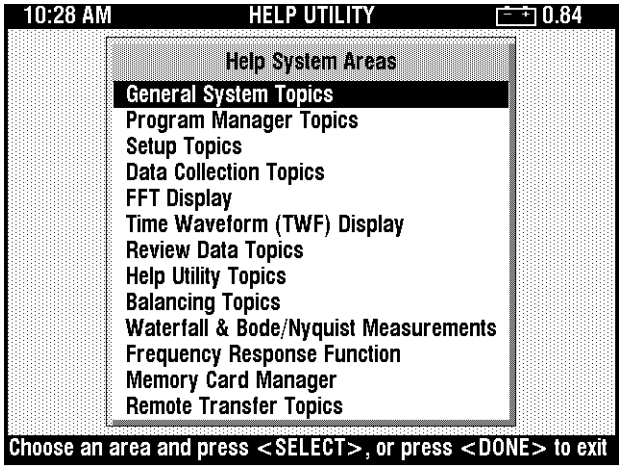
To move around in help windows

You can use the softkeys to choose different Help windows. There are three types of help windows:

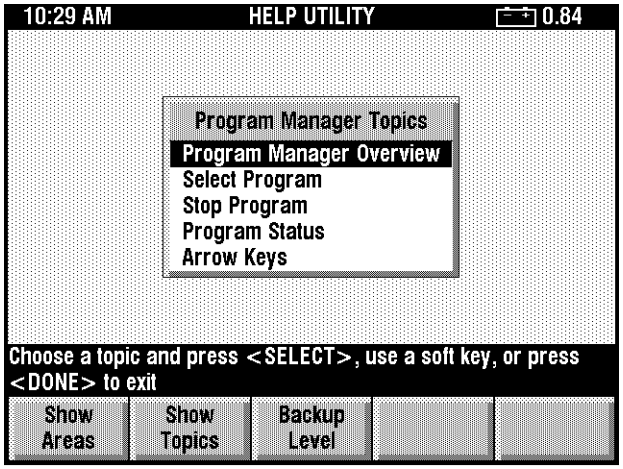
- Areas
- Topics
- Topic information

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These three types of windows also represent levels of organization. The Areas window lists the main subject areas which contain help information.



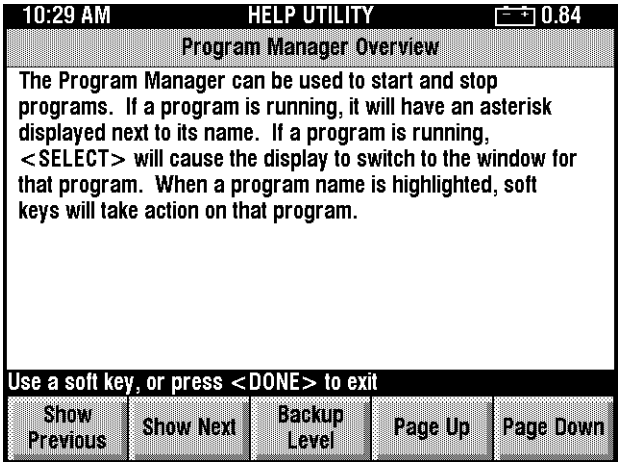
To see the list of topics for a subject area, use the arrow keys to highlight the name of the area, then press <SELECT> to enter that area. You will then see a list of topics for that area in a topics window.



To view help information about a topic in the list, use the arrow keys to highlight the topic, then press <SELECT>. You then view the information window for that topic.

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Topic information windows contain the highest level of detail. When you press <F3> (Backup Level), you move backward to the previous help window level.



Basic dataPAC Operations

This section covers many basic operations for the data collector, including powering up and down, changing your display contrast, initializing the data collector, and setting the date and time. It also describes the data collector storage capacity.

Powering Up the Data Collector

To power up the data collector, press the <ON/OFF> key located in the lower left hand corner. After a brief display of the logo screen, the Program Manager window appears. If you turned the data collector off while in a program, the last screen you viewed appears instead of the Program Manager screen.

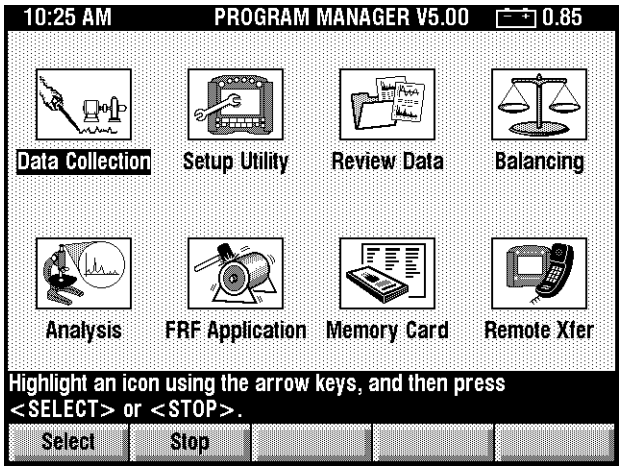
Powering Down the Data Collector

To power down the data collector, press <SHIFT><ON/OFF> in combination.

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Displaying the Operating System Version Number

To view the operating system version number, power up the data collector by pressing the <ON/OFF> key. The Version number appears in the bar above the Program Manager every time you turn the data collector on. In the diagram, the version number is 5.00.



Changing the Display Contrast

Because the dataPAC display is sensitive to temperature changes, you might need to adjust the contrast after you start the instrument. You can also change the display contrast for your angle of viewing or contrast preference. To do so, follow these steps.

1. Press <ON/OFF> to turn the data collector on.
2. Press <SHIFT>. The green LED at the top of the collector stays lit.
3. Press the up or down arrow key to adjust the display contrast to your liking. Repeat by pressing <SHIFT> and the arrow key again until the display is adjusted properly. You can do this from any screen in the dataPAC.

Restarting the Data Collector

You should restart the dataPAC only if the data collector is “locked up” and not responding to any key presses. Try initializing the memory card first to solve any problems. See “Initializing the Data Collector Memory Cards” on page 55.

When you restart the dataPAC by pressing <LIGHT> and the left and right arrow keys, the dataPAC first tries to boot from the card, then checks the serial connection, and keeps going back and forth until it finds a suitable program image. Because the dataPAC goes to the card first, you must remove the card if you want to force it to load a new operating system from the serial connection.

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Caution: **Restarting the dataPAC with this method removes the operating system from internal memory. If the system is stored on a memory card inside the dataPAC, the dataPAC restarts normally. Otherwise, you must reload the system. See "Loading the Operating System with the dataPAC Utility Program" on page 30 for more information.**

1. Press and hold <LIGHT><←><→>. Press each key, one at a time, and hold the keys until all three keys are pressed at the same time.
2. Release the keys.
3. Press the <ON/OFF> key to turn the data collector on. If the operating system is stored on a memory card inside the dataPAC, the dataPAC restarts normally. Otherwise, you must reload the operating system. See "Loading the Operating System with the dataPAC Utility Program" on page 30 for more information. The initialization is complete when the Program Manager appears.

   Generally you perform the "three finger restart" when the dataPAC is on. To restart it when off, you must press the three keys and then release. Then, turn on the instrument and hold the <ON/OFF> key for at least ten seconds.

Loading the Operating System with the dataPAC Utility Program

The dataPAC Utility program transfers the operating system files from your computer to your dataPAC PCMCIA card, either through a serial connection or directly using the local PCMCIA card drive.

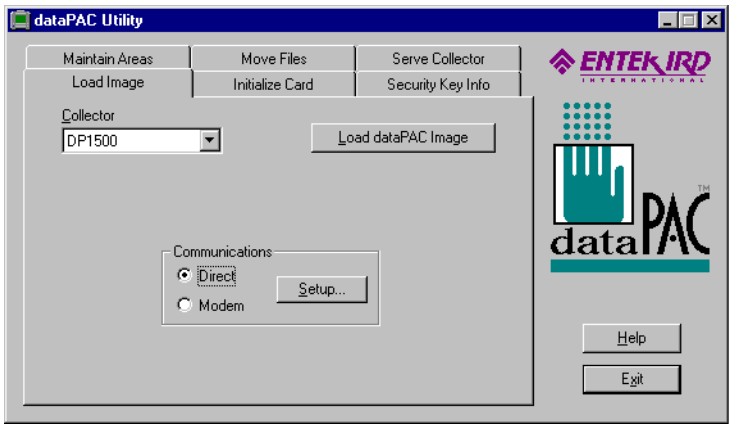
You receive both the operating system and the dataPAC Utility with your installation disks. This procedure tells you how to load the operating system to your dataPAC using the dataPAC Utility. This procedure shows you how to use a serial connection. Other procedures allow you to use a local PCMCIA card drive.

When you restart the dataPAC, the dataPAC first tries to load the operating system from the card, then goes to the serial connection, and keeps going back and forth until it finds a suitable operating system. Because the dataPAC goes to the card first, you must remove the card if you want to force it to load a new operating system from the serial connection.

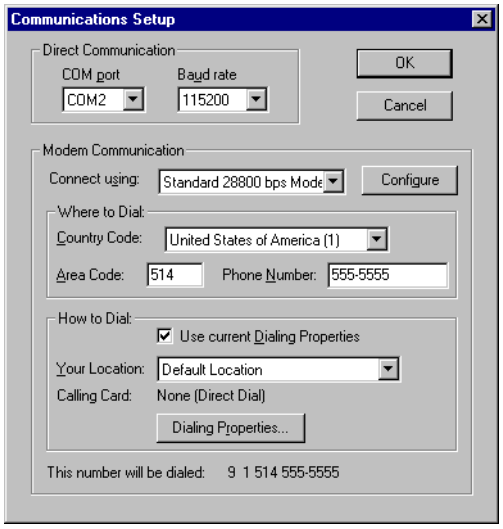
1. Connect the dataPAC to the computer with a serial cable.
2. Remove the memory card from the slot.

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3. Start the dataPAC Utility by pointing to it on the **Start** menu. The dataPAC Utility appears.



4. Select the correct dataPAC model under **Collector**. This example shows the dataPAC 1500 selected.
5. Under **Communications**, choose **Direct**.
6. Choose the **Setup** button.
7. Select the correct communications settings by selecting the correct port and baud rate for your connection under **Direct Communications**. The rest of the settings are ignored.



8. Choose **OK**.

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6. Restart the dataPAC by pressing <LIGHT> and the left and right arrows together. The dataPAC goes through a cold start routine.
7. Choose **Load dataPAC Image** to load the operating system to the dataPAC. A progress bar appears until the task is complete.

Note: The operating system loads to the internal memory with this procedure. If you want to load the operating system to a memory card, you must create a bootable memory card. See "Initializing the Data Collector Memory Cards" on page 55 for information about making a bootable memory card with the dataPAC Utility.

8. Choose **Exit** to exit the dataPAC Utility program.

Using Other Features of the dataPAC Utility Program

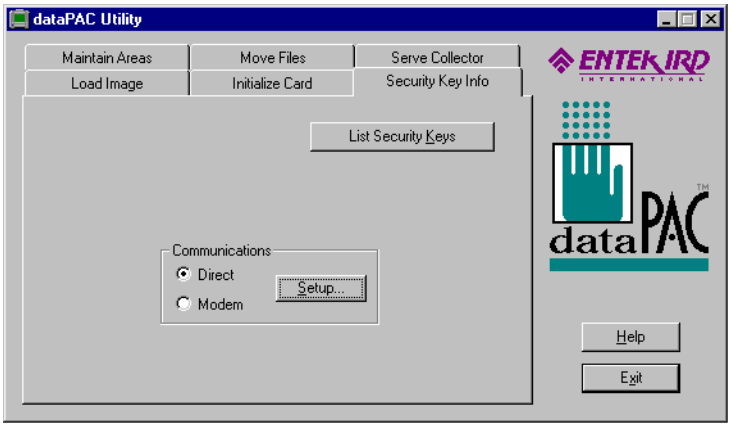
There are other functions available through the dataPAC Utility Program. The dataPAC Utility Program allows you to:

- Obtain security key information, which tells you which optional items are available for your dataPAC.
- Create Areas, which allow you to store dataPAC files on your computer. Areas are also used for remote transfer of files using a modem connection.
- Move files from one Area to another Area.

To list security key information

To list any security keys you have stored in your dataPAC PCMCIA card, follow these steps.

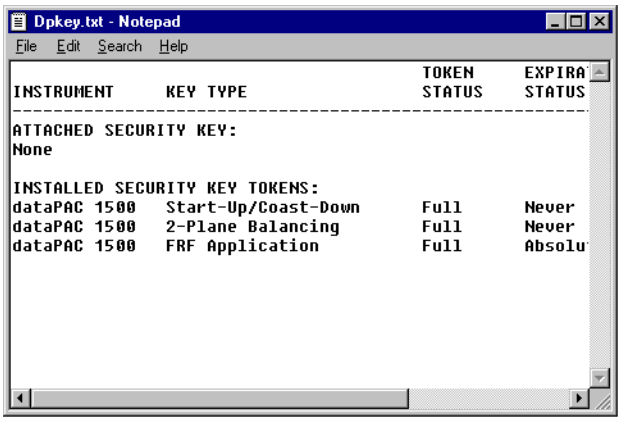
1. Connect the dataPAC to the computer with a serial cable, or place the PCMCIA card in the card drive.
2. Start the dataPAC Utility by pointing to it on the **Start** menu. Select the **Security Key Info** tab.



3. Under **Communications**, select **Direct**.

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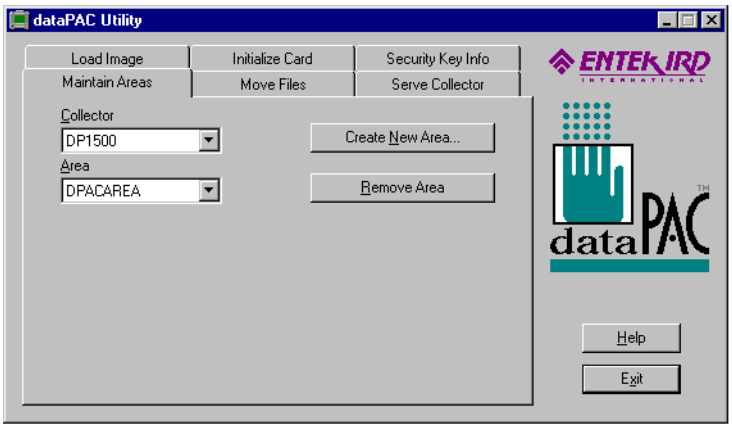
4. Choose **List Security Keys** to see a list of available security keys, as shown below.



To create or remove an area

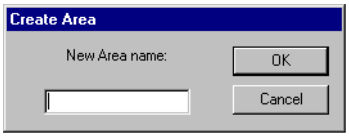
Areas are directories used to store and organize dataPAC files on your computer. You use areas during remote transfer. To create or remove an area, follow these steps.

1. Connect the dataPAC to the computer with a serial cable, or place the PCMCIA card in the card drive.
2. Start the dataPAC Utility by pointing to it on the **Start** menu. Select the **Maintain Areas** tab.

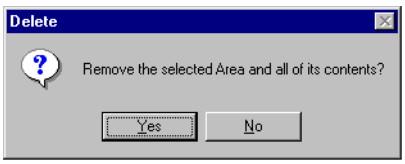


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3. Select the correct dataPAC model under **Collector**. This example shows the dataPAC 1500 selected.
4. To create a new area, choose **Create New Area**. Type the name of the area in the box and choose **OK** to create.

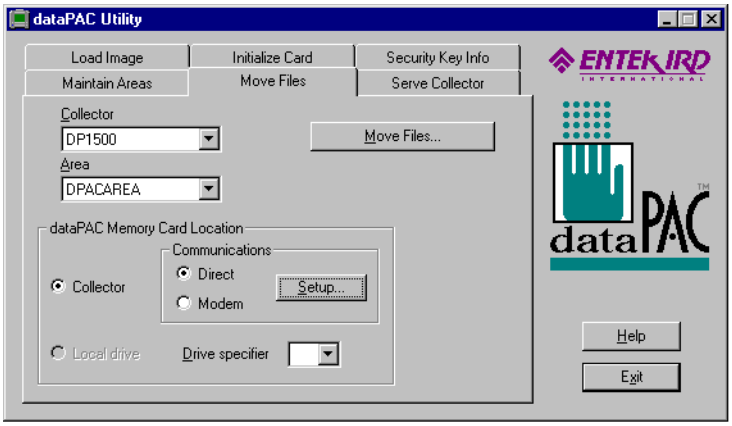


5. To delete an area, select the name from the **Area** list.
6. Choose **Remove Area**. This confirmation dialog box appears. Choose **Yes** to delete the area.



To move files from one area to another area

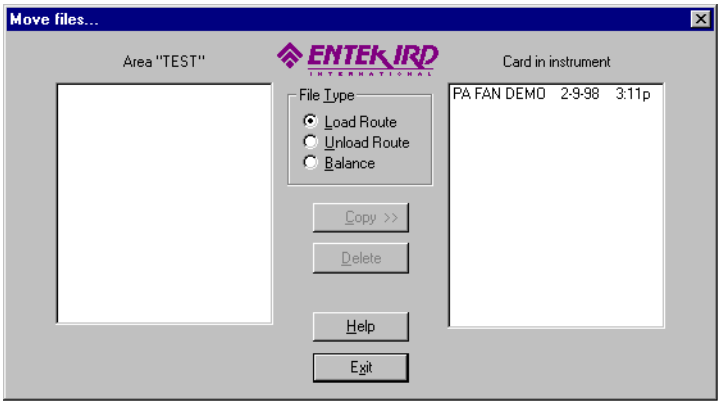
1. Connect the dataPAC to the computer with a serial cable, or place the PCMCIA card in the card drive.
2. Start the dataPAC Utility by pointing to it on the **Start** menu. Select the **Move Files** tab.



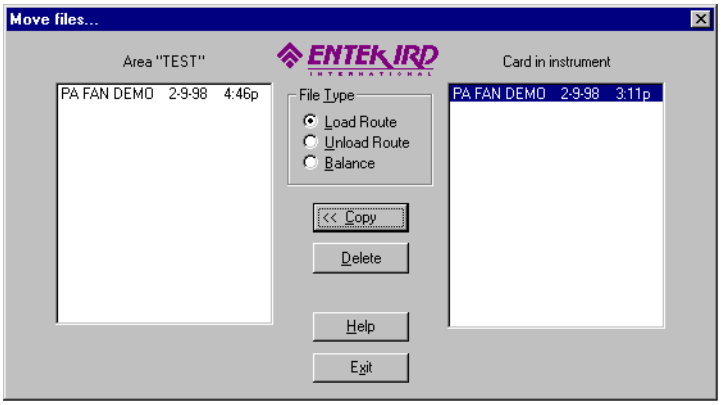
3. Select the correct dataPAC model under **Collector**. This example shows the dataPAC 1500 selected.

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4. Select the name of an area from the **Area** list.
5. Choose the **Move Files** button. The **Move Files** dialog box appears.



6. Select the type of file under **File Type**. A **Load Route** file contains the information for data collection. An **Unload Route** file contains data collection information and data collected. A **Balance** file contains balancing information.
7. Select the file name and choose **Copy**. The arrows on the **Copy** button show the direction of the copy.



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Using the dataPAC Setup Program

There are some options you can select before starting data collection. These options affect the measurement, the data collection process, and the data display. The dataPAC stores these options even when powered off.

The setup program has seven categories that allow you to specify parameters for operation. These categories are shown in the following table.

Setup Category	Allows you to:
Data Collection Options	Specify options for features that affect operation during the process of collecting data. See “Setting Up Data Collection Options” on page 38.
Instrument Options	Specify parameters for system functions, such as system units. See “Setting Up Instrument Options” on page 40.
Instrument Time	Set the date and time on the instrument clock.See “Setting the Data Collector Date and Time” on page 46.
FFT Display Options	Specify the default settings for the FFT display. See “Setting Up FFT Display Options” on page 41.
Time Waveform Options	Specify the default settings for the Time Waveform display. See “Setting Up Time Waveform Options” on page 43.
Transducer Options	Specify the characteristics of a transducer. See “Installing and Defining dataPAC Transducers” on page 48.
Programmed Data Collection	Specify the route, interval for taking data, and start programmed data collection. See “Collecting Programmed Data” on page 147.
Erase Setup	Delete a saved setup from memory.

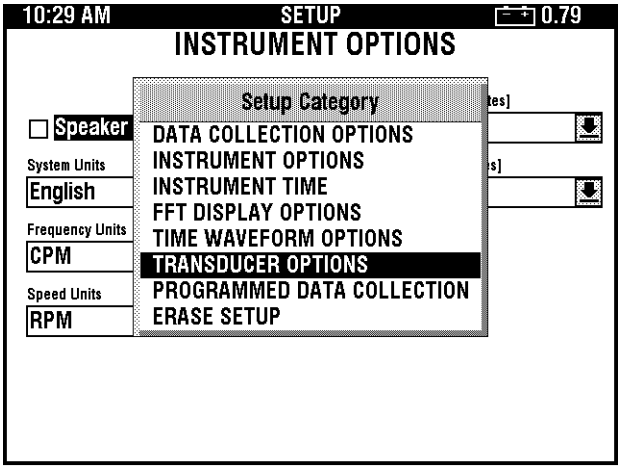
To use the Setup Program, follow these steps.

1. Press <ON/OFF> to turn the data collector on. Return to the Program Manager if needed.
2. Use the arrow keys to select the Setup program icon and press <SELECT>. The Setup program appears.

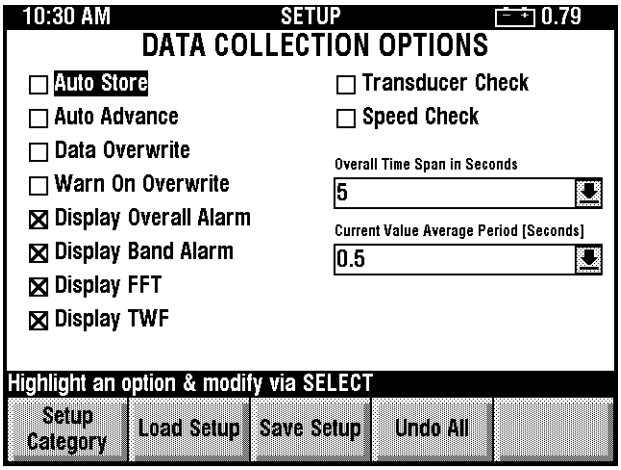
Note: You can also access the Setup program from the Data Collection program by pressing <F1> (Setup).

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3. Switch to the desired setup category by pressing <F1> (Setup Category). The Setup Category window appears.



4. Use the arrow keys to select the desired setup category and press <SELECT>. The selected window appears. This example shows the Data Collection Options.



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Setting Up Data Collection Options

Use the arrow keys to highlight an option that you want to change and press <SELECT>.

To return to the Program Manager window without closing the Setup program, press <SHIFT><MANAGER>.

Auto Store

Pressing <STORE> in the Data Collection Program window starts the data collection process. The Auto Store option causes the dataPAC to begin storing data as soon as the signal settling time has been met. If this option is not selected, the dataPAC prompts you to press <STORE> a second time before it stores data values.

Auto Advance

The Auto Advance option causes the dataPAC to move forward to the next point on the route after storing data for the current point. If this option is not selected, the instrument prompts you to press <ADV> to move to the next point.

Data Overwrite

When this option is selected, the dataPAC replaces existing data with new data. If this option is not selected, new data for a point will be appended to existing data.

For IQ2000 Users: For IQ12000 version 2, the optimal setting for this is selected since IQ2000 will take only the latest measurements when multiple measurements exist for the same point. Storing multiple data sets therefore wastes space on your memory card. However, for IQ2000 version 3 and higher, multiple data sets are supported.

Warn On Overwrite

When this option is selected, the dataPAC displays a dialog box asking for confirmation before it overwrites existing data. This option has an impact only if the Data Overwrite option is selected.

Display Overall Alarm

When this option is selected, the dataPAC displays a message when the data is in alarm. The text of the alarm message comes from the host computer. This option has no effect if the Auto Advance option is enabled.

Display Band Alarm

When this option is selected, the dataPAC displays a message when the data is in band alarm. The text of the alarm message comes from the host computer. This option has no effect if the Auto Advance option is enabled.

Display FFT

When this option is checked, the dataPAC displays the primary FFT data after all of the data for the point has been collected.

If Auto Advance is checked when you check Display FFT, Auto Advance will be automatically disabled. The two selections are incompatible because one tells the dataPAC to automatically go on to the next point, while the other tells it to stop and display the FFT.

Display TWF (1500 Only)

When this option is checked, the dataPAC displays the primary TWF data after all of the data for the point has been collected.

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If Auto Advance is checked when you check Display TWF, Auto Advance will be automatically disabled. The two selections are incompatible because one tells the dataPAC to automatically go on to the next point, while the other tells it to stop and display the TWF.

Speed Check

The Speed Check option causes the dataPAC to determine if the machine speed at each point is within an acceptable range as specified by the host computer, manual entry, or measured speed. If the speed is outside the range, a warning message appears, and you may either skip or collect this point. The determination of machine speed may be based on the host computer, manual entry, or measured speed.

If this option is not selected, the instrument will not check the machine speed. This means that data will be collected even when the machine speed is out of range.

Transducer Check

The Transducer Check option causes the dataPAC to check for a short or open circuit prior to collecting data for a point. If a fault is detected, a warning message appears and you are prompted to choose whether or not to continue.

If Transducer Check is disabled, the dataPAC still tests the transducer for faults when it is installed. If the transducer passes the test, the dataPAC does not repeat the test each time a measurement is initiated. However, if the transducer fails the test at installation and you choose to continue, the dataPAC repeats the test each time a measurement is initiated until the transducer passes the test. Repeated failures are reported so you can choose whether or not to continue.

Overall Time Span in Seconds

This option specifies the time span in the overall window of data collection. Changing this value changes the amount of time for which data is displayed as it trends across the window during data collection. The value is in seconds.

Highlight this option, and then press <SELECT> to open a pop-up window that displays the choices: 5 (the default), 10, 20, 50, 100, 200, 500, or 1000 seconds. Highlight your choice, and then press <SELECT>.

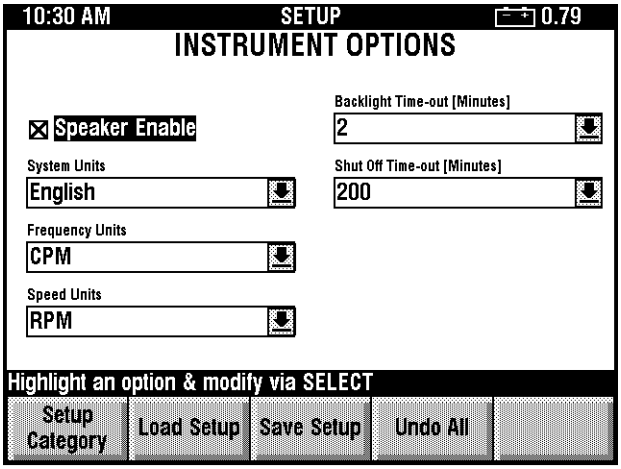
Current Value Average Period (Seconds)

This option allows you to specify the number of seconds to average the data before displaying and storing the overall value in the database. Highlight this option, and then press <SELECT> to open a pop-up menu of choices. The setting choices depend on the value selected for Overall Time Span. Highlight your choice, and then press <SELECT>.

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Setting Up Instrument Options

The Instrument Options windows allow you to set up basic functions of the dataPAC. You can save a group of settings as a named setup so that a user can load it for later use.



Speaker Enable

This option enables the dataPAC speaker so that it beeps each time you press a key. Highlight this option, and then press <SELECT> to place an X in the checkbox to activate the speaker. To disable the speaker, press <SELECT> again. Note that the light at the top of the instrument between the DEC and SKIP keys flashes with each keystroke regardless of whether this option is selected.

System Units

This option selects the units of measure. Highlight this option. Press <SELECT> to open a pop-up menu with three choices: English (the default), Metric, or Decibel. Highlight your choice, and then press <SELECT>.

Frequency Units

This option selects the units of measure for frequency. Highlight this option. Press <SELECT> to open a pop-up menu showing two options: CPM (cycles per minute) and Hz (Hertz, cycles per second). Highlight your choice, and then press <SELECT>.

Speed Units

This option selects the units of measure for machine speed. Highlight this option. Press <SELECT> to open a pop-up menu showing two options: RPM (revolutions per minute) and RPS (revolutions per second). Highlight your choice, and then press <SELECT>.

Backlight Time-Out (Minutes)

This option specifies the number of minutes the dataPAC remains idle before it turns off the backlight to conserve battery power. The value indicates the number of minutes after the last keystroke to the time the backlight turns off. Highlight this option. Press <SELECT> to open a pop-up menu with these choices: 1, 2 (default setting), 5, 10, 20, 50, 100, or 200 (default setting) minutes. Highlight your choice, and then press <SELECT>.

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Shut Off Time-Out (Minutes)

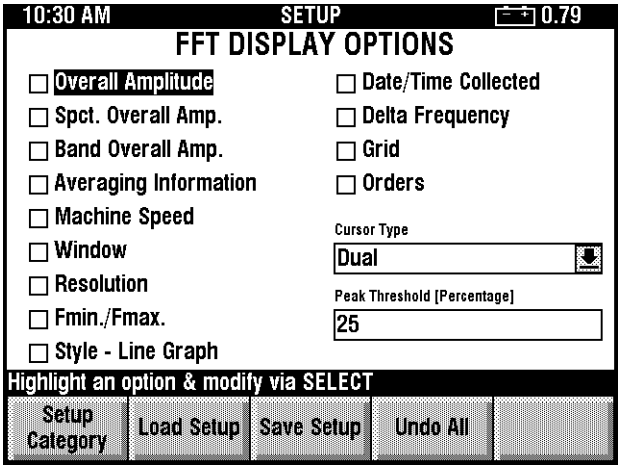
This option specifies the number of minutes the dataPAC can remain idle before it shuts itself off to conserve battery power. If the instrument shuts off while you are changing setup options, it preserves the unsaved options. The instrument returns to the point in the Setup program where it was when it shut off. If the shut-off occurs during data collection, the process is terminated. The value indicates the number of minutes after the last keystroke to the time the instrument turns off. Highlight this option. Press <SELECT> to open a pop-up menu with these choices: 1, 2, 5 (default setting), 10, 20, 50, 100, or 200 (default setting) minutes. Highlight your choice, and then press <SELECT>.

To set up Instrument Time

Refer to “Setting the Data Collector Date and Time” on page 46 for information about setting Instrument Time.

Setting Up FFT Display Options

The FFT Display Options window allows you to set up basic functions of the dataPAC. Enabled options show an X in the checkbox next to them. To change the status of an option, use the arrow keys to highlight the option, then press <SELECT>. You can save a group of settings as a named setup so that you can load it for later use.



Overall Amplitude

Enable this option to display measured primary overall amplitude (when available). This is the broadband overall reading that is often measured when the spectrum was collected. It is not derived from the spectral data set. If no overall measurement is available this field will not be displayed.

Spct. Overall Amp

Enable this option to display an amplitude that is computed from the spectral data using a Root-Sum-Squared (RSS) calculation using the entire spectral data set. When this value is significantly less than the overall amplitude, it may be an indication that there are significant vibration components present that lie outside the Fmin/Fmax limits of the spectral data set.

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Band Overall Amp.
Enable this option to display a calculated amplitude between the high and low cursors using a Root-Sum-Squared (RSS) calculation. Band RSS Amplitude is displayed only when Dual Cursors is selected.

Averaging Information
Enable this option to display the number of averages and type of averaging used to obtain the displayed data. The number of averages and type of averaging is controlled by the route information loaded into your dataPAC.

Machine Speed
Enable this option to display the machine speed at the top of the display, The machine speed is downloaded to the dataPAC along with other route information but can be changed in the Review Data mode using the Set Speed softkey. If it is a triggered measurement, the speed is measured and updated. Also, you may set the speed in Data Collection using the <F3> softkey for non-triggered measurements.

Window
Enable this option to display the type of windowing function applied to the time domain data when calculating the FFT. The Window setup is downloaded from the host computer along with other route information.

Resolution
Enable this option to display the total number of FFT bins and the bin width in Hz or CPM. The setting for this item is downloaded from the host computer along with other route information.

Fmin./Fmax.
Enable this option to display the frequency value for the lowest and highest frequency bins in the FFT data. The setting for this item is downloaded from the host computer along with other route information.

Style - Line Graph
Enable this option to display the FFT as a line graph, rather than a histogram (bar chart).

Date/Time Collected
Enable this option to display the collection date and time for the FFT.

Delta Frequency
With Dual Cursors active and this option enabled, the dataPAC displays the frequency spacing between the high and low cursors.

Grid
Enable this option to set the FFT Display so that a grid overlays a graph when the screen opens. This sets the grid on by default—a softkey allows you to turn the grid on and off at display time.

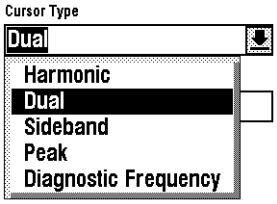
Orders
Enable this option to set the frequency axis to default to *orders of magnitude* of the machine speed, rather than in frequency units (Hz or CPM) when the screen opens. You can alternate, at display time, between Orders and Frequency units using a softkey.

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Cursor Type

Use this item to select the default cursor type on the FFT graph display. You can alternate between cursor modes at display time using a softkey.

To select a default cursor mode, highlight the Cursor type and press <SELECT>. A pop-up menu appears. Some cursor types may not be available in the 1250.



Use the arrow keys to select among the options. See “Using the Cursors with a Spectrum” on page 162 for complete information on cursors and cursor modes.

Peak Threshold (Percentage)

Specifies the default position of the amplitude cursor of the FFT display. Peak Threshold is expressed as a percentage of the highest amplitude signal within the spectral data.

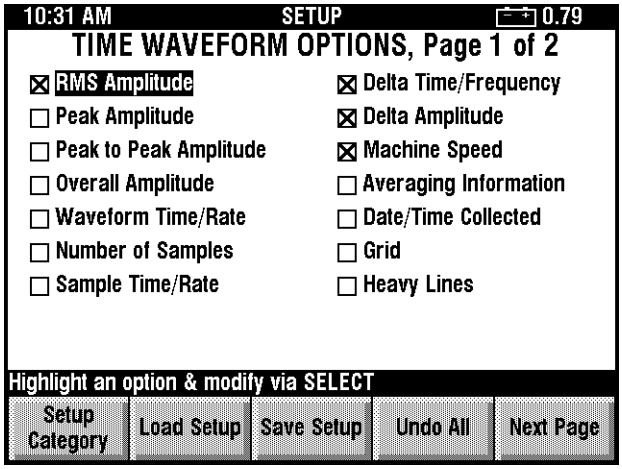
The position of the amplitude cursor is used by the Peak picking function during FFT display. See “Changing the Spectrum Display” on page 168 for more information on this function.

Setting Up Time Waveform Options

The Time Waveform Options windows allow you to set up basic functions of the dataPAC. Enabled options show an X in the checkbox next to them. To change the status of an option, use the arrow keys to highlight the option, then press <SELECT>. You can save a group of settings as a named setup so that a user can load it for later use. This setup contains two pages of information. To choose the other page, press <F5> (Next/Previous Page).

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Time Waveform Options, Page 1



RMS Amplitude
Enable this option to display an amplitude that is computed from the input signal using a Root-Mean-Squared (RMS) calculation on your time waveform.

Peak Amplitude
Enable this option to display a numerical presentation of the peak value of the input signal on your time waveform.

Peak to Peak Amplitude
Enable this option to display a numerical presentation of the Peak to Peak value of the input signal on your time waveform.

Overall Amplitude
Enable this option to display the measured primary overall amplitude when available on your time waveform.

Waveform Time/Rate
Enable this option to display the total time taken to collect one data set, in seconds, degrees, or revolutions, followed by the corresponding rate in CPM or Hz on your time waveform.

Number of Samples
Enable this option to display the number of samples in the data set.

Sample Time/Rate
Enable this option to display the time interval between samples, in seconds, degrees, or revolutions, and the corresponding sampling rate in Hz.

Delta Time/Frequency
Enable this option to display the difference between markers when either dual cursors, or cyclic cursors are selected (delta time). The second number displayed here is the frequency computed as the reciprocal of time.

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Delta Amplitude
Enable this option to display a field showing the difference in amplitude between samples at each of the cursor locations. In calculating this delta, the dataPAC uses the sample with the greatest absolute magnitude at the cursor positions, since several values may occupy the same screen position of a cursor.

Machine Speed
Enable this option to display the 1X machine speed. The machine speed displayed originates from the speed specified in the point collection parameters of the host software but can be overridden by a speed value manually entered during data collection. If it is a triggered measurement, the speed is measured and updated.

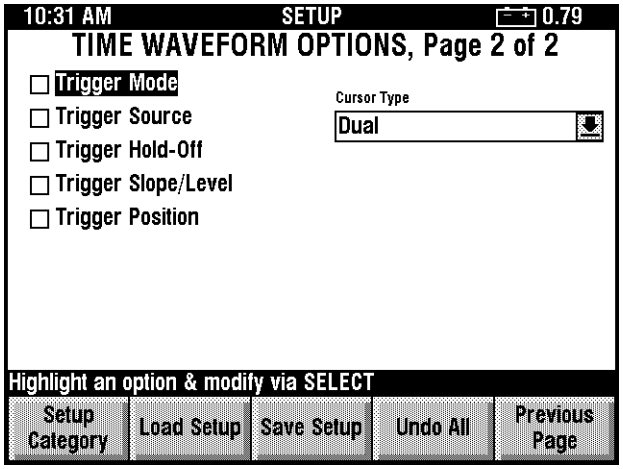
Averaging Information
Enable this option to display the number of averages used to obtain the displayed data and the type of averaging.

Date/Time Collected
Enable this option to display the collection date and time for the time waveform data.

Grid
Enable this option to have the time waveform displayed with grid lines.

Heavy Lines
Enable this option to have the time waveform drawn with thicker lines.

Time Waveform Options, page 2



Trigger Mode
Enable this option to show the trigger mode used to collect the displayed time waveform as None, Internal, or External.

Trigger Source
Enable this option to show the source of the trigger used to collect the displayed time waveform as Internal, External or None.

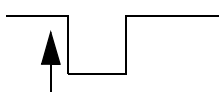
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Trigger Hold-Off

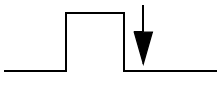
Enable this option to include the length of delay (if any) between trigger events during multiple measurements. When making averaged or repetitive measurements you may want to pause before rearming the trigger, once a trigger has occurred. This field displays the length of the delay. The field is not displayed if the delay is zero, or if trigger hold-off is not applied to the measurement.

Trigger Slope/Level

Enable this option to show the trigger slope and threshold used to collect the displayed Time Waveform. Possible values are “leading,” “trailing,” “positive” or “negative” edge, followed by a threshold value.



positive edge, leading



negative edge, trailing

Trigger Position

Enable this option to display the length of time between the trigger point and the first sample as a percentage of the time waveform collection interval. Positive values are given when the starting point occurs after the trigger, and negative values are given when the starting point occurs before the trigger.

Cursor Type

The current cursor type is indicated by the letter in parentheses next to the words Cursor Type on the softkey. Available cursor types are:

- **D = Dual Cursors** - The dual time cursors are useful for determining the time between two points on the time waveform or the time of any given sample relative to the trigger point. The low cursor is on the left, and the high cursor is on the right. For complete information on using dual and cyclic cursors, see “Using the Cursors on a Time Waveform Display” on page 176.
- **C = Cyclic Cursors** - The cyclic time cursors are used to help identify repeating patterns in the time waveform.They consist of 1 to 15 vertical dashed lines, spaced at even time intervals.

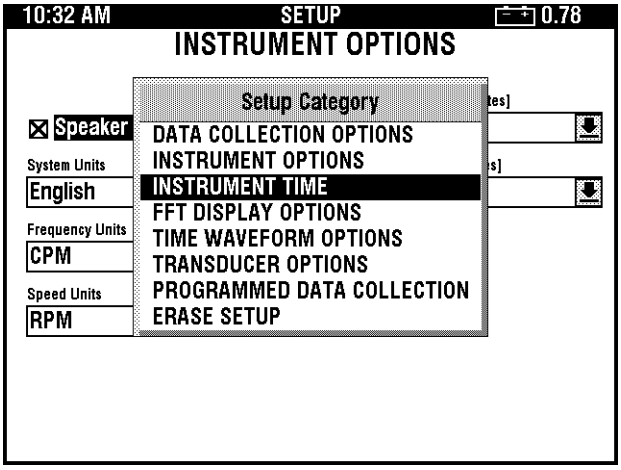
Setting the Data Collector Date and Time

The dataPAC keeps the current date format, date, and time even when powered off. However, there may be times when you need to change these settings. For example, any time the batteries are completely drained you might need to reset the date format, date, and time.

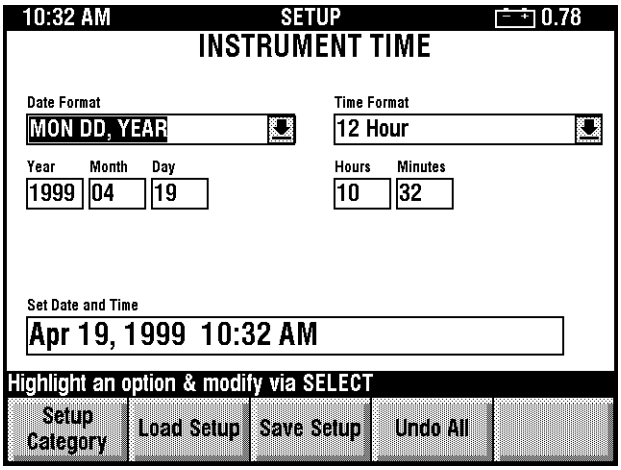
1. Press <ON/OFF> to turn the data collector on. Return to the Program Manager if needed.
2. Select Setup Utility from the Program Manager by pressing the arrow keys and press <SELECT>.

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3. Press the <F1> to choose Setup Category. The Setup Category menu appears.



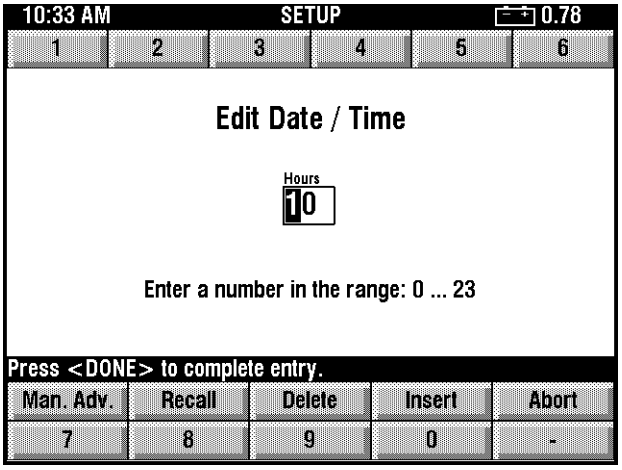
4. Select Instrument Time by pressing the arrow keys, then press <SELECT>. The Instrument Time menu appears.



5. Use this screen to set the date and time for the dataPAC's internal clock. You can set the formats for the display as well. Use the arrow keys to select the field you want to change. Press <SELECT> to drop down the list of selections and use the arrow keys to select the format you want. Press <SELECT> again to choose the desired format.

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6. To change the date, use the arrow keys to select the Year, Month, or Day field and press <SELECT>. The Edit Date / Time screen appears.



   Press the key nearest to the softkey on the display to enter the appropriate number. For more information on using Edit windows, see “Using Edit Windows” on page 25. Press <DONE> when it is correct, and the dataPAC enters the new date or time.

7. Once the format, date, and time are correct, press <DONE> to return to the Program Manager.

Installing and Defining dataPAC Transducers

The Transducer Options window in the Setup Utility provides several functions for installing and changing transducers while collecting data. There are two basic types of transducers:

- Generic
- Defined

The dataPAC provides several “generic” transducers. The four generic transducers represent the three basic vibration transducer types: accelerometers, velocimeters, and displacement (non-contact pickups), as well as a generic DC input for process related data. Once a generic type has been installed, it can be edited and the changes stored. Once a default type has been edited, the next time it is installed, the previously-stored user-edited parameters are recalled.

Defined transducers can come from definitions in the host software when you load a route to the data collector.

When you install a new transducer, you must have the transducer connected to the dataPAC. The instrument verifies that the output voltage level is within the fault levels specified on the transducer setup window.

Generic vs. defined transducer definitions

You can save changes to a generic transducer definition, which is created as part of the dataPAC's database. You cannot, however, save changes to a defined transducer definition, which is defined by the host computer and sent to the dataPAC as part of a route.

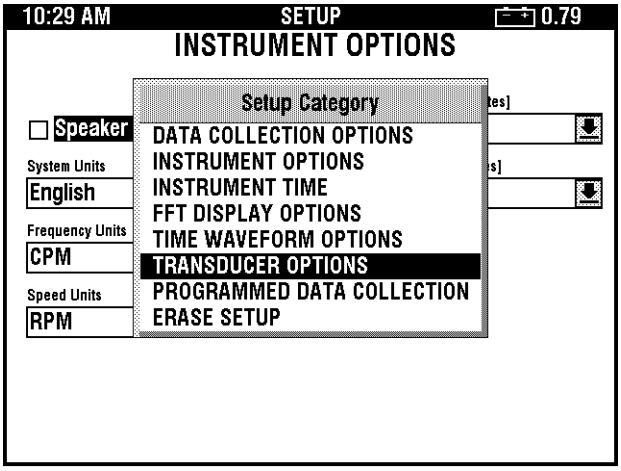
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To install a transducer

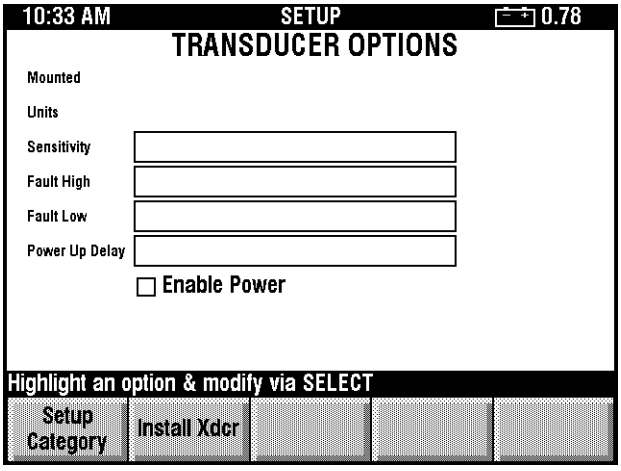
To install a transducer, follow these steps.

Note: For the dataPAC 1000, you can only install a transducer after a route has been loaded onto the memory card currently installed in the dataPAC.

1. Press <ON/OFF> to turn the data collector on. Return to the Program Manager if needed.
2. Select Setup Utility from the Program Manager by pressing the arrow keys and press <SELECT>.
3. Press the <F1> to choose Setup Category. The Setup Category menu appears.

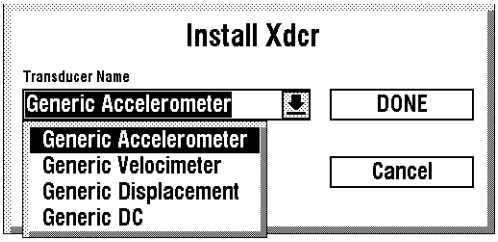


4. Select Transducer Options by pressing the arrow keys, then press <SELECT>. The Transducer Options window appears. When you first open the Transducer Options window, the transducer's name and the option boxes are blank unless a transducer definition has been installed. If a transducer definition has been installed, its values are displayed.



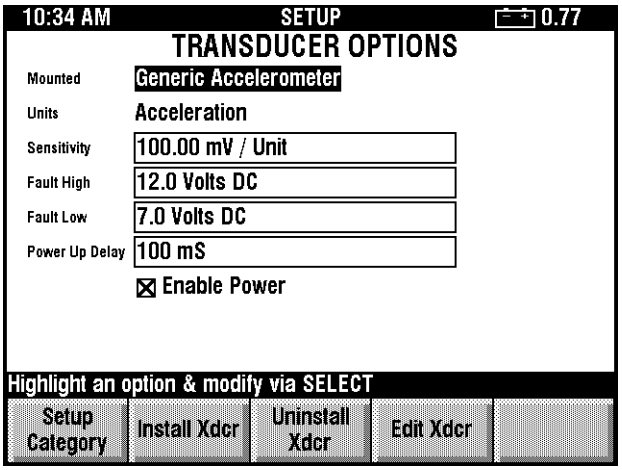
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5. Press <F2> to load a transducer definition from memory. The transducer type will be either a generic type or a specified transducer, if one has been defined by the host software. Pressing <F2> opens the Install Xdcr window.



6. Use the arrow keys to highlight a transducer definition in the Transducer Name box, and then press <SELECT>. Press <SELECT> again with DONE selected to exit and save changes. To exit the Install Xdcr window without choosing a transducer definition, use the arrow keys to highlight Cancel, then press <SELECT>.
7. The dataPAC displays the selected transducer name and characteristics in the window. The following example shows the Generic Accelerometer, one of four transducer definitions supplied with the dataPAC.In this window, two additional softkeys become available.

   To remove the current transducer definition from the window, press <F3> (Uninstall Xdcr). This action does not affect the transducer definition that resides in the dataPAC's memory. If no transducer is installed, this function name will not appear as a softkey option.



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Transducer options

The options for each field are described below.

Mounted

The transducer name is displayed next to this heading.

Units

The units that the transducer measures is displayed next to this heading.

Sensitivity (mV/unit)

Every transducer has a characteristic sensitivity, or calibration. This sensitivity is included with the documentation you received when you purchased the transducer or it may be imprinted on the side of the transducer. If the sensitivity of the transducer is not known, contact the manufacturer. You can enter a number from 0.10 to 99999.99.

Fault High (Volts DC)

Set this field higher than the highest average DC voltage that can reasonably be produced by the transducer during data collection. A voltage reading higher than the Fault High value indicates a transducer fault. The transducer's default Fault High value is displayed after the transducer is installed. You can enter a number from -19.0 to 20.0 Volts DC.

Fault Low (Volts DC)

Set this field lower than the lowest average DC voltage that can reasonably be produced by the transducer during data collection. A voltage reading lower than the Fault Low value indicates a transducer fault. The transducer's default Fault Low value is displayed after the transducer is installed. You can enter a number from -20.0 to 12.0 Volts DC.

Note: If you set Fault High and Fault Low to the same value, the dataPAC never detects a transducer fault.

Power Up Delay (mS)

The Power Up Delay option allows you to specify the number of milliseconds (1/1000 second) after you mount the transducer that the dataPAC waits before using it. You can enter a number from 50 to 20000 mS.

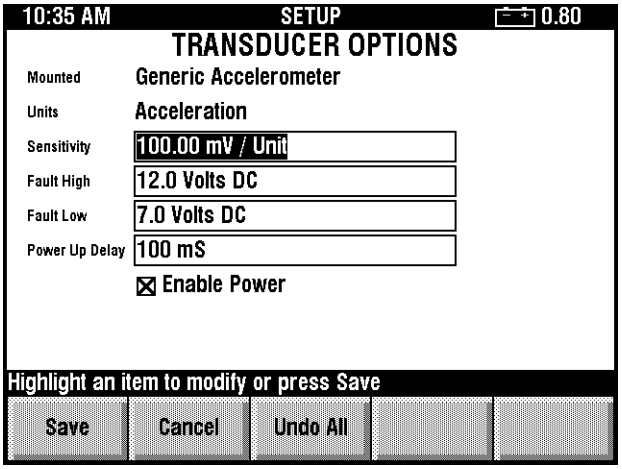
Enable Power

When this option is selected, power is supplied to the transducer (2mA constant current.)

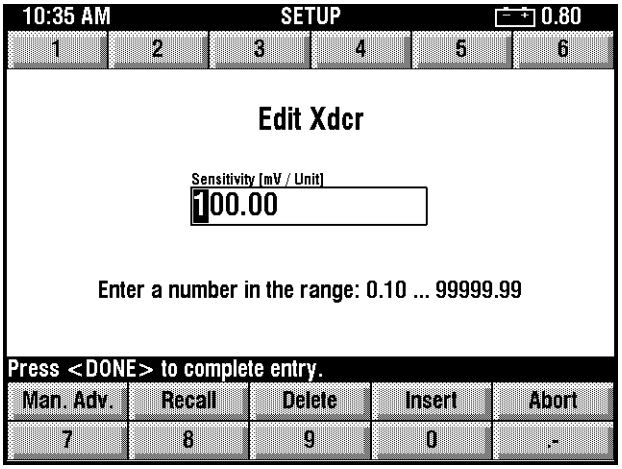
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To edit a transducer

1. Press <F4> (Edit Xdcr) to edit the selected field.



2. Use the arrow keys to select the field you want to make changes in. The fields are described below. Press <SELECT> to make a change. An Edit window appears. See “Using Edit Windows” on page 25 for more information about using Edit windows.



3. Press <DONE> when you complete the changes to the selected field(s). The Transducer Options window reappears.
4. Repeat steps 2 and 3 for other fields if needed. Once all fields are correct, press <F1> (Save) to save the changes. The dataPAC returns to the Transducer Options window when you press <F1> (Save).
5. Press <DONE> to return to the Program Manager window.

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Using Memory Cards

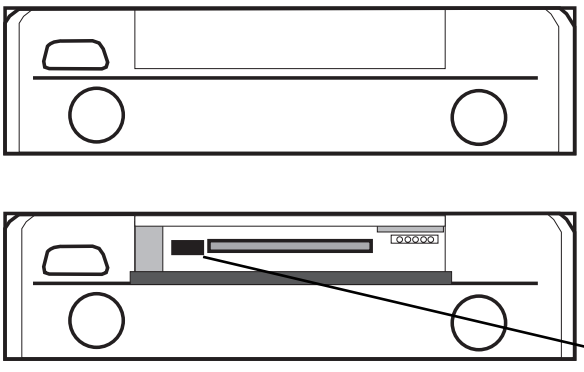
The dataPAC stores program information and collected data on memory cards. This section tells you how to install, remove, and maintain memory cards. It also contains information about the memory card batteries.

The dataPAC uses PCMCIA cards (Personal Computer Memory Card International Association), which are an industry standard storage media designed to be a rugged replacement for floppy disks in portable computer systems. PCMCIA memory cards are quite durable and cannot be damaged by electromagnetic fields. However, you should avoid exposing the cards to direct sunlight, extreme temperature, or excessive moisture.

All dataPAC models support 256K, 512K, 1 MB, 2 MB, and 4 MB memory cards. The dataPAC 1500 V4.03 and above supports 6 MB and 8 MB cards. The older releases put a 4 MB format on a 6 MB card. You can use the 6 MB card, but it will only hold 4 MB of data.

Inserting and Removing a Memory Card

You load the dataPAC memory card into the data collector through a door in the top of the dataPAC. Close all applications and turn the dataPAC off before opening the door. With the front of the dataPAC facing you, open the door by lifting it upwards. Once the door is open, turn the memory card so the logo side of the card is facing you and insert the memory card into the slot. The end with the sockets fits into the data collector.



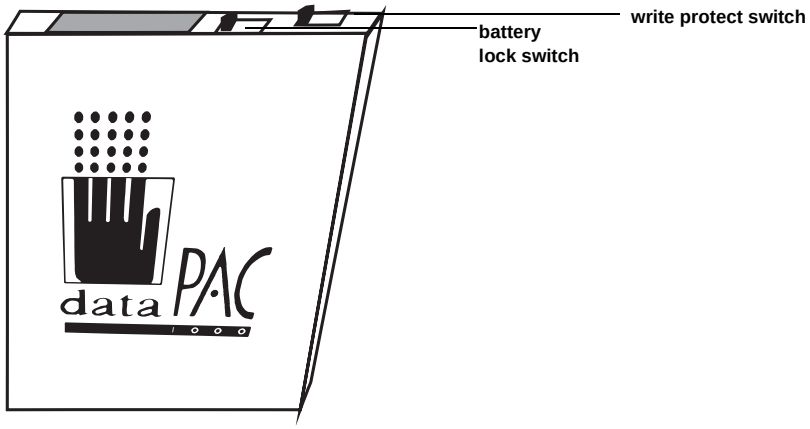
To remove a memory card, close all applications and turn off the dataPAC and open the door in the top of the dataPAC. Press the release button and gently rock the card to work it out of its slot. Continue to rock the card side to side until you can remove it.

Caution: Newer dataPAC models have an internal red LED light which indicates if the dataPAC is accessing the card. If you open the door and the red light is on, do not remove the card. You can damage the card or lose data if you remove the card while the dataPAC is trying to access it.

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Write-protecting a Memory Card

The write-protect switch, battery lock switch, and battery holder are located on the card end opposite the connector. The exact location depends on the model. These instructions and diagrams are meant to be a guide.



The write protect switch must remain in the off position to allow the dataPAC to write route data to the card. To turn the write protection off, turn the card so the dataPAC logo side of the card faces you and move the lock switch to the right.

Memory Card Battery

Note: Newer memory cards do not contain a removable battery. Instead they operate on a lithium battery which recharges while you use the dataPAC. You can ignore this section if your memory card does not have a removable battery.

The battery lock switch must remain in the locked position to retain the battery holder. The battery lock position is to the left. The lithium battery supplied with the memory card should last about two years under normal use. These batteries are widely available or can be ordered from Entek IRD.

Caution: Removing the battery from your memory card erases all data on the card. Before you can use the memory card again you must format and load the card using the dataPAC Utility program. See "Initializing the Data Collector Memory Cards" on page 55 and "Loading the Operating System with the dataPAC Utility Program" on page 30 for more information.

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To remove the battery, turn the card so the dataPAC logo side of the card faces you and move the lock switch to the right. Grasp the battery holder firmly and pull it away from the card. Pick up the battery by the edges.

Caution: To avoid contamination, do not handle the flat sides of the battery. Improper battery handling can cause false indications of low battery condition or loss of data.



Insert a new battery into the battery holder, making sure to match it with the polarity signs on the battery holder. Push the battery holder back into the card and move the battery lock switch back to the left. Once you have installed the new battery you can continue to use the card as before after formatting the card.

Initializing the Data Collector Memory Cards

Initializing the memory card removes all data including list (route) information from the card. You can initialize the memory card and remove lists either within the dataPAC Utility program or through EMONITOR Odyssey or Enshare if you are using EMONITOR Odyssey or Enshare.

The dataPAC uses a PCMCIA memory card for storage. The dataPAC can store the operating system either on the card or in its internal memory. You can choose to load the operating system onto the memory card (making it “bootable”) or leave it resident in the internal memory. The advantage of having the operating system on the memory card is that you do not need to reload the dataPAC operating system if it is lost due to a battery failure.

Note: A dataPAC memory card that is already initialized for use with any previous version of the dataPAC software will need to be re-initialized for use with a new dataPAC version. This is true of any dataPAC software version. When a card is initialized, it is marked for use with one particular software version and can only be used with that version of software until it is initialized for a different version.

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If you have a local PCMCIA card reader then the initialization can be performed more quickly in that drive. But the dataPAC Utility Program does not perform all the initialization steps automatically. First, you must format the card. The Utility program first checks to see that the card has been formatted. If the card has not been formatted then the Utility program will display the “Please format the card” error message. If the card has been formatted then the Utility program completes the rest of the initialization steps automatically. You should format the memory card from DOS (type format then the correct drive letter at the command prompt) or Windows (right-click on the drive in an Explorer window and select format from the pop-up menu) before starting this initialization process.

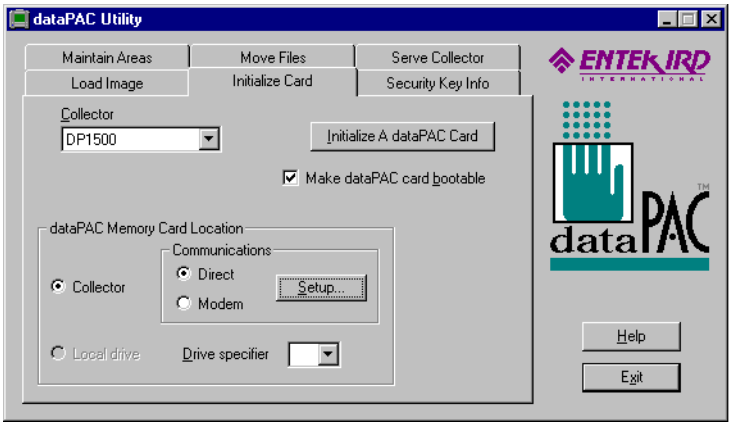
If you do not have a local PCMCIA card reader, then you can initialize the card while its in the dataPAC. When a card is initialized in the dataPAC instrument, all the initialization steps (including the format) are performed automatically.

When you restart the dataPAC by pressing <LIGHT> and the left and right arrow keys, the dataPAC first tries to boot from the card, then checks the serial connection, and keeps going back and forth until it finds a suitable program image. Because the dataPAC goes to the card first, you must remove the card if you want to force it to load a new operating system from the serial connection. For more information about data collector, see “Restarting the Data Collector” on page 29.

Caution: Initializing the data collector card removes all lists (routes) and data from memory. Be sure that you no longer need the lists or data before deleting them.

To initialize the dataPAC card using the dataPAC Utility program on your computer, follow these steps.

1. Connect the dataPAC containing the card you wish to initialize to the computer or put the card into a local drive if available.
2 Start the dataPAC Utility by pointing to it on the **Start** menu. The dataPAC Utility appears.
3. Choose the **Initialize Card** tab to bring up the options for card initialization.



4. Select the correct dataPAC model under **Collector**. This example shows the dataPAC 1500 selected.
5. Select the correct dataPAC **Memory Card Location** settings.

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- For a card drive attached to your computer, choose the letter of the drive and choose **Local drive**. When using a card drive, you must first format the card in the drive using Windows or DOS before you initialize it with the utility. You can not just erase files from the card to initialize it.
- For a card in the dataPAC, choose **Collector**. Choose **Direct** for a serial connection.

6. Choose **Initialize a dataPAC Card** to completely erase the memory card. If you want to make the card bootable by copying the operating system onto it, choose **Make a dataPAC card bootable**.

   The advantage of having the operating system on the memory card is that you do not need to reload the dataPAC operating system if battery failure occurs. The disadvantage is that the operating system files take up as much as 1 MB of space on the card.

Note: If you want the dataPAC to load the program image from the serial port, you must remove the card before rebooting. When you restart the dataPAC, it looks to the card first to load the operating system.

7. Choose **Exit** to exit the dataPAC Utility program.

Memory Card Storage Capacity

The dataPAC uses memory cards for storage. All dataPAC models support 256K, 512K, 1 MB, 2 MB, and 4 MB memory cards. The dataPAC 1500 V5 supports 6 MB and 8 MB cards. The older releases put a 4 MB format on a 6 MB card. You can use the 6 MB card, but it will only hold 4 MB of data.

To determine the appropriate memory card size for your needs, you can use the following guidelines to estimate the size of your routes or lists.

If you are collecting magnitude measurements only with up to two alarms per point, 900 points creates a database size of 248K, so a 256K memory card is sufficient for 900 magnitude only points.

If you are collecting both magnitude and spectrum data, use this table to determine your database sizes and memory card needs.

Number of Points (mag and spec)	Database Size	Memory Card Size
130	245K	256K
260	504K	512K
520	1MB	1MB
1040	2MB	2MB

The storage capacity is the same whether the points are scheduled or unscheduled (off route) measurement points. Analysis routes in the 1500 also follow the same storage capacity guidelines.

If the card is bootable, less storage space is available for routes and data. For example, the size of the dataPAC 1500 V5 operating system is about 960K.

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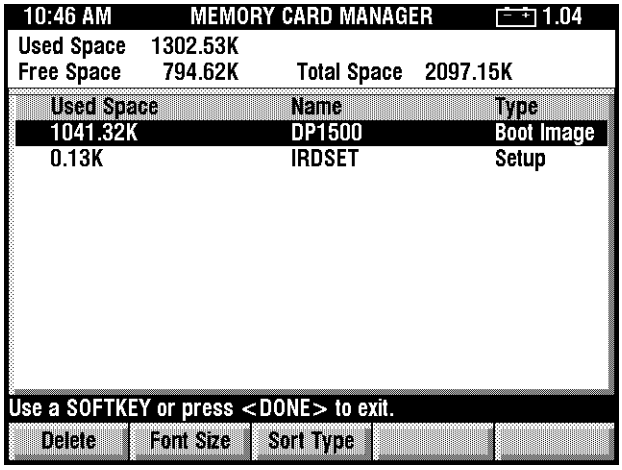
Using the Memory Card Manager

The Memory Card Manager gives you information about the memory card installed in the dataPAC. It also allows you to delete routes, data and screen images to increase available space on the memory card. You can delete Data Collection and Analysis routes altogether, or you can just delete the data and keep the route. Screen images and setups can be deleted entirely.

The databases are presented in a list and you can sort them as you like. You can change the font size of the list to maximize the number of items in the list.

The dataPAC opens the Memory Card Manager automatically if you are doing something that requires more storage space than is available on the memory card. This allows you to delete items and then return to what you were doing.

To open the Memory Card manager, use the arrow keys to highlight the Memory Card icon in the Program Manager window, then press <SELECT>. The dataPAC displays the Memory Card Manager window.



Note: An O next to the used space column indicates that the database is in use and you cannot delete it. An L indicates that the database is locked. You can unlock the item by selecting it and pressing the unlock function key. Items in grey cannot be deleted.

Used Space

The Used Space column tells you how much space is currently in use on the installed memory card.

Free Space

The Free Space column tells you how much space is currently available on the installed memory card.

Total Space

The Total Space column tells you how much space there is on the memory card, both used and available.

List of Databases

The three column table that makes up the main part of the display lists the stored databases individually. The following information is available on each database.

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Used Space - Displays the size (in kilobytes) of each database.

Name - Displays the name of each database.

Type - Displays the database type. Database types include:

- **Route - DEF** - Route definition
- **Route - DAT** - Route data
- **Setup** - Stored instrument setup
- **Screen Image** - Captured screen image
- **Boot Image** - Operating system information

Sorting Database Information

The list of databases may be sorted by name (alphabetically), type, status (open databases listed first), or size. Press <F3> to change sort types. The label of the <F3> softkey displays the type of sort the dataPAC executes the next time you press <F3>.

Changing Font Size on the Display

Press the <F2> (Font Size) softkey to change the font size of the display. A smaller font allows you to see more information in a column.

Deleting Items

Use the up or down arrow key to highlight the file that you want to delete, then press the <F1> (Delete) softkey. You can delete screen images this way as well. Items in grey cannot be deleted.

Note: If needed, you can delete the Boot Image file. Once the file is loaded, it is stored in the dataPAC resident memory. The memory card will no longer be bootable, and you will have to reload the boot file if the battery fails or when the instrument is restarted. See “Loading the Operating System with the dataPAC Utility Program” on page 30 if needed.

Displaying Screen Images

Use the up and down arrow keys to highlight the screen you want to display, and press <F4> (Display). Press <DONE> when you are done viewing the screen image.

Using Security Keys

The dataPAC uses security keys to control access to optional features and functions that are licensed and sold separately from the basic entry level products. Some security keys allow temporary access to certain features. Temporary access allows you to test a feature for a specific period of time, after which the feature is automatically disabled. To get the feature permanently activated, simply contact Entek IRD.

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If you want to add a function to your dataPAC, you must load the program through the security key. This program is called a software token. To add a function, you load a token. To remove a function, you unload a token. Once a token is loaded to a dataPAC, the security key no longer contains the token. The key cannot be used to load the token to another dataPAC. You must first unload the token, the load it to another dataPAC. However, some features may not be available to all dataPAC models.

Note: Before loading a security key, make sure the dataPAC displays the correct date and time. See “Setting the Data Collector Date and Time” on page 46 if you need to change it.

Adding a Feature with a Security Key

To add or enable a function, you must load a software token to your dataPAC. To do so, follow these steps.

1. Turn the data collector off by pressing <SHIFT><ON/OFF>.
2. Open the memory card door at the top of the instrument.
3. Insert the security key onto the security key pins located next to the memory card. It should fit only one way. While the key is in, you have to leave the memory card door open.
4. Turn the data collector on by pressing <ON/OFF>. This action transfers the token from the key to the dataPAC.
5. With the dataPAC on, remove the security key and close the memory card door. The software token is now activated.

Disabling or Transferring a Function

You may want to disable a function on your dataPAC or transfer that function to another data collector. To accomplish this you must transfer the software token from the data collector back to the security key. To do so, follow these steps.

1. Turn the data collector on by pressing <ON/OFF>.
2. Open the memory card door at the top of the instrument.
3. Insert the security key onto the security key pins located next to the memory card. It should fit only one way. While the key is in, you have to leave the memory card open.
4. Turn the data collector off by pressing <SHIFT><ON/OFF>. This action transfers the token back to the security key.
5. Remove the security key from the socket and close the memory card door.

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Security key messages

Below is a list of messages related to security keys that may appear on your dataPAC.

Message	Explanation
Security Key Type xxx Expired	This message indicates that a temporary security key has reached its expiration date. The token is disabled and cannot be used.
Security Key Type xxx Expires in xx.x days	This message appears whenever the data collector is turned on with a temporary key or token installed that will expire within thirty days.
ERROR: Instrument time predates security key	This message indicates that the instrument clock time is set to a time earlier than the time that a temporary security key token was first installed. Reset the clock to the correct time. Features associated with this token will not be available when the time is set incorrectly.
Wrong Security Key for this Product	This message appears when you turn the data collector on with a security key device from a different dataPAC model plugged into the security key socket.

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Chapter 3

Collecting and Reviewing Data

This chapter covers some of the tasks associated with collecting and reviewing data. For information about off route or analysis data collection, Chapter 4 “Off Route Analysis with the dataPAC.” This chapter includes the following sections:

Overview of Collecting Data *64*

Preparing for Data Collection *64*

Collecting Programmed Data *66*

Reviewing Overall Data and Alarms Reports *74*

Reviewing Spectra Data *81*

Reviewing Waterfall Spectra Data *91*

Reviewing Time Waveform Data *94*

Capturing and Printing dataPAC Screens *97*



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Overview of Collecting Data

This chapter describes how you collect data with the dataPAC. The dataPAC allows you to collect data for points in a list (route) and for unscheduled data (points not defined in a route). Once you collect your data, you can review the data using the dataPAC data display functions. You can also print a screen capture using the Screen View Utility or print reports with your computer software, such as EMONITOR Odyssey or Enshare or IQ2000.

For information about off route or analysis data collection, Chapter 6 “Off Route Analysis with the dataPAC.”

This chapter covers all the tasks associated with collecting data. These topics include:

- Connecting the transducer to the data collector.
- Selecting the list.
- Collecting data using the dataPAC.
- Moving through a list.
- Entering inspection codes.
- Reviewing collected data.
- Saving dataPAC screen shots.

When you finish collecting data, you can unload the data into your computer database files.

Preparing for Data Collection

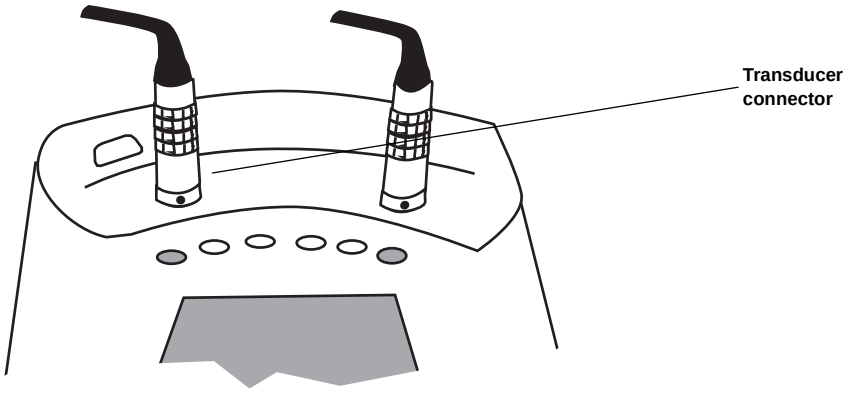
There are several things you should do before you start collecting data with the dataPAC, assuming you have already loaded at least one list (route) into the memory card. This section discusses connecting the transducer and setting up the data collector options.

1. Make sure you have a fully charged battery pack. See “Checking Battery Life” on page 22.
2. Check the date and time on the data collector. See “Setting the Data Collector Date and Time” on page 46.
3. Connect the transducer to the dataPAC. See “Connecting the Transducer to the Data Collector” on page 65.
4. Check the data collection options. See “Selecting the Data Collection Options” on page 65.

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Connecting the Transducer to the Data Collector

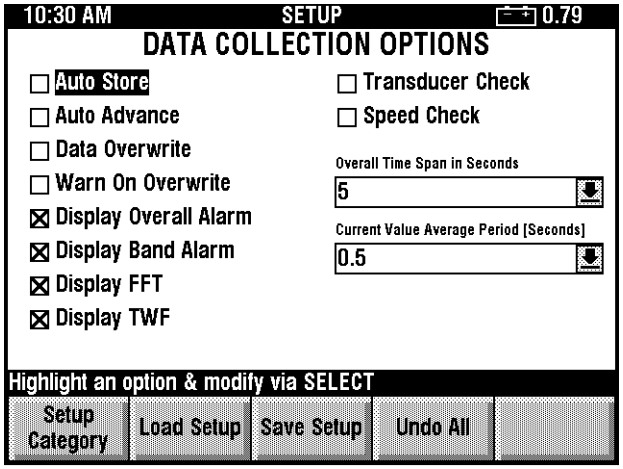
Connect the transducer to the connector at the top of the dataPAC.



Insert the connector into the jack at the top of the dataPAC. The red dot on the connector should match the red dot on the jack. Do not turn or twist the connector. To disconnect, pull out on the knurled part of the connector. It will slip outward slightly and you can pull out the connector.

Selecting the Data Collection Options

There are some options you can select before starting data collection. These options affect the measurement, the data collection process, and the data display. The dataPAC stores these options even when powered off. However, you should check these options each time you start data collection. The options are located in the Data Collection Options setup screen, found in the Setup Utility. See “Using the dataPAC Setup Program” on page 36 for more information about the Setup Utility. Each choice in the Data Collection Options screens is outlined in that section.



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Ranging Measurements Manually

dataPAC 1500 only
With the dataPAC 1500 V5, you can use the arrow buttons to manually range the measurement instead of relying on autoranging.

When the dataPAC1500 begins ranging the measurement, press the up or down arrow button to adjust the ranging. When you are satisfied with the range, press <STORE>.

Collecting Programmed Data

dataPAC 1500 only
You can set up your dataPAC 1500 to turn itself on and collect data at scheduled intervals. This type of data collection is useful for collecting data without having a person there to press the <STORE> key. For example, you can use this function to collect data automatically overnight. At the scheduled time, the dataPAC turns itself on, run through the programmed route, and collects data. When all the data has been collected, the dataPAC turns off until it is time to collect data again. The turn on and turn off events are equal to one data collection cycle.

You can set the start date and time, the number of times you want it to collect data, and the amount of time between data collection cycles. These options are set using the Setup program in the dataPAC.

You specify a route that you want the dataPAC to repeatedly collect by opening it in the Data Collection program. Then, open the Setup program to select the interval settings you want for the data collection program.

The Data Collection program must be running in order for the data to be collected. You cannot use the dataPAC for other purposes while it is collecting programmed data. You must have the correct transducer connected and installed.

This section discusses how to select a route for programmed data collection, and how to create the settings for programmed data collection.

Starting a Route for Programmed Data Collection

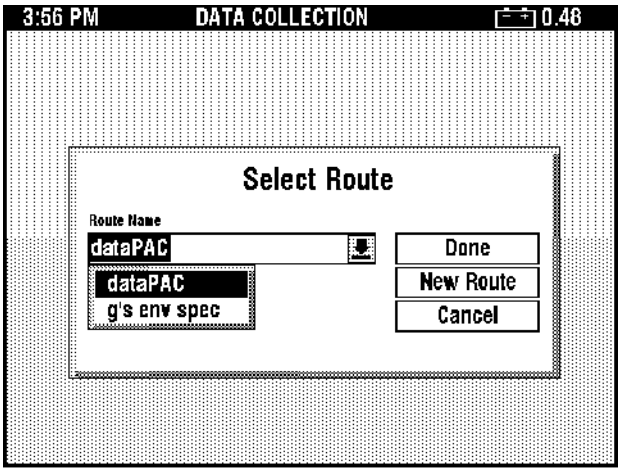
The route you use for programmed data collection should contain points that do not require the transducer to be moved. You can have the route contain just one point, or several points. If you want to collect an off route point, you can create a new route, then create an off route point for that route, then have the dataPAC collect that point.

1. Press <ON/OFF> to turn the data collector on. Return to the Program Manager if needed.
2. Use the arrow keys to select the Data Collection program icon and press <SELECT>.
3. When you first open the Data Collection window, the Select Route window opens. Use the arrow keys to highlight the name of the route you want to select, then press <SELECT>.

   If you want to create a new route just for programmed data collection, choose New Route.

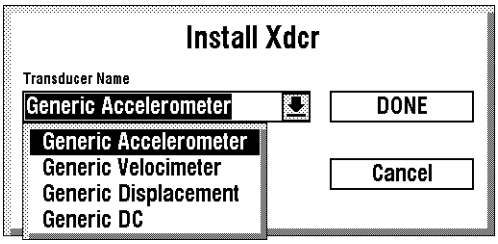
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Make sure that the DONE box in the window is highlighted, then press <SELECT> again.



Note: The Select Route window does not appear if the Data Collection program is open and a route was already selected. To select a different route, press <DONE> to quit the Data Collection program, then start it again.

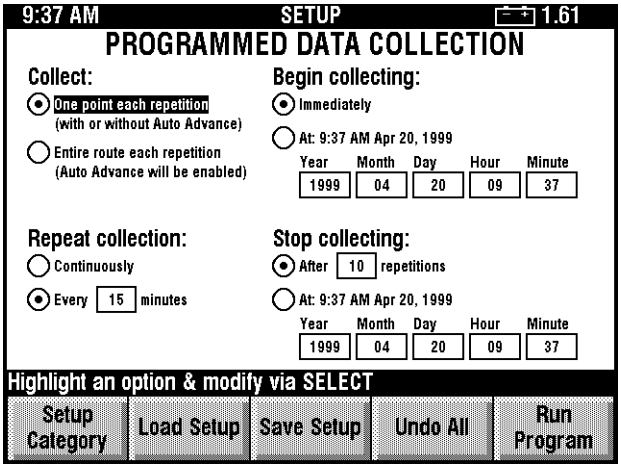
4. Once in Data Collection mode, press <F1> (Setup).
5. In Setup mode, press <F1> (Setup Category). Use the arrow keys to select Transducer Options and press <SELECT>.
6. Choose <F2> (Install Xdcr).



7. Use the arrow keys to select the transducer you will be using and press <SELECT> twice.
8. Press <F1> (Setup Category) to switch to Programmed Data Collection setup.

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9. Use the arrow keys to select Programmed Data Collection and press <SELECT>. The following screen appears. See “Setting Up the Program Parameters” on page 68 for setup instructions.



10. After the parameters are correctly set up, press <F5> (Run Program). See “Running the Program” on page 70 for more information about the program cycle.

Installing the Transducer for Programmed Data Collection

It is best to install the correct transducer before starting the programmed data collection cycle. If the units for the connected transducer do not match the installed transducer in the route, the cycle cannot be completed.

For example, the dataPAC can use “Generic Accelerometer” even if a host-software-defined transducer named “Accelerometer” is required. If you are having trouble with the program running correctly, check the units of the installed transducer first.

For more information about installing transducers, see “Installing and Defining dataPAC Transducers” on page 48.

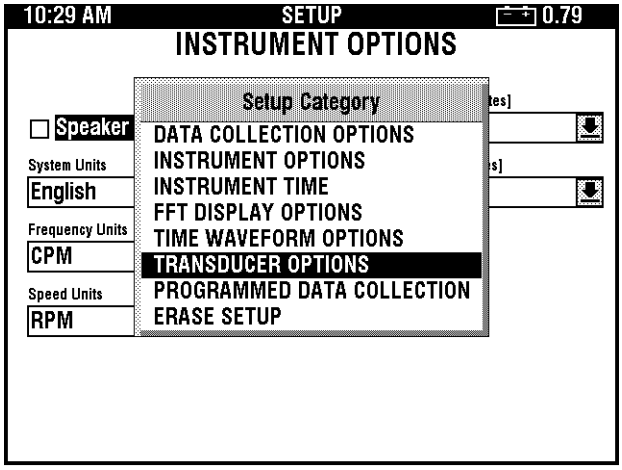
Setting Up the Program Parameters

This section describes the flexibility of the parameters for programmed data collection intervals. You can choose start time, stop time, the number of times it repeats, and whether the data cycle goes through an entire route or just one point. To set up the program parameters, follow these steps.

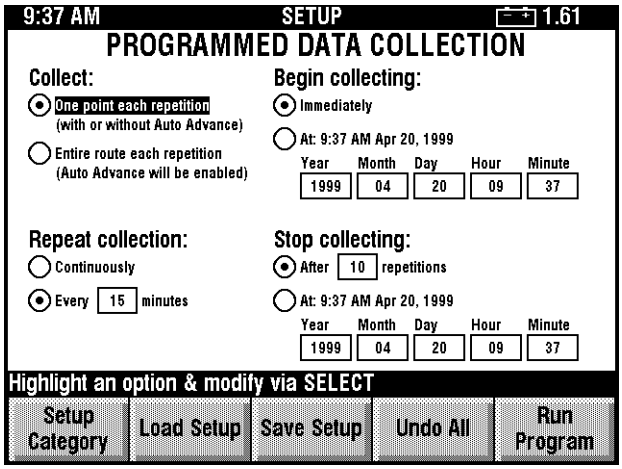
1. After selecting the route in the Data Collection program, press <F1> (Setup).

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2. Switch to the desired setup category by pressing <F1> (Setup Category). The Setup Category window appears.



3. Use the arrow keys to select Programmed Data Collection and press <SELECT>. The following screen appears.



4. Use the arrow keys and <SELECT> button to choose the settings for programmed data collection. Each setting is explained below.

Collect

Select **One point each repetition** to collect just one point at each of the programmed collection times. If Auto Advance is disabled, then the same point is collected at each programmed collection time. If Auto Advance is enabled, then the next point is collect at each collection time. This option is identical to pressing <STORE> each time the program is run. See “Setting Up Data Collection Options” on page 38 for more detailed information about setting the Auto Advance option.

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Select **Entire route each repetition** to collect the entire route at each of the programmed collection times. Auto Advance is automatically enabled while the program is running. At each of the programmed collection times, the first point in the route is collected first. Then, the dataPAC goes through the entire route before turning off again.

Begin Collecting

Select **Immediately** to start the programmed data collection right after pressing <F5> (Run Program.)

To select a time for collection to begin, choose **At**: and use the edit boxes to specify the start time. Then, the program starts at that specific time while the program is running.

Repeat Collection

Select **Continuously** to have the next programmed collection begin immediately after the previous collection. Data is collected continuously and the program is repeated as soon as it is finished.

Select **Every X minutes** to place a pause between each data collection cycle. The programmed collections occur at the specified interval. If it takes 5 minutes to collect all the data, but you have the interval set for one minute, the dataPAC will finish the data collection cycle, then begin the next cycle. So, if you have the interval set for less than the time it takes to collect the data, the dataPAC continuously collects the data.

Stop Collecting

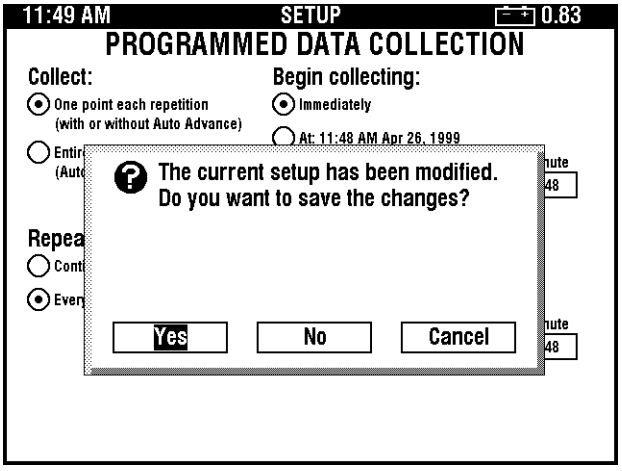
Select **After X repetitions** to stop the program after the collection has repeated a specific number of times.

Select **At** and use the edit boxes to specify the stop time. The program stops at that specific time. If a data collection cycle has not completed at that exact time, the dataPAC finishes the data cycle before stopping.

Running the Program

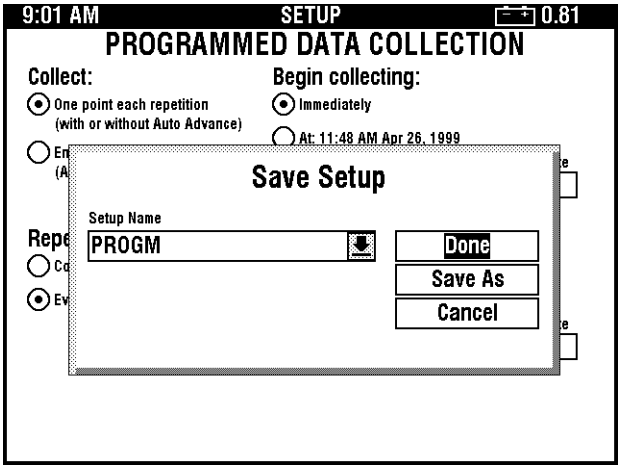
After setting up the program and installing a transducer, you can now run the program. To do so, follow these steps.

1. Once the program is set the way you want it, choose <F5> (Run Program.) If you need to save the setup, the following dialog box appears.



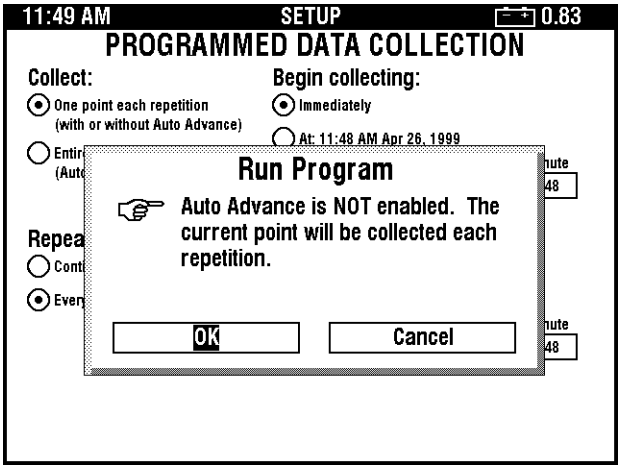
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2. Press <SELECT> to save the setup. The following dialog box appears.



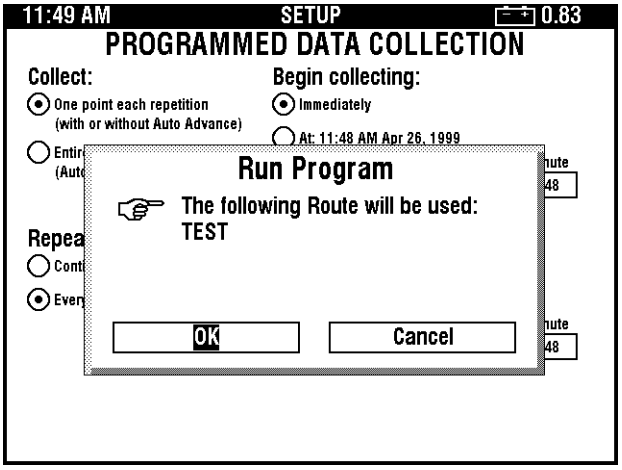
Note: If you have not installed a transducer, the dataPAC prompts you to do so. See "Installing and Defining dataPAC Transducers" on page 48.

3. Press <SELECT> to save the setup with the name in the dialog box. The following dialog box appears.

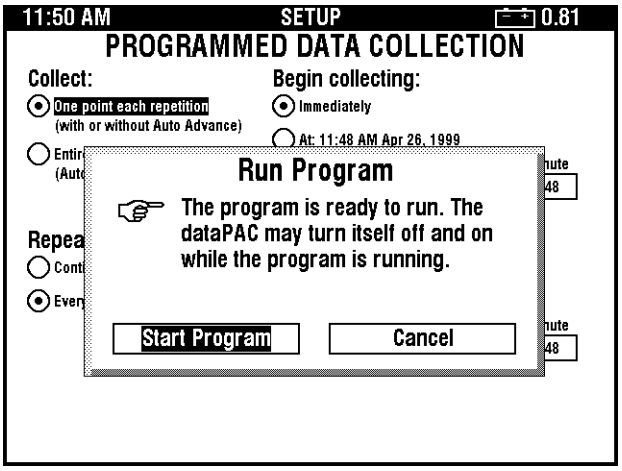


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4. The dialog box above informs you about the Auto Advance settings. Press <SELECT>. The following dialog box appears.

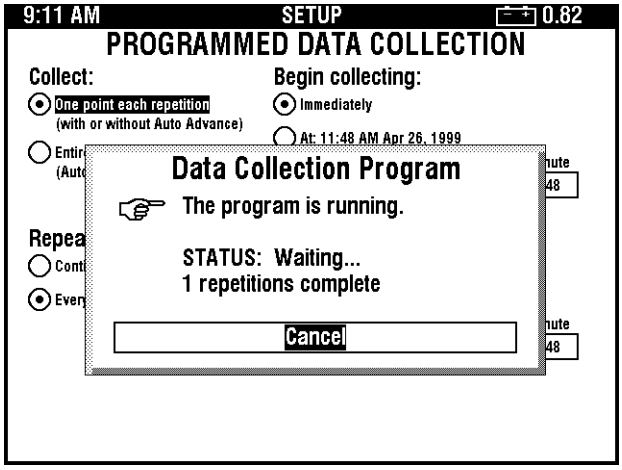


5. The dialog box above informs you about the route name that will be used. Press <SELECT>. The following dialog box appears.



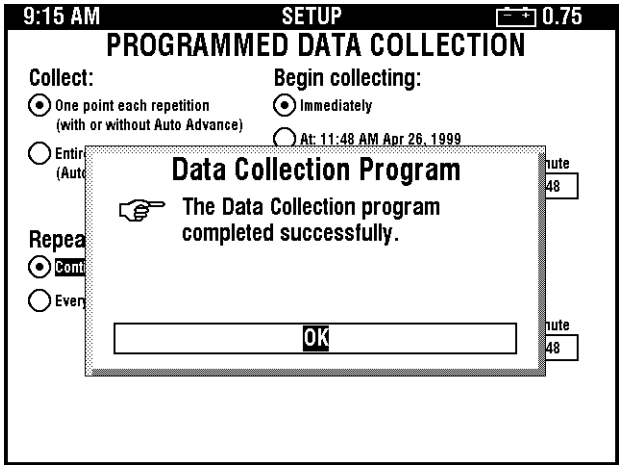
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6. Press <SELECT> to start the program. The following dialog box appears. While the program is running, you cannot do anything else with the dataPAC.



The dataPAC beeps three times to signal when each data cycle has been collected.

7. When the program has completed all data cycles, the following dialog box appears. Press <SELECT> to finish using programmed data collection.



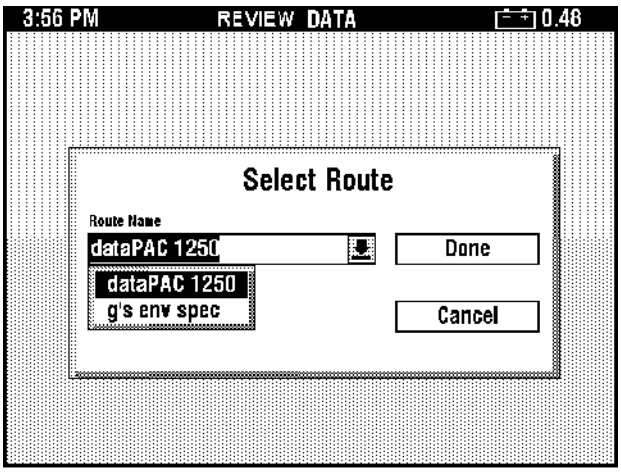
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Reviewing Overall Data and Alarms Reports

There are several functions available to view and analyze data in the dataPAC. This section discusses the available options for viewing and analyzing overall data, as well as alarms reports. It also covers navigating through data in the Review Data window.

Overview of the Review Data window

To review previously collected route or off route data, use the arrow keys to select the Review Data icon in the Program Manager. Press <SELECT> to enter the Review Data program. When you first open the Review Data program, the Select Route window opens.

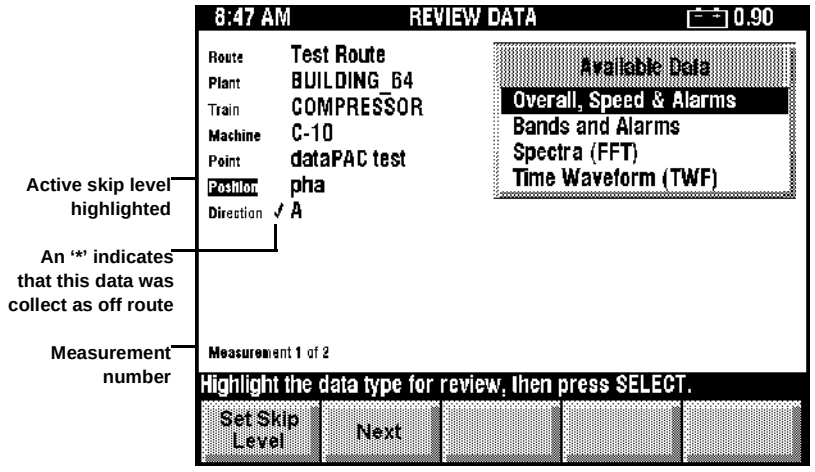


Use the arrow keys to highlight the name of the route you want to select, then press <SELECT>. Make sure that the DONE box in the window is highlighted, then press <SELECT> again. To leave the Select Route window without selecting a route, highlight Cancel, then press <SELECT>. The Select Route window does not appear if the Review Data program is open and a route was already selected.

You can also got to Review Data directly using <SHIFT>F1> (Review Data) from the Data Collection screen. When you enter Review Data with this method, you automatically go to the current point.

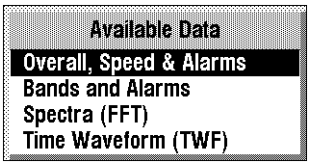
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After you select a route, the main Review Data window opens, as shown.



The measurement number is displayed at the bottom left corner of the window just above the status bar. If this point has more than one measurement, you can press <F2> (Next) and <F3> (Previous) to select the active measurement for which you want to view data.

The Available Data window shows the different types of data. If you collected that type of data for this point, you can view it by selecting the data type.



Use the arrow keys to highlight your choice, then press <SELECT>.

The dataPAC attempts to display a stored measurement which matches the data type specified. If no measurement is available, the dataPAC alerts you to this.

To move through the collected data

In the top left corner of the window, the dataPAC displays a complete identifier for the point you are viewing. Each point is defined by up to six levels of hierarchy:

- Route
- Plant
- Train
- Machine
- Location
- Transducer

These levels are defined by the structure of the route database at the host computer. The number and labels of these identification levels vary according to the way your route database was set up. You can select any point in the dataPAC's memory by using the Set Skip Level softkey, as described below.

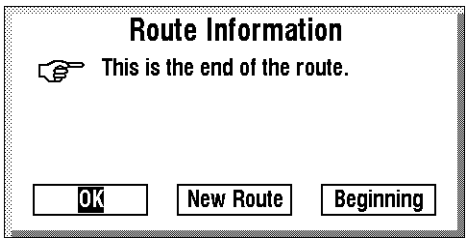
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To change the active skip level, press <F1> (Set Skip Level), then use the up and down arrow keys to set the skip level as desired. Press <F1> (Available Data) when you have selected the skip level. The next time you press <SKIP>, the dataPAC will skip through the database at the level you selected.

When any point is displayed in the Review Data window, you can use the <ADV>, <DEC>, and <SKIP> keys to move between items on a route. The <SKIP> key also allows you to move between routes. The following table provides details about the use of these keys, as summarized in this table.

Key(s)	Result
<ADV>	Move to next point in route
<DEC>	Move to previous point in route
<F2> (Next)	Move to next measurement for the point
<F3> (Previous)	Move to previous measurement for the point
<SHIFT><ADV>	Move to next point “not collected”
<SHIFT><DEC>	Move to previous point “not collected”
<SKIP>	Skip to next item at active skip level
<SHIFT><SKIP>	Skip to previous item at active skip level
<SELECT>	Display selection menu of highlighted level, allowing you to choose one to move to

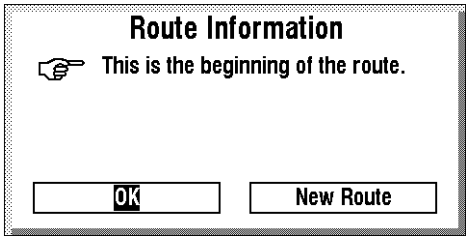
If you reach the end of the route after pressing <ADV> or <SKIP>, the instrument alerts you with the following Route Information window.



- To continue operation in the same route, press <SELECT>. This action causes the dataPAC to return to the Data Collection window and display the first point on the route.
- To switch to a different route, press <SKIP> to open the Select Route window. In the Select Route window, highlight a route name and press <SELECT>, then highlight DONE and press <SELECT> again.

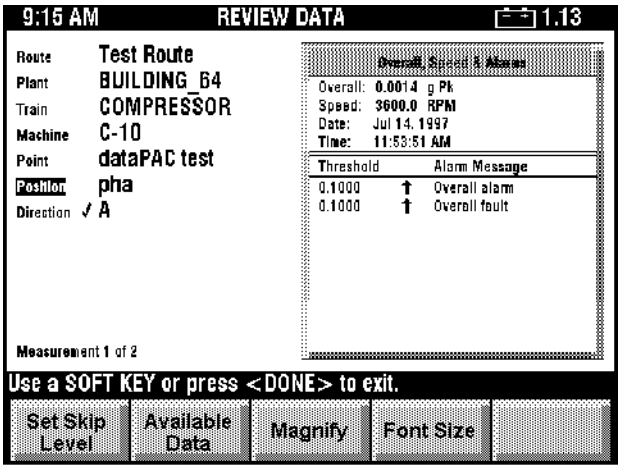
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If you reach the beginning of the route after pressing <DEC> or <SHIFT><SKIP>, the instrument alerts you with the following message.



- To continue operation in the current route, highlight OK, and then press <SELECT>. This action causes the dataPAC to return to the Data Collection window and display the first point on the route.
- To switch to a different route, highlight New Route, and then press <SELECT>. In the Select Route window, highlight a route name and press <SELECT>. Then highlight DONE and press <SELECT> again.

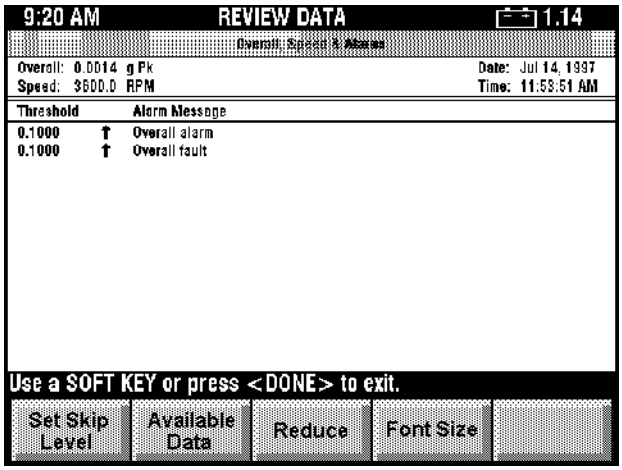
After you make a selection from the Available Data window, the report is displayed in a box at the right if in reduced mode. The following example shows Overall, Speed & Alarms.



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To modify the viewing window

The <F3> (Magnify) softkey allows you to change the size of the viewing window. When the window is small, press <F3> (Magnify) to expand the size to fill the screen. When the window fills the screen, as shown below, press <F3> (Reduce) to return the window to its original size.

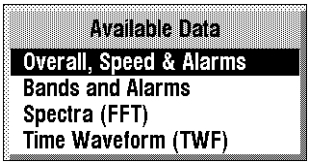


Pressing <F4> (Font Size) toggles between two available font sizes.

To select different data to view, press <F2> to open the Available Data popup window. In the window, highlight your choice, then press <SELECT>.

Reviewing Overall, Speed, & Alarms

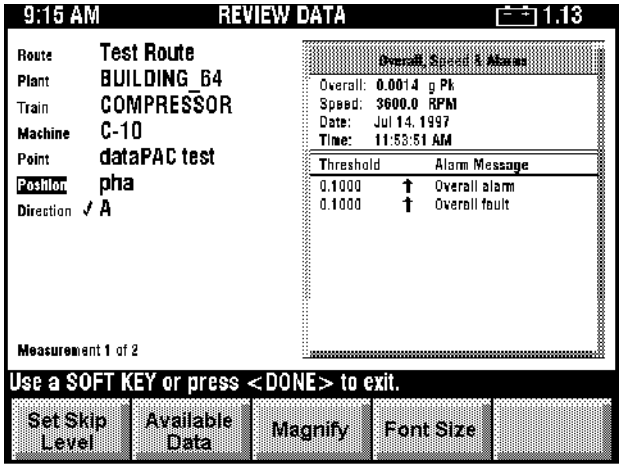
The Available Data window shows the different types of data. If you collected that type of data for this point, you can view it by selecting the data type.



Use the arrow keys to highlight Overall, Speed & Alarms, then press <SELECT>. The dataPAC displays the information if it is available. If no measurement is available, the dataPAC displays a message saying “Data Not Collected.”

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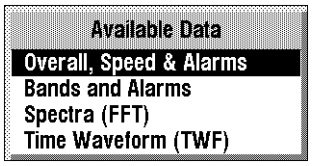
The band alarms are displayed as shown in the following diagram. Notice that the reduced view is selected. You can use the softkeys to change the display including Magnify/Reduce and Font Size.



The threshold value or alarm value for the overall alarm is in the Threshold column. The alarm message is indicated in the next two columns. If no alarms are available, the dataPAC displays a message saying “No Alarms Defined.” If alarms are available, the values are displayed, with an up arrow to indicate an above alarm, and a down arrow to indicate a below alarm. The Alarm Message is the text downloaded from your host software. In the diagram above the text was downloaded from EMONITOR Odyssey or Enshare.

Reviewing Bands and Alarms

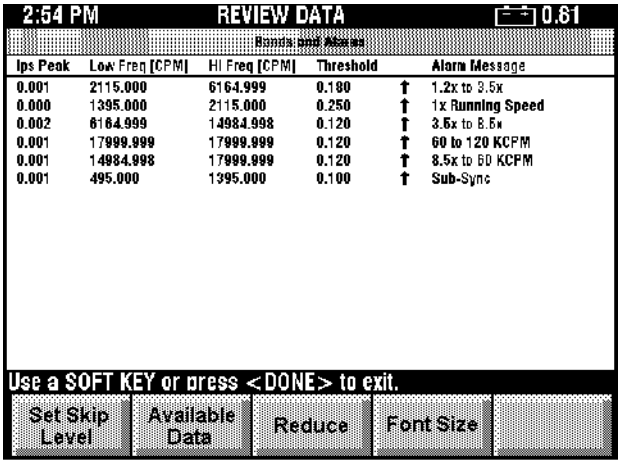
The Available Data window shows the different types of data. If you collected that type of data for this point, you can view it by selecting the data type.



Use the arrow keys to highlight Bands and Alarms, then press <SELECT>. The dataPAC displays band information if it is available. If no measurement is available, the dataPAC displays a message saying “No band data.”

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The band alarms are displayed as shown in the following diagram. Notice that the Magnify view is selected. You can use the softkeys to change the display including Magnify/Reduce and Font Size.

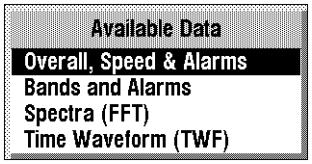


The magnitude value for the band's frequency range is in the first column. The frequency range is indicated in the next two columns. The threshold value is in the Threshold column. An up arrow indicates an above alarm, a down arrow indicates a below alarm. The Alarm Message is the text downloaded from your host software. In the diagram above the text was downloaded from EMONITOR Odyssey or Enshare. If a measurement is in alarm, it has a grey box around it in the magnified screen. During data collection, the name of the band alarm is displayed if the measurement is in alarm.

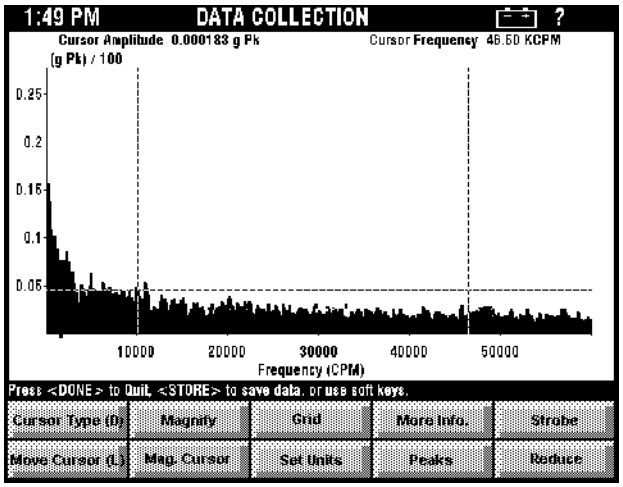
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Reviewing Spectra Data

The Available Data window shows the different types of data. If you collected that type of data for this point, you can view it by selecting the data type.



Use the arrow keys to highlight Spectra (FFT), then press <SELECT>. The dataPAC displays a spectrum if it is available. The dataPAC displays the measurement with the default cursor type, selected in the Setup Utility. See “Setting Up FFT Display Options” on page 41 for more information.



For the dataPAC 1500, if there is an asterisk ‘*’ proceeding the amplitude and frequency readouts, then the data for this cursor location is being computed, instead of the raw spectrum data.

Using the Cursors with a Spectrum

Cursors are available to precisely identify numerical values in a spectrum measurement. Cursors are drawn as either dashed or dotted lines perpendicular to their associated axis.

You can use the cursor to identify the amplitude and frequency of peaks in a spectrum. The value of the cursor location is displayed at the top of the screen. When more than one spectral bin occupies the display position of the active cursor, the values displayed correspond to the bin with the highest amplitude at that display position.

Press the arrow keys to activate the cursor and move it along the spectrum.

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There are several types of cursors available with the spectrum display:

- **Single Cursor** - Displays only the horizontal and vertical axis values of the cursor. Use the right and left arrow keys to move the frequency cursor and use the up and down arrow keys to move the amplitude cursor.
- **Harmonic Cursors** - Displays cursors at multiples of the fundamental frequency.
- **Dual Cursor** - Displays the frequency and amplitude difference between a reference cursor and the active cursor.
- **Sideband Cursors** - Displays equally spaced cursors to either side of the reference cursor.
- **Diagnostic Frequency Cursors** - (dataPAC 1500 only) When frequency items are loaded with a list from EMONITOR Odyssey or Enshare, the dataPAC 1500 can display the frequency item that goes with the cursor.
- **Peak Cursors** - When you press the arrow key, the cursor moves from one peak to the next.

This section contains examples of all the types of cursors.

Press <SHIFT><F1> (Cursor Type (D/H/S/F/P)) to change the current cursor mode for the display. The letter in parenthesis identifies the current cursor mode. Cursor modes are:

- Cursor Type (D) = Dual Cursors
- Cursor Type (H) = Harmonic Cursors
- Cursor Type (S) = Sideband Cursors
- Cursor Type (F) = Diagnostic Frequency Cursors
- Cursor Type (P) = Peak Cursors

Using Dual Cursors with a Spectrum

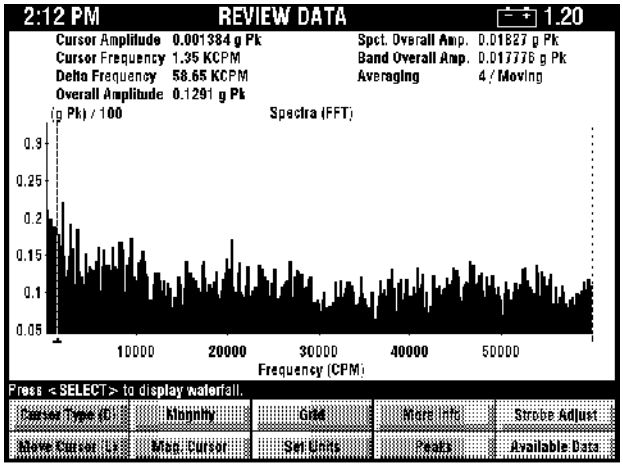
Dual cursors are typically used to identify an area of the display to be expanded horizontally; usually to inspect more closely an interesting portion of the spectrum. Or, you can use them to determine the amplitude in a band between two frequencies.

Note: While collecting a spectra, the dataPAC 1500 can drive a photostrobe at the same frequency as the active spectral cursor. The strobe should be connected to the dataPAC's DATA I/O connector and must be compatible with a TTL trigger input. See "Driving a Strobe While Collecting an Off Route Spectrum" on page 197.

When you select Dual Cursors, the display shows two full height frequency cursors. The frequency and amplitude values of the active cursor are shown at the top of the screen. When more than one spectral bin occupies the display position of the active cursor, the values displayed correspond to the highest amplitude bin at that display position.

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Below is a diagram of the Dual Cursors FFT Display.



To move and switch active cursors

With dual cursors, only one cursor can be moved at a time. The one that you can move is referred to as the active cursor. The active cursor appears as a dashed line, and the inactive cursor appears as a dotted line.

You can move either one of the dual cursors using the arrow keys. Press <SHIFT> while pressing the arrow key for larger adjustments. As you hold the arrow key, the cursor moves progressively faster.

To switch the active cursor, press <F1> (Move Cursor (H/L)) The H and the L represent the high frequency and low frequency cursor.

The low and high cursors never occupy the same horizontal position, pass each other, or change positions. If you are moving one cursor and it bumps into the other, they both begin to move together. If you are moving a cursor and it encounters the edge of the display, it causes the display to contract to show any bins immediately outside the current display range.

To calculate Band RSS Amplitude

In dual cursor mode, the “Band RSS Amplitude” field in the information display at the top of the screen displays the Root Sum Squared amplitude of all bins between the two cursors. To see this display, you must have Band Overall Amp selected in the FFT Display Options, or press <SHIFT><F4> (More Info.). See “Using Other Features of the dataPAC Utility Program” on page 32 for more information.

To calculate Delta Frequency

The difference in frequency between the two cursors is referred to as the Delta Frequency. When the Delta Frequency is displayed in the information table at the top of the screen you will see it updated as you move the cursors with the arrow keys. To see this display, you must have Delta Frequency selected in the FFT Display Options or press <SHIFT><F4> (More Info.). See “Using Other Features of the dataPAC Utility Program” on page 32 for more information.

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To magnify the area between dual cursors

If there are at least three bins between the cursors, then you can press <F2> (Mag Cursor) to expand the display horizontally to show only those bins that lie between the upper and lower frequency limits established by the cursors. When the low and high cursors lie at the extreme edges of the display, the <F2> softkey label is replaced by a label that says Full Spectrum. Pressing the key under these conditions redraws the display so that the entire spectral data set is displayed.

Using Sideband Cursors with a Spectrum

Sideband cursors allow you to display a primary cursor and up to three sideband cursors placed at equal intervals on either side of the primary cursor. The primary cursor is drawn at full height, and the sideband cursors are drawn at reduced height.

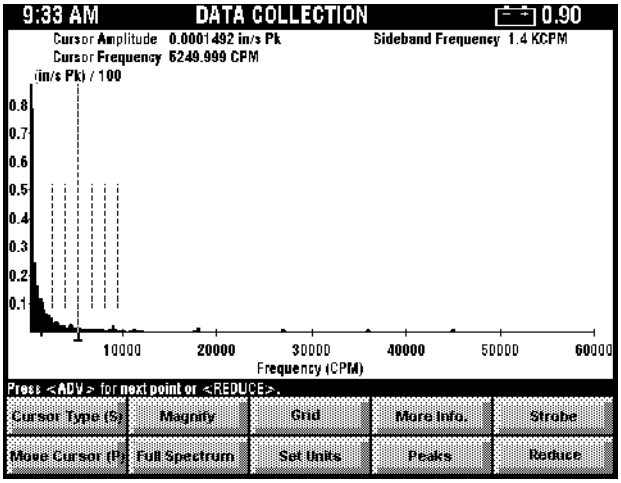
The frequency of the primary cursor is displayed in the information display at the top of the screen as “Cursor Frequency” and is updated as you move the primary cursor.

The sideband frequency is displayed in the information display at the top of the screen and refers to the bandwidth between each sideband marker.

Press <F1> (Move Cursor(P/S)) to toggle between the active cursors for the display. The letter in parenthesis identifies the current cursor type, which moves when you press the arrow keys. Cursor types are:

- Cursor Type (P) = Primary Cursor
- Cursor Type (S) = Sideband Cursors

Below is a diagram of the FFT Display window with sideband cursors.



To move the primary cursor

When <F1> shows (Move Cursor (P)) the primary cursor is active. Pressing the arrow keys when the primary cursor is active changes the position of the primary cursor, and the sideband cursors move with the primary.

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To change the spacing between sidebands

When <F1> shows (Move Cursor (S)) the sideband cursors are active. Pressing the arrow keys when the secondary cursors are active changes the spacing between the sidebands. The primary cursor does not move.

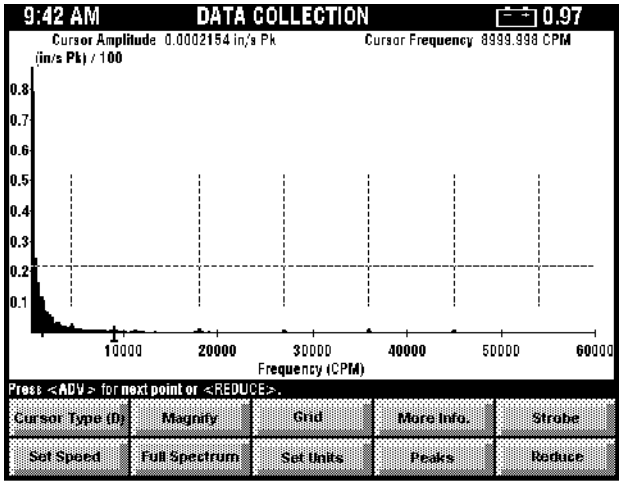
Using Harmonic Cursors with a Spectrum

Harmonic cursors allow you to view a fundamental (usually machine speed) cursor and up to ten harmonic cursors placed at harmonic intervals from the fundamental cursor.

The fundamental cursor is drawn at full height, and the harmonic markers are drawn at reduced height at 1/2, 2, 3, 4...11 times fundamental frequency.

The fundamental cursor frequency is displayed in the information display at the top of the screen and is updated as you move the cursor with the arrow keys.

Below is a diagram of the FFT Display window with harmonic cursors.



To move harmonic cursors

The fundamental cursor is positioned by default at the machine speed (loaded with the route data, or manually entered at collection time). However, you can change the position using the right and left arrow keys.

To set machine speed with harmonic cursors

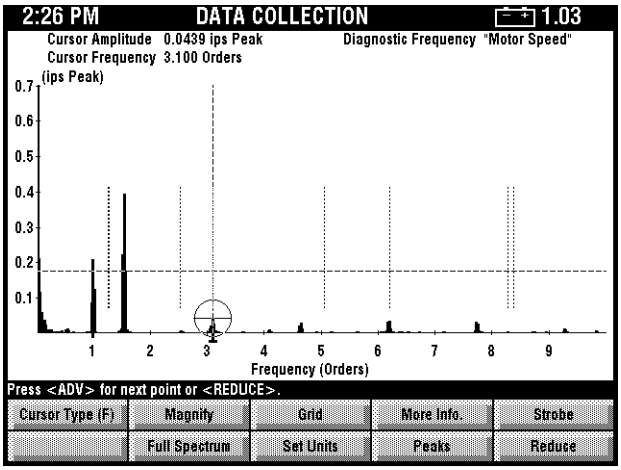
When the spectrum display is viewed with harmonic cursors from the Review Data or Data Collection applications, the Set Speed softkey is available. This softkey stores the machine speed field with the current cursor frequency. This may be useful when the frequency axis is displayed in orders. This mode displays frequency divided by machine speed, making it easy to identify relationships between the machine rotating speed and peaks in the spectrum. This speed is unloaded to the host software system and is archived with your data history.

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Using Diagnostic Frequency Cursors with a Spectrum

dataPAC 1500 V5 only

This illustration shows the diagnostic frequency cursor selected in the dataPAC. To display the Diagnostic Frequency cursor, press <SHIFT><F1> (Cursor Type) and use the arrow keys to select Diagnostic Frequency. These are only available if you loaded them from EMONITOR Odyssey or Enshare.



To move to each Diagnostic Frequency

You can press <SHIFT> and the left or right arrow keys to quickly move to each diagnostic frequency. The label is shown in the upper portion of the screen. This example shows “Motor Speed.” In this example, Motor Speed is at 3.1 orders.

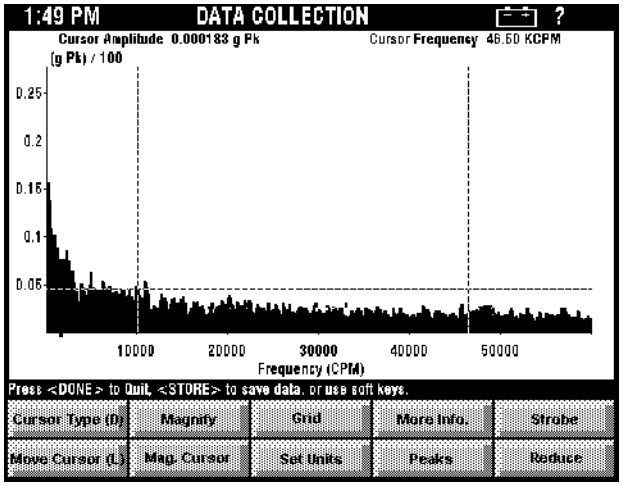
To load Diagnostic Frequencies from the host computer

With version 5 of the dataPAC 1500 and EMONITOR Odyssey 2.0 or Enshare 1.0, you can load frequency labels so that you can use the Diagnostic Frequency cursor.

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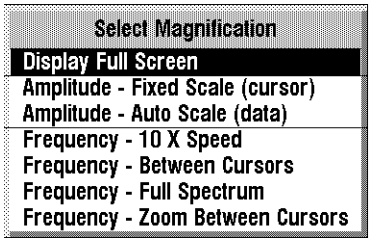
Changing the Spectrum Display

To view a spectrum full screen and use some of the dataPAC's analysis tools, press <F5> (Magnify) to open the spectrum in a full window.



To magnify the entire spectrum display

Press <SHIFT><F2> to open the Select Magnification menu.



Use the arrow keys to highlight a selection, then press <SELECT>. The choices are explained below. After you magnify you can press <F2> (Full Spectrum) to return to the original spectrum.

Display Full Screen

This option temporarily switches to a display mode that shows only the cursor amplitude and frequency in the information display area, and turns off the softkeys and status line, leaving a maximum display area available to view the spectrum. You can move the cursors while in this mode. Pressing any other key returns the display to normal operation, restoring the information display, the softkeys, and the status line to their normal state.

Amplitude - Fixed Scale (cursor)

This function redraws the amplitude scale. Set the top of the scale using the up and down arrows to set the upper amplitude, then apply this magnify function.This item causes the dataPAC to replot the FFT setting the top of the vertical scale to the value of the amplitude cursor.

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Amplitude - Auto Scale (data)

This option redraws the FFT graph with the vertical scale set to the highest peak in the FFT data set. This is the default mode of operation.

Frequency - 10 X Speed

This option adjusts the frequency scale to show only those spectral bins that represent frequencies that are less than 10 times the machine speed, or the collected Fmax, depending on which is less.

Frequency - Between Cursors

This option redraws the FFT graph showing only the FFT data between the low and the high frequency cursors. This option is only available when Dual cursors are active, and when they are not at the extreme limits of the display, and when they include a minimum of three spectral bins. You can also press <F2> (Mag Cursor) to access to this option without using the magnify menu.

Frequency - Full Spectrum

This option displays all of the spectrum data on the graph.

Frequency - Zoom Between Cursors

This option resamples the data, taking a true zoom measurement using the high and low cursors for Fmin and Fmax. This option is only available when Dual cursors are active, and when they are not at the extreme limits of the display, and when they include a minimum range of 2000 Hz.

To use true zoom with an Off Route measurement

This option (available from Off Route only) starts a new “true zoom” measurement using the frequency of the low cursor for Fmin, and the frequency of the high cursor for Fmax. Press<SHIFT><F2> (Magnify) and select Frequency - Zoom Between Cursors. The dataPAC begins a new measurement with true zoom parameters.

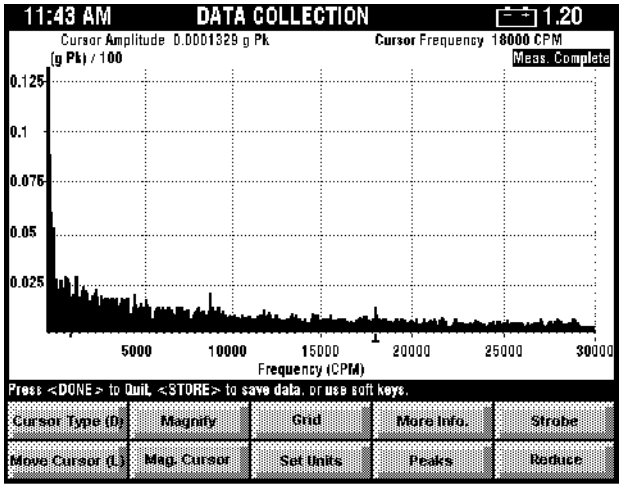
To magnify the area around the primary cursor

Use the arrow keys to move the primary cursor to the area you wish to magnify. Press <F2> (Mag. Cursor) to magnify the area around the primary cursor. Press <F2> (Full Spectrum) again to return to original magnification.

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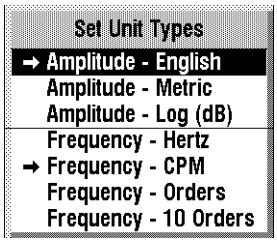
To display a grid

To display a grid on the spectrum display, press <SHIFT><F3> (Grid). A grid appears as shown in the diagram below.



To set different units

Press <F3> (Set Units) to open the Set Unit Types menu.



If you wish to change the current selection for both amplitude and frequency, you must press <F3> (Set Units) again to reopen the menu. The following units are available.

Amplitude - English

This option selects English units for display of amplitude values. For example, it uses in/s instead of mm/s.

Amplitude - Metric

This option selects Metric units for display of amplitude values; for example, mm/s instead of in/s.

Amplitude - Log

This option selects a logarithmic scale for display of amplitude values. Amplitudes are displayed in dB using the reference and scalar specified by host software or using the dataPAC default values.

Frequency - Hertz

This option displays frequency information in units of Hz as opposed to CPM, and machine speed in units of RPS instead of RPM.

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Frequency - CPM

This option displays frequency information in units of CPM as opposed to Hz, and machine speed in units of RPM instead of RPS.

Frequency - Orders

This option displays frequency information in units of orders which is defined to be the ratio of frequency to machine speed. A value of 1 indicates a frequency equal to the machine speed.

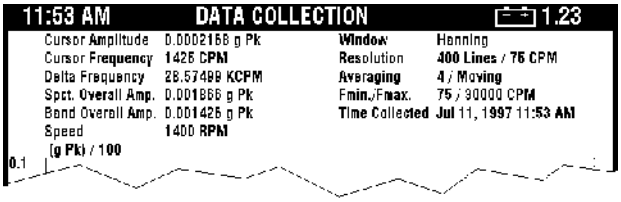
Frequency - 10 Orders

This option adjusts the frequency display axis to show only spectral bins that are less than 10 times the machine speed.

To display all available FFT information

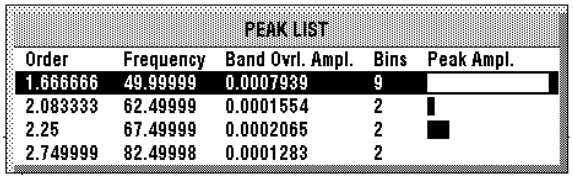
Press <SHIFT><F4> (More Info.) to display all available FFT items in the information display at the top of the screen. The FFT Display Options in the Setup Utility determine what displays here. The More Info. option displays everything regardless of these settings. See “Setting Up Data Collection Options” on page 38 for more information about setup options.

The information displayed is shown in the diagram below.



To identify specific peaks

A peak is defined to be a contiguous series of bins that exceed the current peak threshold as defined by the position of the amplitude cursor. Pressing <F4> (Peaks) displays a list of the peaks found in the spectral data set.



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The table shows the order, frequency, the RSS band amplitude, bins, and peak amplitude as defined below.

- **Order** - The order (frequency/speed) of the highest amplitude spectral line contained in the peak.
- **Frequency** - The frequency of the highest amplitude spectral bin contained in the peak.
- **Band Ovrl. Ampl.** - The RSS (root-sum-square) amplitude calculated from all the spectral lines contained in the peak.
- **Bins** - The number of bins contained in the peak.
- **Peak Ampl.** - The amplitude of the highest amplitude spectral line contained in the peak, represented as a bar showing amplitude relative to other peaks.

When the peak list is created, it highlights the peak nearest the frequency cursor. You can use the up and down arrow keys to select different peaks.

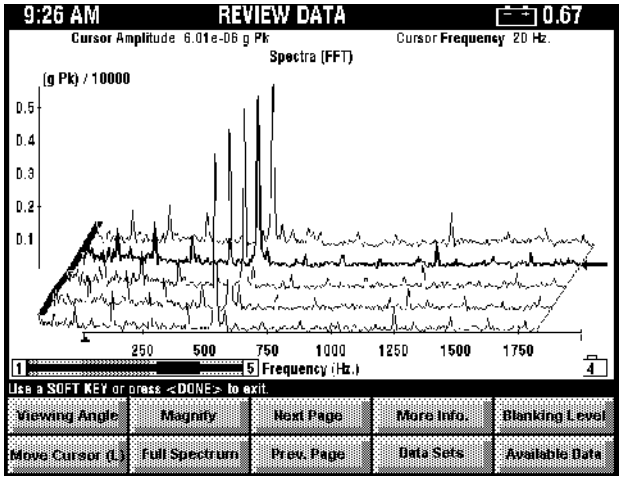
When there is insufficient room to display all the peaks, the peak list is created with a vertical scroll bar, and the list scrolls when you move the selection beyond the upper and lower extremes of the displayed list.

Pressing <SELECT> while displaying the peak list adjusts the frequency scale to show only bins near the highlighted peak. Then you can press <F2> (Full Spectrum) to return to a display of the entire spectrum. Pressing <SHIFT><SELECT> cancels the peak list without affecting the frequency scale.

Reviewing Waterfall Spectra Data

When you collect more than one spectrum for a point, the dataPAC displays the spectrum in a waterfall mode, one after the other. This section describes the ways to review waterfall spectra data.

Waterfall spectral data appears as shown in the following diagram.



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Changing the Viewing Angle of a Waterfall Display

Press <SHIFT><F1> (Viewing Angle) to modify the angle and elevation at which you view the data. After you press this softkey, new softkey options become available:

- **<F1> (Reverse/Normal Order)** - Reverses the display of the data as if you are viewing the data from the rear. It displays the data in the reverse order of collection.
- **<F2> (Left)** - Rotates the display to the left.
- **<F3> (Right)** - Rotates the display to the right.
- **<F4> (Center)** - Centers the display straight on.
- **<F5> (Elevation)** - Changes the elevation level of the display.

Reviewing Specific Spectral Data Sets in Waterfall Mode

Press <F4> (Data Sets) to access more softkey options. When you are finished with the Data Sets softkeys you can press <F5> (OTHER KEYS) to return to the original waterfall softkeys.

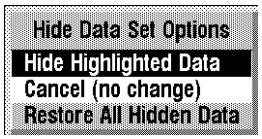
You can press <SELECT> when the arrow on the right is pointing to a highlighted spectrum to view just that spectrum. Press <SELECT> again to return to the waterfall view.

To select the spectrum with the maximum overall value among all displayed data sets

Press <SHIFT><F5> (Find Max. Ovr.) to move the cursor to, and select, the FFT with the maximum overall value among the displayed data sets. By default, the spectrum is highlighted when the waterfall is first displayed.

To hide selected data sets

Pressing <SHIFT><F4> (Hide Data Set) presents the Hide Data Set Options window. Choose an option from the list below. Notice that selections are grayed out if not available.

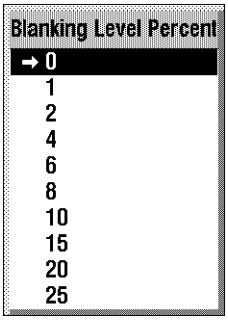


- **Hide Highlighted Data** - This option hides the selected spectrum.
- **Cancel (no change)** - This option returns you to the Data Sets view.
- **Restore All Hidden Data** - This option restores all hidden data.

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To blank out low level noise

Press <SHIFT><F5> (Blanking Level) to eliminate the display of data below the specified percent of full scale. This is helpful in eliminating low level noise while displaying the significant peaks. You select the percent level from the list displayed.

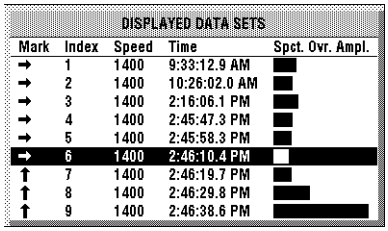


To change the number of FFTs displayed on one page

Press <F2> (Smaller Page) or <SHIFT><F2> (Larger Page) to change the number of FFTs (from 6 to 24) which are currently displayed on the Data Sets screen. The cursor position determines the center point of the reduced data set.

To list the stored data sets in a table

Pressing <F4> (Table On/Off) displays (or hides) the Displayed Data Sets window.

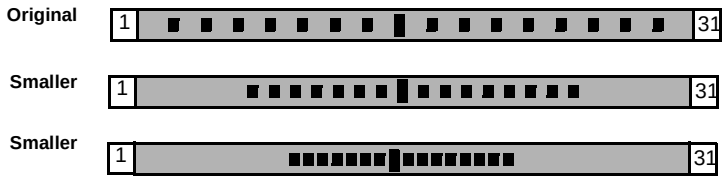


All the currently displayed FFTs are listed showing the exact time that the FFT was captured (to the tenth of a second) and its relative spectral overall amplitude represented by the bar chart on the right.

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To zoom the waterfall in and out around selected data sets

The dataPAC can display 6 to 24 FFTs on the screen at one time (see Smaller/Larger page softkey above). When then number of FFTs stored is more than number displayed, the dataPAC selects FFTs evenly spaced among all the data sets and displays them. When you press <F1> (Z-Zoom in), the dataPAC selects data sets more closely clustered around the selected FFT. This is represented graphically on the screen by the panel in the lower left hand part of the display.

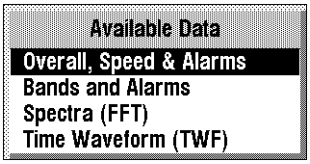


Gaps indicate that there are more spectrum that are currently being displayed. The bar in the middle represents the selected or highlighted spectrum. The number at the end tells you how many spectrum total are in the data set.

Reviewing Time Waveform Data

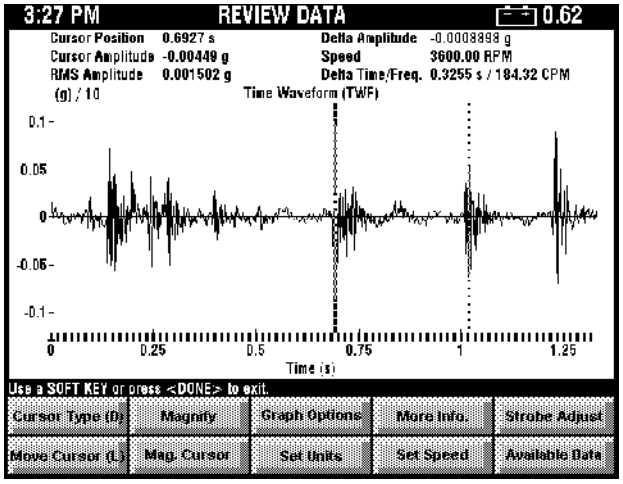
dataPAC 1500 only

Time waveform displays are available only with the dataPAC 1500. The Available Data window shows the different types of data. If you collected that type of data for this point, you can view it by selecting the data type.



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Use the arrow keys to highlight Time Waveform (TWF), then press <SELECT>. The dataPAC displays a time waveform if it is available. The dataPAC displays the measurement with the default cursor type. You set the default cursor type in the Setup Utility. See “Setting Up Time Waveform Options” on page 43 for more information.



Using the Cursors on a Time Waveform Display

Model 1500 Only

Time waveform displays are available only with the dataPAC 1500. Cursors are available to precisely identify numerical values in a time waveform measurement. Cursors are drawn as either dashed or dotted lines perpendicular to their associated axis.

Press the arrow keys to activate the cursor and move it along the time waveform. There are three kinds of cursors available with the time waveform display:

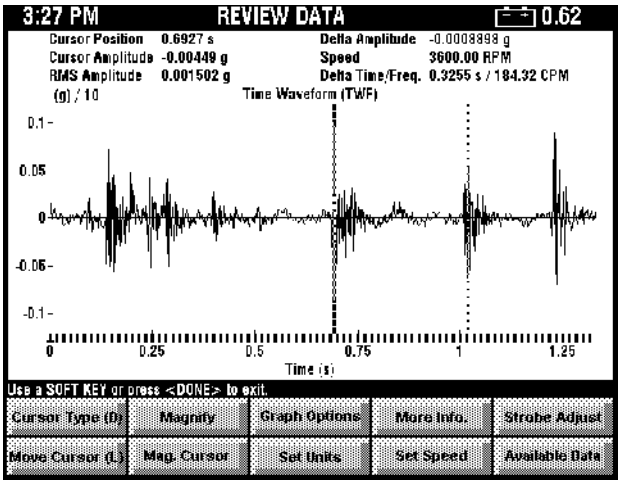
- **Single Cursor** - Displays only the horizontal and vertical axis values of the cursor. Use the right and left arrow keys to move the time cursor and use the up and down arrow keys to move the amplitude cursor.
- **Cyclic Cursors** - Displays several cursors to help identify repeating patterns in the time waveform. They consist of 1 to 15 vertical dashed lines, spaced at even time intervals.
- **Dual Cursor** - The dual time cursors are useful for determining the time between two points on the time waveform or the time of any given sample relative to the trigger point.

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Using Dual Cursors with Time Waveform

Model 1500 Only

The dual time cursors are useful for determining the time between two points on the time waveform or the time of any given sample relative to the trigger point. The low cursor is on the left, and the high cursor is on the right. Below is a diagram of a time waveform display with dual cursors.



To move and switch active cursors

The highlighted cursor is considered active, and its value is displayed in the Cursor Amplitude and the Cursor Position fields at the top of the display. Use the left and right arrow keys to move the active cursor.

Press <F1> (Move Cursor (L/H)) to control which cursor is active. The softkey is labeled Move Cursor (L) when the low cursor is active, and Move Cursor (H) when the high cursor is active.

To calculate delta time/frequency

The Delta Amplitude at the top of the screen shows the amplitude difference between time waveform samples at the high and low cursor positions. The Delta Time/Freq readout shows the difference in time between the high and low cursors. The Delta Freq readout is one divided by the time interval (the reciprocal). To see this display, you must have Delta Frequency selected in the Time Waveform Options, or select More Info. See “Using Other Features of the dataPAC Utility Program” on page 32 for more information.

To magnify the area between dual cursors

Press <F2> (Mag. Cursor) to horizontally magnify the display so that it only shows the area between the low and high cursors. This function is also available with the Time - Show Samples Between Cursors option on the Magnify menu. Press <SHIFT><F2> (Magnify) to access the Amplitude - Fixed Scale (Time Cursor) menu option to set the fixed high and low amplitude scale values to the amplitudes associated with the high and low cursors.

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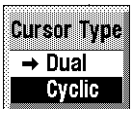
To set the speed value from the time waveform

Press <F4> (Set Speed) while dual cursors are displayed to set the machine speed value equal to the frequency represented by the time spacing between the high and low cursors. This value is stored and unloaded to your computer database with the time waveform data.

Using Cyclic Cursors with Time Waveform

Model 1500 Only

Press <SHIFT><F1> to change the cursor type from Dual to Cyclic. An arrow in the Cursor Type window indicates the type of cursor currently in use. Highlight a cursor type with the arrow keys, then press <SELECT> to change the type of cursor.



The cyclic time cursors are used to help identify repeating patterns in the time waveform.They consist of 1 to 15 vertical dashed lines, spaced at even time intervals.

To move the cursors

The Cursor Amplitude and Cursor Position correspond to the left most vertical marker. You control the cursor position and spacing using the left and right arrow keys.

The <F1> (Move Cursor) key controls whether the arrow keys affect the cursor interval or cursor position. The key is labeled Move Cursor (I) when the key press adjusts the interval, and the key is labeled Move Cursor (P) when the key press adjusts the position.

The Delta Time/Freq display shows the time interval between adjacent cursors, followed by the frequency associated with the time interval.

To set the speed by the time interval between cursors

Press <F4> (Set Speed) while cyclic cursors are displayed to set the machine speed value equal to the frequency represented by the time interval between the cursors. The new speed value is stored and unloaded to your database.

Capturing and Printing dataPAC Screens

Models 1250 and 1500 only, available in 1250 only with a Balance or True-Zoom security key

The dataPAC screen capture utility also allows you to capture dataPAC screen images and store them on the dataPAC memory card. You can then use the computer-based Screen View program to transfer the saved images to a computer in bitmap (.bmp) format where you can view, print and/or export them to other programs. You can store as many screen captures in your dataPAC as memory card allows. To learn more about managing memory, See “Using Memory Cards” on page 53.

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The screen capture utility has two parts:

- The screen capture function on the dataPAC.
- The dataPAC Screen Print and View Utility on the computer.

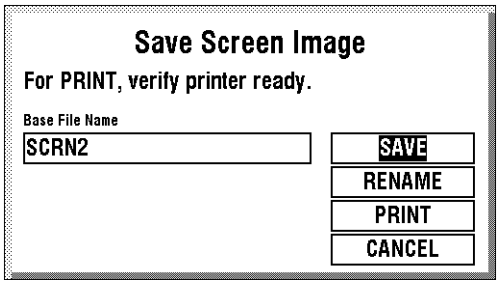
In addition to the screen capture capability, you can directly print the screen as a graphic image with a parallel connection to a PCL-compatible printer. Consult your printer manual to determine if your printer is PCL-compatible. Most of the printers available today are equipped with PCL or a PCL compatible language. Instructions about printing screens directly to a printer are in the following section.

Printing dataPAC Screens Directly

You can purchase a print direct accessory that allows you to connect your dataPAC to a Hewlett-Packard® printer. Our tests have shown that Canon® and Epson® printers are not compatible with the print direct accessory.

Note: If you want to print a previously captured image file, start the Memory Card Manager, select the screen you wish to print, then press <F5> (Print). See “Using the Memory Card Manager” on page 58 for more information.

1. Connect the dataPAC to a parallel port on a printer with the cable and adapter included in the direct print option hardware kit. You will need a cable to connect to the parallel port on the printer.
2. Display the screen you want to print on the dataPAC screen.
3. Press <SHIFT><DONE>. The Save Screen Image dialog box appears.



4. Use the arrow keys to choose the Print option from the menu and press <SELECT>. The image prints on the printer.

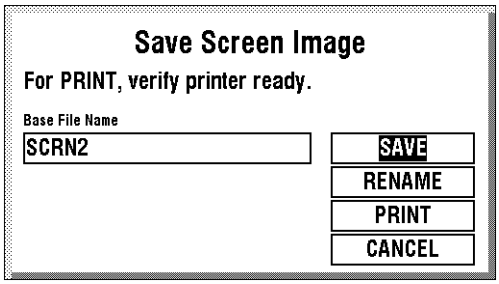
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To capture screen images with the dataPAC

Follow these steps to capture an image while it is displayed on the dataPAC screen:

1. Press <SHIFT><DONE>. The words SAVE SCREEN are on the <DONE> key on some instruments.

   The dataPAC displays the following screen.



2. Use the Edit window to store the image. The dataPAC suggests a name. If you want to accept this name, press <SELECT>. If you want to enter another name for the screen capture, use the Rename option to enter a different name. See “Using Edit Windows” on page 25 for more information about entering text in the dataPAC.
3. The dataPAC stores the image on the memory card. You can view the image file using the Memory Card Manager. See “Using the Memory Card Manager” on page 58 for more information.

Transferring Images to your Computer

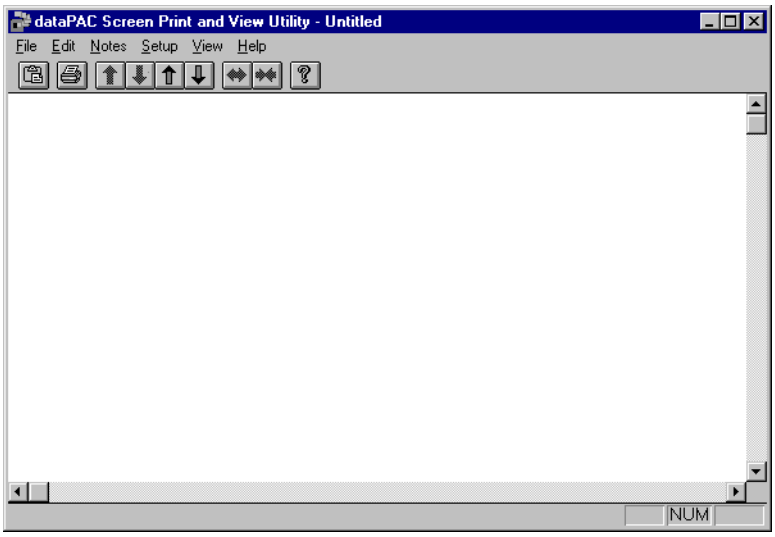
Once you have captured images on your dataPAC, you can transfer them to a computer via a serial cable or a PCMCIA drive. When you transfer images, the utility stores the captured images on your computer in a subdirectory of the directory that holds the dataPAC Screen Print and View Utility. The images directory is called Scrn. Screen images are saved as 640 X 480 monochrome bitmaps with “.bmp” extensions.

To transfer a captured image to a computer, follow these steps.

1. Connect the dataPAC containing the memory card to the computer, or place the memory card in the card drive on your computer, if you have one.

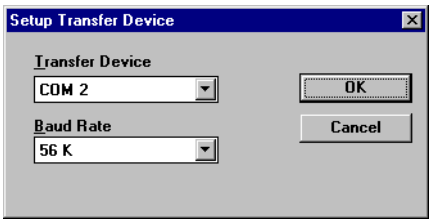
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2. Open the Screen View Utility. It should be located in the dataPAC directory on your hard drive. For example, C:\Program Files\EntekIRD\dataPAC\scrnview.exe. The utility screen appears.



3. From the **Setup** menu, choose **Unload Device**.

   The computer displays the **Setup Transfer Device** dialog box. Use this dialog box to select the **Transfer Device** and **Baud Rate** for transfer.



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4. Under **Transfer Device**, select the COM port that the dataPAC is connected to, or the drive letter of the card drive.

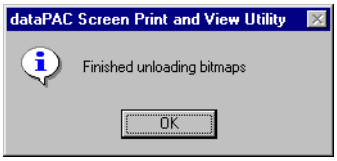
   To transfer with a serial cable, select one of the COM options. To transfer with a PCMCIA drive, select the drive letter of that device.

5. Select a baud rate for transferring the images, then click **OK**.

6. From the **File** menu, choose **Unload Bitmaps**.

   The message "Unloading Bitmaps" appears on the status line at the bottom of your screen. The Utility transfers the images and displays them on the screen. You can view the transferred images while the computer continues to transfer the other images.

   When the computer displays this message, the transfer is complete.

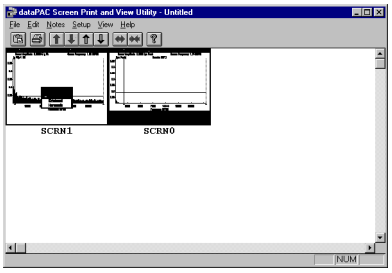


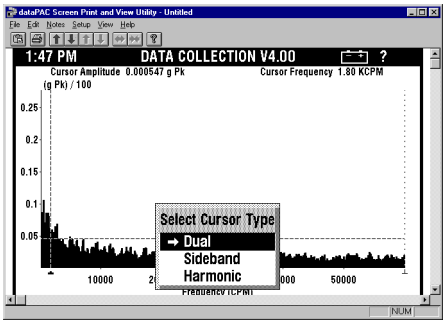
Error messages in dataPAC Screen Print and View Utility

Message	Solution
Screen ____ cannot be transferred because a duplicate screen name exists.	Either delete or rename the screen in the dataPAC 1500 Screen Print and View Utility.
A serial communications failure occurred while attempting to unload bitmaps.	Make sure that the settings on the Unload Device (Setup menu) on the dataPAC 1500 Screen Print and View Utility are correct. Make sure the dataPAC is securely connected to the computer.

Viewing Captured Screens on your Computer

After the computer transfers the images, they are displayed on the screen in either multiple image mode or single image mode.





Below are the steps for enlarging, reducing, printing, copying and deleting screen images using the dataPAC Screen Print and View Utility.

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To select a single image for display

If you are in multiple image mode, use the mouse to click on the image that you want to enlarge. Click again to return to multiple image mode.

To print a single image

1. While viewing multiple images, click the image that you want to print. The Utility enlarges the image.
2. If you can't see the whole image, enlarge the dataPAC Screen Print and View Utility window.
3. From the **File** menu, choose **Print**, or click on the printer icon on the toolbar.
4. Choose **OK** in the dialog box to print the image.

To print multiple images

1. Display multiple images in the window.
2. To size the images correctly, use the  to enlarge or  to reduce the image.
3. From the **File** menu, choose **Print**.

Or click 

Note: From the **File** menu, choose **Print Preview** to see how your images will look on the printed page. You can print from the **Print Preview** window, or close it and resize your images using the left and right arrow buttons.

4. Follow the dialog boxes that appear to print your images.

To copy images to the clipboard

You can copy images from the screen to the clipboard and paste them in other Windows applications. To do this, follow these steps:

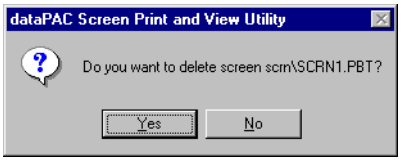
1. Click the image that you want to copy.
2. From the **Edit** menu, choose **Copy to Clipboard**.

Or click 

3. The image is now on the clipboard. You can use the **Paste** command to place the image into another Windows program.

To delete captured images

1. Scroll through the images to locate the image you want to delete.
2. Right-click the image to delete it. The computer displays the following message.



3. Choose **Yes** to delete the image.

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Commands Available while Viewing Images

Mouse commands

- Click an image once to enlarge it.
- Click an image again to reduce the image.
- Right-click an image to delete it. Deleting an image from the screen deletes it from the computer's memory.

Toolbar



If the toolbar is not displayed, you can open it by selecting **Toolbar** from the **View** menu.

Button	Description
	Copies selected image to the clipboard. You can paste the image from the clipboard to other Windows applications.
	Prints selected image or images.
	Moves to the next or previous row of images.
	Moves to the next or previous page of images.
	Enlarges or reduces images. Use the mouse to view one image.
	Displays the About box for the application.

Keyboard

When viewing multiple images, the **PAGE UP** and **PAGE DOWN** keys allow you to scroll through displayed images.

Printing Reports and Plots using Host Software

You can also use EMONITOR Odyssey or Enshare or IQ2000 to print reports, especially if you want to automatically print reports directly after unloading. For more information on printing reports or plots using EMONITOR Odyssey or Enshare, refer to the *EMONITOR Odyssey or Enshare User's Guide.* For more information on printing reports or plots using IQ2000, refer to the *IQ2000 Application User's Guide.*

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Chapter 4

Off Route Analysis with the dataPAC

This chapter describes using the dataPAC 1500 to collect off route and analysis measurements, such as overall, spectrum, time waveform, true zoom, phase/magnitude/speed, measurements, and start up/coast down measurements using waterfall/FFT or Bode/Nyquist.

Collecting Off Route or Analysis Data *106*

Setting Up and Collecting Off Route Overall Measurements *108*

Setting Up and Collecting Off Route Spectrum Measurements.....*112*

Setting Up and Collecting Off Route Orders Measurements *121*

Setting Up and Collecting Off Route Time Waveform Measurements *128*

Setting Up and Collecting Off Route True Zoom Measurements *134*

Setting Up and Collecting Off Route Phase/Magnitude/Speed *138*

Setting Up Start-Up/Coast-Down Measurements *143*

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Using an Internal Trigger Source to Collect Data..... *157*



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Collecting Off Route or Analysis Data

Unscheduled or off route data is additional data you collect that is not part of a list (route). While collecting list data, you may notice some unusual conditions that you want to analyze further. You may also want to collect data for undefined points (points not in your database), or existing points that are not in your current list.

Collecting Off Route Data with the dataPAC 1250

dataPAC 1250

In off route (or analysis) mode, you can take overall or spectral measurements, view them in real time, and store the data for later inspection and analysis.

While collecting data on any route, you can pause and take unscheduled or off route measurements. You can also turn the dataPAC on, select any route, then go off route and collect and analyze data without collecting any route information.

Off route measurements are stored at the current point as an off route measurement or at a user-defined point. The current point is defined by where you leave the regular route to take an off route measurement. You may also simply want to use the dataPAC as a real-time analyzer, solving problems without actually storing the data on your computer.

To unload unscheduled measurements into the host software, you must have first loaded a list so that the unscheduled measurements can be unloaded with that list.

Collecting Off Route or Analysis Data with the dataPAC 1500

dataPAC 1500 Only

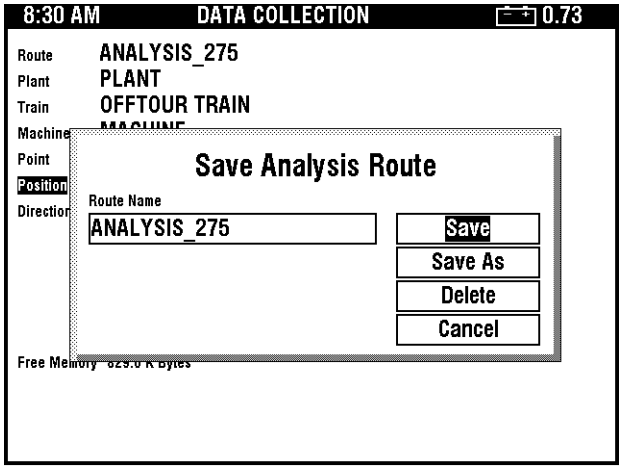
With a dataPAC 1500, there are two ways to get to the off route measurement mode. You can use the Analysis application from the Program Manager, or press the Off Route softkey while collecting route data.

When you use the Analysis application, the dataPAC creates a new route file automatically, and you can begin setting up the measurements and collecting data. When you exit the Analysis application, dataPAC prompts you to save the created route file.

By default, the dataPAC names the file with a random number that increments by one each time you save an analysis route. These files may be unloaded to EMONITOR Odyssey 2.0 or Enshare. Refer to the Loading and Unloading chapter for more information if you are using the host software.

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When you press <DONE> to exit the Analysis application, the follow screen appears.



- To save the analysis route with the name that appears under Route Name, choose Save. The number used is a random number that increments by one each time you save an analysis route. This method should help in selecting a unique name.
- To save the analysis route with a different name, choose Save As.
- To exit the Analysis application without saving the route, choose Delete.
- To return to the Analysis application without saving the route, choose Cancel.

The following sections describe the steps necessary to set up and collect off route measurements.

Ranging Measurements Manually

dataPAC 1500 only

With the dataPAC 1500, you can use the arrow buttons to manually range the measurement instead of relying on autoranging.

When you see the first screen after pressing <STORE>, press the up or down arrow button to adjust the ranging. When you are satisfied with the range, press <STORE>.

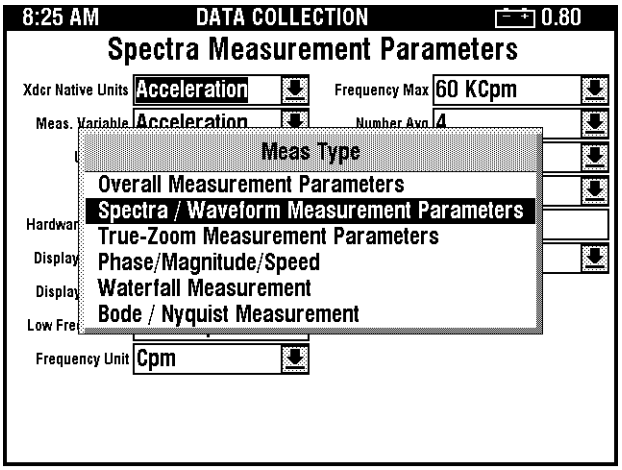
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Setting Up and Collecting Off Route Overall Measurements

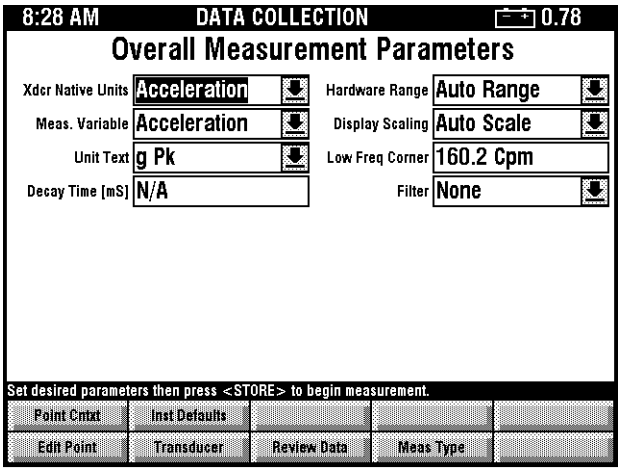
This section discusses how to set up and collect off route magnitude (overall) measurements. To take an off route overall measurement, follow the steps below.

Setting Up Off Route Overall Measurements

1. After entering Off Route or Analysis mode, press <F4> (Meas Type) to display the Measurement Type selection window.



5. Use the up and down arrow keys to select Overall Measurement Parameters, then press <SELECT>. The dataPAC displays the Overall Measurement Parameters window.



6. Press <F1> (Edit Point) to change the measurement setup. You can press <SHIFT><F1> (Point Context) to copy the current point setup from the route measurement to your off route measurement. Alternatively, you can press <SHIFT><F2> (Instrument Defaults) to select the instrument defaults for your off route measurement. Use the field descriptions below to set up the measurement.

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Xdcr Native Units

The Transducer Native Units parameter specifies the type of transducer connected to your dataPAC. The choice of this parameter controls the list of possible selections available for the Measurement Variable parameter.

Meas. Variable

The Measurement Variable parameter selects the signal measurement coming from the transducer. For example, if you have an accelerometer, you can measure acceleration, velocity, or displacement.

Unit Text

The Unit Text parameter selects the signal detection display for this measurement. Select from the available list: RMS, Pk, Pk-Pk, or Other.

The list of selections is dependent upon current selections in the previous two parameters: Transducer Native Units and Measurement Variable. Note that this simply specifies the text that is used to label the measurement.

Decay Time

The Decay Time parameter specifies how long a peak is held before a new peak is captured. A captured peak is exponentially decayed towards zero with each measurement update. If a new peak is detected that is larger than the decayed peak, the peak value is updated. This parameter specifies the time it takes for a detected peak to decay to 37% of its original value. New peaks are those that fall above the decayed value.

Hardware Range

The Hardware Range parameter sets a maximum range for this measurement. Selecting Auto Range causes the system to select an optimum range after you press <STORE> to start a measurement. Generally, you should use Auto Range. However, if want to specify a range, you can select one from the list.

Note: The scaling that is used to display the measured data is controlled with the Display Scaling parameter.

Display Scaling

The Display Scaling parameter controls the scale used to display the measured data. Auto Scale or Track Hardware Range are good options, but if you want to take measurements from several places for comparison, you may want to specify a range so that your displays can be easily compared. Your choices are:

- **Auto Scale** - The display scale automatically adjusts to the measured data.
- **Track Hardware Range** - Presents the data on the same hardware range that it uses to measure the data.
- **Fixed display ranges** - Select from the list of supported ranges.

Low Frequency Corner

The Low Frequency Corner defines the frequency below which the input signal is significantly attenuated. This selection may affect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle.

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Filter

The Filter parameter selects the filter used when collecting the measurement. These filters are used for sound measurements. Your choices are:

- **None** - The dataPAC does not apply a filter to the measurement.
- **ISO 2954** - The dataPAC applies an ISO 2954 filter to the measurement.
- **Sound A** - The dataPAC applies an A weighting filter to the measurement.
- **Sound B** - The dataPAC applies a B weighting filter to the measurement.
- **Sound C** - The dataPAC applies a C weighting filter to the measurement.

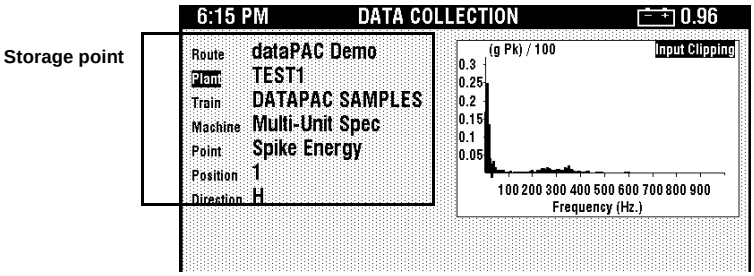
Any measurement that uses these sound filters uses Xdcr Native Units of Other, a Measurement Variable of Dynamic, and a Unit Text setting of Pa for Pascals of pressure.

Collecting an Off Route Overall Measurement

1. After setting up the measurement, connect the proper transducer.
2. Press <STORE> to start the measurement. The dataPAC ranges and collects the data.
3. Once the dataPAC collects the measurement, press <STORE> again to save the measurement. You can view the measurement in progress for as long as you wish without saving. If you are in the minimum window, the dataPAC displays a small folder with the number 1 in it after you press <STORE> to save the measurement. This indicates that the dataPAC has saved the measurement. If you have Data Overwrite enabled, only the data from the last time you pressed <STORE> is unloaded to your database.

Note: See “Selecting the Data Collection Options” on page 127 for more information about the Data Overwrite option.

The measurement is stored as an off route measurement at the storage point displayed below.



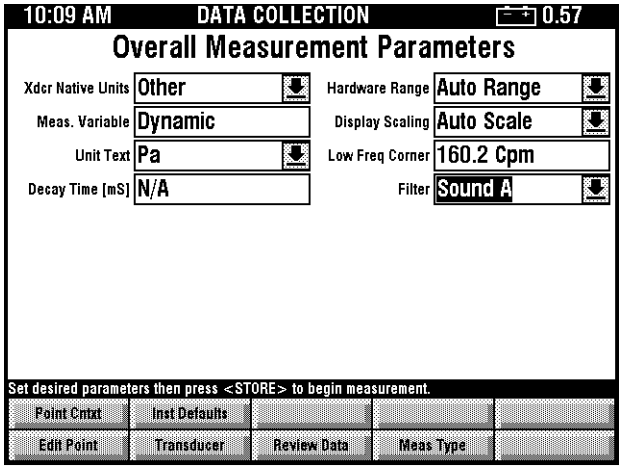
4. Press <DONE> when you are finished. You can view the last measurement, if you stored it, by pressing <F3> (Review Data).

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Collecting Off Route Overall Sound Measurements

dataPAC 1500 Only

To collect a sound measurement using the dataPAC in Analysis mode, set up the overall measurement as shown below. Choose Xdcr Native Units of Other, and a Measurement Variable of Dynamic, and Unit Text of Pa for Pascals of pressure.



Connect and install a microphone transducer to collect the measurement, using "Generic Other" as the type. If you are using an ICP microphone, you select Enable Power. Usually a microphone transducer uses mV/Pa for calibration. There is an ICP microphone available from IMI where the output is 25 mV/Pascal.

The installed transducer must have units that match the Xdcr Native Units, so you should install the "Generic Other" transducer to collect a sound filtered measurement.

Collecting Dynamic Non-Vibration Measurements

dataPAC 1500 only

You can set up and collect non-vibration measurements, such as voltage measurements, using the dataPAC 1500. There are two parameters that allow to do this, the Xdcr Native Units setting, and the Measurement Variable setting.

For the Measurement Variable setting, the "Static" setting is for DC type signals like those from a temperature probe. The "Dynamic" setting is for variable signals like those from a microphone or a vibration transducer.

You should install the "Generic Other" transducer to collect non-vibration measurements.

To set up a temperature probe

You can order a temperature probe from Entek IRD (P/N 37431). To use this device for off route data collection, you would set up a Generic Other transducer, and use the Static setting for the Measurement Variable.

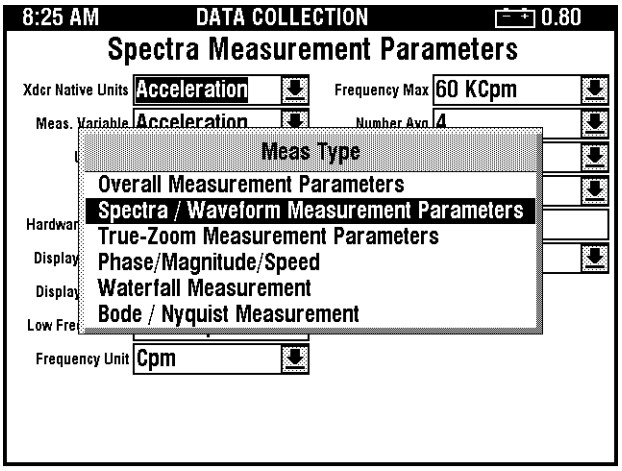
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Setting Up and Collecting Off Route Spectrum Measurements

This section discusses how to set up and collect unscheduled spectrum measurements. To take an off route spectrum measurement, follow the steps below.

Setting Up Off Route Spectrum Measurements

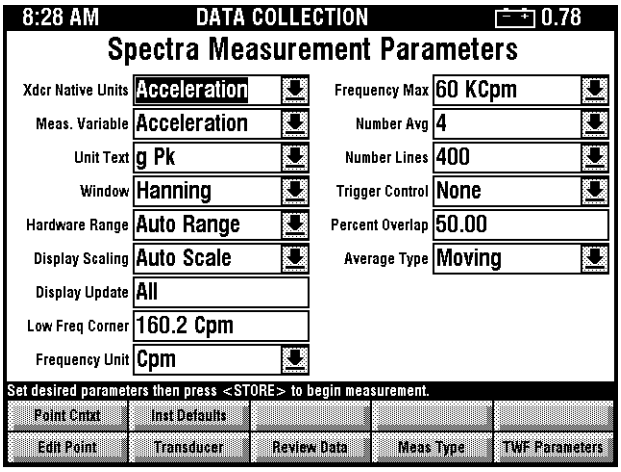
1. In the Program Manager, use the arrow keys to highlight the Data Collection icon, then press <SELECT>.
2. Select a route or define a new route.
3. Once in Data Collection mode, press <SHIFT><F5> (Off Route). This copies all the point information to the new off route point definition. The dataPAC displays a setup page for you to control the measurement parameters. The page displayed is the one that was used the previous time off route mode was used.
4. Press <F4> (Meas Type) to display the Measurement Type selection window.



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5. Use the up and down arrow keys to select Spectra / Waveform Measurement Parameters, then press <SELECT>. The dataPAC displays the setup parameters window for the selected measurement type.

Note: If Time Waveform appears, press <F5> (Spectra Param.) to get to the Spectrum screen. When you change from time waveform to spectra, the time waveform parameters are automatically converted to the corresponding spectral parameters and vice versa.



6. Press <F1> (Edit Point) to change the measurement setup. You can press <SHIFT><F1> (Point Context) to copy the current point setup to your off route measurement. Alternatively, you can press <SHIFT><F2> (Instrument Defaults) to select the instrument defaults for your off route measurement. Use the field descriptions below to set up the measurement.

Xdcr Native Units

The Transducer Native Units parameter allows you to specify the type of transducer connected to your dataPAC. The choice of this parameter controls the list of possible selections available for the Measurement Variable parameter.

The dataPAC 1500 V5 allows you to choose Other, so you can choose Volts as the Unit Text. This allows you to connect to voltage sources and measure voltage.

Meas. Variable

The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have an accelerometer, you can measure acceleration, velocity, or displacement.

Unit Text

The Unit Text parameter allows you to select the display units for this measurement. Select from RMS, Pk, or Pk-Pk.

The list of selections is dependent upon current selections in the previous two parameters: Transducer Native Units and Measurement Variable.

Window

The Window parameter specifies the windowing function applied to the time waveform that is used to compute the spectra. Your choices are: Hanning, Hamming, Kaiser-Bessel, Flat Top, and Rectangular.

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Hardware Range

The Hardware Range parameter is used to set a maximum range for this measurement. Selecting Auto Range causes the system to select an optimum range after you press <STORE>. Generally, it is recommended that you use Auto Range. However, if want to specify a range, you can select one from the list.

Note: The scaling that is used to display the measured data is controlled with the Display Scaling parameter.

Display Scaling

The Display Scaling parameter controls the scale used to display the measured data on the vertical axis. Your choices are:

- **Auto Scale** - The display scale automatically adjusts to the measured data.
- **Track Hardware Range** - Presents the data on the same scale as the hardware range setting.
- **Fixed display ranges** - Select from the list of supported ranges.

Display Update

Press <SELECT> to toggle between All and Limited. All displays the result of each measurement. Limited only displays a subset of the data as it is collected. Limited measurements require less collection time.

Frequency Unit

Press <SELECT> to toggle between CPM/Hz and Orders Based/Orders Track.

Low Frequency Corner

The Low Frequency Corner defines the frequency below which the input signal is significantly attenuated. This selection may affect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle.

Frequency Max

This parameter specifies the maximum frequency that the dataPAC measures.

Number Avg

Select one (1) if you don’t want averaging. Otherwise, select the number of spectra to be acquired and averaged together to produce a measurement.

Number Lines

The number of lines parameter specifies the number of lines (bins) of resolution for the FFT spectra. The larger the number of lines, the better the frequency resolution of the measured data in the spectra. Similarly, the higher the number of lines, the longer it takes to collect the data and the more storage space required to save the collected data. The minimum number is 25 and the maximum is 12,800.

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Trigger Control

The Trigger Control parameter controls the slope type used for the trigger input. Your selections are:

- **None** - No trigger event is used for this measurement.
- **Positive Slope, External** - Defines the external trigger event to occur on a rising edge. Requires an external trigger signal, such as a tachometer.
- **Negative Slope, External** - Defines the trigger event to occur on a falling edge. Requires an external trigger signal, such as a tachometer.
- **Leading Edge/Trailing Edge** - Use this parameter to have the dataPAC automatically select the rising edge or the falling edge of the trigger mark. The selection is dependent upon the trigger pulse width and polarity. For example, if the trigger input is a narrow positive pulse, then Leading Edge selects the rising edge of the trigger event and Trailing Edge selects the falling edge.
- **Positive Slope, Internal** - Defines the trigger event to occur on a rising edge, from the internal vibration signal.
- **Negative Slope, Internal** - Defines the trigger event to occur on a falling edge, from the internal vibration signal.

Note: The internal trigger feature does not support synchronous averaging, but rather supports collection of transient data. See “Setting up and Collecting an Internally Triggered Spectrum or Time Waveform” on page 157.

Percent Overlap/Percent Pretrigger

The Percent Overlap parameter specifies the percent overlap to be used for this measurement. This parameter can reduce the total time that it takes to collect the data required for a spectral measurement with the number of averages greater than one.

The Percent Pretrigger parameter controls the amount of data collected prior to the trigger event. This parameter can range from 1 to 100 percent. It only applies to triggered measurements, so this parameter does not appear if Trigger Control is set to None.

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Average Type

This parameter selects the type of averaging for this measurement. Your selections are:

- **Moving** - The spectral measurements are averaged using equal weighting until the specified number of averages has been collected. The measurement process continues with the new data set being exponentially averaged with the previous data.
- **None** - No averaging is performed. The measurement continues until you press <STORE> again.

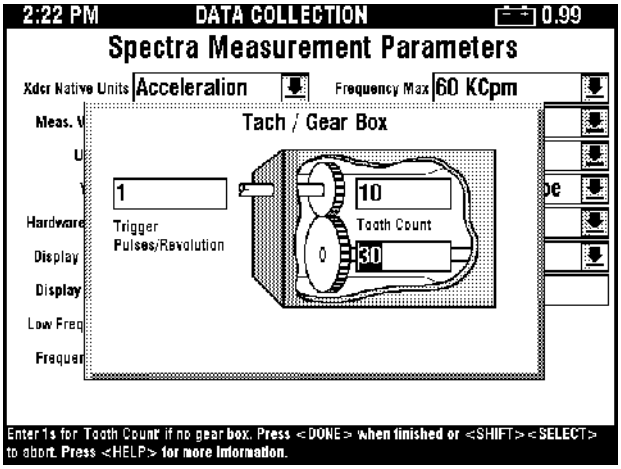
Note: While collecting a spectra, the dataPAC 1500 can drive a photostrobe at the same frequency as the active spectral cursor. The strobe should be connected to the dataPAC 1500's DB-9 connector and must be compatible with a TTL trigger input. See "Driving a Strobe While Collecting an Off Route Spectrum" on page 117.

- **Linear** - The specified number of data sets are collected, linearly averaged together with equal weight, and then the measurement is stopped.
- **R.M.S.** - The specified number of data sets are collected, averaged together using a root mean square calculation with equal weight, and then the measurement is stopped.
- **Peak-Hold** - The specified number of data sets are collected, the amplitude value from each bin is compared against the amplitude previously collected, the maximum for each bin is held and displayed, and then the measurement is stopped.

Tach/Gear Box

The Tach/Gear Box parameters are used to configure the dataPAC to measure information on a shaft that is inaccessible or "buried" in a gear box.

Note: This option is not available if Trigger Control is set to None.



- **Trigger Pulses/Revolution** - Indicates how many trigger pulses occur for each revolution of the reference shaft.

  Depending on the specifics of the Tach/Gear Box, you may not be able to determine the absolute phase angle to determine the absolute phase angle. If the gear ratio is greater than 1, the dataPAC ignores all but one of the pulses, so the phase angle is only relative.

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If the gear teeth are related by an integer value and the shaft with the trigger reference has the larger number of teeth, then and only then will the resulting phase angle have no ambiguity.

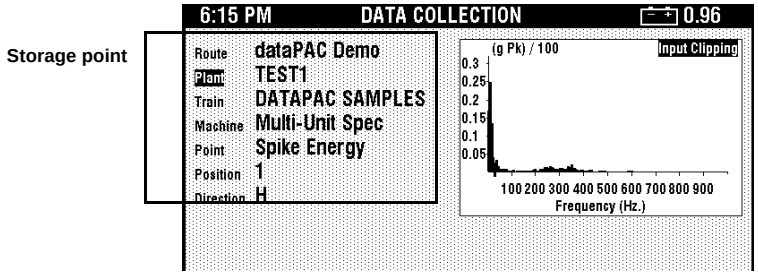
- **Tooth Count -** Indicates how many teeth are present on the external shaft and the internal shaft. If these values are set to 1, then the external shaft trigger is used directly. Otherwise, the external reference is converted to a new reference that matches the speed of the internal shaft. In this case, the phase measurement is only relative.

Collecting an Off Route Spectrum Measurement

1. Press <STORE> to start the measurement. The dataPAC ranges and collects the data.
2. Once the dataPAC collects the measurement, press <STORE> again to store the measurement. You can view the measurement in progress for as long as you wish without storing. If you are in a minimum window, the dataPAC displays a small folder with the number 1 in it after you press <STORE>. This indicates that the dataPAC has saved the measurement. If you have Data Overwrite enabled, only the data from the last time you pressed <STORE> is unloaded to your database.

Note: See “Selecting the Data Collection Options” on page 127 for more information about the Data Overwrite option.

The measurement is stored as an off route measurement at the storage point displayed below.



3. Press <DONE> when you are finished. You can view the last measurement, if you stored it, by pressing <F3> (Review Data).

Driving a Strobe While Collecting an Off Route Spectrum

(Models 1250 and 1500 only)

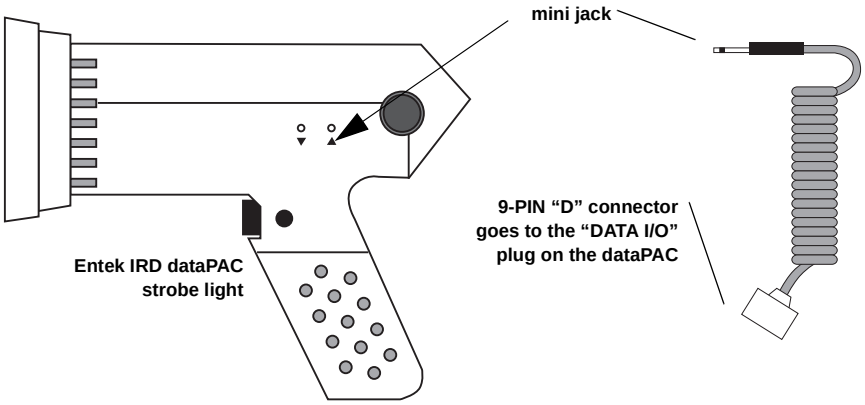
While collecting a spectra, the dataPAC 1500 can drive a photostrobe at the same frequency as the active spectral cursor. When the off route spectrum display is active, it may be used to set the strobe flash rate and phase. This capability provides an effective means for associating rotating components of a machine with their corresponding peaks in the frequency spectrum. By flashing the strobe at the frequency of a particular peak in the spectrum, and then using the strobe to illuminate suspect rotating components, the associated component appears to be stopped.

You can also conduct slow motion studies using the strobe. The dataPAC phase adjustment capability is a powerful tool for viewing for viewing a rotating component through an inspection port. You can use the phase adjustment control to show the component at any desired angular position through a fixed inspection port.

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The strobe flashes at the frequency associated with the active cursor position whenever the FFT measurement updates dynamically. This occurs only in the off route mode of Data Collection. To activate the strobe for an off route spectrum, follow these steps.

1. Connect the strobe light to the dataPAC using the input connector cable provided. The mini-jack plugs into the input of the strobe as shown below, and the 9-pin D connector attaches to the DATA I/O plug of the dataPAC.



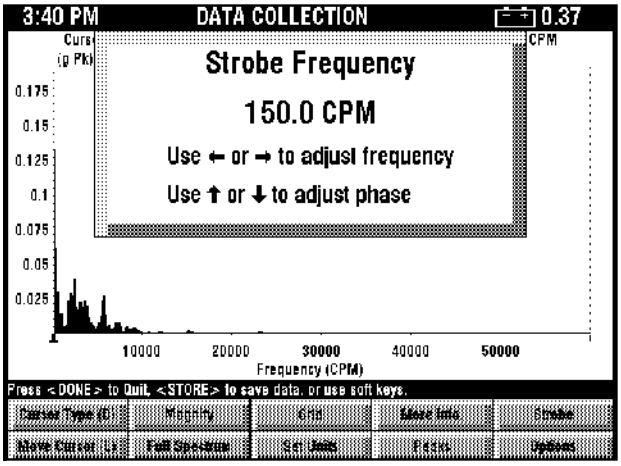
Note: If you are using the dB+ model of the strobe, make sure you are in External mode. For more information about the Strobe dB+, see "Using the Strobe dB+" on page 165.

2. Attach the transducer to the bearing housing.
3. When the machine is shut down, mark the rotor by making a mark on one rotor which serves as a reference when using the strobe light. It is also possible to use some other, existing identifying mark on the rotor as the reference mark, such as a key or keyway.

Note: If the rotor has multiple positions (vanes or fan blades), the reference mark must be at one of the blade positions.

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4. Set up the off route spectrum measurement. See “Setting Up and Collecting Off Route Spectrum Measurements” on page 112.
5. Press <STORE> to begin collection. If you are in reduced screen mode, press <F2> (Magnify) to go to the magnified view.
6. Press <SHIFT><F5> (Strobe) to begin strobe interaction.



6. Press the trigger on the strobe. The dataPAC drives the strobe while it collects the data, but stops when you stop the measurement or when the dataPAC finishes averaging.
8. The strobe flash rate can be tuned dynamically in this mode by moving the frequency cursor. Press the arrow keys for small incremental frequency and phase adjustments. Note that the flash rate is limited to discrete frequencies occupied by the cursor, which are limited by the horizontal display magnification, and by the FFT bin resolution.
9. To conserve battery power the strobe output is disabled when you stop the measurement. You can enable the strobe drive again by pressing <SHIFT><F5> (Strobe) available from the single spectra display mode only.
10. Press <DONE> to return to normal operation. Note that if the measurement process is active when <SELECT> is pressed, the strobe flash rate reverts to the active cursor frequency. Otherwise, the strobe drive is deactivated.

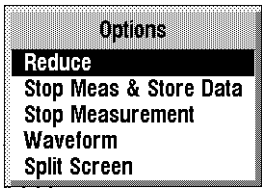
Stopping, Saving, and Viewing an Off Route Spectrum Measurement

You may need to stop or save a measurement while you are taking off route data. This section discusses methods for doing so. It also covers different methods of viewing the off route spectrum data.

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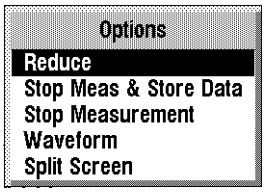
To stop a measurement without saving it

1. While collecting an off route spectrum measurement in the reduced view screen, you can press <F4> Stop Measurement. If you already pressed <F2> (Magnify) to view the spectrum full screen, go to the next step.
2. Press <F5> (Options) to open the Options menu.
3. Use the arrow keys to select Stop Measurement and press <SELECT> to completely stop the measurement without storing the data.



To stop and store a measurement

1. While collecting an off route spectrum measurement in the reduced screen, you can press <F4> Stop Meas & Store Data. If you already pressed <F2> (Magnify) to view the spectrum full screen, go to the next step.
2. Press <F5> (Options) to open the Options menu.
3. Use the arrow keys to select Stop Meas & Store Data and press <SELECT> to completely stop the measurement and store the data.



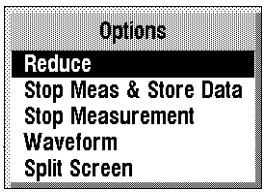
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To select other views (time waveform, split screen)

1. While collecting an off route spectrum measurement, press <F2> (Magnify) to view the spectrum full screen.
2. Press <F5> (Options) to open the Options menu.
3. To exit the current window and display the reduced view window, select Reduce and press <SELECT>.

   To switch to the time waveform window, select Waveform and press <SELECT>.

   To open a split screen showing both the Spectrum display and the time waveform, choose split screen. This is especially helpful for difficult vibration problems so you can simultaneously view and manipulate time and computed frequency information in a real time mode.



Setting Up and Collecting Off Route Orders Measurements

This section discusses how to set up and collect unscheduled orders based/orders track spectrum measurements. This section also contains important background information about the difference between Orders Based and Orders Track.

Background Information about Orders Based and Orders Track

The dataPAC 1500 now supports the specification and collection of a spectrum with an Fmax defined in terms of the number of orders for a given machine speed. With orders based spectra, the sampling rate is not fixed during the collection period. Instead, the time spacing between the samples may be constantly varying so that a fixed number of samples per shaft revolution is collected. The X axis of the time waveform is no longer measured in seconds, but instead it is measured in degrees or shaft position. From this, the corresponding spectral information is no longer measured in Hz or CPM, but instead it is measured in orders.

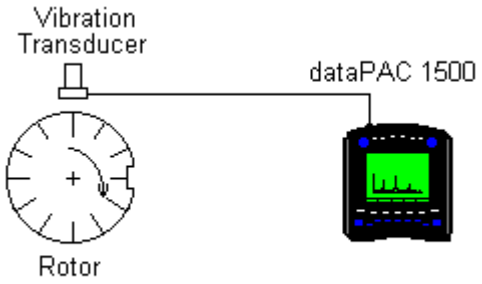
Variable speed machines are widely used in industry because of energy savings and flexible process control. Variable speed machines operate in a speed range, rather than a fixed speed. As a result, variable speed machines induce different vibration or resonance frequencies during the speed increases or decreases. Furthermore, the vibration frequencies of interest shift up or down as the speed changes, making machinery diagnosis difficult.

Rotating machines produce periodic vibrations and acoustic signals related to the shaft rotational speed and its harmonics. For a constant speed machine, the relationship between the vibration signals and frequency patterns can be established by the Fast Fourier Transform (FFT) analysis. The common problems associated with the rotating machinery, such as unbalance, misalignment, looseness, rolling-element bearing flaws, gear defects, etc., are readily identifiable in the frequency spectrum. However, such relationship is not always obvious in variable speed machines.

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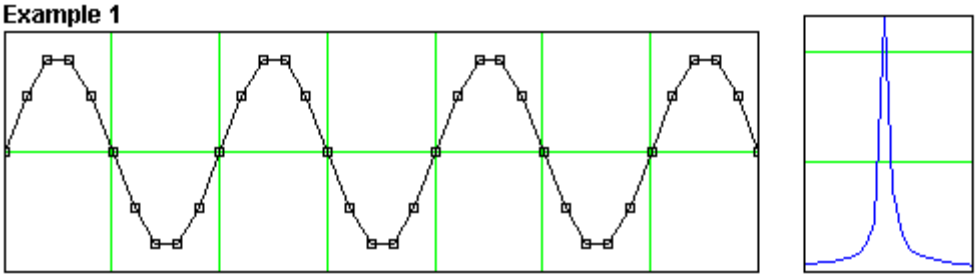
The orders tracking analysis is a measurement technique suitable for variable speed machines. It can sort out the signal components generated by a variable speed machine. Orders are essentially harmonics. But unlike harmonics, many interesting components are non-integer multiples of the first order or machine running speed. When one order of the interest is measured and the others are excluded, the measurement is called an order track.

You can see the advantages of collecting orders tracking measurements as shown in these three examples.



Data taken without speed measurement

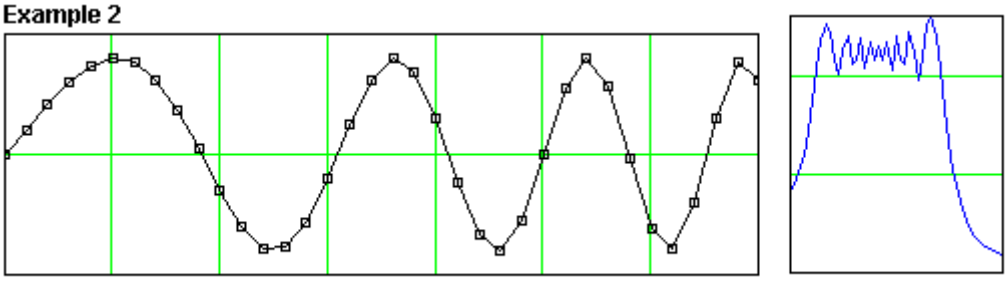
Example 1



Time waveform and spectrum of constant speed machine with uniform sampling rate.

Example 1 - A uniform sampling rate for a machine running at constant speed. The dataPAC does not take a speed measurement. In this case, the data samples have equal time intervals and the number of samples per cycle is a constant. As shown in the figure above, 10 samples per cycle were captured in every cycle with equal time spacing between the samples. The frequency spectrum for this sine wave was concentrated in one bin.

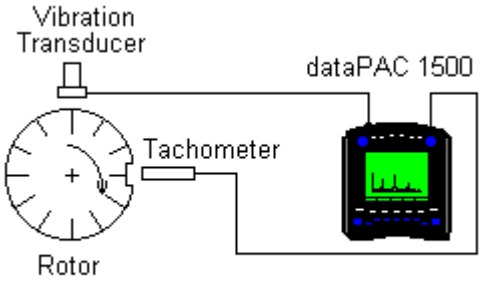
Example 2



Time waveform and spectrum of variable speed machine with uniform sampling rate.

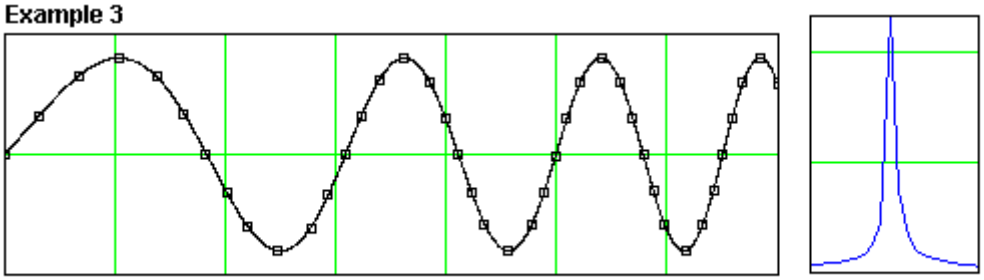
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Example 2 - A uniform sampling rate for a rotor running at variable speeds. When the machine speed increases, the period of the time waveform becomes shorter. But, the data samples were taken at a fixed sampling rate. Due to the speed increase, the number of samples in each cycle decreases. As shown in the figure above, 15 samples were taken in the first cycle, 10 in the second one, and 7 in the third one. Although the spacing between the data samples seems to become larger and larger in the time waveform, the samples actually have exactly the same time interval. The frequency spectrum was widely "smeared" due to the frequency shift. When the smearing problem occurs, the rotating frequency and related components appear in multiple bins or lines in a frequency spectrum.



Data taken with speed measurement

Example 3



Time waveform and spectrum of variable speed machine with variable sampling rate.

Example 3 - Variable sampling rate synchronized with the rotational speed of a variable speed machine. A tachometer is used to sense the shaft speed and provide a pulse or an integral number of pulses for each revolution. In this particular case, 12 pulses were generated for a complete revolution and each pulse indicated that the shaft had rotated 30 degrees. For the illustration purpose, the time waveform was sampled at the same rate as the tachometer pulses in this example, i.e., one sample per every 30 degrees. As shown in the figure above, 12 samples were taken for every cycle regardless how fast or slow the shaft was rotating.

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It is obvious that the samples do not have uniform time spacing in this case. When the machine speed increases, the sampling rate also increases and the samples have less spacing in time. Similarly, the decreases in machine speed results in larger time intervals between the samples. Since the data samples were obtained at a fixed number (in this example, 12 samples) per every revolution, the data in the revolution domain was indistinguishable from those of Example 1 in the time domain with equal time spacing. In other words, the data in the revolution domain in this example was equivalent to the data in the time domain in Example 1. The only difference between the two is that the equal time interval was replaced by equal rotational degrees. This was achieved by variable sampling rate synchronized with the machine rotational speed. Thus, the frequency spectrum for this example is again concentrated in one bin. The smearing was eliminated and the amplitude accuracy of the rotating frequency in the revolution domain was greatly improved.

Setting Up Orders Based Measurements

With the dataPAC 1500, you use the Frequency Unit parameter in the Spectra Measurement Parameters screen to accomplish orders based FFT collection. If you select Orders Based, then the frequency maximum is fixed during the actual data collection. The Fmax can be based on the machine speed value from the previous route point. Notice that when you select Orders Based, your Frequency Max selections are in multiples of running speed, such as 4X.

To collect Orders Based spectra, you can either use a reference input (trigger) for machine speed, or the dataPAC can use the previous active point's machine speed as a basis for setting Fmax. Note that if you set Trigger to None, you do not have to use a trigger input for machine speed. Off route points assume the machine speed of the previous active point.

When you enter off route mode, the previous active point is the route point you were at when you entered off route mode. For subsequent off route points, the previous point is the previous off route point.

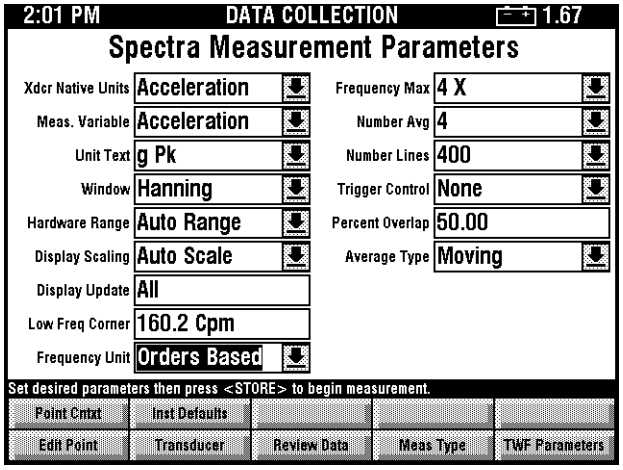
Note that the “Machine Speed” softkey is not available in off route mode. The “Set Speed” softkey is available for off route spectra measurements when the Harmonic cursor is selected. So, you can change the machine speed of an off route point if you take a spectra measurement and use the cursor and softkey.

If you collect data for an off route point and then change the machine speed (with the special spectrum cursor), the new machine speed is not is not applied to the previously collected data set. Note that this is different from the route functionality. After changing the machine speed though, subsequently collected off route data sets reflect the new machine speed.

There are two requirements for implementing this feature. The Fmax value must fall within the range of 10 to 5000 Hz, and the machine speed may not vary by more than 10% during the measurement collection.

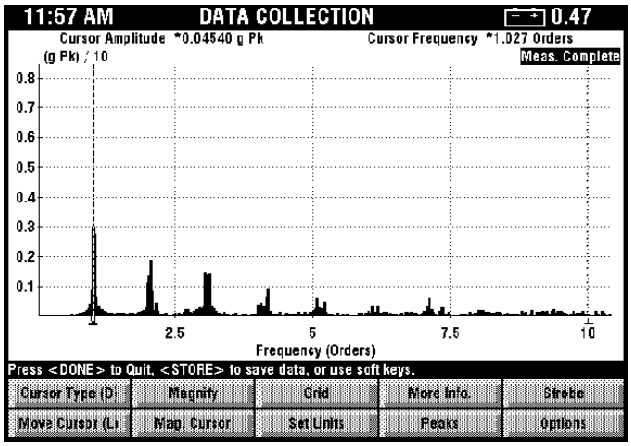
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To set up an off route spectrum measurement with Orders Based and no trigger, set up your measurement parameters as shown in the Spectra Measurement Parameters menu.



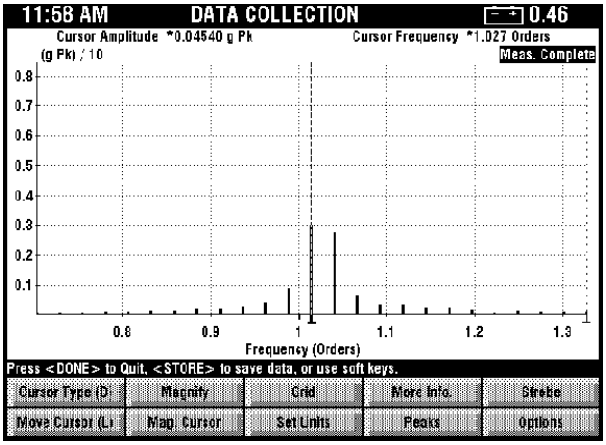
For Orders Based, a fixed sampling rate is used and the tachometer is not required. Although the orders spectra for both Orders Based and Orders Track have the same display unit (orders) in the X axis, the data sampling and results are different for variable speed machines. As shown in the figures below, the smearing is obvious in the Orders Based spectrum and its zoom-in display. In contrast, Orders Track yields clean spectrum. In these examples, the data was taken from a variable speed motor-demo unit.

Here is an example of an Orders Based spectrum measurement.



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Here is an example of a zoomed in Orders Based spectrum measurement. Notice the "smearing" of the lines.



Setting Up an Off Route Orders Track Spectrum Measurement

The dataPAC supports the specification and collection of a spectrum with an Fmax defined in terms of number of orders for a varying machine speed.

As explained above, with orders tracking, the sampling rate is not fixed during the collection period. Instead, the time spacing between the samples may be constantly varying so that a fixed number of samples per shaft revolution is collected. The X axis of the time waveform is no longer measured in seconds, but instead it is measured in degrees or shaft position. From this, the corresponding spectral information is no longer measured in Hz or CPM, but instead it is measured in orders.

You use the Frequency Unit parameter to accomplish orders based FFT collection. If you select Orders Track, the frequency maximum can vary during the data acquisition. Orders track eliminates the non-synchronous frequencies from the spectrum.

Notice that when you select Orders Track, your Frequency Max selections are in multiples of running speed, such as 4X or 10X.

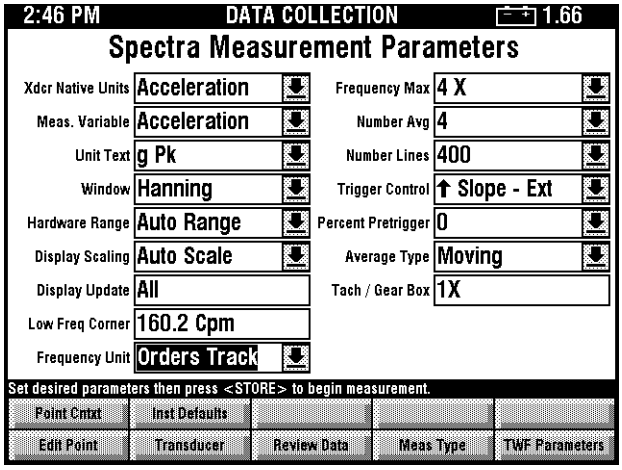
To collect Orders Track spectra, you must use a reference input for a trigger, such as a laser tachometer. Note that when you select Orders Track, Trigger Control changes to Positive Slope.

There are two parameter requirements for implementing this feature. The Fmax value must fall within the range of 10 to 5000 Hz, and the machine speed may not vary by more than 10% during the measurement collection.

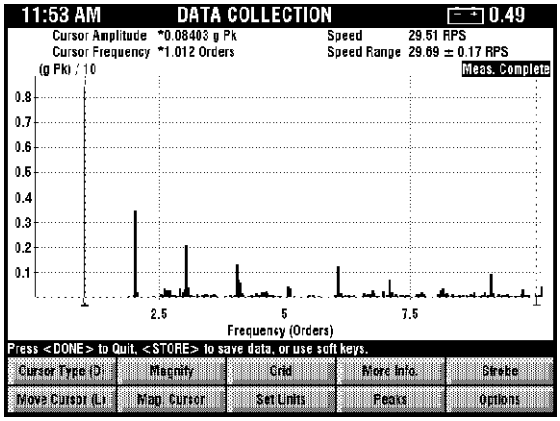
Orders tracking analysis can be used effectively to diagnose the vibrations of variable speed machines. The orders tracking yields data in the revolution domain, not the time domain. In an orders spectrum, signals that are periodic in the revolution domain appear as peaks and orders or harmonic components remain fixed in their position through speed changes. This is a clear advantage when comparing the characteristics of variable speed machines over a period of time.

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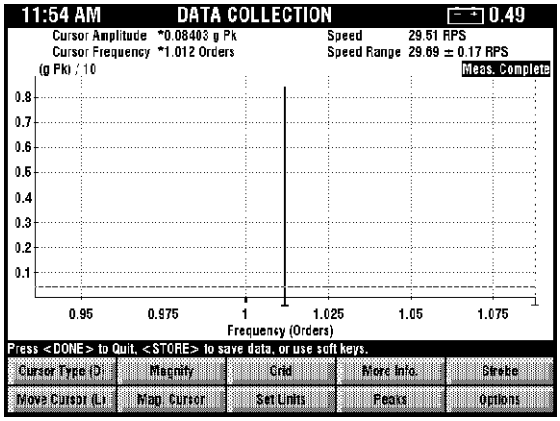
To set up an off route spectrum measurement with Orders Track, set up your measurement parameters as shown in the Spectra Measurement Parameters menu.



Here is an example of an Orders Track spectrum measurement.



Here is an example of a zoomed in Orders Track measurement. Note how clean the spectral line is.



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For Orders Track data collection, you are required to use a trigger to continually determine machine speed.

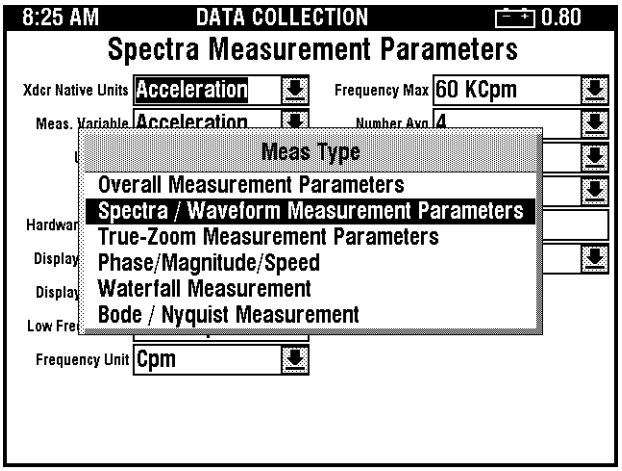
Setting Up and Collecting Off Route Time Waveform Measurements

dataPAC 1500 Only

This section discusses how to set up and collect unscheduled time waveform measurements. To take an off route time waveform measurement, follow the steps below.

Setting Up Off Route Time Waveform Measurements

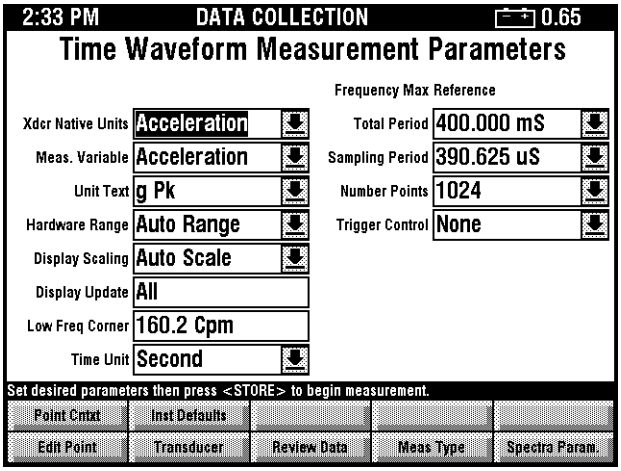
1. In the Program Manager, use the arrow keys to highlight the Data Collection icon, then press <SELECT>.
2. Select a route or define a new route.
3. Once in Data Collection mode, press <SHIFT><F5> (Off Route). The dataPAC displays a setup page for you to control the measurement parameters. The page displayed is the one that was used the previous time off route mode was used.
4. Press <F4> (Meas Type) to display the Measurement Type selection window.



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5. Use the up and down arrow keys to select Spectra / Waveform Measurement Parameters, then press <SELECT>. The dataPAC displays the setup parameters window for the selected measurement type.

Note: If the Spectra Parameters screen appears, press <F5> (TWF Parameters) to get to the Time Waveform screen.



6. Press <F1> (Edit Point) to change the measurement setup. You can press <SHIFT><F1> (Point Context) to copy the current point setup to your off route measurement. Alternatively, you can press <SHIFT><F2> (Instrument Defaults) to select the instrument defaults for your off route measurement. Use the field descriptions below to set up the measurement.

Xdcr Native Units

The Transducer Native Units parameter allows you to specify the type of transducer connected to your dataPAC. The choice of this parameter controls the list of possible selections available for the Measurement Variable parameter.

Meas. Variable

The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have a velocity probe, you can measure either velocity or displacement. The Measurement Variable parameter also includes gSE for the dataPAC 1500.

Unit Text

The Unit Text parameter allows you to select the display units for this measurement. Select from RMS, Pk, or Pk-Pk.

The list of selections is dependent upon current selections in the previous two parameters: Transducer Native Units and Measurement Variable. Note that this simply specifies the text that is used to label the measurement and scales the data appropriately.

Hardware Range

The Hardware Range parameter is used to set a maximum range for this measurement. Selecting Auto Range causes the system to select an optimum range after you press <STORE> to start a measurement. Generally, it is recommended that you use Auto Range. However, if want to specify a range, you can select one from the list.

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Note: The scaling that is used to display the measured data is controlled with the display scaling parameter.

Display Scaling

The Display Scaling parameter controls the scale used to display the measured data on the vertical axis.Your choices are:

- **Auto Scale** - The display scale automatically adjusts to the measured data.
- **Track Hardware Range** - Presents the data on the same scale as the hardware range setting.
- **Fixed display ranges** - Select from the list of supported ranges.

Display Update

Press <SELECT> to toggle between All and Limited. All displays the result of each measurement. Limited only displays a subset of the data as it is collected. Limited measurements require less collection time.

Low Frequency Corner

The Low Frequency Corner defines the frequency below which the input signal is significantly attenuated. This selection may effect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle.

Time Unit

The Time Unit parameter defines the units used for the X axis. Select from:

- **Second** - The X axis displays the time in seconds with the specified total period. This selection can be used with or without a trigger.
- **Orders Based** - The X axis displays the number of machine cycles as specified by the total period. The Orders Based selection can be used with or without a trigger. If you do not use a tachometer, then the dataPAC assumes the machine speed is the same as the current route point. If you use a trigger, then the dataPAC measures the machine speed and sets the X axis accordingly.
- **Orders Track** -The Orders Track selection requires a tachometer input. The tachometer input not only measures the machine speed, but it also dynamically tracks changes in the machine speed. The sampling rate is then adjusted accordingly to track the speed changes so that the requested number of cycles are always collected. The spacing on the X axis represents a variable change in time as opposed to Second or Orders Based. This selection may be helpful for start-up or coast-down analysis or variable speed machinery.

Total/Sampling Period

The Total Period and Sampling Period fields both control the rate at which the input signal is sampled.

This allows you to set either the total period for the desired time waveform, or you may set the sample period between each collected point. Changing this field value changes the maximum frequency for the corresponding spectra.

Number Points

This field controls the number of points to be collected in the time waveform. It also controls the size of the corresponding spectra.

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Trigger Control

The trigger control parameter controls the slope type used for the trigger input. Your selections are:

- **None** - No trigger event is used for this measurement.
- **Positive Slope** - Defines the trigger event to occur on a rising edge.
- **Negative Slope** - Defines the trigger event to occur on a falling edge.
- **Leading Edge/Trailing Edge** - Use this parameter to have the dataPAC automatically select the rising edge or the falling edge of the trigger mark. The selection is dependent upon the trigger pulse width and polarity. For example, if the trigger input is a narrow positive pulse, then Leading Edge selects the rising edge of the trigger event and Trailing Edge selects the falling edge.

Percent Pretrigger

The percent pretrigger parameter controls the amount of data collected prior to the trigger event. This parameter can range from 1 to 100 percent. It only applies to triggered measurements.

Average Type

This parameter selects the type of averaging for this measurement. Your selections are:

- **Moving** - The measurements are averaged using equal weighting until the specified number of averages has been collected. The measurement process continues with the new data set being exponentially averaged with the previous data.
- **None** - No averaging is performed. The measurement continues until the you press <STORE> again.
- **Linear** - The specified number of data sets is collected, linearly averaged together with equal weight, and then the measurement is stopped.
- **R.M.S.** - The specified number of data sets is collected, averaged together using a root-mean-square calculation with equal weight, and then the measurement is stopped.
- **Peak-Hold** - The specified number of data sets is collected, the amplitude value from each bin is compared against the amplitude previously collected, the maximum for each bin is held and displayed, and then the measurement is stopped.

Number Avg

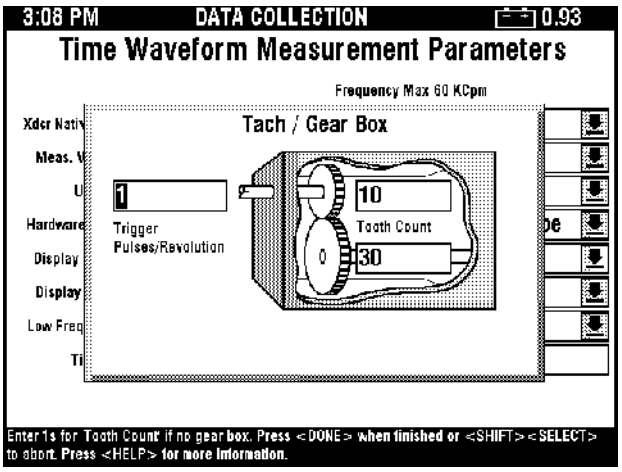
Use this field to enter the number of averages for this measurement.

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Tach/Gear Box

The Tach/Gear Box parameters are used to configure the dataPAC to measure information on a shaft that is inaccessible or "buried" in a gear box.

Note: This option is not available if Trigger Control is set to None.



- **Trigger Pulses/Revolution** - Indicates how many trigger pulses occur for each revolution of the reference shaft. If this parameter is set to a value other than 1, there is an initial phase angle ambiguity.
- **Tooth Count** - Indicates how many teeth are present on the external shaft and the internal shaft. If these values are set to 1, then the external shaft trigger is used directly. Otherwise, the external reference is converted to a new reference that matches the speed of the internal shaft. In this case, the phase measurement is only relative.

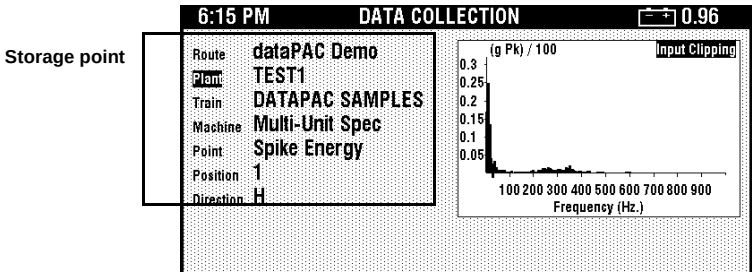
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Collecting Off Route Time Waveform Measurements

1. Press <STORE> to start the measurement. The dataPAC ranges and collects the data.
2. Once the dataPAC collects the measurement, press <STORE> again to store the measurement. You can view the measurement in progress for as long as you wish without storing. The dataPAC displays a small folder with the number 1 in it after you press <STORE>. This indicates that the dataPAC has saved the measurement. The number in the folder indicates the number of measurements you have taken at this point. If you have Data Overwrite enabled, only the data from the last time you pressed <STORE> is unloaded to your database.

Note: See "Selecting the Data Collection Options" on page 127 for more information about the Data Overwrite option.

The measurement is stored as an off route measurement at the storage point displayed below.



3. Press <DONE> when you are finished. You can view the last measurement, if you stored it, by pressing <F3> (Review Data).

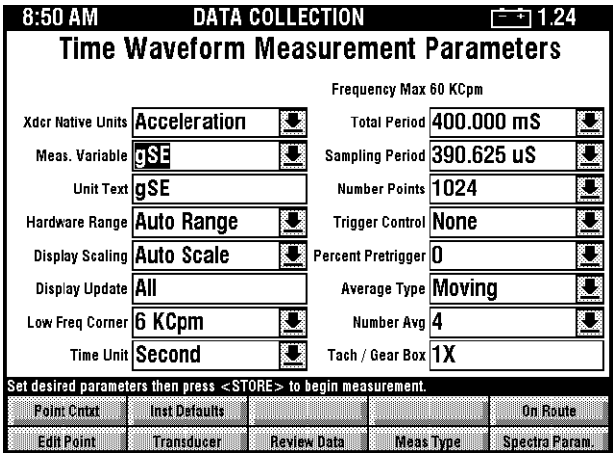
Setting Up Off Route gSE Time Waveform Measurements

dataPAC 1500 Only

General speaking, the amplitude of gSE time waveform has a relationship to the severity of the problem you are trying to detect. In some cases, you may not detect a problem from the gSE overall or gSE spectrum due to averaging and/or windowing, but you can clearly see it using the gSE time waveform. A possible example would be a bearing or gear defect in its very early stages.

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To set up an off route time waveform measurement with gSE collection, set up your measurement parameters as shown in the Time Waveform Measurement Parameters menu.



Collect the measurement as you would any time waveform, making sure that your accelerometer can detect high frequencies.

Setting Up and Collecting Off Route True Zoom Measurements

This section discusses how to collect unscheduled True Zoom measurements. While the True Zoom window looks like a magnification of a portion of the Spectra display, it is more than that. When you select True Zoom, the dataPAC focuses on the frequency range that you specify and collects data showing that range in great detail, allowing you to carefully analyze the results.

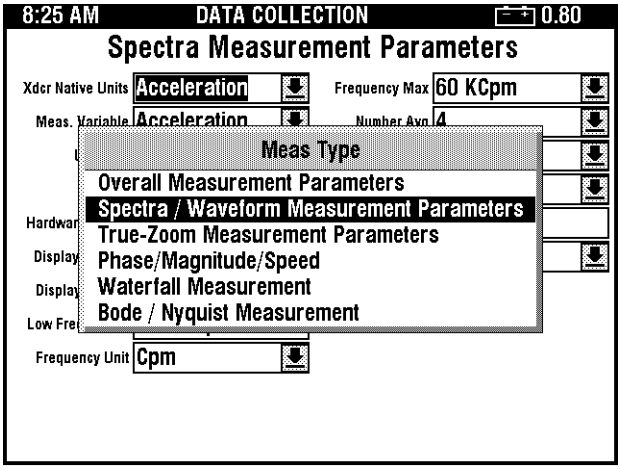
Hint: This can be done automatically from a standard spectrum measurement. Place the right and left cursors to indicated the desired zoom are, then press <SHIFT><F2>, then select Frequency - Zoom between cursors.

Setting Up Off Route True Zoom Measurements

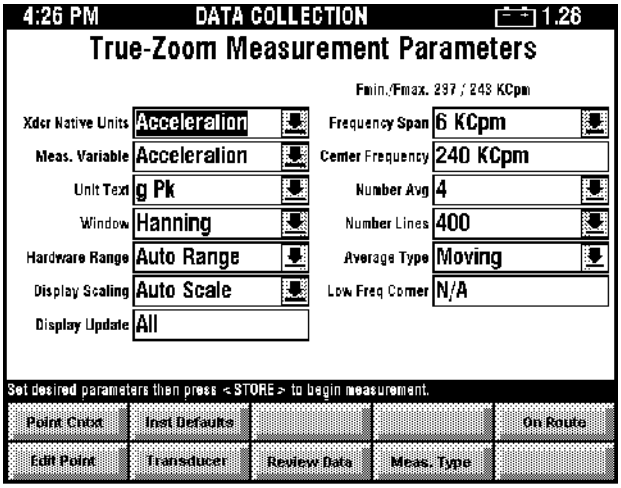
1. In the Program Manager, use the arrow keys to highlight the Data Collection icon, then press <SELECT>.
2. Select a route or define a new route.
3. Once in Data Collection mode, press <SHIFT><F5> (Off Route). The dataPAC displays a setup page for you to control the measurement parameters. The page displayed is the one that was used the previous time off route mode was used.

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4. Press <F4> (Meas Type) to display the Measurement Type selection window.



5. Use the up and down arrow keys to select True-Zoom Measurement Parameters, then press <SELECT>. The dataPAC displays the setup parameters window for the selected measurement type.



6. Press <F1> (Edit Point) to change the measurement setup. You can press <SHIFT><F1> (Point Context) to copy the current point setup to your off route measurement. Alternatively, you can press <SHIFT><F2> (Instrument Defaults) to select the instrument defaults for your off route measurement. Use the field descriptions below to set up the measurement.

Xdcr Native Units

The Transducer Native Units parameter allows you to specify the type of transducer connected to your dataPAC. The choice of this parameter controls the list of possible selections available for the Measurement Variable parameter.

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Meas. Variable

The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have a velocity probe, you can measure either velocity or displacement.

Unit Text

The Unit Text parameter allows you to select the display units for this measurement. Select from RMS, Pk, or Pk-Pk.

The list of selections depends on current selections in the previous two parameters: Transducer Native Units and Measurement Variable. Note that this specifies the text that is used to label the measurement and applies scaling to data.

Window

The Window parameter specifies the windowing function applied to the time waveform that is used to compute the spectra. Your choices are: Hanning, Hamming, Kaiser-Bessel, Flat Top, and Rectangular.

Hardware Range

The Hardware Range parameter sets a maximum range for this measurement. Selecting Auto Range causes the system to select an optimum range after you press <STORE>. Generally, it is recommended that you use Auto Range. However, if want to specify a range, you can select one from the list.

Note: The scaling used to display the measured data is controlled with the display scaling parameter.

Display Scaling

The Display Scaling parameter controls the scale used to display the measured data on the vertical axis. Your choices are:

- **Auto Scale** - The display scale automatically adjusts to the measured data.
- **Track Hardware Range** - Presents the data on the same scale as the hardware range setting.
- **Fixed display ranges** - Select from the list of supported ranges.

Display Update

Select All to display the result of each measurement, or select Limited to display only a subset of the data as it's collected. Limited displays require less collection time.

Frequency Span

The Frequency Span parameter, along with Center Frequency, controls the frequency range of interest for the true-zoom spectral measurement. The Frequency Span defines the difference between the minimum and maximum frequency for the spectra.

Center Frequency

This parameter, along with Frequency Span, controls the frequency range of interest for the true-zoom spectral measurement. The Center Frequency defines the midpoint between the minimum and maximum frequency for the spectra.

Number Avg

Select one (1) if you don't want averaging. Otherwise, select the number of spectra to be acquired and averaged together to produce a measurement.

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Number Lines

The number of lines parameter specifies the number of lines (bins) of resolution for the FFT spectra. The larger the number of lines, the better the frequency resolution of the measured data in the spectra. Similarly, the higher the number of lines, the longer it takes to collect the data and the more storage space required to save the collected data. The minimum number is 25 and the maximum is 12,800.

Average Type

This parameter selects the type of averaging for this measurement. Your choices are:

- **Moving** - The spectral measurements are averaged using equal weighting until the specified number of averages has been collected. The measurement process continues with the new data set being exponentially averaged with the previous data.
- **None** - No averaging is performed. The measurement continues until the you press <STORE> again.

Note: While collecting a spectra, the dataPAC 1500 can drive a photostrobe at the same frequency as the active spectral cursor. The strobe should be connected to the dataPAC 1500's DB-9 connector and must be compatible with a TTL trigger input. See "Driving a Strobe While Collecting an Off Route Spectrum" on page 117.

- **Linear** - The specified number of data sets is collected, linearly averaged together with equal weight, and then the measurement is stopped.
- **R.M.S.** - The specified number of data sets is collected, averaged together using a root-mean-square calculation with equal weight, and then the measurement is stopped.
- **Peak-Hold** - The specified number of data sets is collected, the amplitude value from each bin is compared against the amplitude previously collected, the maximum for each bin is held and displayed, and then the measurement is stopped.

Low Frequency Corner

The Low Frequency Corner defines the frequency below which the input signal will be significantly attenuated. This selection may affect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle.

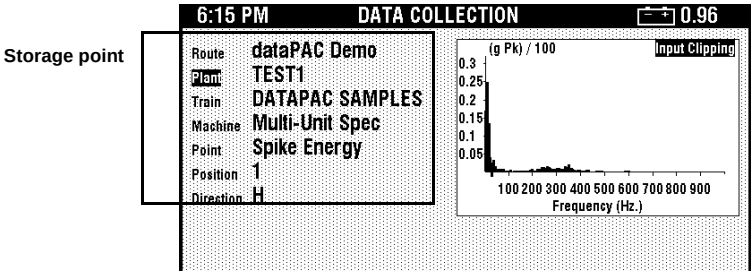
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Collecting Off Route True Zoom Measurements

1. Press <STORE> to start the measurement. The dataPAC ranges and collects the data.
2. Once the dataPAC collects the measurement, press <STORE> again to store the measurement. You can view the measurement in progress for as long as you wish without storing. If in minimum mode, the dataPAC displays a small folder with the number 1 in it after you press <STORE>. This indicates that the dataPAC has saved the measurement. If you have Data Overwrite enabled, only the data from the last time you pressed <STORE> is unloaded to your database.

Note: See "Selecting the Data Collection Options" on page 127 for more information about the Data Overwrite option.

The measurement is stored as an off route measurement at the storage point displayed below.



3. Press <DONE> when you are finished. You can view the last measurement, if you stored it, by pressing <F3> (Review Data).

Setting Up and Collecting Off Route Phase/Magnitude/Speed

dataPAC 1500 only

This section discusses setting up and collecting phase/magnitude/speed measurements off route. The Phase/Magnitude/Speed measurement provides a single graphic view of three important components of vibration analysis: phase, magnitude (or amplitude) and speed (RPM, CPM or Hz).

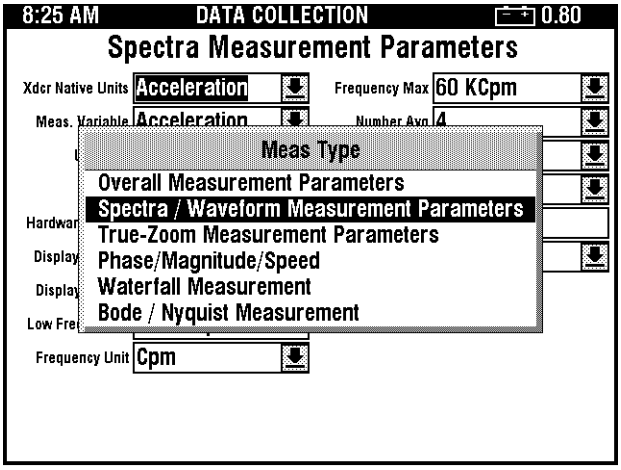
Note: In dataPAC 1500 V4, you cannot use a strobe light to accurately collect a phase measurement on variable speed machinery. A running speed variation as small as 1 RPM causes the phase measurement to appear to drift. Using a strobe light does not allow for adjusting the original reference point based on the variation in running speed. However, V5 does allow you to use a strobe light for phase because it can allow for the running speed variation. See "Using a Strobe to Collect Phase/Magnitude/Speed Measurements" on page 142.

Setting Up Off Route Phase/Magnitude/Speed Measurements

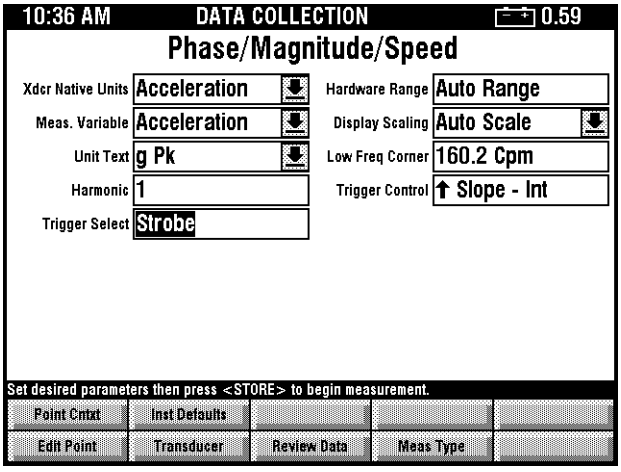
1. In the Program Manager, use the arrow keys to highlight the Analysis icon, then press <SELECT>.

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2. Press <F4> (Meas Type) to display the Measurement Type selection window.



3. Use the up and down arrow keys to select Phase/Magnitude/Speed, then press <SELECT>. The dataPAC displays the setup parameters window for the selected measurement type.



4. Press <F1> (Edit Point) to change the measurement setup. You can press <SHIFT><F1> (Point Context) to copy the current point setup to your off route measurement. Alternatively, you can press <SHIFT><F2> (Instrument Defaults) to select the instrument defaults for your off route measurement. Use the field descriptions below to set up the measurement.

Xdcr Native Units

The Transducer Native Units parameter allows you to specify the type of transducer connected to your dataPAC 1500. The choice of this parameter controls the list of possible selections available for the Measurement Variable parameter.

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Meas. Variable

The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have a velocity probe, you can measure either velocity or displacement.

Unit Text

The Unit Text parameter allows you to select the display units for this measurement. Select from RMS, Pk, Pk-Pk.

The list of selections is dependent upon current selections in the previous two parameters: Transducer Native Units and Measurement Variable. Note that this simply specifies the text that is used to label the measurement and scales the data appropriately.

Harmonic

This parameter controls the harmonic that is used for the phase/magnitude/speed measurement. A value of 1 is the normal setting; it is used to measure the phase and magnitude of the 1X machine speed component. A value of 2 measures the second harmonic and so on.

Trigger Select

This parameter allows you to choose the trigger device used. Version 5 allows you to use either a reference trigger such as a laser tach or a strobe light. If you use the strobe, the Trigger Control is automatically set to ↑ Slope - Int.

Hardware Range

This parameter is used to set a maximum range for this measurement. Selecting Auto Range causes the system to select an optimum range after you press <STORE>. Generally, it is recommended that you use Auto Range. However, if want to specify a range, you can select one from the list.

Note: The scaling that is used to display the measured data is controlled via the display scaling parameter.

Display Scaling

This parameter controls the scale used to display the measured data on the vertical axis. Your choices are:

- **Auto Scale** - The display scale automatically adjusts to the measured data.
- **Track Hardware Range** - Presents the data on the same scale as the hardware range setting.
- **Fixed display ranges** - Select from the list of supported ranges.

Low Frequency Corner

The Low Frequency Corner defines the frequency below which the input signal will be significantly attenuated. This selection may affect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle.

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Trigger Control

This parameter controls the slope type used for the trigger input. Your selections are:

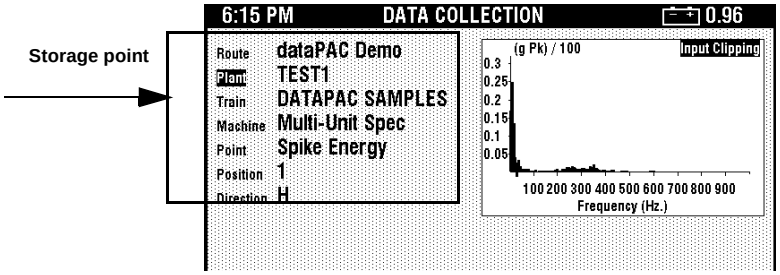
- **Positive Slope - Ext** - Defines the trigger event to occur on a rising edge.
- **Negative Slope - Ext** - Defines the trigger event to occur on a falling edge.
- **Leading Edge/Trailing Edge** - Use this parameter to have the dataPAC 1500 automatically select the rising edge or the falling edge of the trigger mark. The selection is dependent upon the trigger pulse width and polarity. For example, if the trigger input is a narrow positive pulse, then Leading Edge selects the rising edge of the trigger event and Trailing Edge selects the falling edge.
- **Positive Slope - Int** - This parameter is automatically selected if you choose Strobe for the Trigger Select parameter.

Collecting Off Route Phase/Magnitude/Speed Measurements

1. Press <STORE> to start the measurement. The dataPAC ranges and collects the data.
2. Once the dataPAC collects the measurement, press <STORE> again to store the measurement. You can view the measurement in progress for as long as you wish without storing. If in minimum mode, the dataPAC displays a small folder with the number 1 in it after you press <STORE>. This indicates that the dataPAC has saved the measurement. If you have Data Overwrite enabled, only the data from the last time you pressed <STORE> is unloaded to your database.

Note: See “Selecting the Data Collection Options” on page 127 for more information about the Data Overwrite option.

The measurement is stored as an off route measurement at the point displayed in the reduced view window.



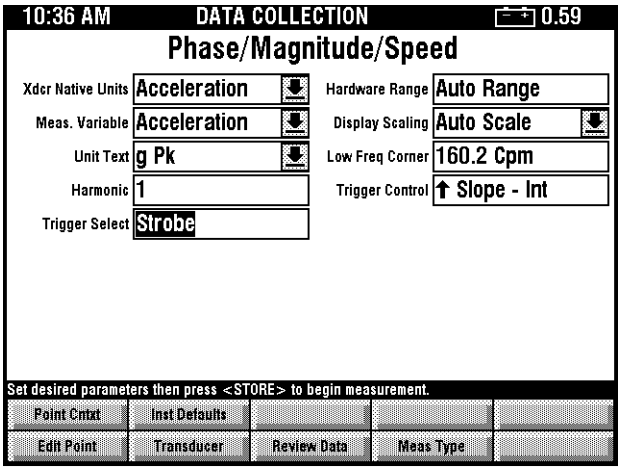
3. Press <DONE> when you are finished. You can view the last measurement, if you stored it, by pressing <F3> (Review Data).

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Using a Strobe to Collect Phase/Magnitude/Speed Measurements

dataPAC 1500 V5 only

The dataPAC 1500 V5 allows you to use a strobe light to collect phase measurements so that you can compare two phase measurements, such as the opposite ends of a shaft. Measuring phase with a strobe is only meaningful if you have another phase measurement to compare it to. Set up the parameters using Strobe for the Trigger Select. This screen shows the set up.



1. After setting up the measurement, press <STORE>.
2. Press the button on the strobe and aim it at the rotating machinery. You can keep the strobe in the on position by pressing the small button on the side of the trigger.
3. Press <F2> (Auto Speed) to get an estimation of the running speed from the transducer. If you do not have a high 1X running speed peak for the item you are viewing with the strobe, the Auto Speed function may not be able to detect the running speed.
4. Use the up and down arrow keys on the dataPAC to adjust the strobe speed so that it matches the running speed of the machine. Lock the marker at one position, such as the 12 o'clock position. Use the 1/2X Speed and 2X Speed softkeys to make sure that you have the correct flash rate. If you still see one mark when you press 1/2 Speed, the correct flash rate may be half as slow as your current speed.
5. Press <STORE> to continue. This action measures the phase shift. If you are collecting a comparative measurement, stop the mark at the same spot as the previous measurement. If you are comparing two measurements, such as the ends of a shaft, be sure to lock each at the same position to get relative phase.
6. Press <STORE> to store the measurement of phase, magnitude, and speed.

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Setting Up Start-Up/Coast-Down Measurements

dataPAC 1500 Only

The dataPAC 1500 allows you to observe a machine during start-up or coast-down to analyze the unusual vibration and resonance conditions that occur as the machine speed changes.

Start-up/coast-down measurements are used to investigate a machine's behavior during either a start-up or a coast-down. This includes the ability to collect and display the information for a Bode plot (phase and magnitude versus frequency), Nyquist plot (polar plot), and spectral waterfall display.

- **Waterfall/FFT** - Waterfall/FFT displays the vibration level in relation to the frequencies at which the vibration occurs. The Waterfall display enables you to view several measurements in relationship to each other.
- **Bode/Nyquist** - The Bode plot is actually two graphs of 1X RPM amplitude and phase as a function of frequency. The screen shows both plots at the same time, one over the other so that you can see at which frequencies the phase shifts occur and observe the 1X RPM vibration level at these points. The Nyquist plot is a polar representation of the amplitude and phase angle as a function of frequency. Three variables are combined into a single plot in polar format. When Bode/Nyquist data is selected, the machine speed and acceleration versus time profile is also collected.

The following parameters are available in Start-Up/Coast-Down measurements. Some are available only for Waterfall/FFT or Bode/Nyquist displays. The Measurement Parameters screen for Waterfall/FFT display looks like the following diagram.

Mode

Press <SELECT> to toggle between Start-Up and Coast-Down. This changes the Speed field to reflect the beginning or end ranges for machine speed.

Speed (RPM)

Depending on whether you have selected Start-Up or Coast-Down, this lets you specify the beginning and ending RPM for the data set sampling. No data collection occurs outside of these limits.

Press <SELECT> while in the Speed (RPM) box to display the Speed (RPM) window.

Use the arrow keys to select either Minimum or Maximum. Press <SELECT> to open an edit window to adjust the speed displayed. Press <DONE> when complete.

If Trigger Type is set to "None," this parameter has no effect.

Meas. Variable

The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have a velocity sensor, you can measure either velocity or displacement.

Press <SELECT> while in the Meas. Variable box to open the Measurement Variable window. Use the arrow keys to move in the list. Press <SELECT> to select the variable.

Unit Text

Press <SELECT> while in the Unit Text box to select the display units for this measurement.

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The selections depends upon the current selection in the Measurement Variable parameter. Note that this simply specifies the text that is used to label the measurement. The scaling for the measured data is automatically set based upon the selected Unit Text.

- **RMS** - Root Mean Square amplitude is the amplitude of a sine wave at the frequency of interest.
- **Pk** - Peak Amplitude is the RMS Amplitude multiplied by the square root of 2. This is the peak (0 to maximum) amplitude of a sine wave at the frequency of interest and is calculated from the RMS value.
- **PP** - Peak to Peak Amplitude is the RMS Amplitude multiplied by the square root of 2 times 2. This is the peak-to-peak (minimum to maximum) amplitude of a sine wave at the frequency of interest and is calculated from the RMS value.

Use the arrow keys to move in the list. Press <SELECT> to select the Unit Text.

Hardware Range

Hardware Range allows you to specify the detectable range when acquiring the signal. Press <SELECT> key and the Hardware Range dialog box opens.

Press <SELECT> to display a list of Hardware Range values. Use the arrow keys to select a value. This parameter is used to control the hardware range when taking a measurement. Measurement starts at the specified range. Anything over the specified value is not stored (it is clipped).

Press the right arrow key to highlight the Auto Scale If Clipping option then press <SELECT> to enable it. If enabled, the hardware re-ranges if the signal amplitude exceeds the selected hardware range. Press <DONE> when complete.

Note: Auto Scale if Clipping is most useful for machines that take a long time to start-up or coast-down. If this function is enabled, and signal clipping occurs during the measurement, then a new hardware range must be selected. Since data cannot be collected during the ranging process, there will be a gap in the collected data set.

Display Scaling

Press <SELECT> in the Display Scaling box to select from a list of display scale values.

This parameter controls the display scale for measured data. Auto Scale or Track Hardware Range are good options, but if you want to take measurements from several places for comparison, you may want to specify a range so that your displays can be easily compared. Select from:

- **Auto Scale** - Adjusts automatically to the measured data.
- **Track Hdw Rng** - Presents the data on the same hardware range that is being used to measure the data.
- **Fixed display ranges** - A list of supported ranges.

Display Update

Use the <SELECT> key to toggle between Final Results and Live while in the Display Update box. If set to Live, the dataPAC displays the measured data immediately. If set to Final Results, the dataPAC displays the data once measurement is complete.

Note: More data can be collected in the same amount of time using the Final Results setting.

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Spacing

Press <SELECT> to control the spacing between collected spectra or between Phase/Magnitude/Speed/Acceleration points.

- **Speed-Linear** - Collects data with uniform spacing between the two specified speed limits.
- **Speed-Log** - Collects data with logarithmic spacing between the two specified speed limits. More data is collected at lower machine speeds than at higher machine speeds.
- **Time** - Enables you to specify that data be collected on uniform time intervals (data is collected only if the machine speed has changed since the last data set for triggered data collection). The time interval has a tenth-of-a-second resolution.
- **Manual** - Enables you to control when data is to be collected based on pressing <STORE>.

Frequency Max

Press <SELECT> while in this box to display a list of maximum frequencies to use during measurement. Use the arrow keys to select an item in the list, and press <SELECT>.

Low Freq Corner

Press <SELECT> while in this box to define the frequency below which the input signal is significantly attenuated. This selection may affect the time required for the input signal to settle. The lower the frequency, the longer the time required for the signal to settle. Select a higher Low Frequency Corner, and the dataPAC ranges faster. Select a lower Low Frequency Corner, and the dataPAC gives better low frequency data, but takes longer to get it.

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Window

Press <SELECT> key in the Window box to specify the windowing function applied to the time waveform that is used to compute the spectra.

- **Hanning** - A general purpose window for use with random-type data. Hanning provides a good compromise between amplitude accuracy and frequency accuracy. Use this setting for most of your machinery monitoring activities.
- **Hamming -** A general purpose window that is similar to the Hanning window. It provides better frequency resolution but decreased amplitude accuracy when compared to the Hanning window. You can use it to separate close frequency components.
- **Kaiser-Bessel** - This window is even better than the Hamming for separating close frequencies because the filter has even less leakage into side bins. However, the initial main envelope covers several bins, so resolution is less than with Hamming. Gives fair peak amplitude accuracy, fair peak frequency accuracy.
- **Flat Top** - This window has a very wide filter which covers several bins. It shows a signal appearing at several frequencies, but has the advantage of giving very accurate amplitude. Its primary use is for calibration. Use this when amplitude accuracy is more important than frequency resolution. In data with closely spaced peaks, a Flat Top window may smear the peaks together into one wide peak. Use this setting for sinusoidal or calibration signals.
- **Rectangular** - The data collector does not apply a window. Use this for transient signals that die out before the end of the time sample, or for exactly periodic signals within the time sample. The advantage of using this comes in start-up or coast-down, if the windows are triggered by a signal in phase with rotation, where very good tracking order can be achieved.

Number Lines

Press <SELECT> to display a list of the number of lines (bins) of resolution for the spectra. The larger the number of lines, the better the frequency resolution of the measured data in the spectra. Similarly, the higher the number of lines, the longer it takes to collect the data, and the more storage space required to save the data. The minimum number is 25, and the maximum number is 12,800.

Data Sets

Press <SELECT> in the Data Sets box to select the number of data sets to be collected.

A data set consists of a single FFT for an FFT/Waterfall measurement. A data set consists of a phase, magnitude, speed, and acceleration measurement for a Bode/Nyquist measurement.

Note: It may not always be possible to collect and display the specified number of data sets. This occurs if the machine goes through the specified speed range faster than the dataPAC can collect the data. Under these conditions, the dataPAC collects as much data as possible. Setting the Display Update parameter to Final Results minimizes this problem by removing the live-time display burden.

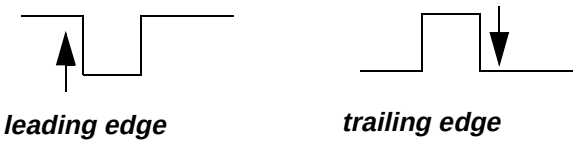
Use the arrow keys to select from the list, then press <SELECT> when complete. If you select Custom, use the edit window to enter the specific number of data sets to be collected, between 2 and 999, and press <DONE>.

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Trigger Type

Press <SELECT> while in the Trigger Type box to select from a list of trigger types.

- **None** indicates that the machine speed is not to be measured. This is only possible for an FFT/Waterfall measurement.
- **Positive Slope** indicates that the machine speed is measured using the positive edge of the trigger signal as the phase reference.
- **Negative Slope** indicates that the machine speed is measured using the negative edge of the trigger signal as the phase reference.
- **Leading Edge** or **Trailing Edge** automatically selects the rising edge or the falling edge. The selection depends upon the trigger pulse width and polarity. If the trigger input in a narrow positive pulse, Leading Edge selects the rising edge for the trigger event, and Trailing Edge selects the falling edge. If the trigger input is a narrow negative pulse, then leading edge selects the falling edge, and trailing selects the rising edge. See the illustrations below.



Trigger Level

If the Trigger Type is set to something other than None, press <SELECT> to toggle between Auto and TTL. Auto sets the trigger level based on the trigger input signal. TTL sets the trigger level to a value of 1.4 volts.

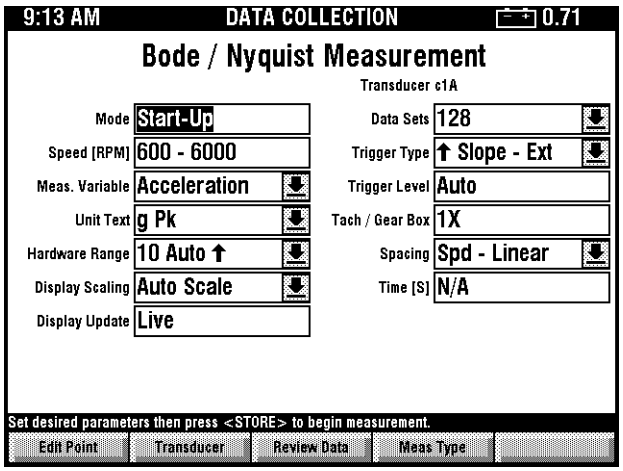
Tach/Gear Box (Bode/Nyquist only)

Tach/Gear Box settings are not applicable for Waterfall/FFT measurements.

Time (S)

Time (S) settings are not applicable for Waterfall/FFT measurements.

The Measurement Parameters screen for Bode/Nyquist display looks like the following diagram.



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Mode
Press <SELECT> to toggle between Start-Up and Coast-Down. This changes the Speed field to reflect the beginning or end ranges for machine speed.

Speed (RPM)
Depending on whether you have selected Start-Up or Coast-Down, this lets you specify the beginning and ending RPM for the data set sampling. No data collection occurs outside of these limits.

Press <SELECT> while in the Speed (RPM) box to display the Speed (RPM) window.

Use the arrow keys to select either Minimum or Maximum. Press <SELECT> to open an edit window to adjust the speed displayed. Press <DONE> when complete.

If Trigger Type is set to “None,” this parameter has no effect.

Meas. Variable
The Measurement Variable parameter allows you to choose how to measure the signal coming from the transducer. For example, if you have a velocity sensor, you can measure either velocity or displacement.

Press <SELECT> while in the Meas. Variable box to open the Measurement Variable window. Use the arrow keys to move in the list. Press <SELECT> to select the variable.

Unit Text
Press <SELECT> while in the Unit Text box to select the display units for this measurement.

The selections depends upon the current selection in the Measurement Variable parameter. Note that this simply specifies the text that is used to label the measurement. The scaling for the measured data is automatically set based upon the selected Unit Text.

- **RMS** - Root Mean Square amplitude is the amplitude of a sine wave at the frequency of interest.
- **Pk** - Peak Amplitude is the RMS Amplitude multiplied by the square root of 2. This is the peak (0 to maximum) amplitude of a sine wave at the frequency of interest and is calculated from the RMS value.
- **PP** - Peak to Peak Amplitude is the RMS Amplitude multiplied by the square root of 2 times 2. This is the peak-to-peak (minimum to maximum) amplitude of a sine wave at the frequency of interest and is calculated from the RMS value.

Use the arrow keys to move in the list. Press <SELECT> to select the Unit Text.

Hardware Range
Hardware Range allows you to specify the detectable range when acquiring the signal. Press <SELECT> key and the Hardware Range dialog box opens.

Press <SELECT> to display a list of Hardware Range values. Use the arrow keys to select a value. This parameter is used to control the hardware range when taking a measurement. Measurement starts at the specified range. Anything over the specified value is not stored (it is clipped).

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Press the right arrow key to highlight the Auto Scale If Clipping option then press <SELECT> to enable it. If enabled, the hardware re-ranges if the signal amplitude exceeds the selected hardware range. Press <DONE> when complete.

Note: Auto Scale if Clipping is most useful for machines that take a long time to start-up or coast-down. If this function is enabled, and signal clipping occurs during the measurement, then a new hardware range must be selected. Since data cannot be collected during the ranging process, there will be a gap in the collected data set.

Display Scaling

Press <SELECT> in the Display Scaling box to select from a list of display scale values.

This parameter controls the display scale for measured data. Auto Scale or Track Hardware Range are good options, but if you want to take measurements from several places for comparison, you may want to specify a range so that your displays can be easily compared. Select from:

- **Auto Scale** - Adjusts automatically to the measured data.
- **Track Hdw Rng** - Presents the data on the same hardware range that is being used to measure the data.
- **Fixed display ranges** - A list of supported ranges.

Display Update

Use the <SELECT> key to toggle between Final Results and Live while in the Display Update box. If set to Live, the dataPAC displays the measured data immediately. If set to Final Results, the dataPAC displays the data once measurement is complete.

Note: More data can be collected in the same amount of time using the Final Results setting.

Data Sets

Press <SELECT> in the Data Sets box to select the number of data sets to be collected.

A data set consists of a single FFT for an FFT/Waterfall measurement. A data set consists of a phase, magnitude, speed, and acceleration measurement for a Bode/Nyquist measurement.

Note: It may not always be possible to collect and display the specified number of data sets. This occurs if the machine goes through the specified speed range faster than the dataPAC can collect the data. Under these conditions, the dataPAC collects as much data as possible. Setting the Display Update parameter to Final Results minimizes this problem by removing the live-time display burden.

Use the arrow keys to select from the list, then press <SELECT> when complete. If you select Custom, use the edit window to enter the specific number of data sets to be collected, between 2 and 999, and press <DONE>.

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Trigger Type

Press <SELECT> while in the Trigger Type box to select from a list of trigger types.

- **None** indicates that the machine speed is not to be measured. This is only possible for an FFT/Waterfall measurement.
- **Positive Slope** indicates that the machine speed is measured using the positive edge of the trigger signal as the phase reference.
- **Negative Slope** indicates that the machine speed is measured using the negative edge of the trigger signal as the phase reference.
- **Leading Edge** or **Trailing Edge** automatically selects the rising edge or the falling edge. The selection depends upon the trigger pulse width and polarity. If the trigger input in a narrow positive pulse, Leading Edge selects the rising edge for the trigger event, and Trailing Edge selects the falling edge. If the trigger input is a narrow negative pulse, then leading edge selects the falling edge, and trailing selects the rising edge. See the illustrations below.



leading edge ***trailing edge***

Trigger Level

If the Trigger Type is set to something other than None, press <SELECT> to toggle between Auto and TTL. Auto sets the trigger level based on the trigger input signal. TTL sets the trigger level to a value of 1.4 volts.

Tach/Gear Box (Bode/Nyquist only)

The Tach/Gear Box parameters are used to configure the dataPAC to measure information for a buried shaft, where you cannot measure the shaft speed directly. Select this option to enter the number of gear teeth associated with the input trigger source.

- **Trigger Pulses/Revolution** - Indicates how many trigger pulses occur for each revolution of the reference shaft. If this parameter is set to a value other than 1, there will be an initial phase angle ambiguity.
- **Tooth Count** - Indicates how many teeth are present on the external shaft and the internal shaft. If these values are set to 1, then the external shaft trigger is used directly. Otherwise, the external reference is converted to a new reference that matches the speed of the internal shaft. In this case, the phase measurement is only relative.

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Spacing

Press <SELECT> to control the spacing between collected spectra or between Phase/Magnitude/Speed/Acceleration points.

- **Speed-Linear** - Collects data with uniform spacing between the two specified speed limits.
- **Speed-Log** - Collects data with logarithmic spacing between the two specified speed limits. More data is collected at lower machine speeds than at higher machine speeds.
- **Time** - Enables you to specify that data be collected on uniform time intervals (data is collected only if the machine speed has changed since the last data set for triggered data collection). The time interval has a tenth-of-a-second resolution.
- **Manual** - Enables you to control when data is to be collected based on pressing <STORE>.

Time (S)

Time (S) settings are not applicable for Body/Nyquist measurements.

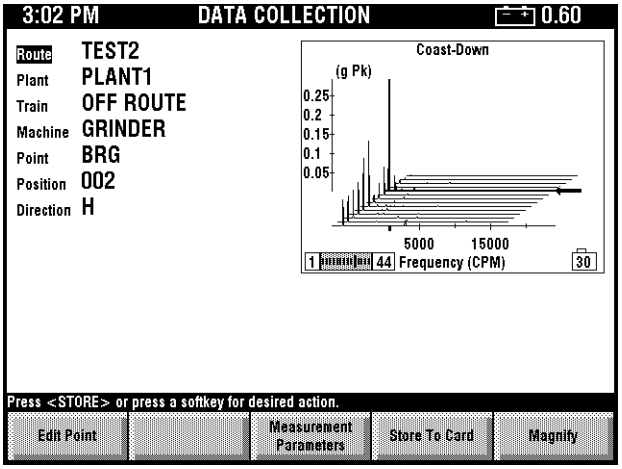
Collecting and Analyzing Data Using Waterfall/FFT

The following procedure describes how to perform a typical Waterfall/FFT start-up or coast-down analysis.

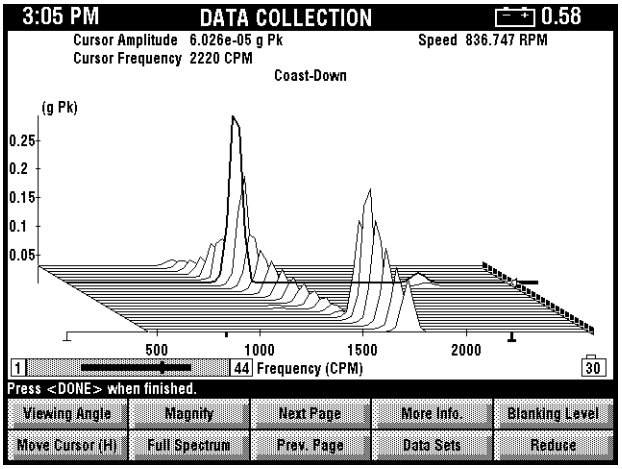
1. Connect the reference input device to the dataPAC 1500. Align the reference input device (photocell or laser tachometer) to capture shaft speed and relative phase.
2. Attach a transducer to the bearing housing.
3. Select the Analysis program from the dataPAC 1500 Program Manager window, and press <SELECT>.
4. Press <F4> (Meas Type). The Measurement Type window opens.
5. Use the arrow keys to highlight Waterfall Measurement, then press <SELECT>.
6. Use the arrow keys to move through the Measurement Parameters and set up the measurement. See “Setting Up Start-Up/Coast-Down Measurements” on page 143 for a description of each parameter.
7. Select the correct Transducer setting. Press <F2> to install a transducer. See “Installing and Defining dataPAC Transducers” on page 48 for details on installing a transducer. Install the transducer and press <DONE> to return to the Measurement Parameters window.

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8. Start the machine or stop the machine as needed. Press <STORE> to begin measurement. The dataPAC 1500 begins collecting start-up or coast-down data based on the parameters you entered.



Once measurement is complete, the waterfall is displayed for all measurements made for the point.



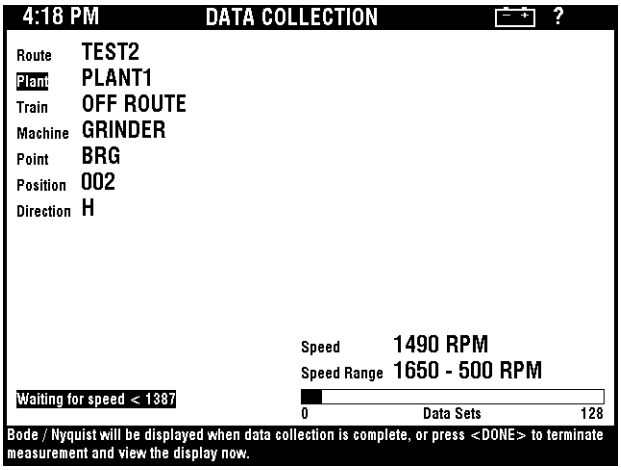
9. Pressing the softkeys enables you to modify the display. See “Reviewing Waterfall Spectra Data” on page 172 for details on reviewing your data. When you have manipulated the display to your satisfaction, press <DONE>.
11. Store the collected data by pressing <F4> (Store to Card). Note that this option is only available when the data displayed has not already been stored and spectral display is not full screen.
12. Review data or continue collecting data, if desired. You may pause to:
    - Review the data just collected by pressing <F5> (Magnify).
    - Continue data collection and edit a point description by pressing <F1> (Edit Point).

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Collecting and Analyzing Data Using Bode/Nyquist

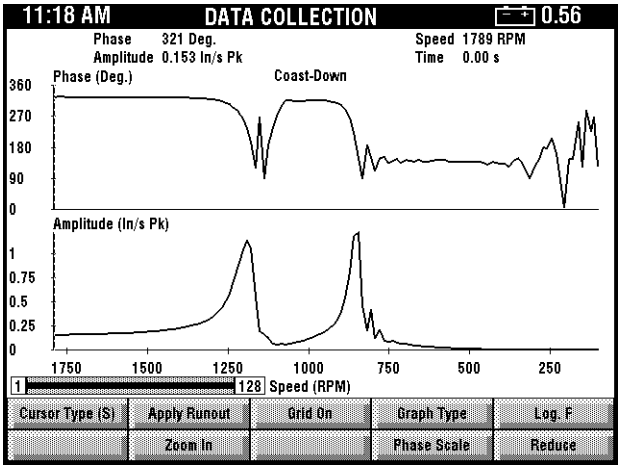
The following procedure describes how to perform a typical Bode/Nyquist start-up or coast-down analysis.

1. Connect the reference input device to the dataPAC 1500. Align the reference input device (photocell or laser tachometer) to capture shaft speed and relative phase.
2. Attach a transducer to the bearing housing.
3. From the dataPAC 1500 Program Manager window, use the arrow keys to select the Analysis program, and press <SELECT>.
4. Press <F4> (Meas Type). The Measurement Type window opens.
5. Use the arrow keys to highlight Bode/Nyquist Measurement, then press <SELECT>.
6. Use the arrow keys to move through the Measurement Parameters and set up the measurement. See “Setting Up Start-Up/Coast-Down Measurements” on page 143 for a description of each parameter.
7. Select the correct transducer setting. Press <F2> to install a transducer. See “Installing and Defining dataPAC Transducers” on page 48 for details on installing a transducer. Install the transducer and press <DONE> to return to the Measurement Parameters window.
8. In the Measurement box, press <SELECT> until Bode/Nyquist is selected as the measurement type.
9. Start the machine or stop the machine as needed. Press <STORE> to begin measurement. The dataPAC 1500 begins collecting start-up or coast-down data based on the parameters you entered.

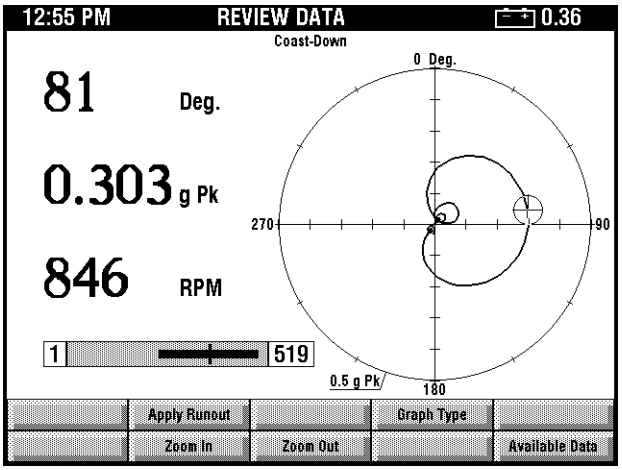


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Once the measurement is complete, the display selected in Graph Type is shown. The following diagram is an example of a Bode plot

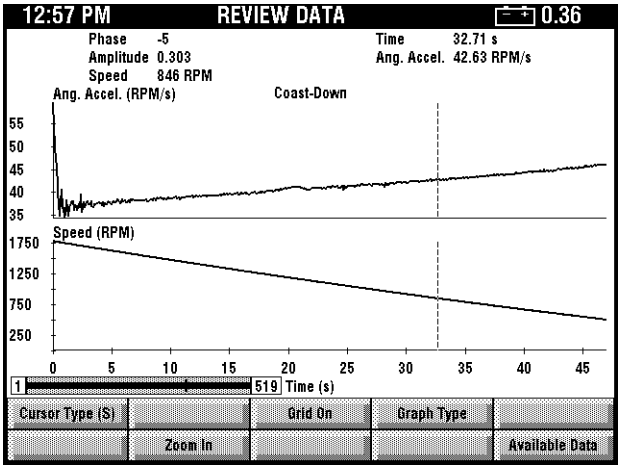


This diagram is an example of a Nyquist plot.



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A speed profile looks like the following diagram.



10. You can modify the display by pressing the softkeys. When you have manipulated the display to your satisfaction, press <DONE>.

Note: You can press the (Apply Runout) or (No Runout) softkeys. This function is employed to remove or "zero" the initial run-out component during slow roll.

11. Store the collected data by pressing <F4> (Store to Card). Note that this option is only available when the data displayed has not already been stored and spectral display is not full screen.
12. Review data or continue collecting data, if desired. You may pause to:
    - Review the data just collected by pressing <F5> (Magnify).
    - Continue data collection and edit a point description by pressing <F1> (Edit Point).

Methods for Measuring Machine Speed

The dataPAC has several ways to measure machine speed and this section discusses all of them. Also, it indicates which dataPAC models and which versions of software support the various features.

Phase-Magnitude-Speed

First, the dataPAC 1500 supports a phase-magnitude-speed type measurement which includes a measurement of the machine speed. This measurement requires a reference input, such as a laser tachometer. The term reference input refers to the BNC input on the dataPAC 1500. There are other accessories besides the LASETACH® that can be used for a reference input, such as a photo cell accessory. All versions of the dataPAC 1500 software support this measurement type. The dataPAC 1250 does not have a reference input and does not support the phase-magnitude-speed measurement type.

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Orders Based/Orders Track

The dataPAC 1500 version 4 and 5 software supports “Order Normalized” measurements. In general, these measurements require a reference input in order to measure and track the machine speed during the measurement. There are a lot more details and some limitations that are important to understanding dataPAC's “Order Normalized” support. See “Setting Up and Collecting Off Route Orders Measurements” on page 121. Previous dataPAC 1500 software versions do not include support for “Order Normalized” measurements. The dataPAC 1250 does not support this function.

Machine Speed Softkey

The “set machine speed” ability of the Data Collection application has also been expanded in dataPAC 1500 versions 4 and 5. The “Machine Speed” softkey <F3> allows you to change the machine speed of any point. When you select “Machine Speed” from within the Data Collection application you are presented with a menu. The menu has three options: Manual Entry, Tachometer, and Spectra.

- Select Manual Entry to key in the new machine speed manually.
- Select Tachometer to measure the new machine speed with a tachometer.
- The Spectra menu option provides some ability to measure the machine speed without using a tachometer accessory. Selecting Spectra causes an intermediate/temporary spectra measurement to be taken and displayed. The “Harmonic” style cursor is displayed on the spectrum. With the Harmonic cursor displayed, the “Set Speed” softkey can be used to set the machine speed according to the cursor location. This feature was not available as described with prior dataPAC 1500 software versions.

Balancing Application

In the Balancing application there is some ability to measure the machine speed with the strobe light instead of the reference input. See “One Plane Balancing with a Strobe Light” on page 165.

Strobe Light

You can drive a strobe light using the dataPAC 1250 or 1500 and the strobe accessory, which gives you an estimate of machine speed based on visually “freezing” the rotating equipment with the strobe. See “Driving a Strobe While Collecting an Off Route Spectrum” on page 117 for more information.

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Using an Internal Trigger Source to Collect Data

dataPAC 1500 V5 Only

There are several applications for using an internal trigger source to collect data. Imagine a stamping press. You want to collect vibration data just as the press stamps, which is considered to be transient data. Before version 5, this was impossible because even if you could time your press of the <STORE> button with the press of the stamp, the dataPAC would try to range for some unspecified amount of time before collecting the data. The data you would have gotten would not be meaningful. Plus, if you pressed <STORE> before the stamp, then the dataPAC would auto range to some vibration level much lower than what occurs during the stamp. So when the press stamps you get clipping or some other range error.

With this new internal trigger feature, you can observe a few cycles of the press and set up the range and trigger levels. Then, if the trigger level is set properly, the dataPAC can measure exactly what you want.

This section shows you how to use an internal trigger source to collect data. This section also offers information about performing a bump test with the internal trigger source. This is just an example of an application for the internal trigger source.

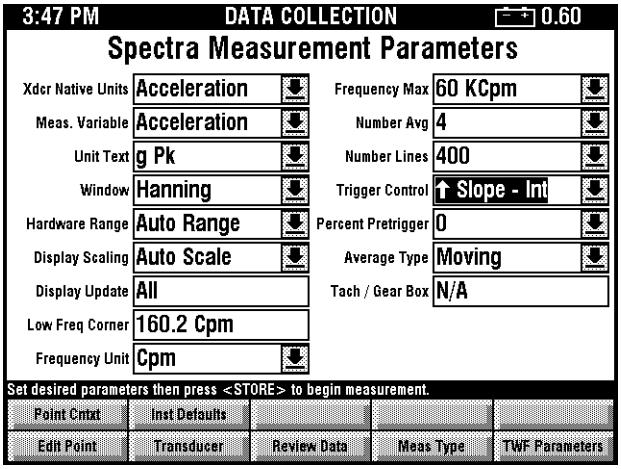
Setting up and Collecting an Internally Triggered Spectrum or Time Waveform

dataPAC 1500 V5 only

You can collect a triggered time waveform, and associated spectrum, using the internal vibration signal as the trigger source. This feature does not support sychronous averaging, but rather supports collection of transient data.

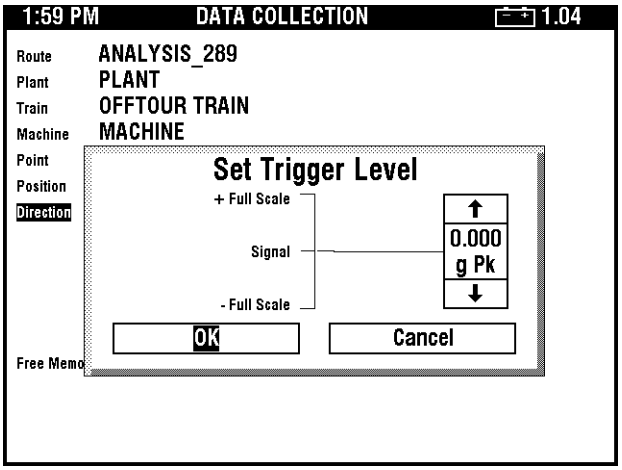
This feature allows you to manually set the point at which the dataPAC collects data. For example, if you would like to measure levels of vibration of a stamping press at the point where the press stamps, causing the highest levels of vibration, you could use this internal vibration signal to trigger the dataPAC to take data.

1. Open the Analysis application from the Program Manager.
2. Press <F4> (Meas Type) and select Spectra Measurement Parameters.



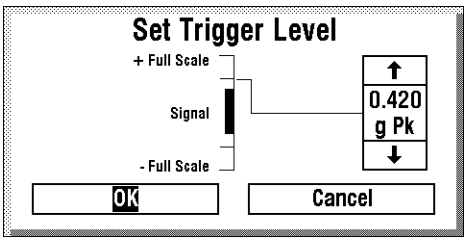
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3. Move the highlight to Trigger Control and choose one of the internal choices, either ↑ Slope - Int or ↓ Slope - Int. Set up the other parameters as needed.
4. Press <STORE> to begin collecting data. The following screen appears.



5. Press the arrow keys to set the trigger level. You want to make the trigger level the level of vibration that you expect to occur when the transient data occurs. You want to observe the full scale value of the transient data for a while before selecting a trigger level.

   The best way to accomplish this is to watch the black bar expand around zero. After it expands to the highest point of vibration, such as when the stamping press stamps, it leaves “high water marks” at the highest point of vibration. You want to place the trigger point slightly below the highest “high water mark.” This diagram shows an example of a correctly set trigger level.



   If the black bars go past the full scale range, adjust the range using the Hardware Range parameter in the Measurement Parameters screen.
6. Choose OK. The dataPAC begins collecting the data after the vibration levels reach the trigger level you set.

Performing a Bump Test

The dataPAC 1500 V5 can be used to perform a bump test. A bump test detects the natural resonant frequencies of a machine by striking the machine, and measuring the vibration data taken at the moment the machine is struck. The ability to use the internal vibration trigger as the start point for collecting data allows you to do a bump test.

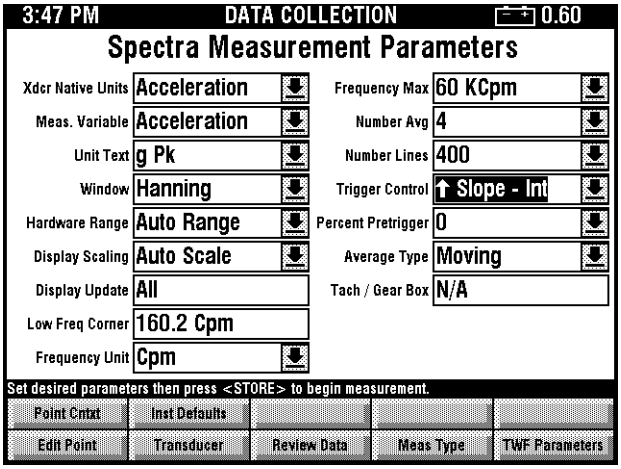
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The bump test helps you predict the natural frequencies of the machine. However, it is not a quantitative test. It is just a quick and easy way to identify if natural frequencies are causing the vibration problem.

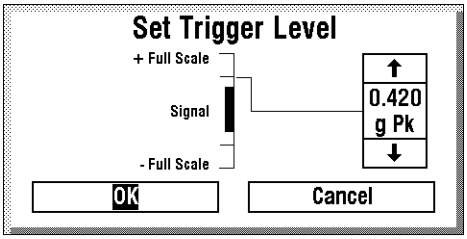
If the machine's vibration is the same as a natural frequency, the vibration level will be enhanced by that harmonic vibration at the same frequency. This can cause problems because the amount of natural vibration is added to the original vibration, so it becomes amplified. Performing a bump test excites those natural frequencies, allowing you to observe them, and find ways to reduce the harmonic effect. Often simply changing the machine's running speed will cause the harmonic effects to lessen.

To perform a bump test, follow these steps.

1. Set up an internally triggered spectrum measurement on the dataPAC 1500.



2. Press the <STORE> key so that the Set Trigger Level dialog box appears.



3. Using a rubber mallet or a heavier hammer and a piece of wood (to protect the machine), strike the machine.
4. Watch the trigger levels and use the arrow keys to set the trigger level scale accordingly.
5. Choose OK when the trigger level is correct for the amount of vibration you observe when striking the machine.
6. Strike the machine again, which causes the vibration levels to go over the trigger level, and the dataPAC starts collecting data.
7. You can store and analyze the measurement in the dataPAC.

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Chapter 5

Balancing Measurements

This chapter describes balancing procedures and measurements you can take with the dataPAC coupled with a speed-measuring device such as a strobe light or laser tachometer.

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Setting Up the Balancing Parameters *163*

One Plane Balancing with a Strobe Light *165*

Two Plane Balancing with a Strobe Light *175*

One Plane Balancing with a Reference Trigger *184*

Two Plane Balancing with a Reference Trigger *190*

Unloading Balancing Runs using a Modem *199*

Collecting Phase Measurements for Analysis *207*



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Overview of Balancing Measurements

The dataPAC provides a simple, direct method to balance your rotating machinery in one or two planes. You may use either the strobe light drive capability in your dataPAC or some speed-measuring device, such as a laser tachometer. Because phase measurement is key to balancing, relative phase studies are also possible with this tool.

Note: This tool is available only with the dataPAC 1250 and 1500 models equipped with a speed-measuring device. Two plane balancing is an option available only with the dataPAC 1500. The data you collect while balancing cannot be unloaded to your host software program, such as EMONITOR Odyssey or Enshare or IQ2000.

This chapter covers all tasks associated with balancing using a dataPAC. Using the balancing program on the dataPAC, you can:

- Balance a machine in one plane with a strobe light or a reference trigger.
- Balance a machine in two planes with a strobe light or a reference trigger.
- Perform quick relative phase checks.

Balancing is the technique for determining the amount and location of the heavy spot on a rotating shaft so that you can balance it with an equal amount of weight in the opposite direction. These methods go through the technique, with stopping points where you start and stop the machine to perform weight addition or subtraction.

There are three types of measurements in the balancing process:

- The *initial vibration* measurement is taken without any added weights on the machine. The initial vibration measurement establishes a reference of how the machine vibrates at each plane without any extra weight added. This vibration is what will be corrected by the correction weight.
- The *trial weight* measurements are taken with a single trial weight attached to the machine at one plane or the other. The trial weight measurements are used to determine how the machine is affected by the added weight.
- The *residual* measurements are taken with the correction weight or the correction weight and trim weights attached to the machine. The correction weight should cancel out the initial unbalance. A residual vibration measurement is taken to measure the remaining unbalance. Trim weights are added to the machine to cancel out the vibration measured during a residual measurement.

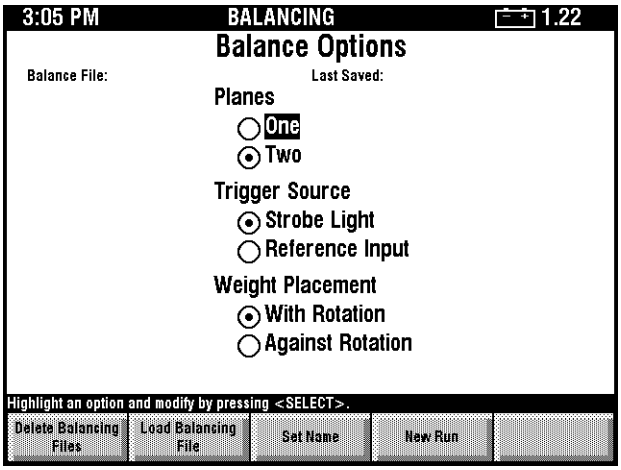
It is left to you to decide when the machine is sufficiently balanced.

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Setting Up the Balancing Parameters

The following procedure describes the method used to set up the balancing parameters for the dataPAC. In general, you can follow the prompts that appear in the status line on the dataPAC.

1. Choose Balancing Program from the dataPAC Program Manager window by using the arrow keys to select the Balancing icon, and pressing <SELECT>. The Balancing Options window opens.

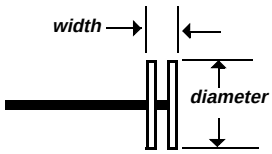
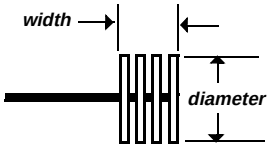
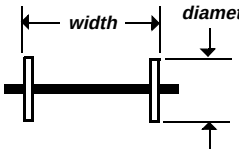


2. Set the Balance Options by using the arrow keys to move through the Balancing Options window. Press <SELECT> to select the number of Planes, Trigger Source, and Weight Placement options. The options are described below.

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Planes

To determine whether single-plane or two-plane balancing is required, a good rule-of-thumb is the rotor's width-to-diameter (W/D) ratio. The W/D ratio is the width (excluding shaft length) of the combined rotors divided by their diameter. The following chart can be used to help determine whether to use one- or two-plane balancing.

	W/D RATIO	1-PLANE	2-PLANE
	Less than 0.5	0 - 1000 RPM	Above 1000 RPM
	More than 0.5 but less than 2	0 - 150 RPM	150 - 2000 RPM or above 70% of 1st critical
	More than 2	0 - 100 RPM	Above 100 RPM to 70% of 1st critical

Trigger Source

The balancing program must have accurate information regarding the RPM of the rotating shaft. This can be provided in two ways: a strobe light that is manually adjusted to flash at the correct rate, or a sensor input that automatically tracks the speed of the rotor or the shaft.

Weight Placement

You place weights on the rotor to balance the machine. The position of this weight is given in degrees or positions (where the total number of positions equals the number of blades or vanes) from the reference notch or mark. You must tell the dataPAC whether you are measuring the angle with or against the direction of the shaft rotation.

The Weight Placement option affects how angles are measured. If Weight Placement is set to "With Rotation," angles are measured from the reference mark, in the direction of the machine's normal rotation.

If Weight Placement is set to "Against Rotation," angles are measured from the reference mark, in the opposite direction of the machine's normal rotation.

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One Plane Balancing with a Strobe Light

This section discusses the procedure for balancing a machine in one plane using the dataPAC and an attached strobe light. The entire procedure is divided into parts based on when you start and stop the machine. You must complete the entire procedure until the vibration level has been reduced enough for your needs.

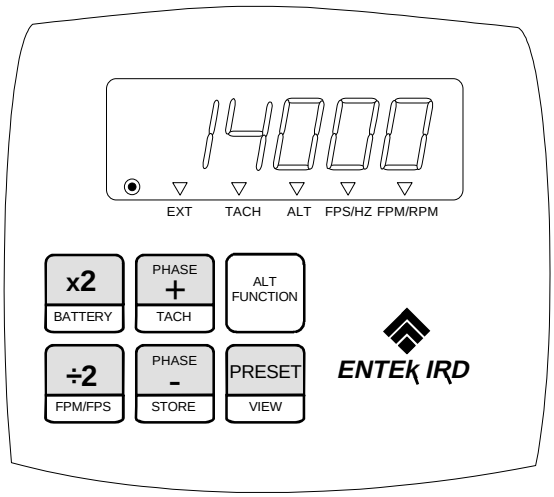
Using the Strobe dB+

The dataPAC Strobe dB+ is the newest strobe available from Entek. It synthesizes all signals digitally, in small, very precise steps. These signals are derived from a stable crystal oscillator.

To use the strobe by itself, turn the knob counter-clockwise to increase the flash rate and clockwise to decrease it. The knob is velocity sensitive. Turn the knob slowly to have each “click” equal to 0.1 FPM. Turning the knob more quickly will adjust the FPM by larger steps. When adjusting flash rate, quickly turn the knob (or use the x2 or ÷2 buttons) to coarsely change the FPM. Then slowly turn the knob for fine adjustments. Turn slower still for very fine adjustments.

To turn on the stroboscope, depress the trigger. You can lock the trigger in position using the side locking button. Push the trigger as far as it will go, and then press the locking button. Release the trigger with the lock on and the trigger is held in place. To release the lock, simply depress the trigger and release.

The back panel on the Strobe dB+ consists of a backlighted liquid crystal display with six alphanumeric digits which indicate modes, flash rates, and other items. Below the six digits are five small triangles which indicate the present mode or value currently indicated - Ext (External mode), TACH, ALT function, FPS/HZ (Flashes Per Second), and FPM/RPM (Flashes Per Minute).



The External triangle is on whenever the strobe is in the external mode. The external mode means an external signal, such as the dataPAC, is plugged into the external input jack. The FPM triangle is on when the display is displaying Flashes Per Minute. The FPS triangle is on when the display is displaying Flashes Per Second or Hertz (Hz). (FPS = FPM ÷ 60)

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Below the display are six buttons which control the operation of the stroboscope.

There are three major operating modes for the strobe: Internal, External and Charging. In the Internal mode, the knob adjusts the flash rate from 30 to 14,000 Flashes Per Minute (FPM). In the External mode, an external signal from a remote sensor is used to trigger the flash and the knob has no effect. The strobe is in External mode when the dataPAC is connected to it. The Charging mode occurs when the strobe has the battery charger plugged into it.

The strobe is in the external mode whenever there is a plug in the input jack. The input jack is indicated with an up (in) triangle.

In the External mode the dataPAC makes all the flash rate adjustments. The Alt Function mode and triangle is automatically set in this mode, since the primary function of the buttons have no use in this mode.

Refer to the *dataPAC Strobe dB+ Operating Guide* for more information about using the Strobe dB+.

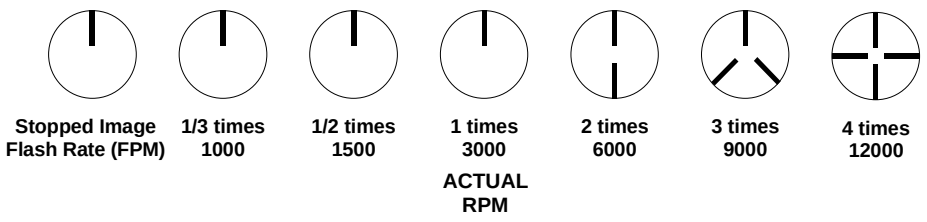
Measuring Speed with a Strobe

The primary use for a stroboscope is to stop motion for diagnostic inspection purposes. However, the stroboscope can also be used to measure speed. In order to do this several factors need to be considered. First, the object being measured should be visible for all 360° of rotation, such as the end of a shaft. Second, the object should have some unique part on it, like a bolt, key way, or imperfection to use as a reference point. If the object being viewed is perfectly symmetrical, then you need to mark the object with a piece of tape or paint in a single location only, to be used as a reference point.

If the speed of rotation is within the range of the stroboscope, start at the highest flash rate and adjust the flash rate down. At some point you will stop the motion with only a single image of the object in view. Note that at a flash rate twice the actual speed of the image you will see two images. As you approach the correct speed you may see three, four or more images at harmonics of the actual speed. The first SINGLE image you see is the true speed. To confirm the true speed, note the reading and adjust the stroboscope to exactly half this reading, or just press the 1/2 X softkey on the dataPAC. You should again see a single image (which may be phase shifted with respect to the first image seen).

For example, when viewing a shaft with a single keyway you will see one stationary image of the key way at the actual speed and at 1/2,1/3,1/4, etc., of the actual speed. You will see 2 images of the key way at 2 times the actual speed, 3 key way at 3 times, etc. The FPM equals the shafts Revolutions Per Minute (RPM) at the highest flash rate that gives only one stationary image of the key way.

Example - object rotating at 3000 RPM



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If the speed is outside the full scale range of the stroboscope (14,000 FPM for the dB+), it can be measured using the method of harmonics and multipoint calculation. Start at the highest flash rate and adjust the flash rate down. You will encounter multiple images so be aware of these. Note the flash rate of the first SINGLE image you encounter, call this speed "A," Continue decreasing the flash rate until you encounter a second SINGLE image. Note this speed as "B." Continue decreasing the speed until you reach a third SINGLE image at speed "C."

For a two point calculation the actual speed is given by:

RPM = AB/(A-B)

For a three point calculation:

RPM = 2XY(X+Y)/(X-Y)2 where

X = (A-B) and

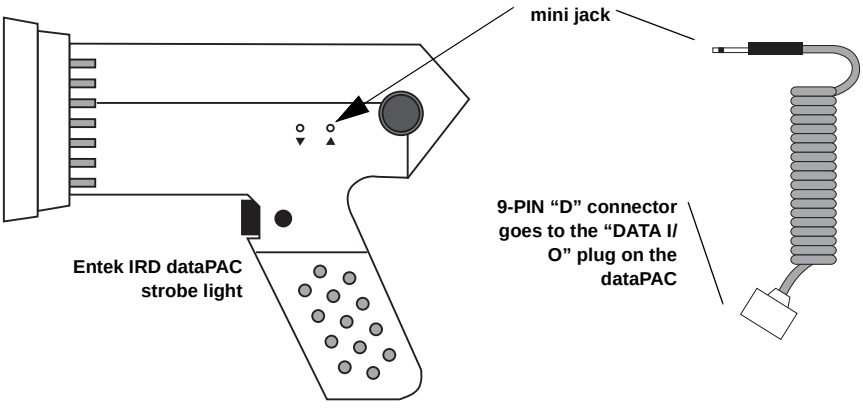
Y = (B-C)

When the dataPAC is used with the strobe (External mode), the readout displays directly in RPM (FPM).

In instances when you can shut down the device and install a piece of reflective tape then an optical tachometer is easier to use for RPM measurement. Stroboscopes must be used when you can't shut down the device. The human eye is not easily tricked into seeing a stopped image by a stroboscope when the flash rate is slower than 300 FPM. Therefore, stroboscopes are impossible to use below 300 FPM for inspection or to measure RPM.

Taking the Initial Vibration Measurement

1. Connect the strobe light to the dataPAC using the connector cable provided. The mini-jack plugs into the strobe as shown below, and the 9-pin D connector attaches to the DATA I/O plug of the dataPAC.

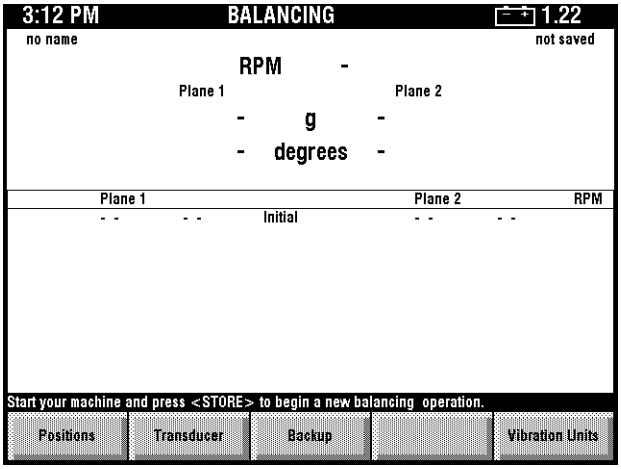


2. Attach a transducer to a bearing housing.
3. When the machine is stopped, mark the rotor by making a mark on one rotor that serves as a reference when using the strobe light. It is also possible to use an existing mark on the rotor as the reference mark, such as a key or keyway.

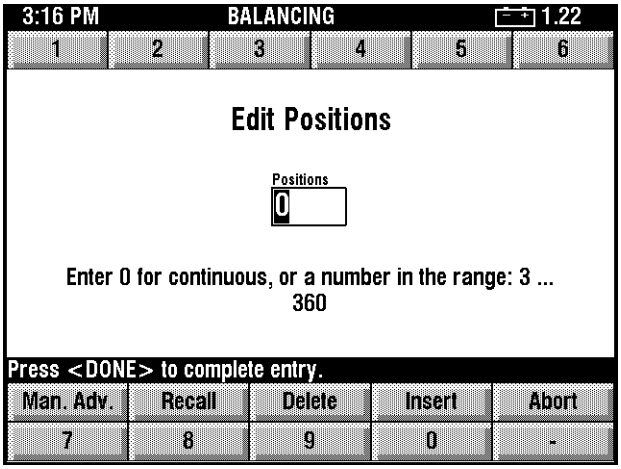
Note: If the rotor has multiple positions (vanes or fan blades), the reference mark must be at one of the blade positions.

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4. Start a balancing session by pressing either <F2> or <F4>. To enter new balancing data, press <F4> (New Run) from the Balancing Options window. To continue a saved balancing session, press <F2> (Continue Loaded Run). The Balancing window opens.



5. Select the correct transducer setting if necessary. Press <F2> (Transducer) to open the Transducer Options window. See “Installing and Defining dataPAC Transducers” on page 48 for more information.
6. Press <F1> (Positions) to enter the number of positions. The number of positions refers to the number of rotor components, such as blades on a fan. The Edit Positions window opens.

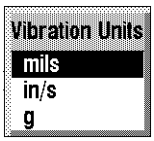


Enter 0 for a rotor without vanes or blades, or enter the number of vanes or blades. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).

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Note: Vibration units and speed displayed match the system and frequency units selected in the dataPAC Instrument Options screen. See “Setting Up Instrument Options” on page 40.

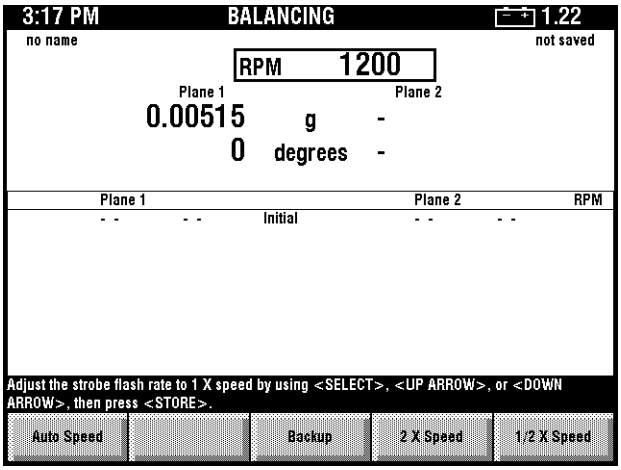
7. Select the correct vibration units by pressing <F5> (Vibration Units). Use the arrow keys to highlight the desired units and then press <SELECT>. The units selected must be compatible with the installed transducer.



8. Start the machine and allow it to reach normal running speed.
9. Press <STORE> to take an initial vibration measurement.

Note: You can press <F3> (Backup) to revert to a previous screen, or, in some cases, press <F3> (Go To) to back up several steps.

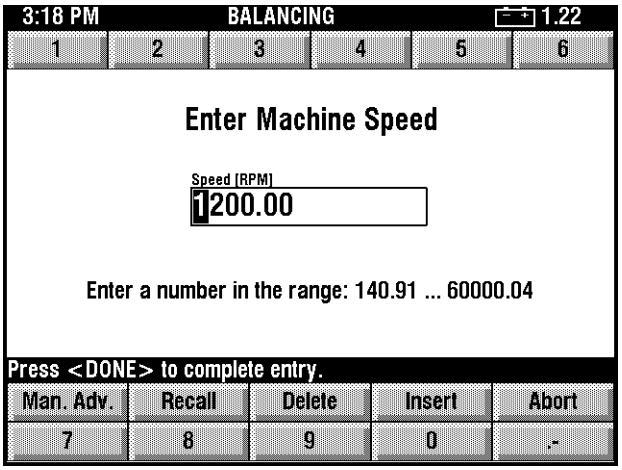
10. Aim the strobe at the reference mark on your rotor. Press the trigger on the strobe, which causes it to begin to flash. The dataPAC displays the current vibration amplitude dynamically. The rate is displayed in the boxed area at the top of the screen.



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11. Approximate the machine speed with the dataPAC. You can do this either by entering the machine speed or by pressing Auto Speed, then fine tuning the flash rate.

- Press <SELECT> to open the Enter Machine Speed window. Enter the appropriate value. When the entry is complete, press <DONE>.



Make fine or large adjustments to the flash rate as needed by pressing the up and down arrow keys until the reference mark appears to stand still. The overall objective with the strobe is to adjust the flash rate so that it matches the machine speed, and therefore the reference mark on the rotor appears to stand still. You can hold down the arrow keys to accelerate the rate of adjustment.

WARNING: Although the machine appears stationary while viewed with the strobe, it is, in fact, running. Touching the machine while it is running can cause injury!

- Press <F1> (Auto Speed) to capture the RPM of the machine. If the strobe flash rate is close to the actual 1X machine speed so that the reference mark image is slowly rotating, you can use the <F1> (Auto Speed) key to adjust the strobe flash rate.

  This causes the strobe to flash at the RPM rate as determined by the signal coming from the vibration pickup. In many cases, pressing Auto Speed captures the RPM speed accurately. This feature only works when you are close to the frequency and there is a peak dominant at that frequency. See Help screens for more information if needed.

  If the previous step is unsuccessful in locking speed, press <F2> (Restore Speed) to restore the speed to a value that existed prior to pressing Auto Speed.

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12. At this point you should check 1X. It is possible to think the strobe is set correctly when you are actually on a sub-harmonic of the RPM. To check, press <F4> (2 X Speed) to double the strobe flash rate. After pressing <F4>, you should immediately notice there are two reference marks visible. If not, you are on a sub-harmonic and need to re-adjust the strobe rate. If you see two marks, press <F5> (1/2 X Speed) to halve the strobe rate, returning to the rate that existed prior to pressing <F4>. There should be only one phase mark again.
13. When the marker appears to be frozen, press <STORE>.
14. Adjust the position of the mark for convenience. The phase mark should be moved to a point that can be easily seen and accurately measured, for example, top dead center or in line with the machine foot or bracket. After you add the trial weight, you will exactly reposition to this point for accurate phase measurements.

    Use the up and down arrow keys to move the mark one degree at a time. Or, press <F1> and <F2> to move the mark incrementally by 20° at a time in either direction.

    As you move the reference mark you will see the Phase Adjust angle value change on the Balancing window.

    At this point you may wish to normalize phase to 0 before proceeding. This is accomplished by pressing <F5>. This is optional.
15. Press <STORE> to complete the initial measurement.
16. Shut down the machine and continue the balancing procedure in the next section.

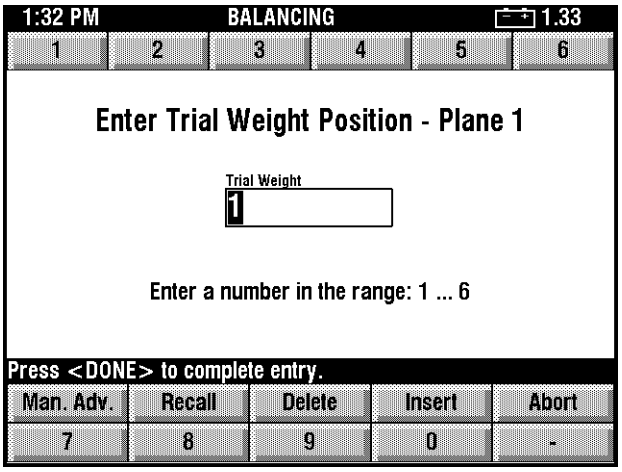
Adding the Trial Weight and Taking a Measurement

1. Press <F1> (Continue) when you have completed the initial measurement. The Edit Trial Weight window opens.
2. Enter the trial weight. This is the amount of weight you will attach to the rotor. When your entry is complete, press <DONE>.

   The dataPAC displays the Weight Units window. Highlight a unit of measure on the displayed list and press <SELECT>. The units selected for the trial weights become the default units for the correction and trim weights. Correction and trim weight units can be changed because the dataPAC converts between units.

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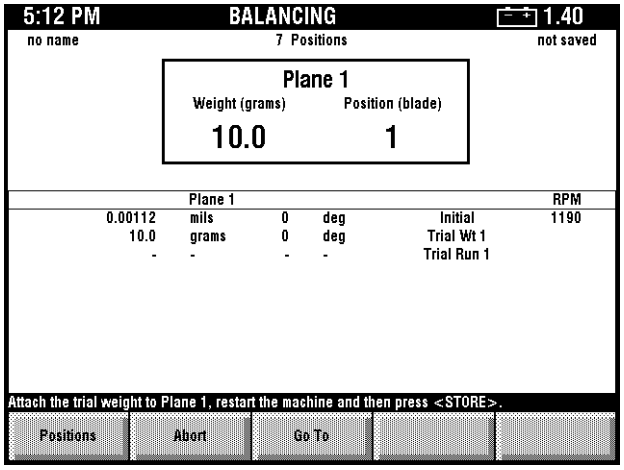
3. Enter the trial weight position. Use the edit window to enter the location of the trial weight on the rotor.



If the machine has no vanes or blades, you should specify the trial weight location in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, specify the location in positions (vanes or blades), from 1 to the total number of vanes or blades.

In either case, the position is measured from the reference mark in the direction specified in the Weight Placement field on the Balance Options Screen. Press <DONE> when complete.

Notice, after you have entered the trial weight, the lower half of the dataPAC display indicates the vibration level of the initial vibration as well as the trial weight you just entered. This display updates as you complete each step of the balancing operation.



4. Attach the trial weight to the rotor.
5. Start the machine and let it reach operating speed.

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6. Press <STORE> to take a trial weight measurement.

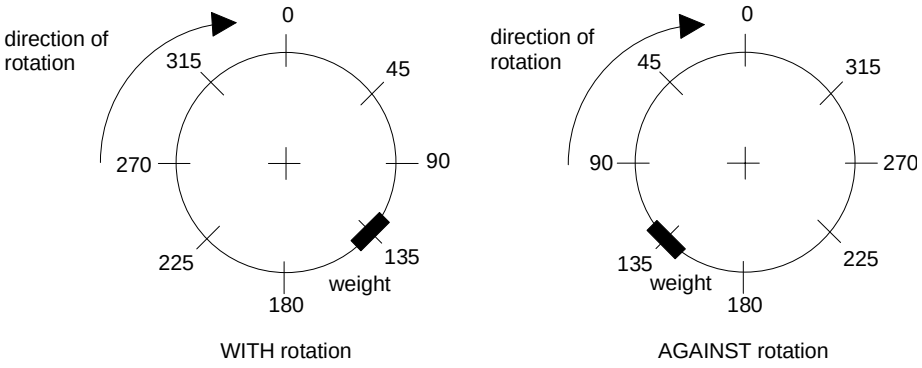
Note: You may get a warning after applying the trial weight if the original 1X vector does not change significantly. If this happens, you are given the choice to Continue or Backup. You can Backup and add more weight if you want.

7. Press the trigger on the strobe, and enter the machine speed and adjust the reference mark as before.
8. When the marker appears to be frozen, press <STORE>.
9. Adjust the position of the mark back to the zero position.
10. Press <STORE> to complete the measurement.
11. When the trial weight measurement is complete, shut down the machine and remove the trial weight from the rotor. Continue the balancing procedure in the next section.

Adding the Correction Weight and Taking a Residual Measurement

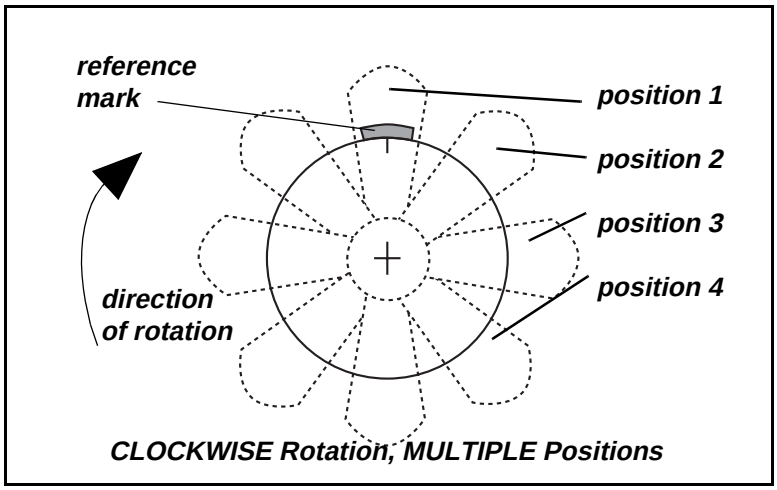
1. The dataPAC has calculated and now displays a recommended balancing weight labeled “Correction” on the dataPAC display. Attach correction weight according to the display. The “Position” column indicates where to attach the correction weight.
   - For rotors with zero positions the position is shown in degrees, in the direction of rotation set in Weight Placement, from the 0° mark.
   - For rotors with multiple “positions” or vanes, the Position column indicates on which positions the weights must be added. The 0° position is considered position 1, and the other positions are numbered sequentially, in the direction of rotation.

Note: Always view the direction of rotation from the same point.



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With machines having multiple positions, the reference blade is 1. For 8 positions, correction weights may be at positions 1, 2, 3,... 8. The dataPAC automatically splits the required correction weights between two adjacent blades (vector splitting).



2. Start the machine and let it reach operating speed.
3. Press <STORE> to take a residual measurement with the correction weight attached.
4. Press the trigger on the strobe, and enter the machine speed and adjust the reference mark as before.
5. When the marker appears to be frozen, press <STORE>.
6. Adjust the position of the mark as you did previously.
7. Press <STORE> to complete the residual measurement.
8. Shut down the machine and attach the trim weight(s) whose weight and location are indicated on the dataPAC display.

Note: Do not remove the original correction weight.

9. Continue to trim-balance the machine as required by continuing to take vibration readings. After securely attaching the trim weight, bring the rotor up to balance speed and press <STORE>. The dataPAC takes vibration readings, calculates new trim weights and displays it as before.

   If the vibration has been reduced to an acceptable level, you are through. Balancing is complete. Save your balancing data, if necessary, by pressing <SHIFT><F5>. The Save Balancing Data window appears. Enter the file name. When your entry is complete, press <DONE>, or press <SHIFT><F5> (Abort) to cancel the entry.

   However, if the rotor is still out of balance, repeat adding the correction weight and taking residual measurements as many times as are necessary until the rotor is properly balanced. If the balance never improves, check to see if you entered the correct trial weight size and location, or check other factors such as misalignment or a faulty bearing.

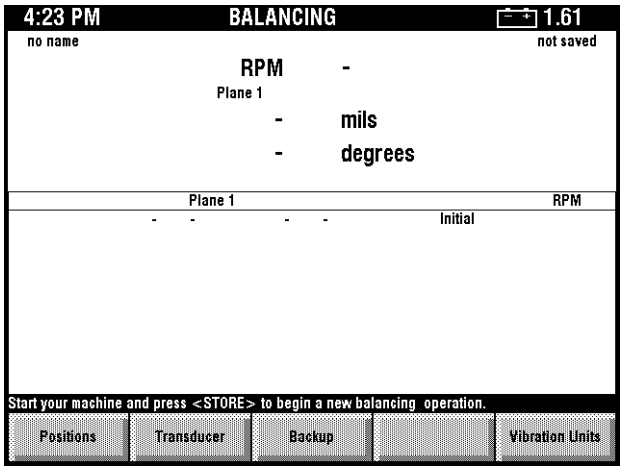
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Two Plane Balancing with a Strobe Light

This section discusses the procedure for balancing a machine in two planes using the dataPAC and an attached strobe light.

Taking the Initial Vibration Measurement

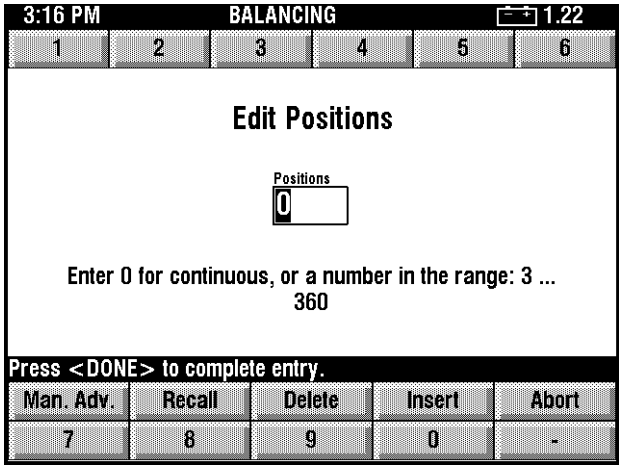
1. Start a balancing session by pressing either <F2> or <F4>. To enter new balancing data, press <F4> (New Run) from the Balancing Options window. To continue a saved balancing session, press <F2> (Continue Loaded Run). The Balancing window opens.



2. Select the correct transducer setting. If necessary, press <F2> (Transducer) to open the Transducer Options window. See “Installing and Defining dataPAC Transducers” on page 48 for more information.
3. Attach a transducer to a bearing housing in each plane at each end of the shaft. You must have two identical transducers and the two-plane balancing kit (sold separately) to complete two-plane balancing.

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4. Enter the number of positions on the rotor by pressing <F1> (Positions). The number of positions refers to the number of rotor components, such as blades on a fan. The Edit Positions window opens.



   Enter 0 for a rotor without vanes or blades, or enter the number of vanes or blades. When your entry is complete, press <DONE> To cancel, press <SHIFT><F5> (Abort).

Note: Vibration units and speed displayed match the system and frequency units selected in the dataPAC Instrument Options screen. See “Setting Up Instrument Options” on page 40 for more information.

5. Select the correct vibration units by pressing <F5> (Vibration Units) to open the vibration units window. The units selected must be compatible with the installed transducer.

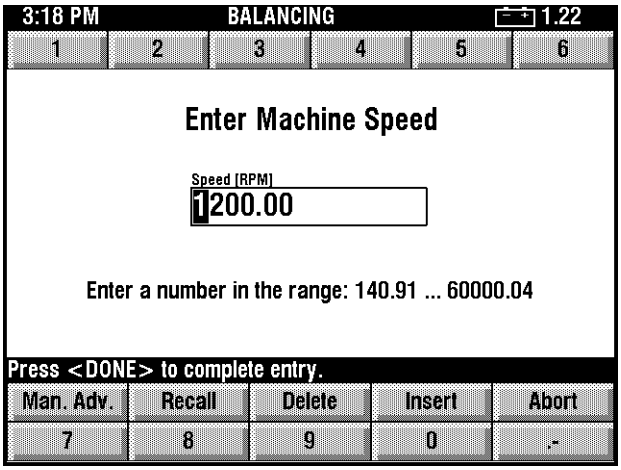
   Use the arrow keys to highlight the desired units and then press <SELECT> to return to the Balancing window.

6. Start the machine if needed and allow it to reach normal operating speed.
7. Press <STORE> to begin the initial measurement.
8. Press the trigger on the strobe, which causes it to begin to flash. The dataPAC displays the current vibration amplitude dynamically. The rate is displayed in the box marked “Speed.”

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9. Approximate the machine speed with the dataPAC. You can do this either by entering the machine speed or by pressing Auto Speed, then fine tuning the flash rate.

   - From the Balancing window, press <SELECT> to open the Enter Machine Speed window.



   Enter the appropriate value. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).

   Make fine or large adjustments to the flash rate. The overall objective with the strobe is to adjust the flash rate so that it matches the machine speed, and the reference mark on the rotor appears to stand still. Hold the strobe so that the reference mark is visible as the strobe flashes. Using the arrow keys, adjust the strobe flash rate until the reference mark appears to stand still. You can hold down the arrow keys to speed up the change rate.

WARNING: Although the machine appears stationary while viewed with the strobe, it is still running. Touching the machine while it is running can cause injury.

   - Press <F1> (Auto Speed) to capture the RPM of the machine. If the strobe flash rate is close to the actual 1X machine speed, that is, the reference mark image is slowly rotating, you can use the <F1> (Auto Speed) key to adjust the strobe flash rate. This causes the strobe to flash at the RPM rate as determined by the signal coming from the vibration pickup. In many cases, pressing Auto Speed may be all you need to capture the RPM speed accurately. This feature only works when you are close to the frequency and there is a dominant peak at that frequency. See the dataPAC Help screens for more information, or see “Measuring Speed with a Strobe” on page 166.

   You can restore speed if needed. If the previous step is unsuccessful in locking speed, press <F2> (Restore Speed) to restore the speed to the value that existed prior to pressing <F1> (Auto Speed).

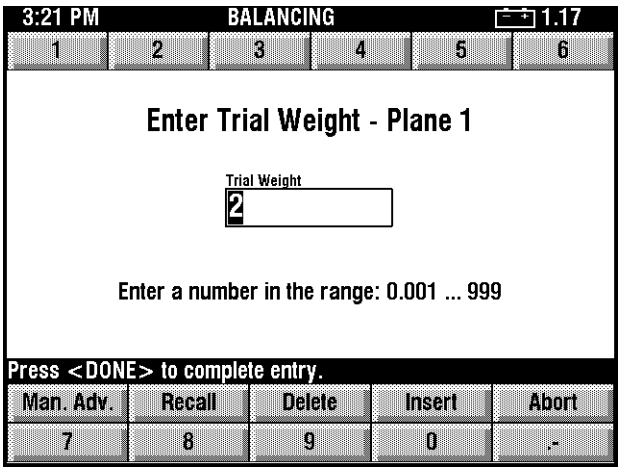
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10. At this point you should check 1X. It is possible to think the strobe is set correctly when you are actually on a sub-harmonic of the RPM. To check, press <F4> (2 X Speed) to double the strobe flash rate. After pressing <F4>, you should immediately notice there are two reference marks visible. If not, you are on a sub-harmonic and need to re-adjust the strobe rate. If you see two marks, press <F5> (1/2 X Speed) to halve the strobe rate, returning to the rate that existed prior to pressing <F4>. There should be only one phase mark again.
11. When the marker appears to be frozen, press <STORE>.
12. Adjust the position of the reference mark for convenience by moving the phase mark to a point that can be easily seen and accurately measured, for example, top center or in line with the machine foot or bracket. After you add the trial weight, you must exactly reposition to this point for accurate phase measurements. Use the up and down arrow keys to move the mark one degree at a time. Or, press <F1> (Decrease 20 deg.) and <F2> (Increase 20 deg.) to move the mark incrementally by 20° at a time in either direction.

    As you move the reference mark the Phase Adjust angle value changes in the Balancing window. At this point you may wish to normalize phase to 0 before proceeding by pressing <F5>. This is optional.
13. Press <STORE> to complete plane 1 measurement and begin plane 2 measurement.
14. Press the trigger on the strobe, and adjust the Plane 2 machine speed as you did for Plane 1.
15. When the marker appears to be frozen, press <STORE>.
16. Adjust the plane 2 phase to your reference mark or to zero as you did for Plane 1.
17. Press <STORE> to complete the initial measurement for Plane 1 and Plane 2.
18. Shut down the machine and continue the balancing procedure in the next section.

Adding the Trial Weight and Taking a Measurement in Plane 1

1. When you have completed the initial measurement, press <F1> (Continue). The Enter Trial Weight - Plane 1 window appears.

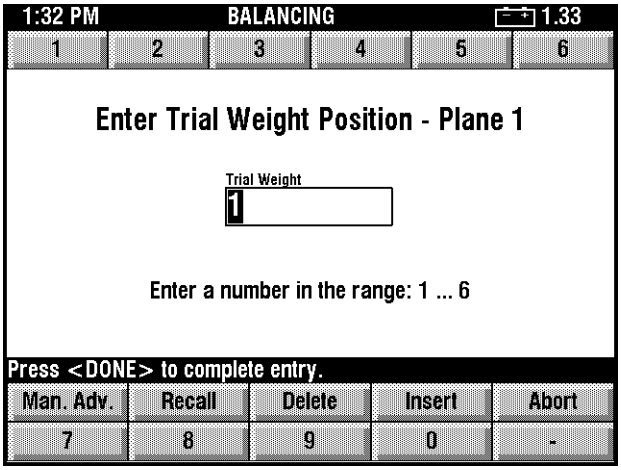


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2. With the Edit Trial Weight - Plane 1 window open, enter the magnitude of the trial weight you are about to attach to the rotor in the first plane. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).
3. The dataPAC displays the Weight Units window. Highlight a unit of measure on the displayed list and press <SELECT>. The units selected for the trial weights become the default units for the correction and trim weights. Correction and trim weight units can be changed; the dataPAC will convert between units.

Note: You must always enter trial weight values in the same units of measure for each plane.

4. Enter the plane 1 trial weight location. Use the edit window to enter the location of the trial weight on the rotor in the first plane.

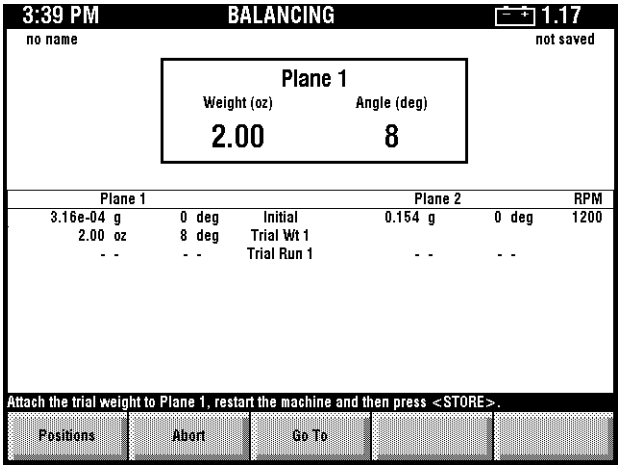


If the machine has no vanes or blades, the trial weight location should be specified in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, the location is specified in positions (vanes or blades), from 1 to the total number of vanes or blades.

In either case, the position is measured from the reference mark in the direction specified in the Weight Placement filed on the Balance Options screen. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).

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Notice that after you enter the trial weight, the lower half of the dataPAC display indicates the initial vibration in both planes, as well as the trial weight just entered. The dataPAC updates the summary display as you compete each step of the balancing operation.



5. Turn off the machine and attach the plane 1 trial weight to the rotor. The trial weight must be placed at the angle you entered previously.
6. With the trial weight attached securely, restart the machine and allow it to reach normal operating speed.
7. Press <STORE> to begin taking a trial weight measurement. You will take measurements in both the first and second plane to see the effect of the trial weight in plane 1.

Note: You may get a warning after applying the trial weight if the original 1X vector does not change significantly. If this happens, you are given the choice to Continue or Backup. You can Backup and add more weight if you want.

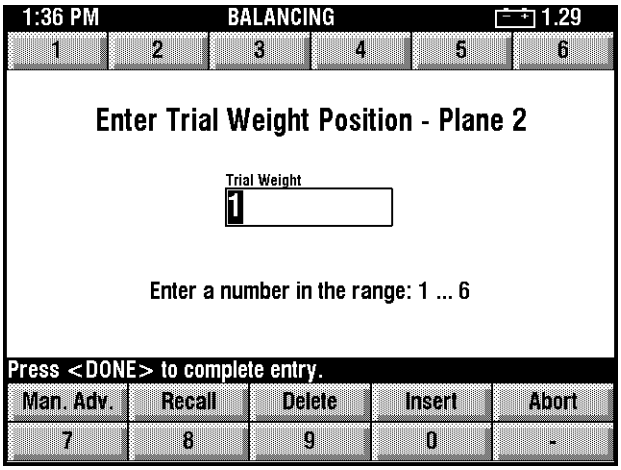
8. When the marker appears to be frozen, press <STORE>.
9. Adjust the plane 1 phase to the zero position or reference mark as before.
10. Press <STORE> to complete plane 1 measurement and begin plane 2 measurement.
11. Press the trigger on the strobe, which causes it to begin to flash.
12. Adjust the plane 2 machine speed. Adjust the strobe flash rate to match the machine speed, as described earlier. When the marker appears to be frozen, press <STORE>.
13. Adjust the plane 2 phase to the zero position or reference mark as before. Press <STORE> to complete the trial measurement for plane 1 and plane 2.
14. Shut down the machine and continue the balancing procedure in the next section. Leave the plane 1 trial weight on the rotor.

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Adding the Trial Weight and Taking a Measurement in Plane 2

1. Press <F1> (Continue) to enter the plane 2 trial weight and continue the balancing procedure.
2. With the Edit Trial Weight - Plane 2 window open, enter the magnitude of the trial weight you are about to attach to the rotor in the second plane.

   When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).
3. The Enter Trial Weight Position - Plane 2 window opens. Use the edit window to enter the location of the trial weight you are about to attach to the rotor. When your entry is complete, press <DONE>.



   If the machine has no vanes or blades, the trail weight location should be specified in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, the location is specified in positions (vanes or blades), from 1 to the total number of vanes or blades.

   In either case, the position is measured from the reference mark in the direction specified in the Weight Placement field on the Balance Options screen. Press <DONE> when complete.

   Notice that after you enter the trial weight, the lower half of the dataPAC display indicates the vibration level of the initial vibration in the second plane, as well as the trial weight just entered. This display updates as each step of the balancing operation is completed.
4. Turn off the machine and attach the trial weight to the rotor in the second plane. The trial weight must be placed at the angle you just entered.
5. With the trial weight attached securely, restart the machine and allow it to reach normal operating speed.
6. Press <STORE> to take a plane 2 trial weight measurement.
7. Press the trigger on the strobe light and adjust machine speed as described earlier.

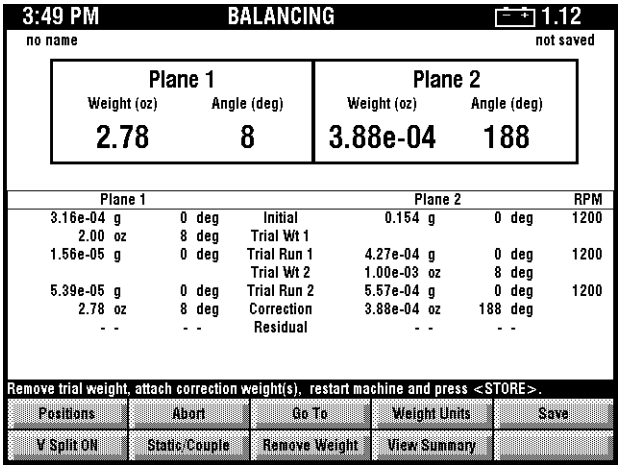
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8. When the marker appears to be frozen, press <STORE>.
9. Adjust the plane 2 phase to the zero mark or reference mark as before.
10. Press <STORE> to complete plane 1 measurement and begin plane 2 measurement.
11. Adjust the strobe flash rate to match the machine speed, as described earlier. When the marker appears to be frozen, press <STORE>.
12. Adjust the plane 2 phase to zero or to the reference mark you used before. Press <STORE> to complete the trial measurement for plane 1 and plane 2.
13. Shut down the machine and remove the trial weights from the both planes. Continue the balancing procedure in the next section.

Adding the Correction Weights and Taking a Residual Measurement

1. Attach correction weights. The dataPAC calculates and displays a recommended balancing weight labeled “Correction” on the dataPAC display. There are two correction weights, one for each plane. The “Position” column indicates where to attach the correction weight.
   - For rotors with zero positions, the position is shown in degrees, in the direction of rotation set in Weight Placement, from the 0° mark.
   - For rotors with multiple “positions” or vanes, the Position column indicates on which positions the weights must be added. The 0° position is considered position 1, and the other positions are numbered sequentially, in the direction of rotation.

   Prepare the prescribed balancing weight and attach it to the rotor. Make sure you attach the weight the number of degrees or positions, in the direction of rotation set in Weight Placement, away from the reference mark.



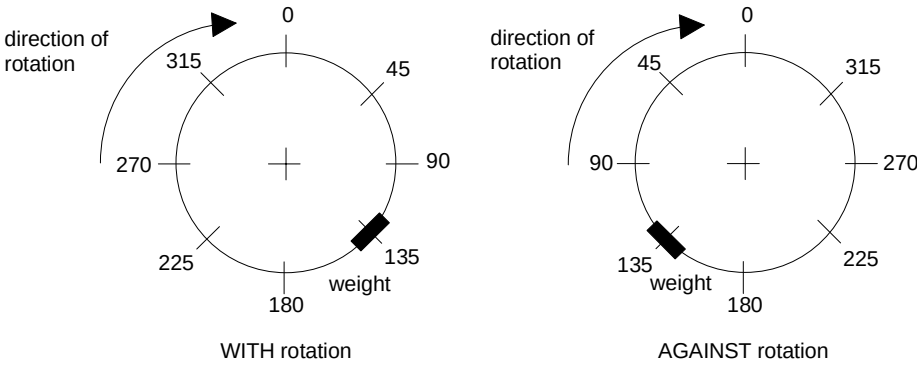
You may toggle between Dynamic or Static/Couple corrections by pressing <F2>. In Static/Couple display mode, the correction and trim weights are displayed as a static/couple weight pair.

Additionally, the dataPAC calculates the amount of weight that might be removed, if weights are already attached to the rotor. Press <F3> to toggle between Remove Weight and Add Weight.

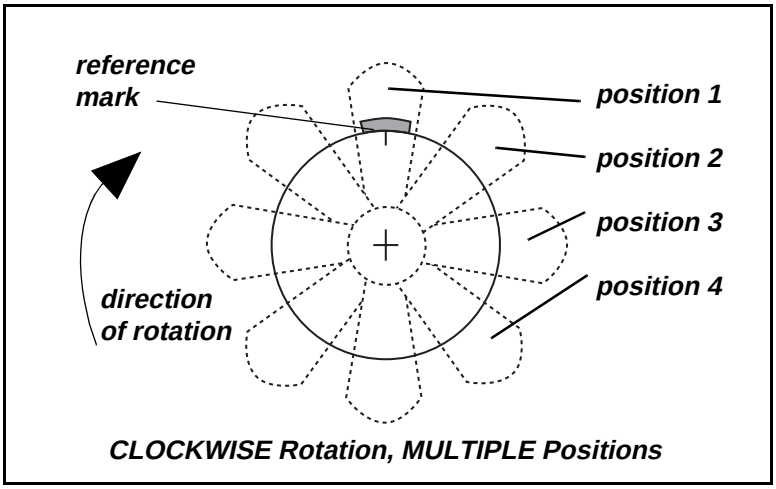
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The dataPAC also calculates split vectors if weight needs to be divided between two contiguous blades, rather than attached to a single blade. Press <F1> (VSplit On/Off) to turn Vector Splitting off and on.

Always view the direction of rotation from the same point.



With machines having multiple positions, the reference blade is 1. For 8 positions, correction weight call-outs may be at positions 1, 2, 3,... 8. The dataPAC automatically splits the required correction weights between two adjacent blades if Vector Splitting is turned on.



2. With the correction weight attached securely, restart the machine and allow it to reach normal operating speed.
3. Press <STORE> to begin taking a residual measurement. You will take measurements in both the first and second plane to see the affect of the correction weights in both planes.
4. Press the trigger on the strobe light and adjust the machine speed as before.

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5. When the marker appears to be frozen, press <STORE>.
6. Adjust the plane 1 phase to zero or a reference mark as before.
7. Press <STORE> to complete plane 1 measurement and begin plane 2 measurement.
8. Press the trigger on the strobe.
9. Adjust the plane 2 machine speed. Adjust the strobe flash rate to match the machine speed, as described earlier. When the marker appears to be frozen, press <STORE>.
10. Adjust the plane 2 phase to zero or a reference mark as before. Press <STORE> to complete the residual measurement for plane 1 and plane 2.
11. Shut down the machine and attach the trim weights whose weights and positions are indicated on the dataPAC display.

Note: Do not remove the original correction weights.

12. Continue to trim-balance the machine as required. After securing the trim weights, bring the rotor up to speed and repeat the measurement. The dataPAC takes vibration readings, calculates new trim weights, and displays them as described above.

    If the vibration has been reduced to an acceptable level, balancing is complete. Save your balancing data, if desired, by pressing <SHIFT><F5>. The Save Balancing Data window appears. Enter the file name. When your entry is complete, press <DONE>, or press <SHIFT><F5> (Abort) to cancel the entry. If the rotor is still out of balance, repeat trial weight addition as many times as necessary until the rotor is properly balanced.

One Plane Balancing with a Reference Trigger

This section discusses the procedure for balancing a machine in one plane using the dataPAC and an attached reference trigger, such as a laser tachometer. This procedure is divided into parts based on when you start and stop the machine. You must complete the entire procedure until the vibration level has been reduced enough for your needs.

Setting Up the Entach Digital Laser Tachometer

If you are using the Entach tachometer, you choose a measurement mode before using the tachometer as a reference trigger. The Entach has several measurement modes. For balancing applications with the dataPAC, use the RPM measurement mode.

When you connect the tachometer cable to the dataPAC, the Entach automatically switches on.

Refer to the *Entach Operating Guide* for more information about using the Entach digital laser tachometer.

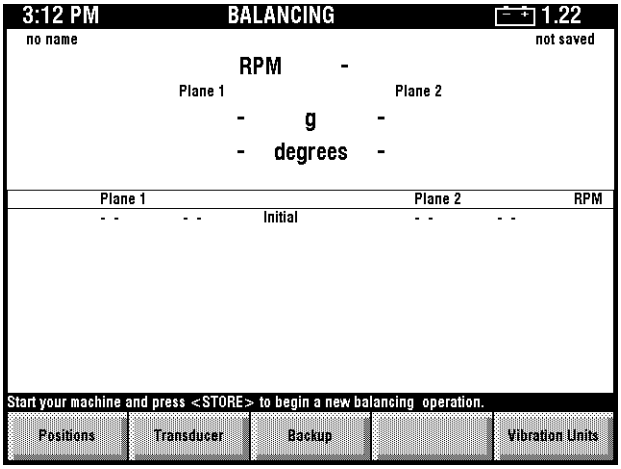
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Taking the Initial Vibration Measurement

1. Connect the reference trigger to the dataPAC 1500's REF input using the connector cable provided. Align the trigger with the machine you want to balance.
2. Attach a transducer to a bearing housing.
3. With the machine stopped, make a mark on one rotor which will serve as a reference when using the reference trigger. It is also possible to use some other, existing identifying mark on the rotor as the reference mark, such as a key or keyway.

Note: If the rotor has multiple positions (vanes or fan blades), the reference mark must be at one of the blade positions.

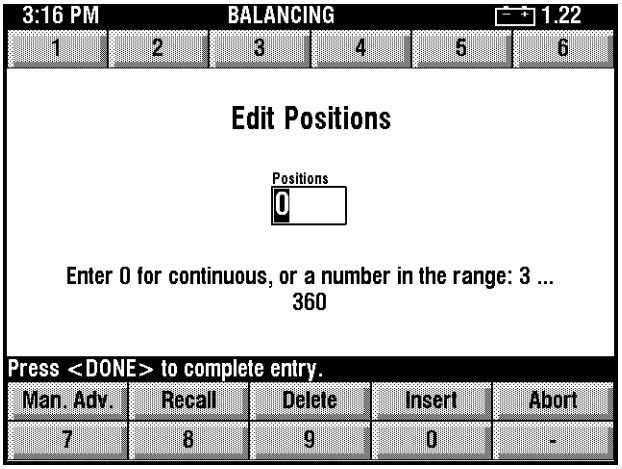
4. Start a balancing session by pressing either <F2> or <F4>. To enter new balancing data, press <F4> (New Run) from the Balancing Options window. To continue a saved balancing session, press <F2> (Continue Loaded Run). The Balancing window opens.



5. Select the correct transducer setting if necessary. Press <F2> (Transducer) to open the Transducer Options window. See "Installing and Defining dataPAC Transducers" on page 48 for more information.

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6. Press <F1> (Positions) to enter the number of positions. The number of positions refers to the number of rotor components, such as blades on a fan. The Edit Positions window opens.



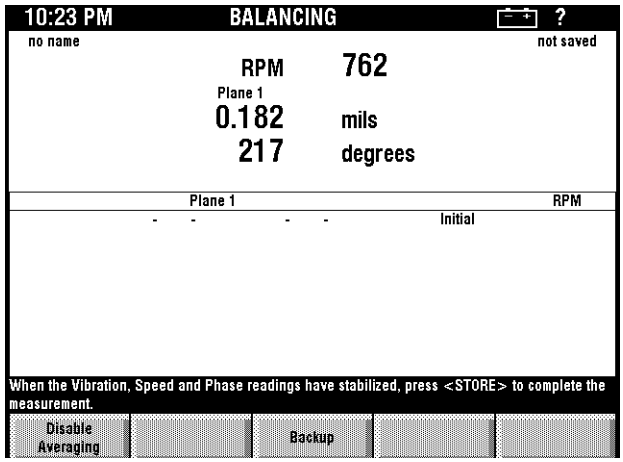
Enter 0 for a rotor without vanes or blades, or enter the number of vanes or blades. When your entry is complete, press <DONE>, or press <SHIFT><F5> (Abort) to cancel the entry.

Note: Vibration units and speed displayed are consistent with system and frequency units selected in the dataPAC Instrument Options screen. See “Setting Up Instrument Options” on page 40.

7. Select the correct vibration units by pressing <F5> (Vibration Units). The units selected must be compatible with the installed transducer. The Vibration Units Selection window opens.

   Use the arrow keys to highlight the desired units and then press <SELECT> and return to the Balancing window.

8. Start the machine and allow it to reach normal running speed.
9. Press <STORE> to take an initial vibration measurement.

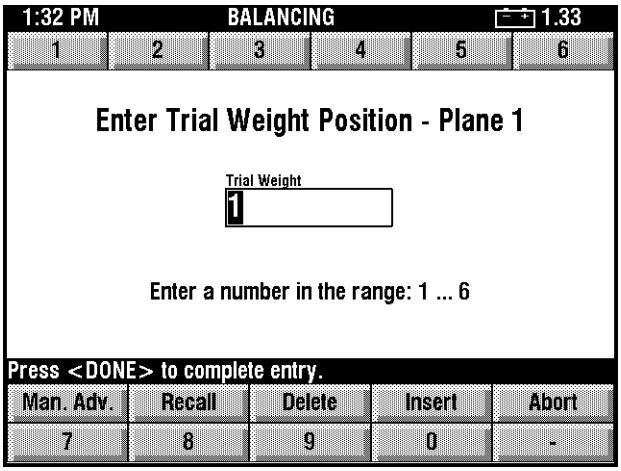


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10. The dataPAC automatically measures the speed, vibration, and phase. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
11. Enable or disable averaging. Pressing <F1> (Enable/Disable Averaging) allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise or interfering signals that are close in frequency. However, if values are slowly creeping to a higher or lower value, you can turn off averaging to discard the previous values and read a true value more quickly.
12. When the speed, vibration, and phase values are stable, press <STORE>. The initial measurement is complete.
13. Shut down the machine and continue the balancing procedure in the next section.

Adding the Trial Weight and Taking a Measurement

1. Press <F1> (Continue) when you have completed the initial measurement. The Edit Trial Weight window opens.
2. Enter the trial weight using the Edit Trial Weight window. When your entry is complete, press <DONE>. The dataPAC displays the Weight Units window.
3. Highlight a unit of measure on the displayed list and press <SELECT>. The units selected for the trial weights become the default units for the correction and trim weights. Correction and trim weight units can be changed because the dataPAC converts between units.
4. Enter the trial weight position using the edit window.

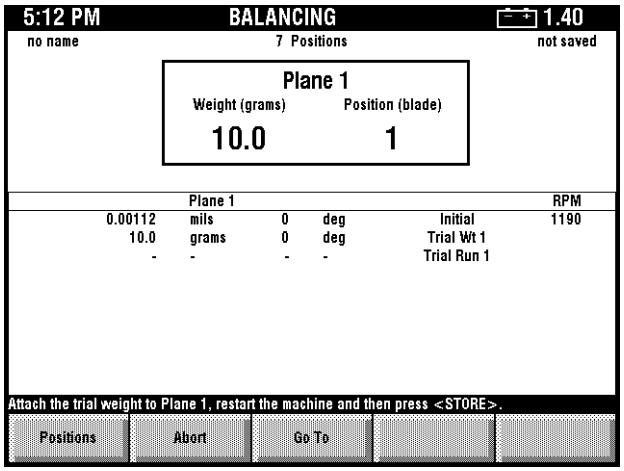


If the machine has no vanes or blades, the trial weight location should be specified in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, the location is specified in positions (vanes or blades), from 1 to the total number of vanes or blades.

In either case, the position is measured from the reference mark in the direction specified in the Weight Placement field on the Balance Options Screen. Press <DONE> when complete.

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Notice, after you have entered the trial weight, the lower half of the dataPAC display indicates the vibration level of the initial vibration as well as the trial weight you just entered. This display updates as you complete each step of the balancing operation.



5. Attach the trial weight to the rotor.
6. Start the machine and let it reach operating speed.
7. Press <STORE> to take a trial weight measurement.
8. The dataPAC automatically measures the speed, vibration, and phase. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
9. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging) during measurement. This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values are slowly creeping to a higher or lower value, you can turn off averaging to discard the previous values and read a true value more quickly.
10. When the speed, vibration, and phase values are stable, press <STORE>. The trial weight measurement is complete.
11. Shut down the machine and remove the trial weight from the rotor. Continue the balancing procedure in the next section.

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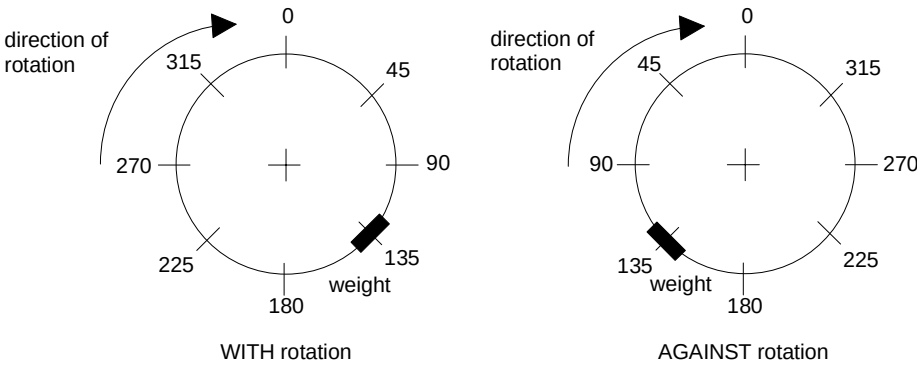
Adding the Correction Weight and Taking a Residual Measurement

1. The dataPAC has calculated and now displays a recommended balancing weight labeled “Correction” on the dataPAC display. Attach correction weight according to the display. The “Position” column indicates where to attach the correction weight.

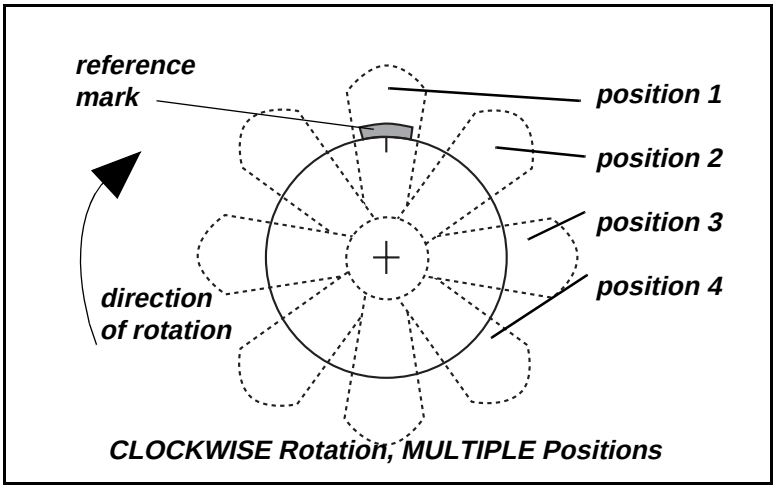
- For rotors with zero positions the position is shown in degrees, in the direction of rotation set in Weight Placement, from the 0° mark.
- For rotors with multiple “positions” or vanes, the Position column indicates on which positions the weights must be added. The 0° position is considered position 1, and the other positions are numbered sequentially, in the direction of rotation.

  Make sure you attach the weight the number of degrees or position, in the direction of rotation set in Weight Placement, away from the reference mark.

Note: Always view the direction of rotation from the same point.



With machines having multiple positions, the reference blade is 1. For 8 positions, correction weights may be at positions 1, 2, 3,... 8. The dataPAC automatically splits the required correction weights between two adjacent blades if you turn Vector Splitting on by pressing <F1>.



2. Start the machine and let it reach operating speed.

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3. Press <STORE> to take a residual measurement with the correction weight attached.
4. The dataPAC automatically measures the speed, vibration, and phase. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
5. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging) during measurement. This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values are slowly creeping to a higher or lower value, you can turn off averaging to discard the previous values and read a true value more quickly.
6. When the speed, vibration, and phase values are stable, press <STORE>. The residual measurement is complete.
7. Shut down the machine and attach the trim weight(s) whose weight and location are indicated on the dataPAC display.

Note: Do not remove the original correction weight.

8. Continue to trim-balance the machine as required. After securely attaching the trim weight(s), bring the rotor up to balance speed and press <STORE>. The dataPAC takes vibration readings, calculates new trim weight(s) and displays it as described above.

   If the vibration has been reduced to an acceptable level, balancing is complete. Save your balancing data, if desired, by pressing <SHIFT><F5>. The Save Balancing Data window appears. Enter the file name. When your entry is complete, press <DONE>, or press <SHIFT><F5> (Abort) to cancel the entry.

   However, if the rotor is still out of balance, repeat adding the correction weight and taking residual measurements as many times as are necessary until the rotor is properly balanced. If the balance never improves, check to see if you entered the correct trial weight size and location, or check other factors such as misalignment or a faulty bearing.

Two Plane Balancing with a Reference Trigger

This section discusses the procedure for balancing a machine in two planes using the dataPAC and an attached reference trigger.

Taking the Initial Vibration Measurement

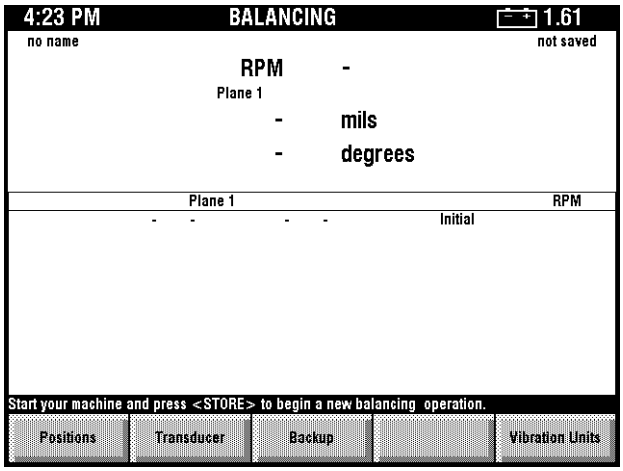
1. Connect the reference trigger to the dataPAC 1500's REF input using the connector cable provided. Align the trigger with the machine you want to balance.
2. With the machine stopped, make a mark on one rotor which will serve as a reference when using the reference trigger. It is also possible to use some other, existing identifying mark on the rotor as the reference mark, such as a key or keyway.

Note: If the rotor has multiple positions (vanes or fan blades), the reference mark must be at one of the blade positions.

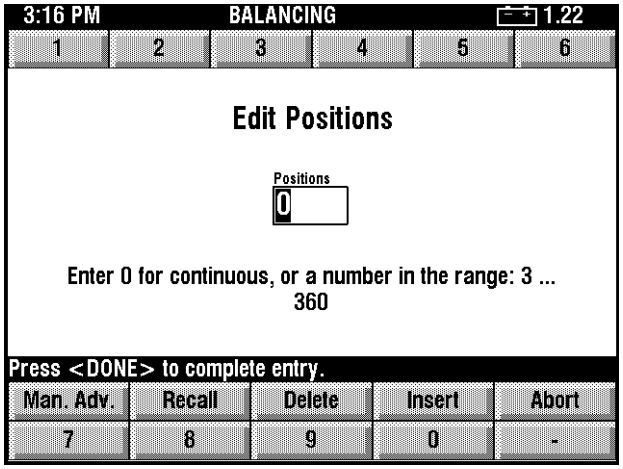
3. Attach a transducer to a bearing housing in each plane at each end of the shaft. You must have two identical transducers and the two-plane balancing kit (sold separately) to complete two-plane balancing.

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4. Start a balancing session by pressing either <F2> or <F4>. To enter new balancing data, press <F4> (New Run) from the Balancing Options window. To continue a saved balancing session, press <F2> (Continue Loaded Run). The Balancing window opens.



5. Select the correct transducer setting. If necessary, press <F2> (Transducer) to open the Transducer Options window. See “Installing and Defining dataPAC Transducers” on page 48 for more information.
6. Enter the number of positions on the rotor by pressing <F1> (Positions). The number of positions refers to the number of rotor components, such as blades on a fan. Enter 0 for a rotor without vanes or blades, or enter the number of vanes or blades. When your entry is complete, press <DONE> To cancel, press <SHIFT><F5> (Abort).

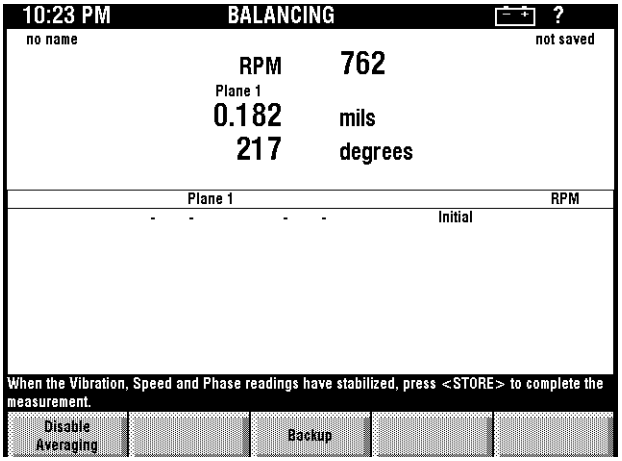


Note: Vibration units and speed displayed are consistent with system and frequency units selected in the dataPAC Instrument Options screen. See “Selecting the Data Collection Options” on page 127 for more information.

7. Select the correct vibration units by pressing <F5> (Vibration Units) to open the vibration units window. The units selected must be compatible with the installed transducer. Use the arrow keys to highlight the desired units and then press <SELECT> to return to the Balancing window.

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8. Start the machine and allow it to reach normal operating speed.
9. Press <STORE> to begin the initial measurement.

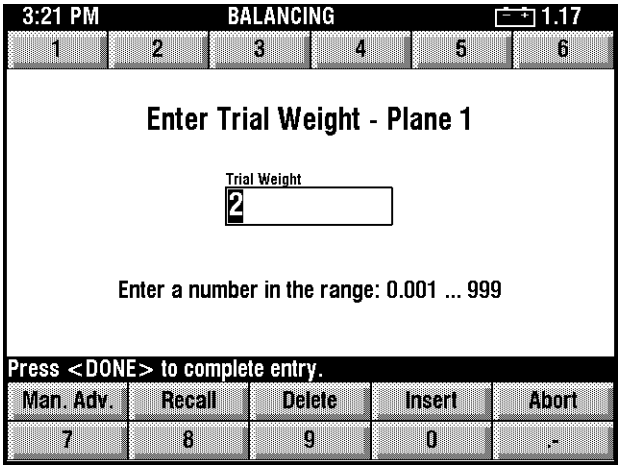


10. The dataPAC automatically measures the speed, vibration, and phase in the first plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
11. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging). This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values slowly creep to a higher or lower value, you can turn averaging off to discard the previous values and read a true value more quickly.
12. When the speed, vibration, and phase values are stable, press <STORE>. This completes the plane 1 measurement and begins the plane 2 measurement.
13. The dataPAC automatically measures the speed, vibration, and phase in the second plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
14. Press <STORE> to complete the initial measurement for plane 1 and plane 2.
15. Shut down the machine and continue the balancing procedure in the next section.

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Adding the Trial Weight and Taking a Measurement in Plane 1

1. When you have completed the initial measurement, press <F1> (Continue). The Enter Trial Weight - Plane 1 window appears.

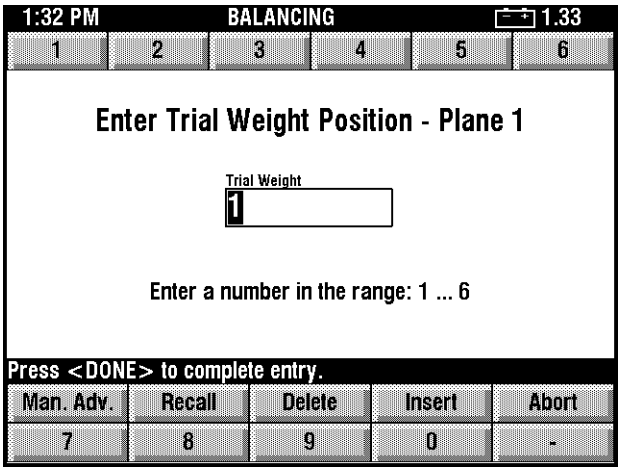


2. With the Edit Trial Weight - Plane 1 window open, enter the magnitude of the trial weight you will attach to the rotor in the first plane. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).
3. The dataPAC displays the Weight Units window. Highlight a unit of measure on the displayed list and press <SELECT>. The units selected for the trial weights become the default units for the correction and trim weights. Correction and trim weight units can be changed because the dataPAC converts between units.

Note: You must always enter trial weight values in the same units of measure for each plane.

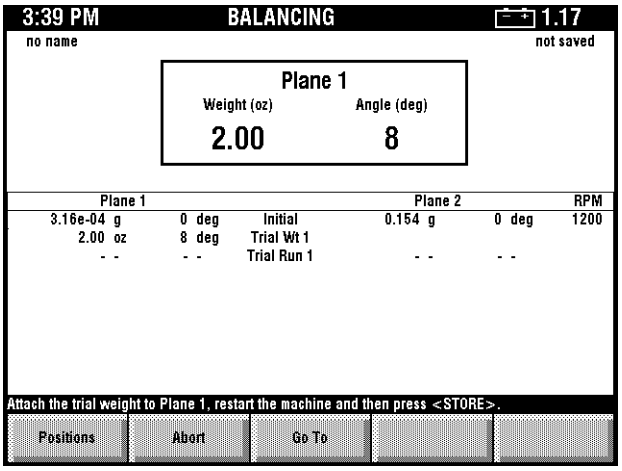
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4. With the Edit Trial Weight Angle - Plane 1 window open, enter the angle at which you are about to attach to the rotor in the first plane. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).



If the machine has no vanes or blades, the trial weight location should be specified in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, the location is specified in positions (vanes or blades), from 1 to the total number of vanes or blades.

Notice that after you enter the trial weight, the lower half of the dataPAC display indicates the initial vibration in both planes, as well as the trial weight just entered. The dataPAC updates the summary display as you compete each step of the balancing operation.



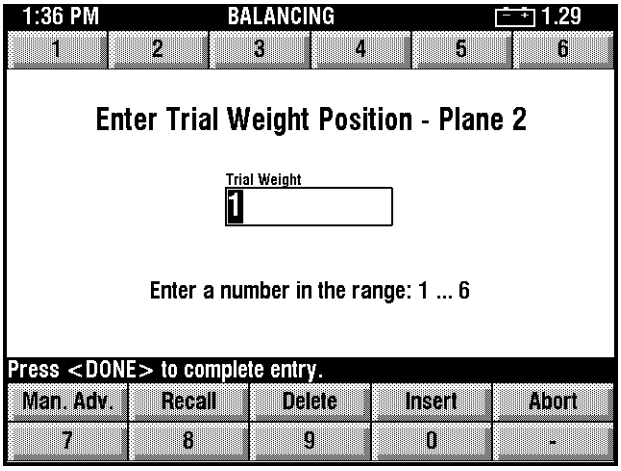
5. Attach the plane 1 trial weight to the rotor. The trial weight must be placed at the angle previously established.
6. With the trial weight attached securely, restart the machine and allow it to reach normal operating speed.
7. Press <STORE> to begin taking a trial weight measurement.

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8. The dataPAC automatically measures the speed, vibration, and phase in the first plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
9. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging) during measurement. This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values are slowly creeping to a higher or lower value, averaging can be turned off to discard the previous values and read a true value more quickly.
10. When the speed, vibration, and phase values are stable, press <STORE>. This completes the plane 1 measurement and begins the plane 2 measurement.
11. The dataPAC automatically measures the speed, vibration, and phase in the second plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
12. Press <STORE> to complete the measurement.
13. Shut down the machine and continue the balancing procedure in the next section. Leave the plane 1 trial weight on the rotor.

Adding the Trial Weight and Taking a Measurement in Plane 2

1. Press <F1> (Continue) to enter the plane 2 trial weight and continue the balancing procedure.
2. Use the Edit Trial Weight - Plane 2 window to enter the magnitude of the trial weight you are about to attach to the rotor in the second plane. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5> (Abort).
3. Use the Enter Trial Weight Position - Plane 2 window to enter the location of the trial weight you are about to attach to the rotor. When your entry is complete, press <DONE>. To cancel, press <SHIFT><F5>.



If the machine has no vanes or blades, the trail weight location should be specified in degrees (0 - 359). If you entered the number of vanes or blades earlier in the procedure, the location is specified in positions (vanes or blades), from 1 to the total number of vanes or blades.

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In either case, the position is measured from the reference mark in the direction specified in the Weight Placement field on the Balance Options screen. Press <DONE> when complete.

Notice that after you enter the trial weight, the lower half of the dataPAC display indicates the vibration level of the initial vibration in the second plane, as well as the trial weight just entered. This display updates as you complete each step of the balancing operation.

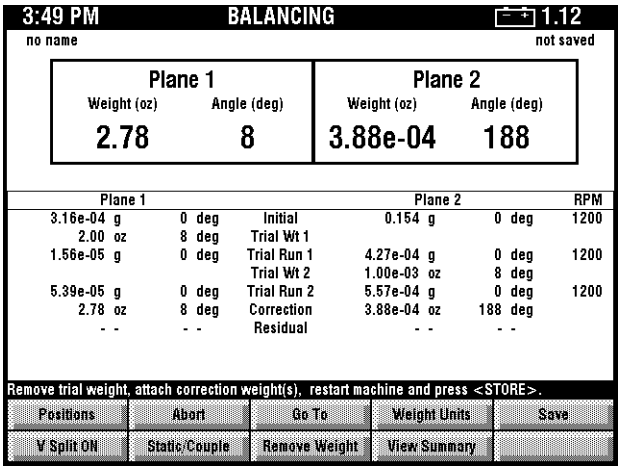
4. Attach the trial weight to the rotor in the second plane. The trial weight must be placed at the angle you entered previously.
5. With the trial weight attached securely, restart the machine and allow it to reach normal operating speed.
6. Press <STORE> to take a plane 2 trial weight measurement.
7. Measure plane 1 speed, vibration, and phase. The dataPAC automatically measures the speed, vibration, and phase in the first plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
8. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging) during measurement. This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values slowly creep to a higher or lower value, you can turn off averaging to discard the previous values and read a true value more quickly.
9. When the speed, vibration, and phase values are stable, press <STORE>. This completes the plane 1 measurement and begins the plane 2 measurement.
10. Measure plane 2 speed, vibration, and phase. The dataPAC automatically measures the speed, vibration, and phase in the second plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
11. Press <STORE> to complete the measurement.
12. Shut down the machine and remove the trial weights from the both planes. Continue the balancing procedure in the next section.

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Adding the Correction Weights and Taking a Residual Measurement

1. Attach correction weights. The dataPAC calculates and displays a recommended balancing weight labeled “Correction” on the dataPAC display. There are two correction weights, one for each plane. The “Position” column indicates where to attach the correction weight.

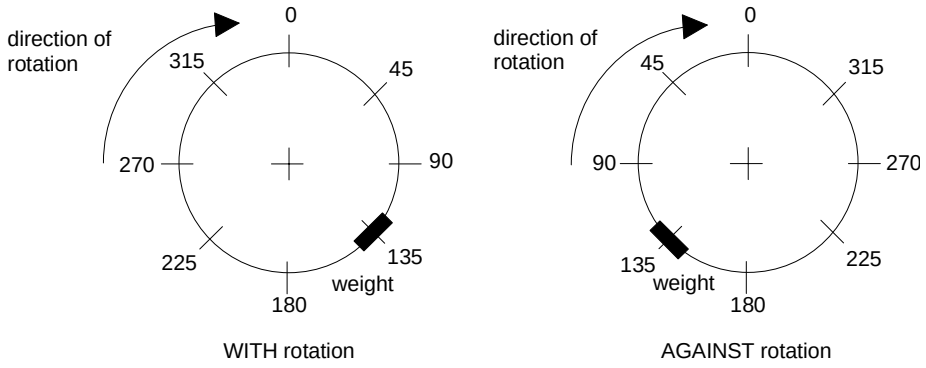
   - For rotors with zero positions, the position is shown in degrees, in the direction of rotation set in Weight Placement, from the 0° mark.
   - For rotors with multiple “positions” or vanes, the Position column indicates on which positions the weights must be added. The 0° position is considered position 1, and the other positions are numbered sequentially, in the direction of rotation.



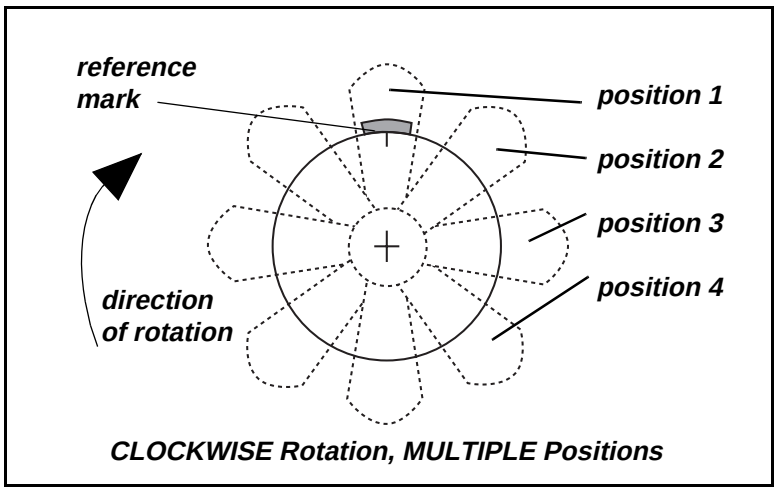
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You may toggle between Dynamic or Static/Couple corrections by pressing <F2>. Additionally, the dataPAC calculates the amount of weight that might be removed, if weights are already attached to the rotor. Press <F3> to toggle between Remove Weight and Add Weight. The dataPAC also calculates Split Vectors if weight needs to be divided between two contiguous blades, rather than attached to a single blade.

Always view the direction of rotation from the same point.



With machines having multiple positions, the reference blade is 1. For 8 positions, correction weights may be at positions 1, 2, 3,... 8. The dataPAC automatically splits the required correction weights between two adjacent blades if Vector Splitting is turned on.



2. With the correction weight attached securely, restart the machine and allow it to reach normal operating speed.
3. Press <STORE> to begin taking a residual measurement.
4. The dataPAC automatically measures the speed, vibration, and phase in the first plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
5. Enable or disable averaging by pressing <F1> (Enable/Disable Averaging) during measurement. This allows you to turn on or off vibration and phase averaging. Averaging helps to stabilize the vibration and phase reading at the proper values by averaging out the effect of noise. However, if values slowly creep to a higher or lower

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value, you can turn off averaging to discard the previous values and read a true value more quickly.

6. When the speed, vibration, and phase values are stable, press <STORE>. This completes the plane 1 measurement and begins the plane 2 measurement.
7. The dataPAC automatically measures the speed, vibration, and phase in the second plane. The values are constantly updated on the screen. Allow these values to stabilize before continuing to the next step.
8. Press <STORE> to complete the measurement.
9. Shut down the machine and attach the trim weights whose weights and positions are indicated on the dataPAC display.

Note: Do not remove the original correction weights.

10. Continue to trim-balance the machine as required. After securing the trim weights, bring the rotor up to balance speed and take a measurement. The dataPAC takes vibration readings, calculates new trim weights, and displays them as described above.

    If the vibration has been reduced to an acceptable level, balancing is complete. Save your balancing data, if necessary, by pressing <SHIFT><F5>. The Save Balancing Data window appears. Enter the file name. When your entry is complete, press <DONE>, or press <SHIFT><F5> (Abort) to cancel the entry.

    However, if the rotor is still out of balance, repeat adding the correction weight and taking residual measurements as many times as are necessary until the rotor is properly balanced. If the balance never improves, check to see if you entered the correct trial weight size and location, or check other factors such as misalignment or a faulty bearing.

Unloading Balancing Runs using a Modem

Model 1500 only

Using the dataPAC 1500 V5 Remote Transfer program, you can connect the dataPAC to a Hayes-compatible modem and load and unload to a host computer. This allows you to copy routes and balancing runs to and from a host computer.

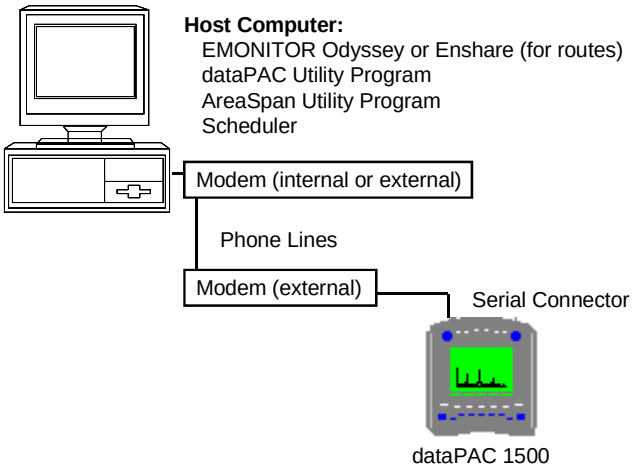
The Remote Transfer program also allows you to place an external modem attached to the dataPAC into auto answer mode, so that the remote host computer can “call” the dataPAC in order to transfer files and information. This external modem is connected to the dataPAC with a special cable which you can order from Entek IRD. The external modem must have a 25-pin connector to connect to the dataPAC with the special cable.

This section discusses loading route files to the dataPAC from a host computer, using lists created in EMONITOR Odyssey or Enshare. You can also load and unload balancing information.

The host computer must be running the dataPAC Utility program in server mode in order to allow connections.

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This diagram shows the connections between the remote dataPAC and the host computer.



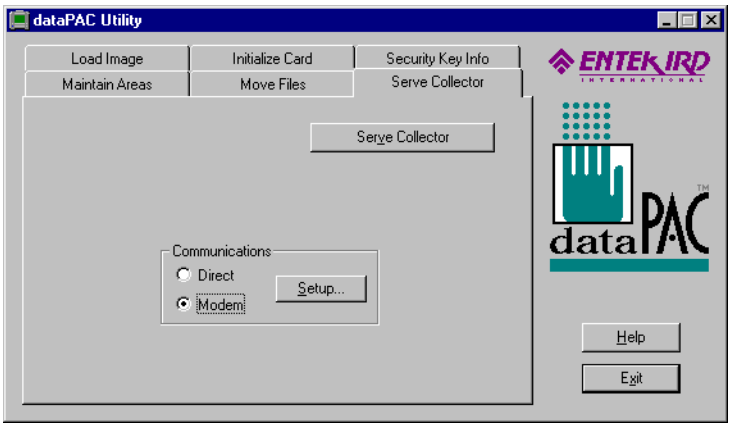
Setting Up Remote Transfer on the Host Computer

To load and unload routes, the host computer must have the following programs installed:

- dataPAC Utility Program
- Scheduler (if automation is wanted)

The dataPAC Utility Program acts a server for the dataPAC to connect to. The Utility must be in a listening server mode in order to receive route files from the dataPAC. To start the server mode, follow these steps.

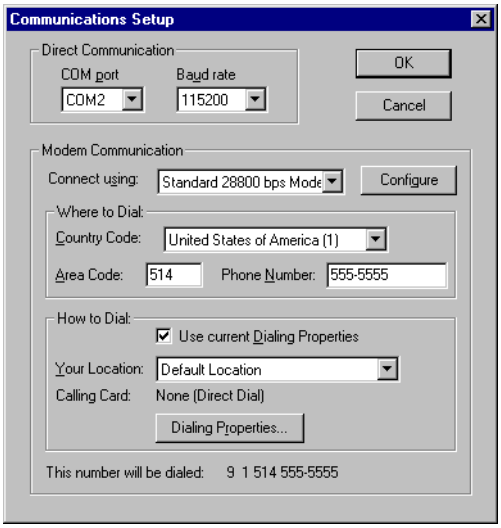
1. Start the dataPAC Utility Program by pointing to it on the **Start** menu.
2. Choose the **Serve Collector** tab.



3. Under **Communications**, choose **Modem**.

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4. Choose the **Setup** button. Make sure the modem is correctly set up. You can configure the modem by pressing the **Configure** button. Refer to the modem manufacturer's documentation for details on setting up the computer modem.



5. Choose **OK**.
6. Choose the **Serve Collector** button. The host computer now acts as a server, "listening" for a connection from the dataPAC. This dialog box appears when the connection is complete.

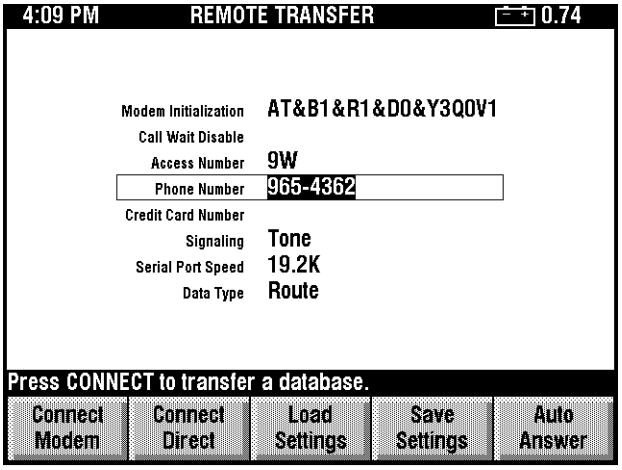


Setting Up Remote Transfer on the dataPAC

There are several settings that you must enter for the modem connected to the dataPAC. For some of these settings, you may have to refer to the modem manufacturer's manuals in order to get the correct settings. Follow these steps to enter each setting for remote transfer.

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1. In the Program Manager, use the arrow keys to highlight the Remote Transfer icon, then press <SELECT>. The following screen appears.



2. Use the arrow keys to move the box up to the setting you want to change, then press <SELECT>. Each setting is explained in detail in the next section.

Remote transfer settings

This section discusses each setting available in the Remote Transfer program, as well as typical settings.

Modem Initialization

The Modem Initialization field contains a string of commands is sent to the modem before making any connection through a modem. This string is made up of commands from the Hayes modem command set. The default modem initialization string should work fine for most Hayes-compatible modems.

Call Wait Disable

The Call Wait Disable field contains the special dialing characters that cause call waiting to be disabled during a telephone call. Common choices include:

- *70
- 70#
- 1170
- Other allows you to enter any other call waiting disable character set.

This prevents the call from being interrupted by the call waiting tone. You should refer to your telephone service provider to determine the proper call wait disable setting for you. These characters are dialed first when placing a call.

Access Number

The Access Number field contains the special dialing characters that obtain an outside line. Leave this field blank if you do not need an outside line or if you never dial a special number to obtain an outside line.

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Obtaining an outside line usually involves two steps, first, dialing a special character such as 9, then waiting for another dial tone. Check your modem's manual to see if it supports a "wait for dial tone" dialing command. The "W" character normally serves this purpose. For our example, "9W" would be the complete Access Number. You can use a comma in place of the W, because a comma also means a pause command. These characters are dialed after the Call Wait Disable characters and before the Phone Number.

Phone Number

The Phone Number field contains the phone number of the location you are calling. Any special long distance dialing characters, such as an area code or country code, should also be entered in this field. These characters are dialed after any Access Number and before any Calling Card Number.

Calling Card Number

The Calling Card Number field contains the complete number that you would enter to charge a call to a calling card. The S character is a common modem command that causes the modem to wait for the "bong" that phone companies use to prompt the caller for a credit card number. The Credit Card Number should usually be proceeded by the S character. These characters are dialed after the Phone Number and are the last characters dialed.

Signaling

The Signaling field contains the signaling method used to dial. You can choose either Tone or Pulse. Use Tone dialing if it is available.

Serial Port Speed

The Serial Port Speed field contains the setting for speed of the communications between the dataPAC and the modem or host computer. It should be set to the fastest rate that is supported by the modem or host computer's serial port. Your selections are:

- 115.2K
- 57.6K
- 38.4K
- 19.2K

This is not the baud rate of the connection made between the two modems during a call. That rate is automatically negotiated between the two modems. However, the modem's communication rate during a call cannot exceed the Serial Port Speed. Generally, a serial port should be faster than a phone line connection, so this should not be a problem.

Data Type

The Data Type field specifies the type of data to transfer during load and unload operations. Select Route to transfer routes, and select Balance Run to transfer balancing data. This setting can be changed while a connection is established.

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To save or load settings

You can save settings for future use, or load previously saved settings. For example, if you have more than one phone number that you dial in to, you can save time by storing settings for each. The default settings are the ones that appear the first time you start Remote Transfer. You can save over the Default settings to create your own default. To save or load settings, follow these steps.

1. When all settings are filled in, choose <F4> Save Settings.
2. You can either save the settings as Default, or save the settings under a new name. To save under a new name, press the arrow keys to highlight Save As, then press <SELECT>.
3. Enter the name in the Save Settings Screen.
4. Press <DONE> to save the settings.

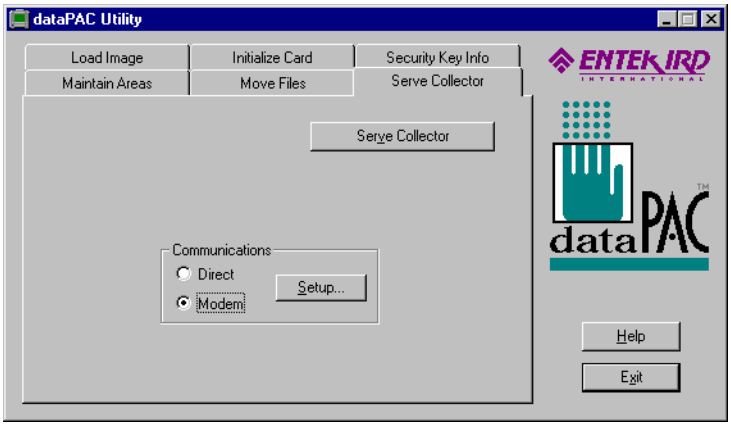
To load previously saved settings, follow these steps.

1. Press <F3> (Load Settings).
2. Use the arrow keys to select a name from the list. Press <SELECT>.
3. Press <SELECT> with the Done button highlighted. The settings will appear in the Remote Transfer screen.

Unloading Balancing Files to the Host Computer

From the host computer

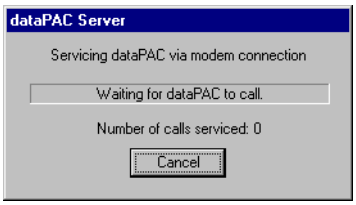
1. Start the dataPAC Utility Program by pointing to it on the **Start** menu.
2. Choose the **Serve Collector** tab.



3. Under **Communications**, choose **Modem**. You can choose **Setup** to make sure the modem is setup correctly.

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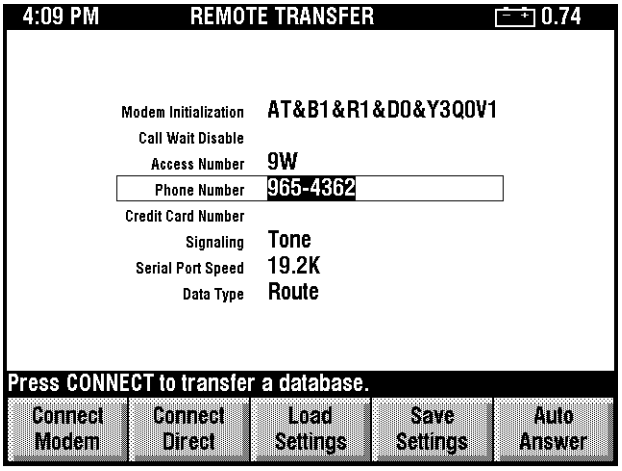
4. Choose **Serve Collector**. When the following dialog box appears, the computer is ready to receive a call from the dataPAC.



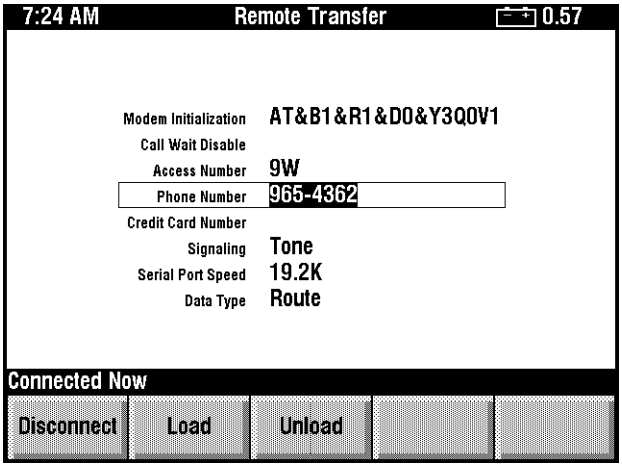
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From the dataPAC site

1. Connect the dataPAC to the external modem using the supplied cable. The cable connects to the I/O port on the dataPAC.
2. Open the Remote Xfer application by selecting it in the dataPAC Program Manager. The following screen appears.



3. Make sure the settings are correct for your dialing location, then press <F1> (Connect Modem).
4. The dataPAC dials the number designated and connects to the host computer.



5. Choose <F2> (Unload) and select the Area, typically ENTEK.
6. Select a Balance Run from a list of items in the selected Area. All balance runs are included in the list of balance runs available to unload.

   If there are no balance runs, you will see a message informing you of this.

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Balance runs that are locked at the instrument are listed but you cannot unload a locked route because it is opened by another dataPAC application. You will see a message informing you of this. If you see error messages, check to make sure the route is not locked by entering the Memory Card Manager program. If there is an “L” beside the file name, the file is locked. Choose the “Unlock” softkey to unlock the file.

You cannot overwrite an existing route (or balance run) in the selected host Area. An appropriate error message is displayed when you attempt to do so.

Collecting Phase Measurements for Analysis

The dataPAC is very useful in performing quick phase checks with the strobe light. In short, phase analysis allows you to analyze how one point on the machine is vibrating relative to another point. Typical tests include moving the transducer from a horizontal to a vertical orientation on a bearing housing to check the phase shift. See “Using the Strobe dB+” on page 165 for more information on operating your strobe. To do phase analysis, follow this procedure.

1. Attach the transducer to a bearing or other point on the machine where you suspect significant vibration is present.
2. Start a new balancing session by pressing <F2> (New Run).
3. Press <STORE> to start the measurement.
4. Press the trigger on the strobe to flash the strobe at the rotor and “freeze” it by adjusting the speed. If you do not know the machine speed, start with a value higher and work your way down until you get only one reference mark.
   - You can enter the machine speed in the Machine Speed edit window, then make fine or large adjustments to the flash rate with the arrow keys. The overall objective with the strobe is to adjust the flash rate so that it matches the machine speed, and the reference mark on the rotor appears to stand still. Hold the strobe so that the reference mark is visible as the strobe flashes. You can hold down the arrow keys to speed up the change rate.

WARNING: Although the machine appears stationary while viewed with the strobe, it is still running. Touching the machine while it is running can cause injury.

   - You can press <F1> (Auto Speed) to capture the RPM of the machine. If the strobe flash rate is close to the actual 1X machine speed, that is, the reference mark image is slowly rotating, you can use the <F1> (Auto Speed) key to adjust the strobe flash rate. This causes the strobe to flash at the RPM rate as determined by the signal coming from the vibration pickup. In many cases, pressing Auto Speed may be all you need to capture the RPM speed accurately. This feature only works when you are close to the frequency and there is a peak dominant at that frequency. See Help screens for more information.

   You can restore speed if needed. If the previous step is unsuccessful in locking speed, press <F2> (Restore Speed) to restore the speed to the value that existed prior to pressing <F1> (Auto Speed).

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5. At this point you should check 1X. It is possible to think the strobe is set correctly when you are actually on a sub-harmonic of the RPM. To check, press <F4> (2 X Speed) to double the strobe flash rate. After pressing <F4>, you should immediately notice there are two reference marks visible. If not, you are on a sub-harmonic and need to re-adjust the strobe rate. If you see two marks, press <F5> (1/2 X Speed) to halve the strobe rate, returning to the rate that existed prior to pressing <F4>. There should be only one phase mark again.
6. Move the phase mark to 0°. 12.Adjust the position of the reference mark for convenience by moving the phase mark to a point that can be easily seen and accurately measured, for example, top center or in line with the machine foot or bracket. After you add the trial weight, you must exactly reposition to this point for accurate phase measurements. Use the up and down arrow keys to move the mark one degree at a time. Or, press <F1> (Decrease 20 deg.) and <F2> (Increase 20 deg.) to move the mark incrementally by 20° at a time in either direction.

   As you move the reference mark the Phase Adjust angle value changes in the Balancing window. At this point you may wish to normalize phase to 0 before proceeding by pressing <F5>. This is optional.
7. Press <F4> (Pause). The strobe stops flashing.
8. Move the transducer to another position.
9. Press <F4> (Resume). The strobe will begin flashing again. With the strobe pointed at the rotor, notice the new location of the reference mark. Measure the angle in the direction of rotation. This is the phase shift angle.

   Alternatively, you can adjust the strobe flash rate to move the reference mark back to its original position by using the up and down arrow keys (±1° increments) or <F1> and <F2> softkeys (±20° increments), and read the relative phase shift on the dataPAC.

Note: At any point in this procedure, you can back up one step by pressing <F3> (Backup). Pressing <F5> (Abort) allows you to terminate the operation.

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Chapter 6

Frequency Response Function (FRF)

This chapter shows you how to use the Frequency Response Function to determine the resonant frequency and relative dynamic stiffness of a structure. The FRF feature is only available for the dataPAC 1500.

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Hardware Required by the FRF Module *210*

Understanding the Concepts Behind the FRF Module *216*

Setting Up FRF Measurements *219*

Collecting and Analyzing FRF Data *226*



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Overview of the dataPAC 1500 FRF Module

The FRF module is an optional addition to your dataPAC 1500, activated using a security key. Contact Entek IRD for information on purchasing this module and hammer kit. For more information about using a security key, see “Using Security Keys” on page 59.

The dataPAC 1500 FRF Module provides six powerful tools to measure a mechanical system’s frequency response. Using these six tools you can determine the resonant frequency and the relative dynamic stiffness of a structure. Unlike other dynamic stiffness testing products on the market, the dataPAC 1500 FRF Module provides special functionality to ensure your physical testing setup is correct and that each measurement you collect results in valid data.

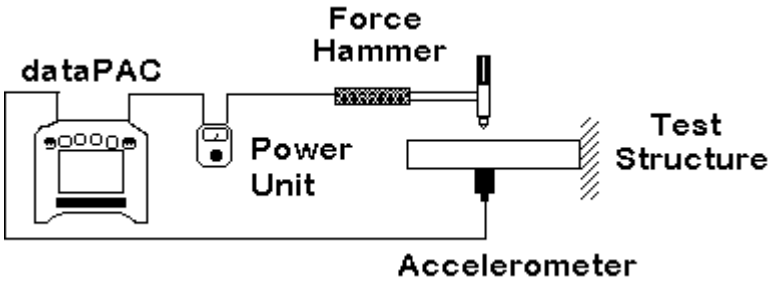
Using the FRF Module you can complete the following tasks:

- Perform a test procedure where you can set up and test both the input and response channels.
- Collect the initial test data by striking a structure with the force hammer.
- Display the data in any of the available formats, including accelerance, mobility, dynamic compliance, effective mass, mechanical impedance, and dynamic stiffness.
- Test the data for coherence.

Note: You cannot unload FRF data to your host software program. You can, however, use screen captures of your data or print the plots directly. For details on screen captures, see “Capturing and Printing dataPAC Screens” on page 178.

Hardware Required by the FRF Module

In order to perform frequency response testing, you use a calibrated force hammer to excite (strike) the structure being tested and an accelerometer to record how the structure responds to the excitation. The force hammer incorporates a load cell to measure the excitation impact force and timing. Since the system measures both the input and output forces, the dataPAC can quantify exactly how the structure reacts to the known input force.



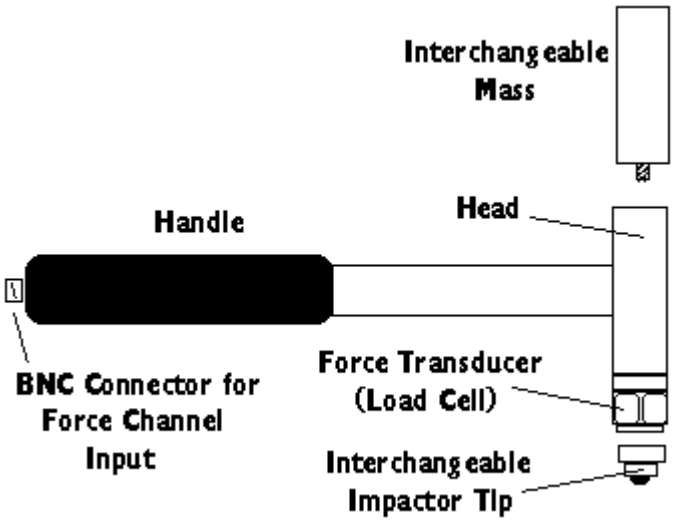
The force hammer connects to the dataPAC through the BNC REF connector. A power unit supplies a constant current source to the force transducer and connects the hammer and the dataPAC. Although the REFerence input is normally used for tracking the phase of a vibration input, this input can perform similar signal processing to the main input. The accelerometer measures the structure’s response. It connects to the main input jack.

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Force Hammer

The force hammer is a specially designed tool that provides a nearly constant force over a broad frequency range. It is capable of providing a measurable amount of vibration amplitude across its designed frequency range.

The hammer size, length, material, and velocity at impact determine the amplitude and frequency content of the impact force. This force must be sufficient to excite all resonances of the structure being tested in the frequency range being measured.



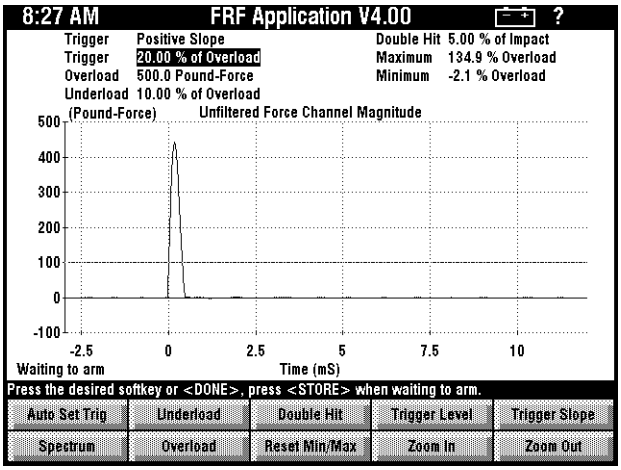
Each force hammer comes with a number of accessories. These accessories include interchangeable tips and masses that attach to the head of the hammer. The mass you select for a particular test is determined by the damping rate of the structure being tested. You need more mass for large structures, since hammer mass required is directly proportional to the size of the structure being tested. You determine your tip selection by the frequency range and impact duration needed for the test. Steel tips provide a short duration, high amplitude excitation across a wide frequency range. Conversely, rubber tips provide long duration excitation across a narrow frequency span. Plastic tips provide a set of characteristics between steel and rubber. Highly damped structures require a high amplitude, long duration excitation. Lightly damped structures require a relatively small, short duration excitation. The frequency range of the excitation needed varies with every unique structure. In most cases, start with a plastic tip and change to rubber or steel as dictated by your initial test results. Typical force hammer characteristics are shown below.

Hammer Type	Force Range	Frequency Range	Sensitivity
1	100 lbf (440 N)	8000 Hz	50 mV/lbf (12 mV/N)
2	500 lbf (2200 N)	8000 Hz	10 mV/lbf (2.3 mV/N)
3	1000 lbf (4400 N)	8000 Hz	5 mV/lbf (1.2 mV/N)
4	5000 lbf (22000 N)	5000 Hz	1 mV/lbf (0.23 mV/N)

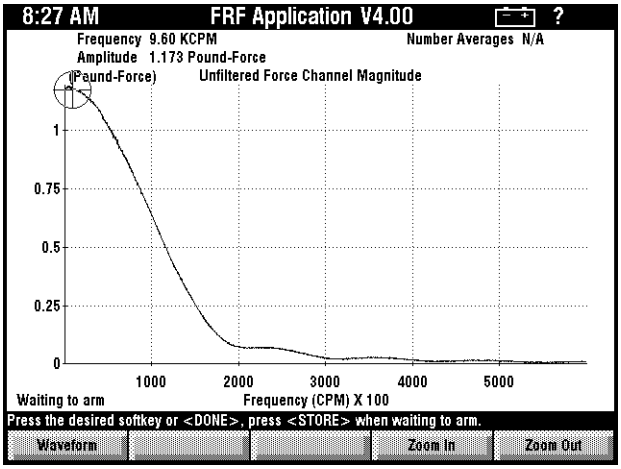
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Select the hammer based on the relative damping of the structure under test. You can use any force hammer whose output does not exceed 5 volts. Large, heavy structures normally have a much higher damping rate than smaller, lightweight ones. Refer to the table above for the force, frequency, and sensitivity ranges of commonly used hammers.

For examples of different tips, see the following plots. The following diagram shows an impact from the steel hammer tip. This waveform of the force channel shows an impact that is very sharp and short in duration.



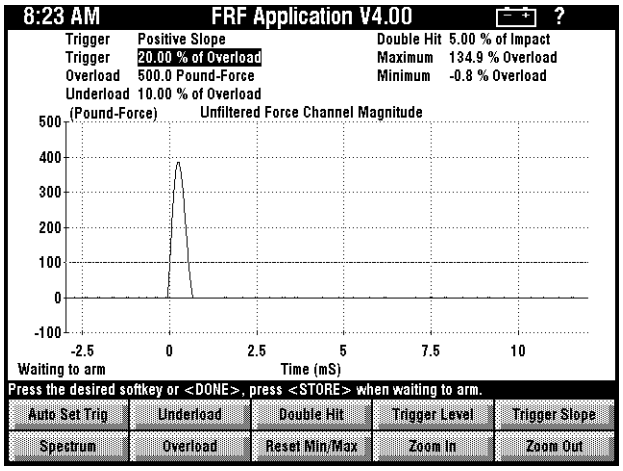
The steel tip is very hard, so when you strike a structure with it there is virtually no “give” and the hammer bounces back very quickly. On structures that are not firmly anchored or are lightly damped, this type of tip can cause frequent double hit errors. Pressing <F1> (Spectrum) switches to the spectrum display of the force channel. The Force Spectrum for a steel strike is shown below.



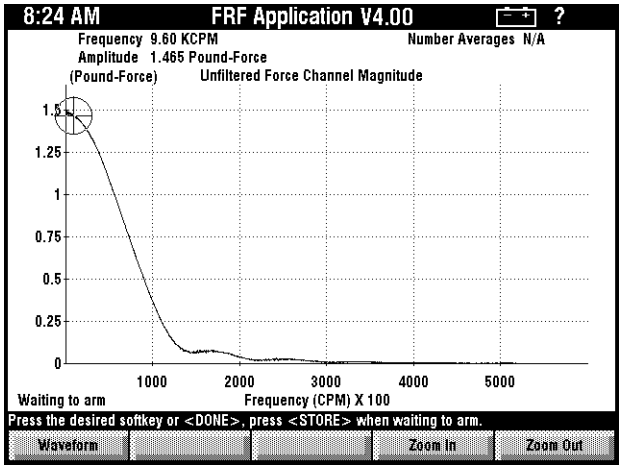
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The force spectrum shows how the impact force is distributed across the spectral frequency range. The graph above illustrates that as the frequency increases there is a steady decline in the amount of energy at these frequencies. Without sufficient energy to excite the higher frequencies, you cannot measure or determine if the structure is resonant at those higher frequencies. Since the data at these higher frequencies may be noise, the FRF calculations, which are a ratio of the input and output channels, can be misleading. When you are setting up to collect FRF measurements, you should take a look at the force spectrum to determine that the hammer and tip you are using is sufficient to measure the frequency range you have selected.

The following is a force waveform and spectrum with a plastic tip.



In the display above, the impact force is not quite as sharp as the steel tip even though this measurement was taken with approximately the same impact force. This results in a slightly longer pulse width due to the softer material. The next graph displays the spectrum of this impact.

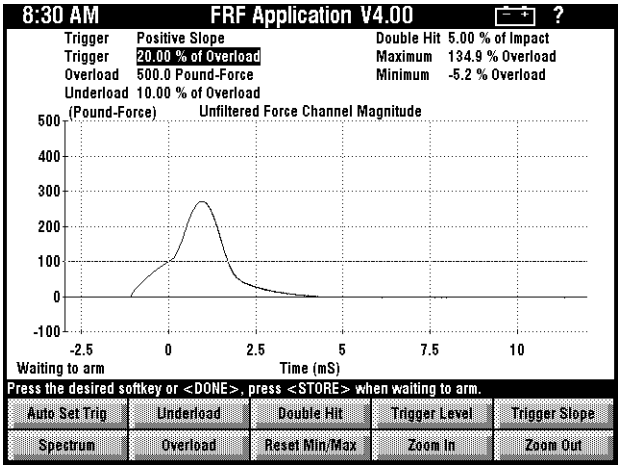


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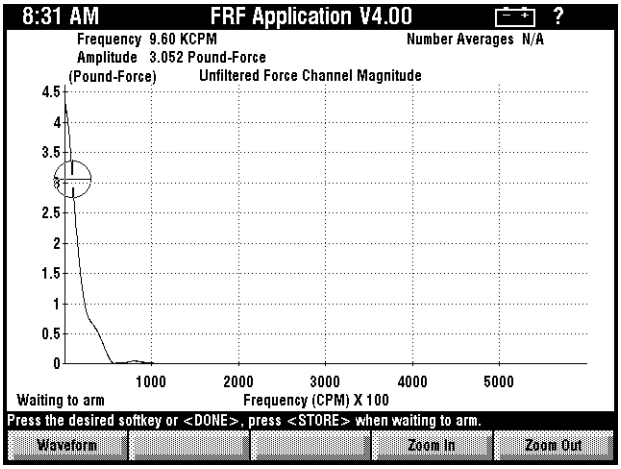
While the force waveforms for the steel and plastic tips appear similar, notice the significantly lower frequency range that this impact excited. Using a guideline for acceptable energy of approximately 20%, you can see that this setup (hammer/tip/impact force) offers a range to about 100,000 CPM. Reviewing the force spectrum taken with the steel tip would show an acceptable range of approximately 150,000 CPM.

Given the data shown in the graphs above, you might think it would be best to collect all data with a steel tip to always get the maximum frequency range. However, a lightly damped structure can cause double hits. So you may want to use a softer tip for some applications.

Another characteristic of a softer tip is the ability to concentrate more energy into the lower frequencies. Compare the graphs of the force spectrum taken with the steel and plastic tips. Notice that the graph with the plastic tip starts on a slightly higher scale; this characteristic becomes even more pronounced as you use softer tips. Below is a diagram of an impact taken with a soft rubber tip.

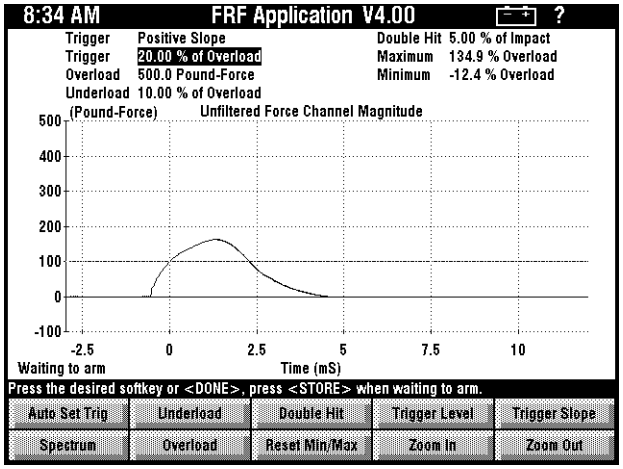


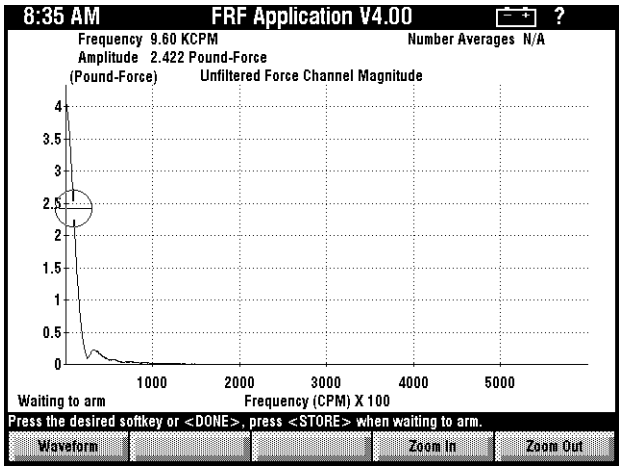
This soft rubber tip produces a much wider pulse due to the compression of the rubber upon impact. There is a significant reduction in the amount of acceptable frequency content in the force spectrum shown below.



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Note the amplitude scale is approximately three times that of the plastic tip. You can use any combination of tips to manipulate the usable frequency range and to concentrate more energy into the lower frequencies. The graphs shown below were made by using two rubber tips on top of each other.





You can experiment with several tips until you find a suitable frequency range for your application.

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Accelerometer

You use an accelerometer to collect the response data with the FRF Module. You can use any accelerometer compatible with the dataPAC instrument.

The force hammer you use, the type of hammer tip, and the expected frequency range all contribute to the choice of the pickup used (mV/g). A hard hammer tip can create a significant g force. Since the accelerometer range is inversely proportional to the accelerometer sensitivity, you may want to choose a low sensitivity accelerometer to allow for adequate response range due to the impact. The table below shows how accelerometer sensitivity and maximum range are inversely related. The sensitivity is expressed in millivolts per g of acceleration (mV/g).

Sensitivity mV/g	Amplitude Peak g peak
10	500
50	100
100	50
500	10

Large massive structures sometimes require large modally tuned hammers capable of generating a significant force because of heavy damping. When these conditions exist, you might need a higher sensitivity transducer to pickup the small amount of energy passed on to the response transducer. On larger structures, the added weight of a higher sensitivity transducer and magnet mounting does not affect the response. See “Connecting the Accelerometer” on page 220 for more details.

A good general purpose frequency response tool kit should include a variety of accelerometers ranging from 10 to 500 mV/g. Three or four pickups within this sensitivity range (10, 50, 100, and 500 mV/g) allows you to test a wide variety of structures.

When testing an unknown structure, it is generally advisable to start with a low sensitivity transducer such as 10 mV/g and increase the transducer sensitivity as needed.

Note: The mass of the accelerometer should be small relative to the device under test.

Understanding the Concepts Behind the FRF Module

If you are not familiar with frequency response testing this section offers a practical understanding of the underlying theory and goals of this type of non-destructive evaluation. It is also important for users already familiar with frequency response testing to understand some of the specific techniques used by the dataPAC 1500 FRF Module.

What is Stiffness?

The stiffness of a structure can be measured by the amount of force needed to move (or deflect) the structure a prescribed distance. The force is normally measured in pound-force (lbf) or Newtons (N). The displacement is measured in inches (in) or meters (m). Stiffness is expressed as a ratio of the force it takes to displace a structure a given distance.

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If it takes 900 lbf to move a structure 0.001 inches, then the stiffness is expressed as K using:

$$K = \frac{F}{A} = \frac{900\text{lbf}}{0.001\text{inch}} = 900000$$

where: K represents the dynamic stiffness in the units lbf / inch
F is the force in lbf it takes to move the structure
A is the distance the structure moved

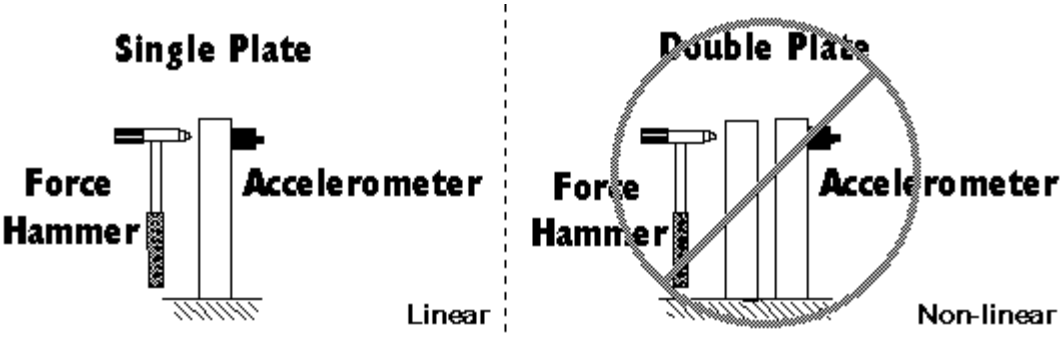
Static vs. Dynamic Stiffness

In the previous example, the formula assumes that the structure would react the same way no matter what the frequency was of the exciting force. During normal operation, mechanical structures are acted upon by a great number of external forces. These external forces occur at different frequencies. By ignoring the frequency of the exciting force, you measure static stiffness. However, when you include the excitation frequency and the resulting frequencies in the structure, you measure dynamic stiffness. Dynamic stiffness is a much more accurate measure of how a structure responds to external forces such as during cutting operation. Unlike static stiffness, there is no single dynamic stiffness number for all frequencies. The dataPAC calculates a different dynamic stiffness number for each frequency.

FRF Module Requires Linear Structure Response

In order for the frequency response functions to be able to predict a mechanical structure's behavior to real world forces using a simple transient excitation (a blow from the force hammer), the structure must have a linear response curve.

Suppose you are testing a simple metal plate. You place your accelerometer that measures structural response on one side of the plate. You then strike the opposite site with your force hammer. Since the material between the exciting force and the accelerometer is consistent in its physical properties, the ratio between the applied force and the displacement of the structure will be fairly constant no matter how much force is applied.



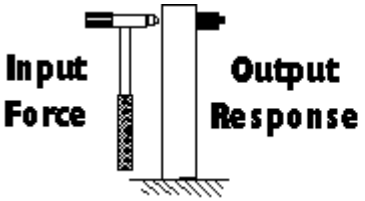
Now suppose you put two plates side by side with a small gap in between. You move your accelerometer to the outer side of one of the plates and then strike the outer side of the opposite plate. Typical examples of non-linear response systems include clearance or looseness between parts, some types of mechanical joints, and variable rate (load sensitive) stiffness such as spring isolators.

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Six Frequency Response Functions

The six response function tests provided in the FRF Module can be categorized two ways. The most important characteristic is whether the test is measuring the ratio of the input to the output or vice versa. Knowing which ratio a function uses is extremely important when analyzing collected data, since you may need to look for “valleys” in the data instead of the “peaks” normally significant in vibration analysis.

The functions that measure a structure’s resistance to movement use the input force divided by the output response ratio. Since this number represents how resistant a structure is to an external force, you must be concerned when this value is low. When the resistance to motion is low, resonance is more likely to happen.



Input Force / Output Response = Resistance to Movement

Output Response / Input Force = Reaction to Input

Conversely, the functions that measure how far a structure moves in relation to an input force use the ratio of output response divided by input force. Since you are concerned with large amounts of movement relative to a stable input force, you look for large amplitudes in the data, much the same as conventional vibration analysis.

The second characteristic of each frequency response test is which physical unit of measure it uses to quantify the output response level. The three possible units are acceleration, velocity, and displacement. Since you use an accelerometer to measure the output response, the instrument integrates the acceleration signal to compute velocity, or double integrates to compute displacement.

The table below lists the six frequency response functions by the parameter each represents and the ratio used. These are the function names you will see in the FRF Module for the data types that can be used to display your collected frequency response data.

Response Measurement	Response/Impact Force (Reaction)	Impact Force/Response (Resistance)
Acceleration	Accelerance	Effective mass
Velocity	Mobility	Mechanical impedance
Displacement	Dynamic compliance	Dynamic stiffness

In addition to the six frequency response tests, you can also view the input or output data in time waveform or spectrum plots as well as a coherence plot that describes the exact relationship between the input force and the output response.

The coherence plot has an X axis in frequency units and a Y axis that represents the relative coherence from 0 to 1. The more closely an amplitude in the response signal correlates to the input force, the greater the coherence value. Each frequency bin in the spectrum of the two signals has its own coherence value. This is a powerful tool to help you determine whether data from response channel is a result of the input force (high coherence) or some other external excitation or background vibration (low coherence).

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Signal Processing Features of the FRF Module

The frequency response functions are measured by simultaneously sampling both the input force and output response signals. The stored time waveform data for both channels contains frequency, amplitude, and phase information. The frequency response and coherence data is then computed from the Fourier transforms (auto spectrum and cross spectrum) of the time waveform data. You can then view the stored data in any of eleven formats. These plots include the six frequency response functions, the time waveform or spectrum data for each channel, and a coherence plot to verify the response data correlates directly to the input force.

The nature of frequency response testing dictates that a broad-band input signal yields the best test results. If you sufficiently excite all frequencies in the range being measured, you can detect all resonances in the test range. It follows that a short duration input excitation (hammer blow) yields the widest possible frequency range excitation. However, there is a chance that the input excitation may not last long enough to complete the output sampling across the entire frequency range specified. If this happens, the measurement samples random noise which may be erroneously used in the frequency response calculation. To reduce the input signal random noise, the dataPAC applies a force window (mathematical filter). The force window has leading and trailing cosine curves and only admits data input for a short time immediately following the input excitation event (hammer blow).

Just as spurious background noise can be sampled on the input channel, it can also happen in response channel sampling. In order to avoid this, the dataPAC applies an exponential decay window to the output channel sampling. The window starts with a steep cosine filter and ends with an exponential taper over time as the output signal fades due to structural damping.

In order to capture the complete hammer blow event in the sampled data, the dataPAC triggers input sampling before the hammer contacts the structure. This feature allows the user to specify a trigger level and slope that ensures that no data is lost between the time of hammer impact and data collection start.

Setting Up FRF Measurements

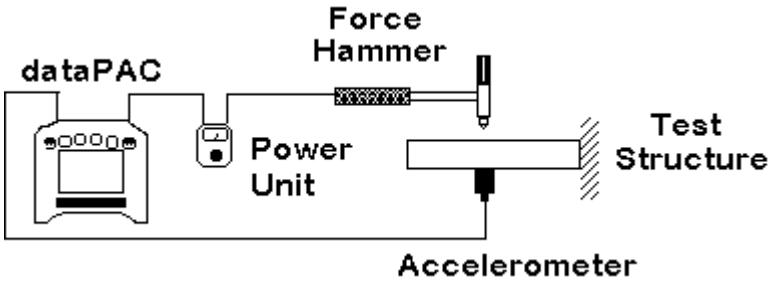
This section discusses the physical connection of hardware, instrument configuration, and initial measurement collection. The next section covers procedures for data validation and techniques for analyzing the test results.

Connecting the Force Hammer

Before connecting any cabling, configure the hammer with the desired mass and tip. If you are uncertain which combination is best for the test, try starting with a mid range mass and a plastic tip. Then switch to a different mass or steel/rubber tip as needed.

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In order to collect the data needed for the frequency response calculation, you need to sample both the force input and structure response signals. You do this by connecting the force hammer output, through a power unit/amplifier, into the reference (REF) input (BNC jack) and by connecting the response channel accelerometer to the main input of the dataPAC instrument.



Connect a BNC cable between the hammer output and power unit input jack. Now connect the power unit output jack to the dataPAC instrument reference input (BNC jack). Verify that the power unit is switched on and the batteries have sufficient energy to drive the hammer.

Many power units also have a selectable amplification setting. If your unit has this capability, set your amplification to 1X signal gain or adjust the sensitivity setup in the dataPAC instrument accordingly. For instance, if you operate the power unit set to 10X signal amplification, you need to multiply the actual hammer sensitivity by 10 when configuring the dataPAC instrument. Usually you want to use a 1X setting though, to keep from exceeding the dataPAC instrument input range (the reference input (REF) accepts a 0–20Vdc signal).

Connecting the Accelerometer

Connect the accelerometer to the main input jack of the dataPAC instrument. Before mounting the transducer to the test structure, be sure the mounting surface (no matter what mounting method you use) is free of debris, as clean as possible, and flat. Any rocking or movement of the pickup in relation to the mounting surface seriously degrades data quality. In choosing a transducer and mounting method, consider the characteristics of the structure being measured. Test results on a lightweight structure will likely be affected if you attach a large transducer, especially using a correspondingly heavy magnetic base.

Mounting methods for performing the frequency response testing differ significantly from normal predictive maintenance data collection. Wax mounting is a very popular, practical mounting technique. By using a thin layer of petro wax, you get very good signal transfer without damping the effective frequency range of the pickup. Magnet mounting is acceptable, but remember that by adding a significant amount of mass to the pickup you are introducing a resonance at a much lower frequency than the accelerometer itself would have. Although signal transfer is fairly good with a magnet, you can lose up to two thirds of the upper frequency range of the pickup. Stud mounting may be used, but is often avoided due to the difficulty of drilling and tapping a mounting location. Do not consider using a hand-held probe for transducer mounting. Even in predictive maintenance roles, this style of collecting data provides very poor signal transfer and virtually all signal is lost above 1000 Hz (60,000 CPM).

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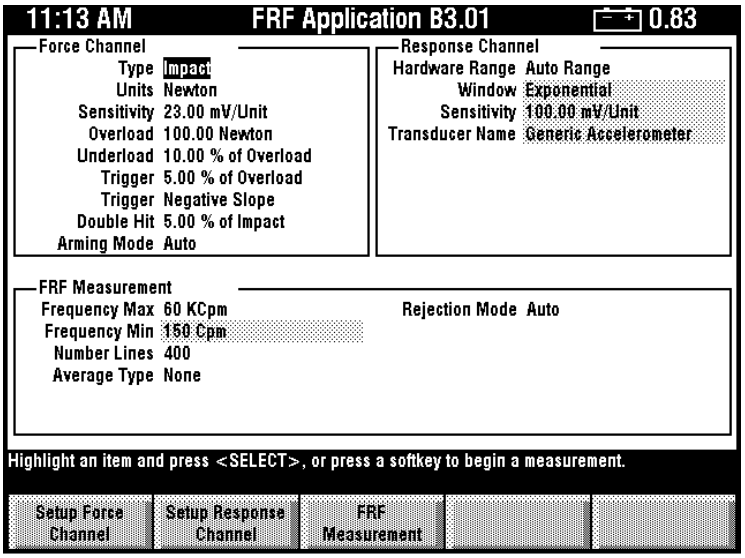
Attach the selected transducer to the appropriate place on the structure you wish to test.

Setting Up the Force Channel and Response Channel

Configuring the dataPAC instrument to collect frequency response data involves setting up the two channels, the Force Channel and the Response Channel. After these are set up, you can set up the FRF measurement itself. Generally, you set up the Force Channel first, followed by the Response Channel.

To set up the two channels, you first use the Force Channel and the Response Channel text menus. Then you can validate the values set in the text screen by performing the dynamic tests with the force hammer. Once you have adjusted the force and response channels using the dynamic setup, you are ready to proceed with setting up for the initial FRF testing.

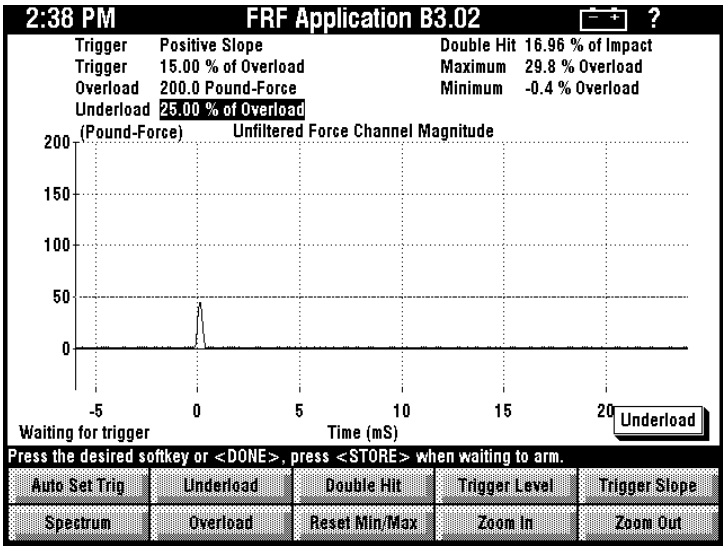
1. After completing the physical connection sequence, turn on the dataPAC and start the FRF application by choosing the FRF icon from the Program Manager screen. The setup screen appears. The initial screen provides the tools needed to configure the data sampling from the force and response channels as well as the actual frequency response measurement parameters.



2. The setup screen is divided into three sections. Each section is titled according to its purpose. This screen contains the text mode setup. First set up the Force Channel by using the arrow keys to move through the fields. See “Force Channel Setup - Text Mode” on page 223 for information on each field.
3. Press <F1> (Setup Force Channel) to open the dynamic setup screen for the Force Channel.

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4. With all inputs connected to the instrument, strike the structure with the hammer. The screen is similar to that pictured below.



5. Press a function key to modify the format of the data displayed and graphically change the measurement parameters previously set in the text mode.
   - **Auto Set Trig** - <SHIFT><F1> select to automatically set the trigger level based on the trial force hits.
   - **Underload** - <SHIFT><F2> changes the underload level.
   - **Double Hit** - <SHIFT><F3> changes the double hit level.
   - **Trigger Level** - <SHIFT><F4> changes the amplitude level for the pre-trigger.
   - **Trigger Slope** - <SHIFT><F5> toggles the trigger slope direction.
   - **Spectrum** - <F1> presents the spectrum of the most recent hammer blow. Pressing it again returns you to the waveform view.

Note: It is important to review the spectral data obtained for a given hammer configuration. The spectral data will provide you an indication of the maximum usable frequency for this configuration.

- **Overload** - <F2> changes the overload level.
- **Reset Min/Max** - <F3> resets the min-max scale to your preset max value if the last hammer blow caused the display to scale higher than the max preset.
- **Zoom In** - <F4> Zooms in on the time axis.
- **Zoom Out** - <F5> Zooms out on the time axis.

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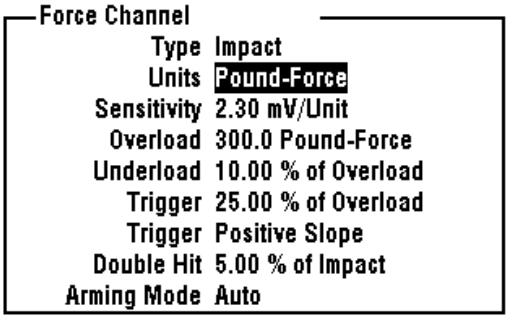
In this screen, the current measurement parameters are displayed above the data for the hammer blow. The center of the screen contains a plot of amplitude versus time for the most recent hammer blow. The currently selected (highlighted) measurement parameter (above the plot) is superimposed over the plot window. In this example, the underload parameter is highlighted and the underload amplitude level is superimposed over the plot. Since the last hammer blow impact force level did not exceed the underload level, an “Underload” warning appears in the lower right corner of the plot. All measurement errors are presented in this location.

As noted at the top of the plot window, this data is unfiltered. By using unfiltered data to set the collection parameters, the FRF Module insures that any spurious signal sources are taken into account when setting collection parameters.

6. Use the up and down arrow keys to change the current parameter. The longer you press the key, the more quickly the parameter value changes. The graphic depiction of the parameter changes along with the text value in the top portion of the screen. When you are satisfied with the measurement parameters, press <DONE> to return to the main setup screen.
7. In the main setup screen, use the arrow keys to select the measurement parameters for the Response Channel in the text mode. See “Response Channel Setup - Text Mode” on page 225 for information on each field. You cannot change a parameter if it is grayed out. If you are uncertain what range to set manually, select the Auto Range setting, then use the dynamic settings.
8. Press <F2> (Setup Response Channel) to open the dynamic setup screen for the Force Channel so that you can fine tune your text settings.
9. Once the Response Channel setup screen appears, strike the test structure multiple times with the hammer. The dataPAC reads the peak acceleration from the output channel. The unit then displays a suggested range for measurement.
10. Press <F1> (Accept) to accept the current suggested range as the automatic range used in subsequent testing and return to the main setup screen. Press <F2> (Reset) to reset the data to the previous values. Press <F3> (Reset) to cancel the operation and return to the main setup screen.

Force Channel Setup - Text Mode

The force channel setup controls processing of the input signal and detection of erroneous input conditions. Unlike most other frequency response testing tools, the FRF Module checks the force input signal for several conditions that invalidate the results of the test. The details and options for each parameter are listed below.



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Type
This field is set to Impact at this time, but as new test methods are added to the FRF Module, this may become a variable setting.

Units
The Units field controls the unit of measure that is used to gauge the amount of impact force. The units are expressed in either Newtons (N) or Pound-Force (lbf).

Sensitivity
The Sensitivity field expresses the sensitivity of the force hammer, expressed in millivolts of output per input unit of force. The unit of force is controlled by the Units field. For instance, if the force hammer has a load cell with 2.3 mV/Newton, you would set the Units field to Newtons and this field to 2.3. Be careful when setting this field. If the power unit connected between the force hammer and the dataPAC has a variable amplifier, you must take into account the amplification setting when entering this value. If the amplifier is set to 10X magnification of the hammer signal in our hammer example, you need to set this field at 23 instead of 2.3.

Overload
The Overload field detects a hammer blow that has too much total force. It is expressed in the same force units as the Units field. If a hammer blow force exceeds this amount, the dataPAC presents an Overload warning dialog during FRF measurement. This field can be adjusted from the Setup Force Channel screen during dynamic input testing. See “Setting Up the Force Channel and Response Channel” on page 221. If you are uncertain what value should be specified here, enter a value that is 10 to 15 times greater than the base sensitivity of the force hammer and be sure to test and adjust it from the dynamic setup screen.

Underload%
This value detects a hammer blow that probably has insufficient input force to properly excite all resonant frequencies in the structure being tested. It establishes a “floor” that serves as a minimum value for the input force. If a hammer blow does not exceed this force level, the dataPAC presents an Underload warning notification during testing. If you are uncertain what value to specify here, start with 10% and adjust it as needed from the dynamic setup screen.

Trigger%
Trigger percentage specifies the force amplitude level where the pretrigger condition is satisfied and the instrument begins sampling the input and output channels for FFT processing. By beginning the data sampling as the input force is increasing and not waiting until peak input is reached, none of the event is lost due to time lag between structural excitation and data sampling. The trigger percentage is a percentage of the overload value specified previously. Try using 20% as a starting point and adjust it as necessary from the dynamic setup screen.

Trigger Slope
The trigger percentage can be triggered by a positive or negative slope. This field controls which slope direction to trigger on. For frequency response testing, you usually use a positive slope.

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Double Hit (% of Impact)

The double hit detection feature of the FRF Module is a useful tool to help verify the validity of collected data. It is easy to allow the hammer to bounce once or more when striking the excitation blow. Even though you may not feel the bouncing, the FRF Module can detect it by checking the force input signal for any secondary peaks that occur after the primary excitation peak that exceed this value. This value is expressed as a percentage of the peak input force—not the overload value that the previous fields use. That means that the double hit level is much more sensitive to the actual hammer blow force, resulting in a more accurate detection of hammer bounce. Start with a 5% value for this parameter and adjust if necessary from the dynamic setup screen.

Arming Mode

This is a convenience feature that controls when new data is sampled. If this field is set to Auto, anytime the FRF Module detects a hammer blow, it collects new data and overwrites any data currently being displayed. If this field is set to Manual, you must press <STORE> before any new input signals are detected and sampled from the hammer. Be careful when using the Auto mode that the data you are currently viewing isn't overwritten by an accidental hammer blow.

Response Channel Setup - Text Mode

Hardware Range

The Hardware Range for FRF measurement can be set to a specific value or automatically range. The Auto Range setting here is not the same as a typical Auto Range procedure in any other dataPAC instrument function. The Auto Range setting for FRF requires you to use the dynamic setup screen to predetermine a range automatically. The dataPAC does not perform an automatic ranging operation during sampling of the FRF data because no automatic ranging process is fast enough to prevent loss of FRF data. Therefore, by setting the range value from a dynamic test performed before collecting data, the dataPAC sets an acceptable range for the specific test situation without losing data.

The Window, Sensitivity, and Transducer Name fields cannot be changed.

Setting Up the FRF Measurement

In the main setup screen, you set up the FRF measurement parameters.The FRF measurement parameters are essentially the same as the parameters for a typical spectrum measurement. The FRF Measurement parameters determine the FFT data format of the frequency response data. You control the Fmax, lines of resolution, and averaging type to be used (none or linear). The Fmax and lines of resolution selected here determine the duration of time waveform collected from both input channels after the hammer blow.

Use the arrow keys to select the field and change it if needed.

The Fmin setting is determined by dividing the Fmax by the lines of resolution. The Rejection Mode parameter controls how data is averaged. If the Average Type parameter is set to anything other than None, successive FRF measurements are averaged together.

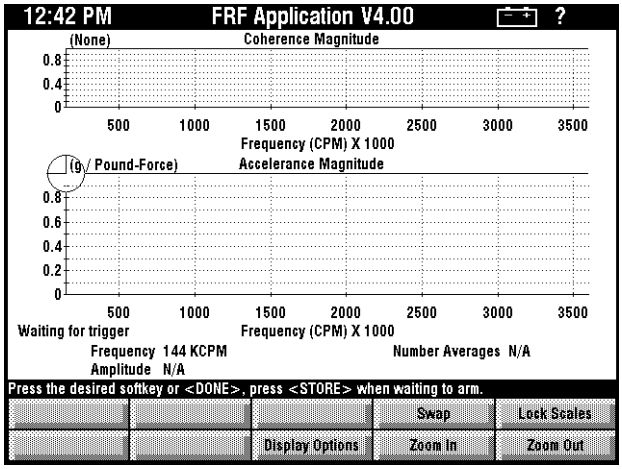
If the Rejection Mode is set to manual, you must confirm that each collected data set be allowed to average with previous data and then the result is displayed. If the Rejection Mode is automatic, the new data averages with the previous sample and displays immediately, unless an error is detected. Then you are prompted to accept or reject the data.

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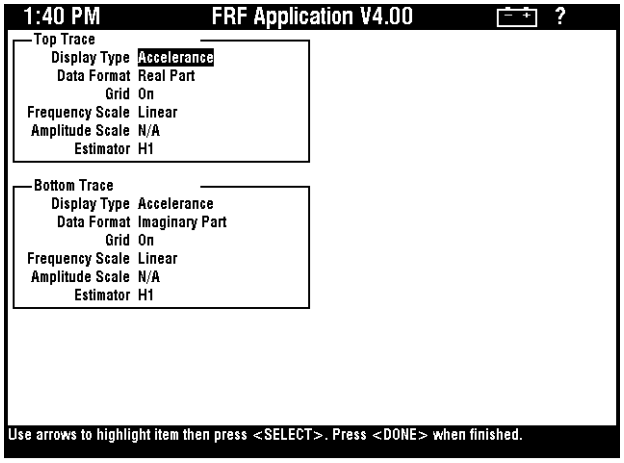
Collecting and Analyzing FRF Data

When your setup parameters are complete, you can begin collecting data samples. To do so, follow these steps.

1. Press <F3> (FRF Measurement). The measurement screen appears.

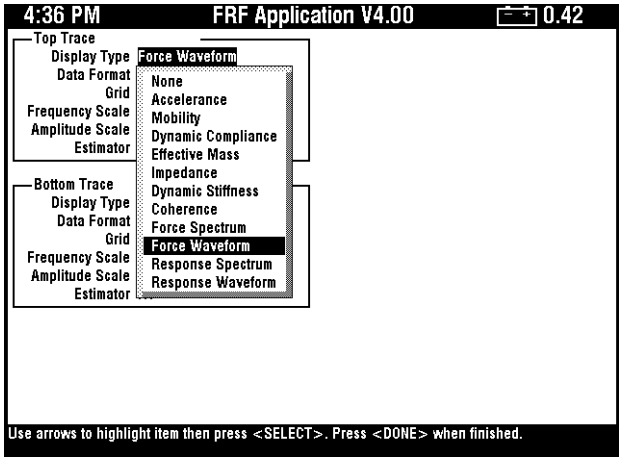


2. Press <F3> (Display Options) and press <SELECT> to view the available display types.



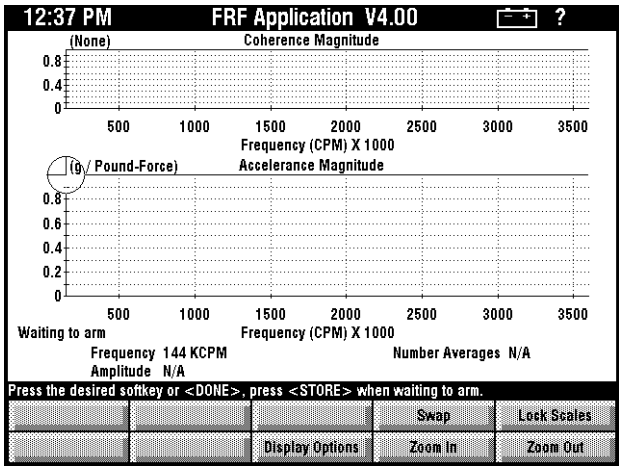
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3. Use the arrow keys to select the Display Type field and press <SELECT>. Your choices are shown below.



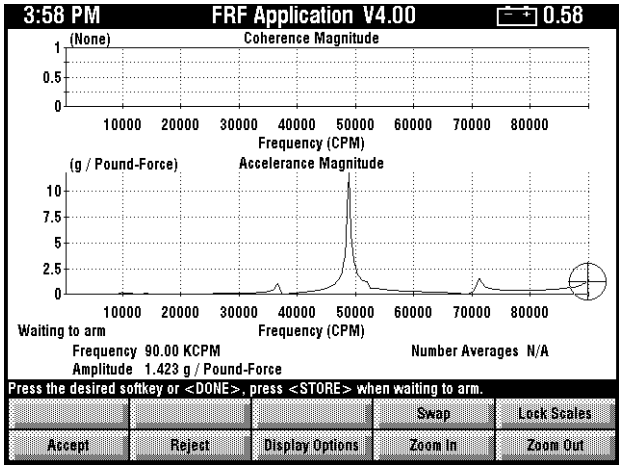
The six basic resonance functions allow you to choose four different data formats: Magnitude, Phase, Real Part, Imaginary Part. You can compare them by placing one in the top trace on your display and one on the bottom trace. Alternatively, choose None for the top trace and the bottom trace displays full screen. Examples of different combinations of displays are shown in “Reviewing the FRF Data” on page 228.

4. If you have Auto Arming selected, the dataPAC displays “Waiting to arm” as indicated in the screen below. If you have Manual Arming selected, press <STORE> and the dataPAC screen switches to “Waiting for trigger.”

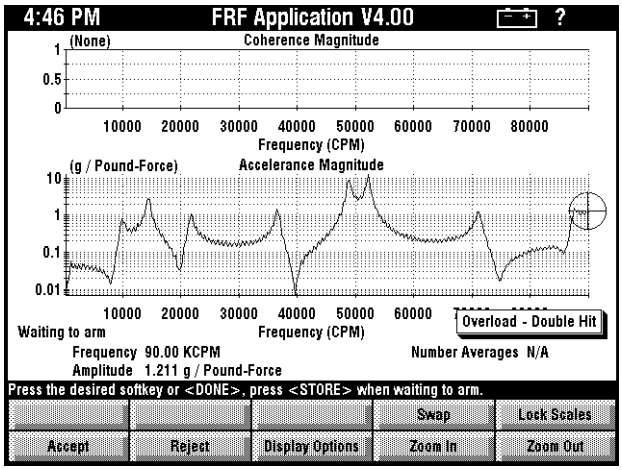


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5. Strike the structure with the hammer as you did when setting up the force and response channels. The hammer should strike the surface perpendicular to the surface plane and in the same plane as the response transducer. After the impact, the dataPAC collects the spectrum and computes the data.



6. If you are using the Manual Rejection mode, press <F1> (Accept) to accept this data for averaging. Continue collecting additional averages, rejecting any data set which contains undesirable conditions. For example, the data in the display below shows both Overload and Double Hit conditions.



7. Once you acquire satisfactory data, you can review it and analyze it as described in the following sections.

Reviewing the FRF Data

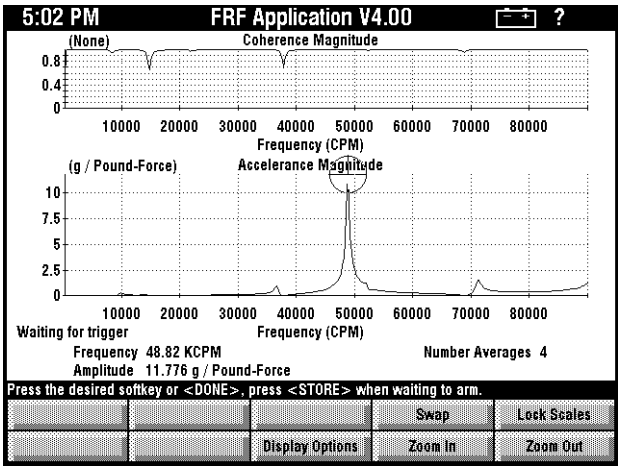
Once you have collected the FRF data, you can view it in many different ways. It may be helpful to change the display parameters to better interpret the data. The FRF function has a number of features that allow for detailed analysis of the collected data.

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To pinpoint data using the cursor

Like all dataPAC graphical displays, you can move the cursor with the arrow keys to precisely read the corresponding values. The cursor in the FRF module consists of a circle and crosshair that follows the peaks and valleys in the data as you move it along the axis.

In the example below, the cursor is on the resonant frequency occurring at 48,820 CPM. The amplitude is also displayed at the bottom of the screen. In this example, the amplitude is 11.775 g/Pound-Force and is clearly the highest amplitude in the displayed spectrum.

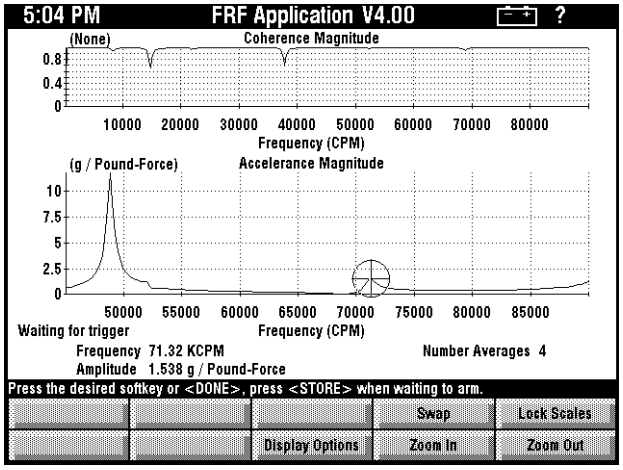


To zoom in and zoom out

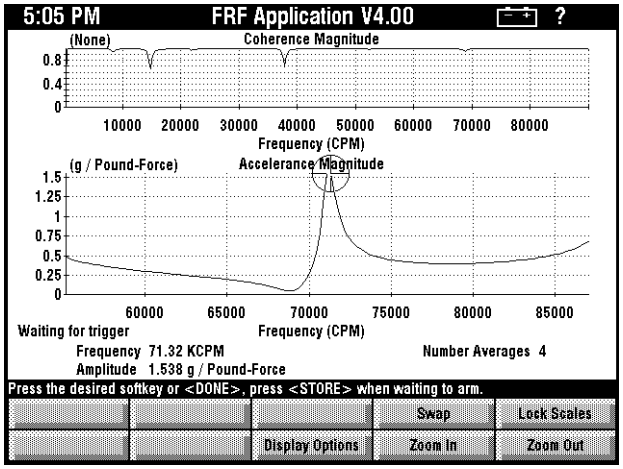
The dataPAC normally uses the auto scale to fit the data in the display. When you see a very large dominant peak, as in the example below, you can selectively zoom in on the display to see smaller peaks. Each time you press <F4> (Zoom In), the dataPAC shows a smaller portion of the spectrum centered around the cursor. The following diagrams show repeated zooming on the spectral display centered on the small peak to the right of the dominant peak.

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In the diagram below, the display is zoomed, but dominant peak at 48,000 CPM is still in window.



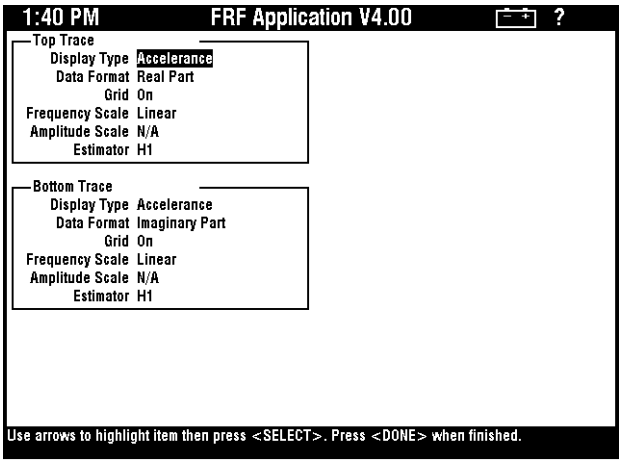
In the diagram below, the display is zoomed in one more time and dominant peak was no longer in the display area; the spectrum is now rescaled for the smaller peak at 72,000 CPM. Press <F5> (Zoom Out) to return to full scale display.



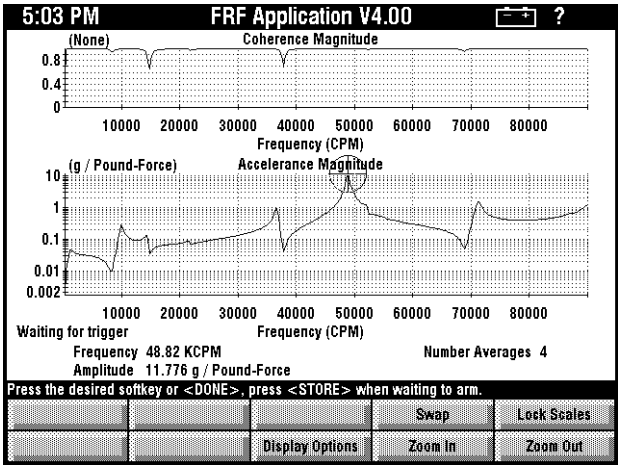
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To improve display scaling using logarithmic displays

Logarithmic displays provide yet another means of viewing the data. To change the display, press <F3> (Display Options). Then use the arrow keys to select Frequency Scale and press <SELECT> to toggle between Linear and Logarithmic.



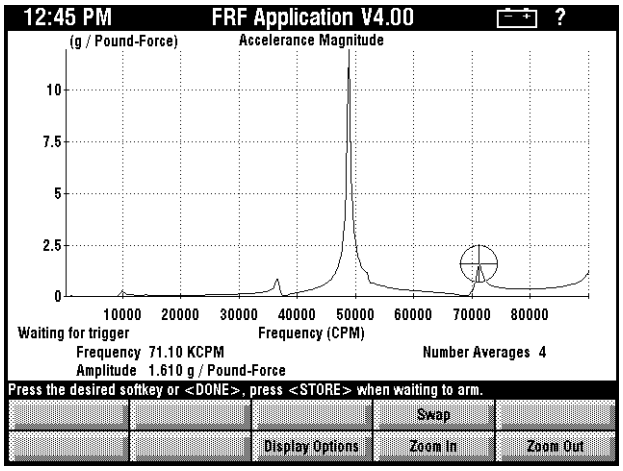
These displays allow better visibility of lower amplitude peaks. Both the amplitude scale and the frequency scales can be viewed logarithmically rather than linearly. Amplitude and frequency scales options are independent of each other. You may choose to view one linearly and the other logarithmically. The graphs displayed below shows data viewed with a logarithmic amplitude scale and a linear frequency scale.



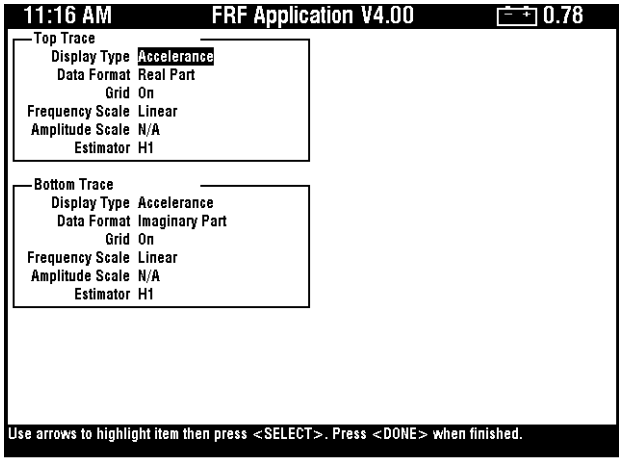
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To use single or dual plot displays

When analyzing FRF data it is sometimes helpful to view a dual plot display of two functions. You can also use the entire screen for better resolution of a single plot. To get a single plot display, choose None under Top Trace Display Type and choose any display type for the bottom trace. The dataPAC displays only the bottom trace in a single plot. This enlarges the plot from a dual plot display so you can see more detail.



To display two plots, set both the top trace and bottom trace as shown below.



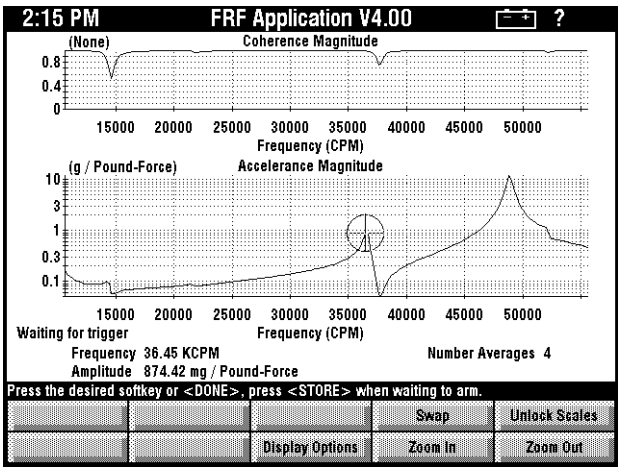
Structural Analysis Using the FRF

FRF testing allows us to compare two channels of data simultaneously to determine how one channel compares to the other. Significant machine operating characteristics including resonant frequencies, phase data, and others can be determined using this functionality. Below are a few examples how you can use this capability.

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To determine resonant frequencies using accelerance

When you strike the structure with the impact hammer broad band energy across the entire frequency spectrum (dependent on hammer, tip, frequency range selected) is put into the structure. If you consider that the energy is distributed equally across the frequency range, frequencies which show a high accelerance can be considered to be excited at that particular frequency. In some plots, you may notice that the frequency spectrum dips to or very close to zero. This indicates anti-resonances. The display below shows both of these conditions.



Importance of coherence in FRF testing

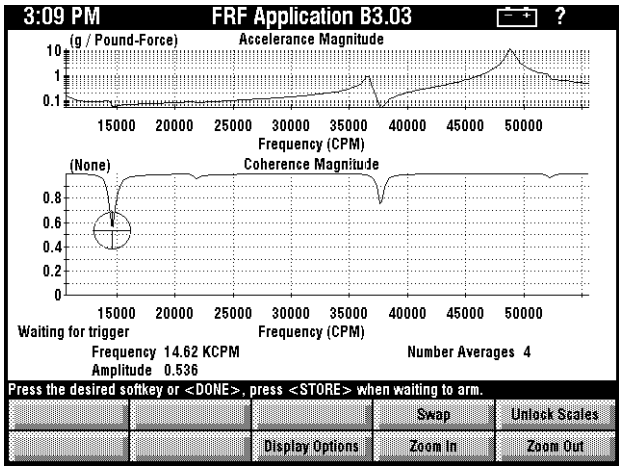
Coherence is a measure of the repeatability and reliability of the data collected. Just as averaging is considered necessary for reliable FFT data, averaging is also necessary for good FRF testing.

Coherence measures the input and output to determine how closely the data sample just collected matches with the data already averaged. Coherence is always expressed on a scale of 1.0 with 1.0 having the highest confidence level.

You can select coherence as one of the display traces when analyzing data. Although you can select coherence after collecting data, viewing it while collecting data immediately determines if your data is good. In the display shown below, the coherence trace was swapped from the top trace to the lower trace to provide more detail.

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Note that the cursor is positioned on a point (14,620 CPM) that shows a fairly low level of coherence (0.536). When comparing this to the accelerance trace on top, you can see that this occurs on an anti-resonance and the input signal at this frequency is very low. With very little input at this frequency, it is likely that the coherence is low. Outside of the two anti-resonant frequencies, the coherence level is quite high and this would be considered good data.



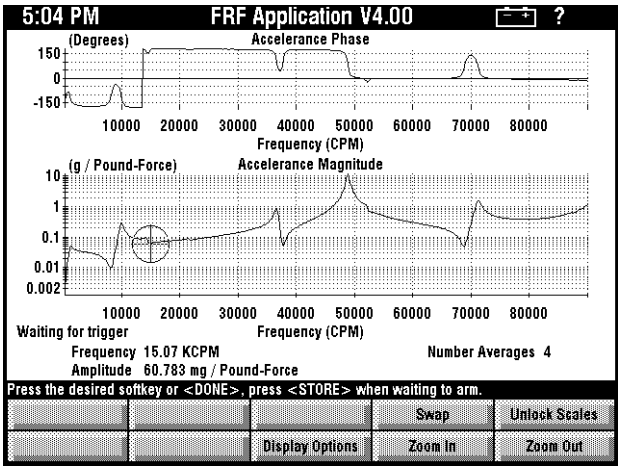
To use phase as a display option

In fundamental vibration training you learn that in the start-up or coast-down of a machine, the machine may run through critical speeds that excite the shaft mass natural frequencies and may cause significant increases in the vibration amplitude. You can use a Bode plot to determine these critical speeds. The Bode plot measures a filtered 1X vibration amplitude and phase against RPM. In addition to the increase in amplitude, the critical speed is positively identified by a 180 degree shift in phase angle.

Structural resonances, like shaft critical resonances, also exhibit this characteristic 180 degree phase shift. To get a plot showing the phase readings vs frequency, change the data type to Phase in the data display options.

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The following display shows the plot of Accelerance Phase on the top trace and Accelerance Magnitude on the bottom trace. Note the 180 phase shift at resonant frequencies. In viewing the phase plots, you need to be aware that the phase measurements near the axes can wrap around to the other axis. You can see this wrapping in the phase plot below at approximately 14,000 CPM.



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Appendix

Frequently Asked Questions and Answers

This section contains the most frequently asked questions about using the dataPAC.

General dataPAC Questions

Q: Why does my dataPAC beep for no apparent reason?

Some dataPAC models beep intermittently, sometimes at a very low volume, for no apparent reason. This beep is harmless but can be annoying. Contact Entek IRD Customer Support to arrange for servicing. If you send the unit in, Entek IRD can eliminate this beep.

Q: What do I do if the dataPAC locks up?

If the dataPAC locks up and does not respond to key presses, simply press <LIGHT> and the left and right arrow keys simultaneously. This is sometimes referred to as a three finger reset. If you have the operating system stored on the memory card, the dataPAC loads that operating system. If not, you can load the operating system over the serial port from your computer. See “Restarting the Data Collector” on page 29 for more information about restarting your dataPAC.

Collecting Data with the dataPAC

Q: How can I reduce the ranging time required during collection?

Long ranging times are associated with trying to collect low frequency vibration data. Applying an overall filter helps reduce long ranging times. In particular, overall filters with the highest low frequency cutoff point decrease ranging time the most. Try to set your max frequency and lines of resolution such that the formula results in the highest value that would be practical in your application.

Another technique that can reduce ranging time is to only use filters that are built into the data collector.

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Glossary

The Glossary contains definitions of many of the terms used with the dataPAC and the online help system. Boldface type indicates terms that are defined elsewhere in the glossary.

alarms – An alarm alerts you to a change in a measurement. For example, an alarm can notify you when the measured value for a machine exceeds a pre-defined value. You can create one or more alarms for each measurement definition.

averaging – Refers to the process of combining multiple data samples to reduce the random errors and provide a more reliable measurement.

band – A frequency range, such as the frequency range between 1,800 and 3,200 Hz. A **band set** consists of one or more bands. You can use bands to define specific frequency ranges and values used - **band maximum amplitude** or **band sum -** for a **band alarm.**

band alarm – An **alarm** that operates on defined frequency **bands** in a **measurement.** Each band can have its own alarm levels. The band definition determines whether the alarm in each band is set on the **band maximum amplitude** or the **band sum**.

band filter – A filter to use during data collection to help obtain high quality data. You can use a band filter (**high pass, low pass,** or both) or a percentage filter to remove specific frequency ranges from the **measurement.**

band maximum amplitude – Also known as peak in band and band peak. The Band maximum amplitude is the highest amplitude at a **spectral line** in a **band.**

band set – One or more **bands**, each of which defines a specific frequency range. A band set might contain three bands: from 500 to 1,200 Hz, from 2,000 to 3,800 Hz, and from 3,800 to 5,000 Hz. You can use a band set to define specific frequency ranges for a **band alarm.**

band sum – Also called band limited overall value. This is the total energy in a spectrum between two frequencies. If the **band** contains the entire spectrum, the band sum value is the same as the **magnitude** value for the entire spectrum.

baseline measurement – A reference measurement you identify from the archive data for a measurement definition. It indicates the proper operating condition of a piece of equipment. You can use it as a comparison to other measurements, and in alarms.

corner frequency – The low frequency corner defines the frequency below which the input signal is significantly attenuated. It is the same as a **high pass filter**.

cursor – A line or symbol that traces the data and provides an accurate read out of the x-axis (typically time or frequency) and the y-axis (typically vibration amplitude) values.

cyclic cursors – A line that traces the data and is used to help identify repeating patterns in the time waveform. Consists of 1 to 15 vertical dashed lines, spaced at even time intervals.

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data collector – A data collector is a device that measures and stores vibration and other data. Vibration data may include magnitude, spectrum, time waveform, and phase data. Other data may include process measurements such as pressure, temperature, and operating hours.

dual cursors – A pair of cursors used to determine the difference between two points on the x-axis. Used for both spectrum and time plots. The dual time cursors are useful for determining the time between two points on the time waveform or the time of any given sample relative to the trigger point.

edit window – A dataPAC display that allows you to enter numbers and letters using the **softkeys**.

Frequency Response Function (FRF) – The FRF measures a structural response to a hammer strike, indicating natural resonant frequencies and the six frequency response functions.

harmonic cursors – Multiple cursors that are at constant multiples of a fundamental frequency. Typically you position a single **cursor** at the desired fundamental frequency and then press a key to activate the harmonic cursors. These cursors help identify the related frequency components in a spectrum.

high pass filter – A filter that excludes all frequencies below a defined frequency, also called a low frequency corner. It allows, or passes, frequencies above the defined frequency. It is useful for removing high vibration, low frequency signal components that would dominate the signal.

low pass filter – A low pass filter excludes frequencies above a defined frequency. It allows, or passes, frequencies below the defined frequency. It is useful as an anti-aliasing filter.

magnitude alarm – An alarm that defines the safe operating boundary for magnitude data from a piece of equipment or a process. Magnitude data can be overall vibration, temperature, operating speed, or any other **process measurement.**

magnitude measurement – Single value representing the total energy of a measurement. For example, a vibration magnitude represents the total energy in a vibration spectrum. Trends of magnitude readings are typically used to predict when a machine or process could exceed safe operating conditions.

measurement – A measurement is a single reading collected from a location and controlled by a measurement definition. Measurements are usually collected with a **data collector**, and stored in the database. The measurement may be magnitude data such as an overall displacement value, spectrum data such as a single acceleration spectrum, or some other kind of data.

measurement filter – A filter that is applied when taking a measurement. It is specified as part of a measurement definition, and may be either a **band filter** or other type of filter such as an envelope or overall filter.

memory card – A removable hardware card, or **PCMCIA card**, containing non-volatile memory for additional storage, used with a computer or data collector. PCMCIA stands for Personal Computer Memory Card International Association.

operating system – The internal software of a data collector that determines how the data collector operates. You should always use the most recent operating system version available to you.

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orders – Multiples of the operating speed of a piece of equipment. The first order is the operating speed. The second order is two times the operating speed, and so on.

overload – Occurs when the input signal from your transducer exceeds the current setting of the data collector hardware. You should not collect data when the input signal is generating an overload condition of the data collector; instead, you should adjust the data collector settings for the transducer.

PCMCIA card – A removable hardware card, or memory card, containing non-volatile memory for additional storage, used with a computer or data collector. PCMCIA stands for Personal Computer Memory Card International Association.

plot – A plot is a graphical display of data. Some examples are **spectrum, trend,** and **time plots.**

resolution – The accuracy of something based on the number of discrete values used to define it. One example is the resolution of a **spectrum measurement**. This refers to the number of **spectral lines** that are combined to display the spectrum data. A higher resolution results in a clearer image due to more discrete values defining the object.

sideband cursors – Displays two equally spaced cursors to either side of a reference cursor.

signature – A signature can be either a time or a spectrum measurement. It is a general term used for multi-valued data, as opposed to single-valued data such as a magnitude or a process measurement.

softkey – The softkey is located directly below the data collector display. The definition of the softkey changes depending on the current state of the data collector. Pressing the key below the softkey label accesses the displayed operation.

spectral line – A spectral line is an individual discrete frequency in a spectrum measurement. A spectral line is sometimes called a “bin”, a “delta f”, a “line”, or a “line of resolution.”

spectrum alarm – Also called narrowband **alarm.** It defines the safe operating boundary for spectrum data from a piece of equipment.

spectrum measurement – A measure of amplitude versus frequency, typically vibration for monitoring systems. Spectrum measurements are useful for identifying the contribution of individual components (bearings, fans, gears, etc.). It is much easier to separate elements of vibration in the frequency domain than in the time domain.

spectrum plot – A spectrum plot is a graph of amplitude versus frequency. Usually the amplitude is a measure of the acceleration, velocity, or displacement at that frequency.

tachometer – A device for measuring the speed of rotation of a machine or component.

time waveform measurement – A measure of time along the horizontal axis and amplitude along the vertical axis (similar to oscilloscope readings). It is easy to see the vibration amplitude and general shape of the signal in a time waveform measurement. They are useful for identifying simple vibration signals and viewing impulsive type signals.

time waveform plot – A time waveform plot is a graphical display of amplitude versus time for a single measurement.

transducer – A transducer is a device for making measurements. These include accelerometers, velocity pickups, displacement probes, and temperature sensors.

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true zoom – A focus on the frequency range that you specify, collecting data showing that range in great detail.

unscheduled measurement – Measurements you make that are not part of a list in the **data collector.**

waterfall spectra – A spectral display that shows several spectra over time, cascading them using time as the z-axis.

zoom – A focus on the frequency range that you specify, collecting data showing that range in great detail. Also refer to **true zoom**.

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