VISUALSONICS

INSIGHT THROUGH *IN VIVO* IMAGING™

VisualSonics
Vevo® 2100 Imaging System

Operator Manual

VisualSonics Inc.

VisualSonics—North America	VisualSonics—Europe
3080 Yonge Street, Suite 6100	VisualSonics Europe
Box 66	Kruislaan 406
Toronto, Ontario	Matrix V
Canada	Suite 412
M4N 3N1	1098 SM Amsterdam
Tel: +1 (416) 484-5000	The Netherlands
Toll-Free: 1-866-416-4636 (North America)	Tel: +31 (0) 20 751 2020
Fax: +1 (416) 484-5001	Toll-Free: +800 0751 2020
	Fax: +31 (0) 20 751 2021

www.visualsonics.com | support@visualsonics.com

U.S. and Foreign Patents that may apply:

US 7,426,904, US 7,230,368, US 7,133,713, US 7,052,460, US 6,851,392, US 6,511,430, EU1642154

Other U.S. and Foreign Patents pending, including published applications that may apply:

US 2004/0122324, US 2004/0236219, US 2005/0215878, US 2005/0197543, US 2005/0197572, US 2006/0241446, US 2006/0241448, US 2006/0241461, US 2007/0066898, US 2007/0167755, US 2007/0185396, US 2007/0182287, US 2007/0196005, US 2007/0205697, US 2007/0205698, US 2007/0222339, US 2007/0238954, US 2007/0239001, US 2008/0015420, WO 2004/034694, WO 2004/032725, WO 2004/099814, WO 2005/099345, and WO2005/070472

This manual documents the Vevo 2100 Imaging System and the Vevo 2100 Imaging System software version 1.0.0.

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Contents

Section 1

Getting started

This section introduces you to the Vevo 2100 Imaging System.

In this section

Chapter 1

Introduction

Thank you for using the Vevo® Imaging System, the high-resolution in vivo micro imaging system from VisualSonics®.

The Vevo 2100 Imaging System supports the following ultrasound imaging modes:

- B-Mode imaging
- M-Mode imaging
- PW (Pulsed Wave) Doppler Mode imaging
- Color Doppler Mode imaging
- 3D-Mode imaging
- Power Doppler imaging
- Contrast Mode imaging

The system provides an array of measurement tools in addition to the following custom measurement packages:

- Cardiac measurement package
- Abdominal measurement package
- Vascular measurement package
- Embryology measurement package
- Ophthalmology application package

This operator manual provides detailed procedures and descriptions for operators who use the system to acquire and analyze ultrasound image data.

WARNING: Do not use the Vevo 2100 Imaging System for human applications.

In this chapter

Operator Manual conventions

This documentation uses the following typeface conventions:

Bold

- Selections you make when you are using the software
- Subheadings
- Names of power switches and rear panel connectors
- Labels (such as **Tip:**)
- Column headings in a table
- Keywords and parameters in text

Control Block

- Control panel keys, dials, toggles, sliders.

Italic

- Cross references
- Menu paths
- Citations (titles of books, diskettes, and CDs)
- Terms defined in text
- Variables and values that you must provide

`Monospace`

- Examples and software code examples
- File names, programming keywords and other elements that are difficult to distinguish from surrounding text
- Message text and prompts addressed to you
- Text that you must type

Chapter 2

System description

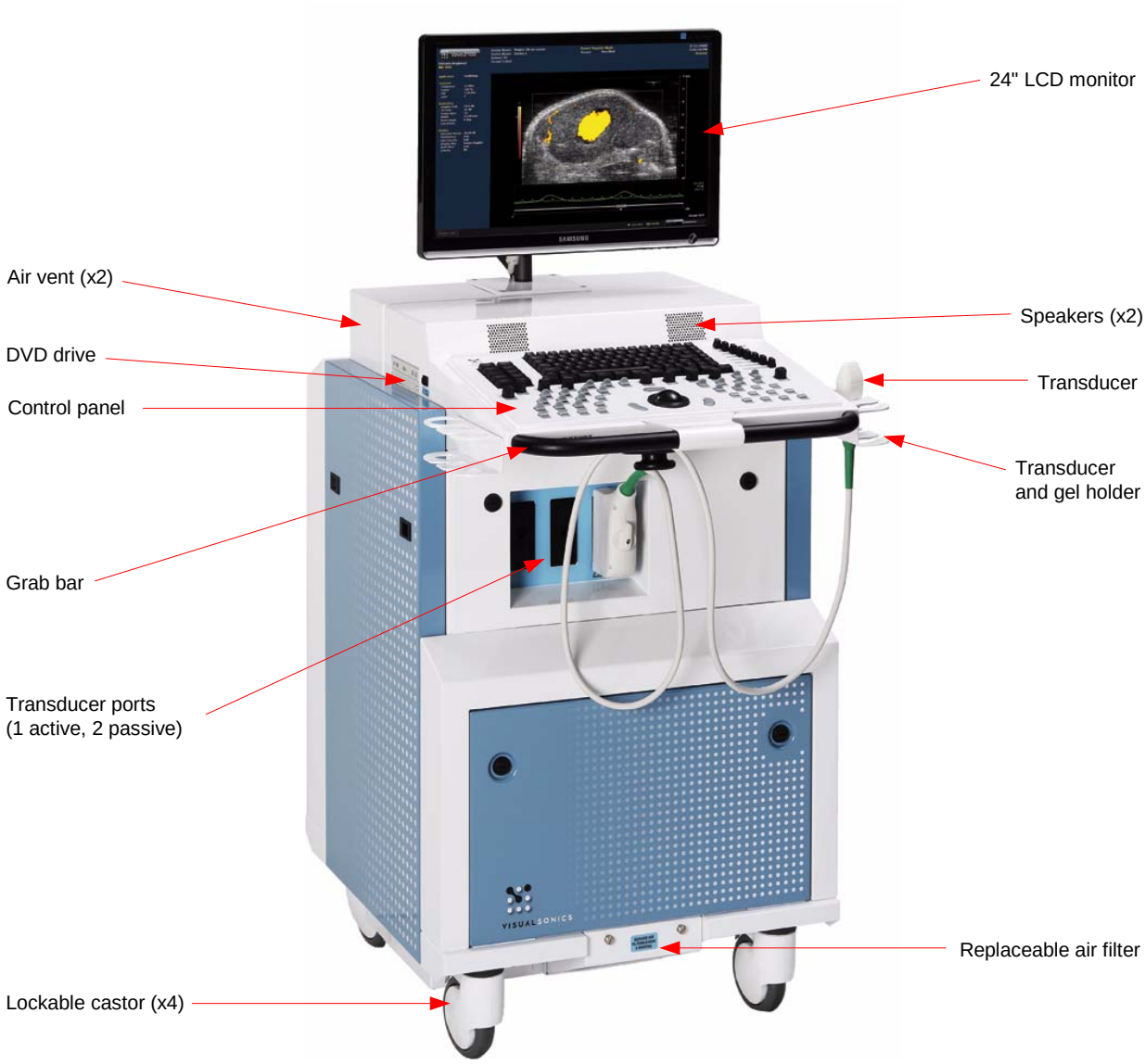
The Vevo 2100 Imaging System enables in vivo visualization, assessment, and measurement of anatomical structures and hemodynamic function in longitudinal imaging studies for small animal phenotyping.

In this chapter

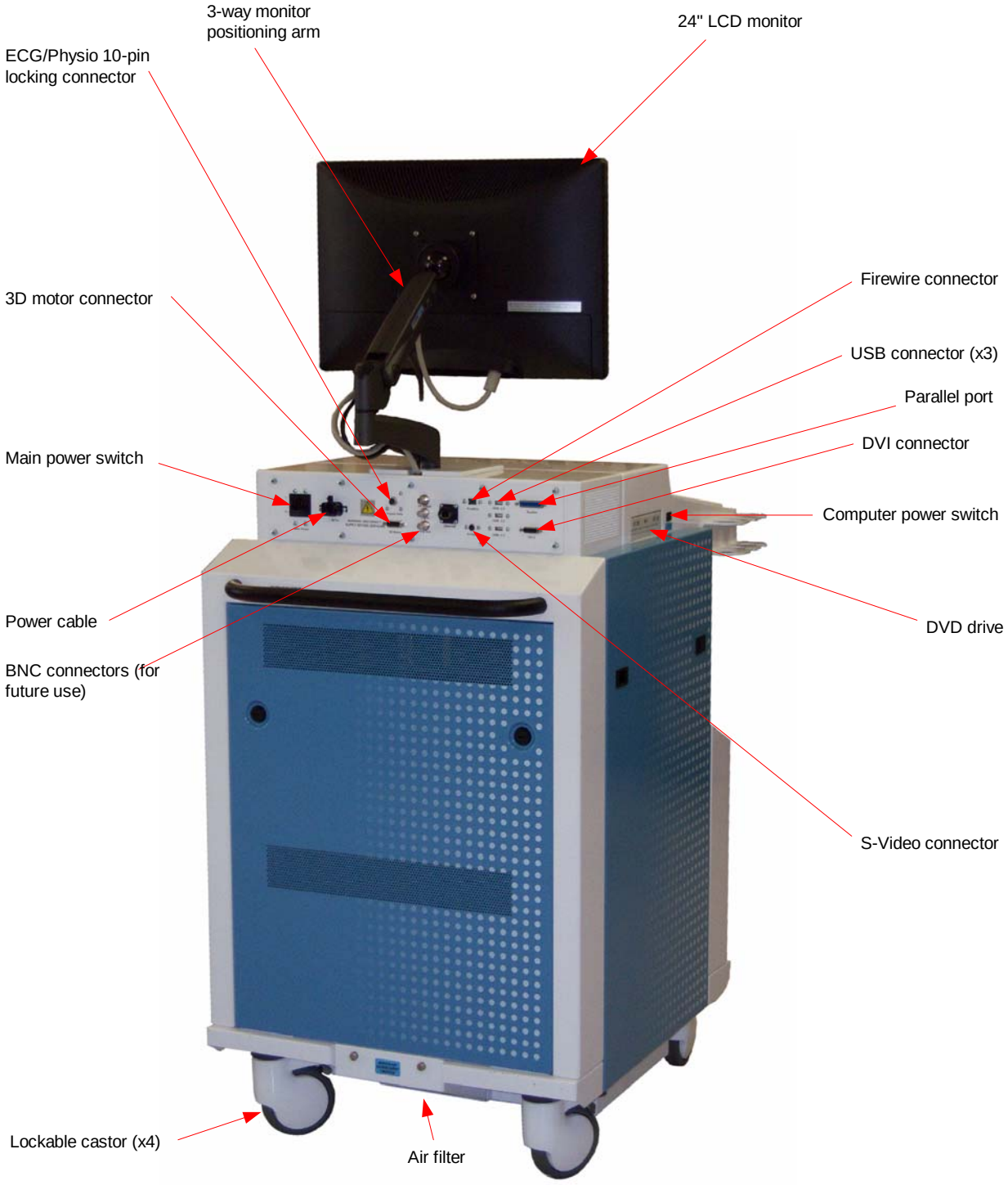
Cart description

The cart houses the Vevo 2100 Imaging System. This section describes the key cart components.

Front view of the Vevo 2100 Imaging System



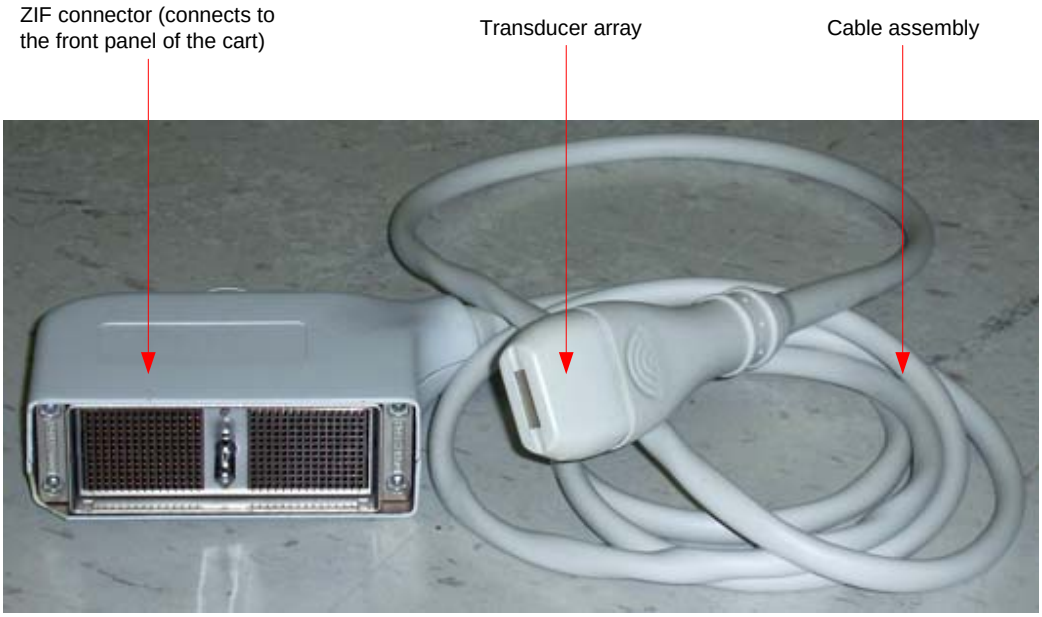
Rear view of the Vevo 2100 Imaging System



MicroScan™ transducer

The MicroScan™ array transducer (the transducer) is the device you use to acquire real-time visualization of the hemodynamic or anatomical target. The unit is designed as a hand-held probe for rapid screening procedures. You can attach it to the Vevo Imaging Station.

The components of the integrated transducer system are displayed in the following illustration.



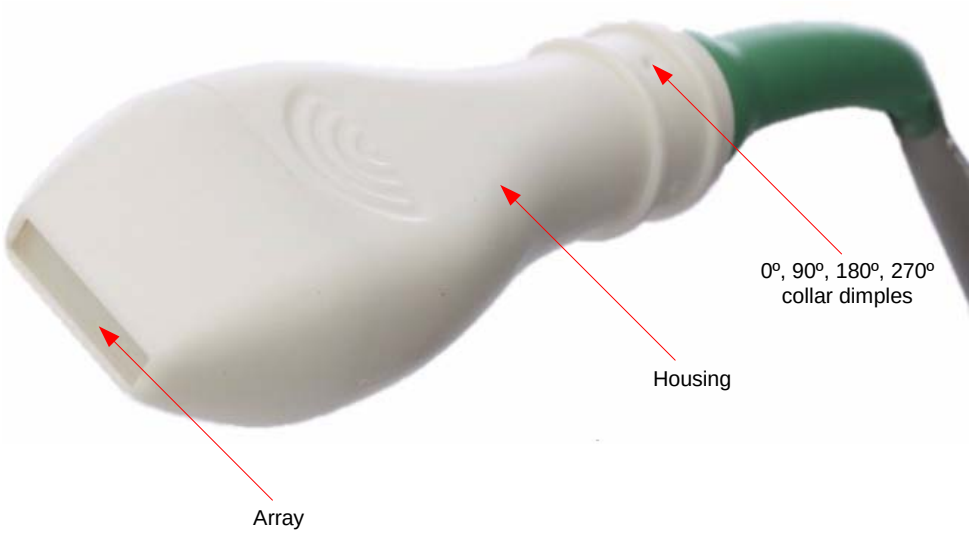
Related information

- For information on connecting the transducer to the Vevo Imaging Station, see *Working with the Vevo Imaging Station*
- *Options and accessories* (see page 422)

Transducer array description

The 256-element array transducer delivers a usable frame rate of more than 300 frames per second depending on the transducer you use and the field of view that you have set for your image acquisition.

The features of the transducer are displayed in the following illustration.



Transducer options

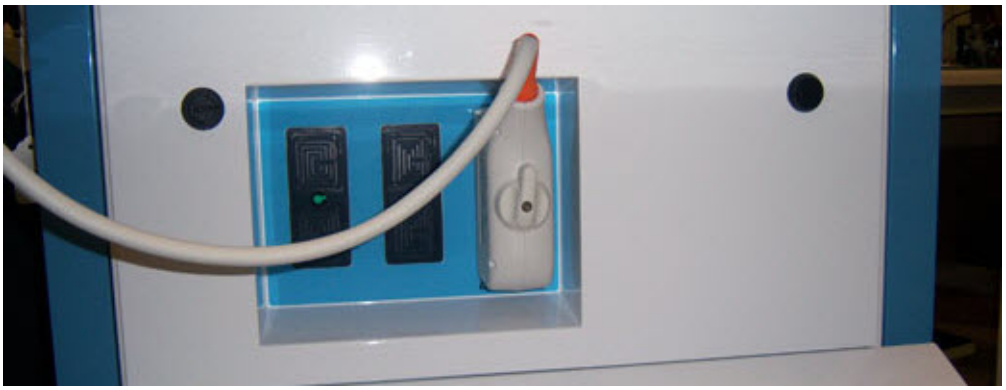
VisualSonics offers five transducers with center frequencies ranging from 12.5MHz to 45MHz to serve applications ranging from rabbit to mouse.

Transducer	Collar color	Description
MS-200	Orange	Rabbit, general and abdominal imaging
MS-250	Yellow	Rat cardiology and abdominal imaging
MS-400	Red	Optimized for mouse cardiovascular imaging with frame rates greater than 300 frames per second
MS-550D	Blue	Mouse cancer and abdominal imaging
MS-550S	Gray	Optimized for mouse embryology imaging and injection

IMPORTANT: Only transducers manufactured by VisualSonics may be used.

Front panel

The front panel of the Vevo 2100 Imaging System features three transducer ports and a transducer cable holder, as shown in the following illustration.

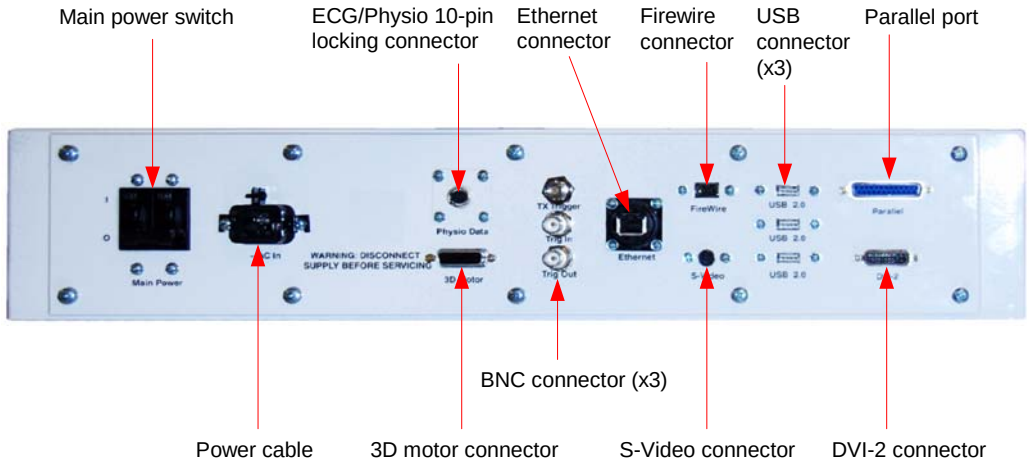


Related information

- *Connecting and disconnecting the transducer* (page 106)

Rear panel

The rear panel provides the connectors and power controls as detailed in the following illustration.

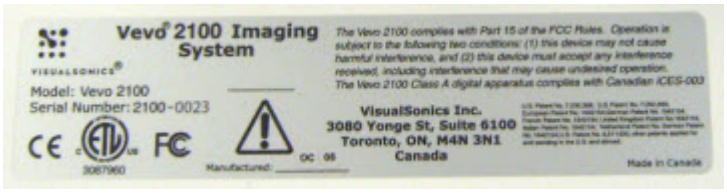


Rear panel connector	Description
Main power switch	After the power cable is connected, push the switch up to power the Vevo 2100 Imaging System.

WARNING: Do not modify the attachment plug or use an adapter. This could cause an electrical hazard. If you need to use a different plug, contact a Technical Support Representative at 1-866-416-4636 (North America, toll-free), +800 0751 2020 (Europe, toll-free) or by email at support@visualsonics.com.

CAUTION: Before connecting the system ensure the voltage is correct. Ensure the power cable is undamaged before plugging the system directly into the wall outlet. Use of an extension cord or a power bar is discouraged.

The voltage is specified on the power connection plate on the rear panel of the system.



AC in	Connect the power cable here.
ECG/Physio 10-pin locking connector	Connect your animal handling platform (optional VisualSonics accessory) cable here.
3D motor connector	Connect your 3D motor stage (optional VisualSonics accessory) cable here.
TX Trigger, Trig In, Trig Out	Connect BNC cables here. For future use.
Ethernet connector	Connect your network data cable here.
FireWire connector	Connect your Firewire equipped data storage device here.
S-Video connector	Connect your S-Video equipped external video recording device here.
USB connectors	Connect your USB equipped data storage device here.
DVI connector	Connect an additional monitor (optional VisualSonics accessory) in the open DVI port.

With the exception of the Ethernet network cable, cables being connected to the rear panel of the Vevo 2100 Imaging System must be 3 m (9' 10") in length, or shorter.

Related information

- *Turning your system On and Off* (page 34)
- *Accessories* (page 422)
- *Connecting the blood pressure equipment* (page 110)
- *Connecting the 3D motor stage to the Vevo Imaging Station* (page 102)

Control panel

The control panel provides all image acquisition controls as well as the primary study management controls.

The control panel also provides variable backlighting under the keys and controls.

To adjust the backlighting level under the control panel:

Press and hold FN while you tap either the Up arrow key to increase the brightness or the Down arrow key to decrease the brightness between the Off setting and through a series of seven brightness levels.

Related information

- For a detailed description of each control on the control panel see *Control Panel controls* (page 406).

Grab bars

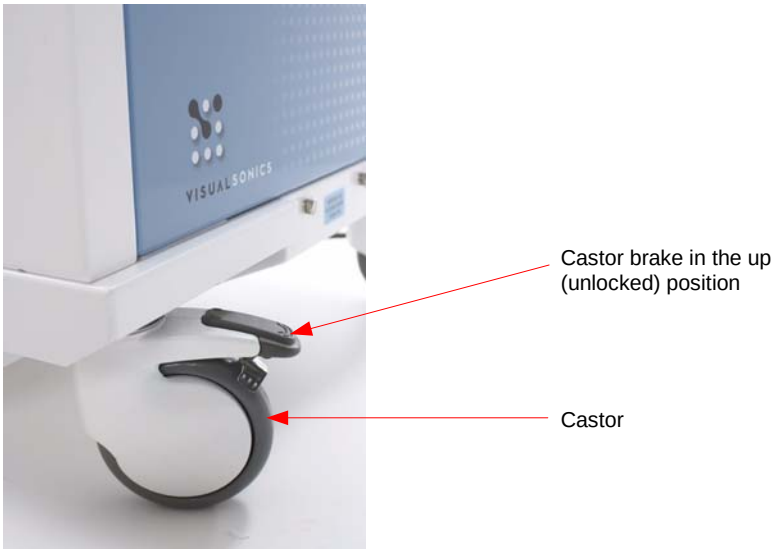
Use the front and back grab bars when you are moving the system. Don't use them to lift the system. They are not designed to bear the weight of the system.

Transducer and gel holder

Use the transducer or gel holders located on the left and right sides of the cart to store your transducers and gel bottles. Store both items facing up.

Castors

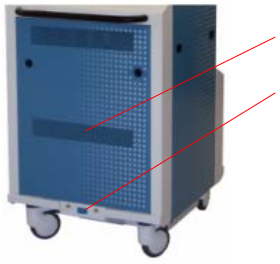
Castors allow the Vevo 2100 Imaging System to be moved easily. The four castors can be locked using a lever located above each castor. The castors are locked when their levers are down.



WARNING: Ensure that the Castors are locked whenever the Vevo 2100 system is not being transported" together with the warning symbol.

Air filters

The Vevo 2100 Imaging System includes three air filters as described in the following illustration.



WARNING: Do not obstruct or block the filter inlets; overheating of the electronics could occur.

Related information

- *Cleaning your air filters* (page 440)

Vents

The cart includes six air vents. Two are located toward the rear of the left and right panels of the control panel module. Two more are located in the rear panel, and two more are located at the bottom center of the front and rear of the cart.

WARNING: Do not obstruct or block these vents; overheating of the electronics could occur.

Internal data storage devices

The Vevo 2100 Imaging System includes a DVD+-RW drive and two hard drives. One hard drive contains the Microsoft® Windows® Vista operating system and the Vevo software and the other hard drive is used for study storage.

The DVD drive is located on the left side of the Vevo 2100 Imaging System.

Use it to read or write data to and from CDs and DVDs.

The system also provides USB, Firewire and S-Video connectors on the rear panel so you can export image data to a wide range of external devices.

> **Note:** The S-Video connection may not be active on your cart, depending on the configuration. Some internal configuration may be required. Contact VisualSonics for more information.

Related information

- *Rear panel* (page 21)

Network connection

The computer unit includes a 100 Mbps Ethernet network connection.

Related information

- *Rear panel* (page 21)

Display monitor

The LCD monitor features an all-way adjustable mounting arm so you can position the monitor exactly where you want it.

Speakers

Integrated speakers provide an audio representation of the blood flow acquired in PW Doppler Mode to complement the image on the PW Doppler spectral display.

Isolation transformer

The isolation transformer that powers the Vevo 2100 Imaging System is located inside the Vevo 2100 Imaging System. The isolation transformer protects you and the equipment from electrical shock and power surges.

The Vevo 2100 Imaging System is designed to operate according to the electrical specifications of the region to which the system has been shipped. The nameplate on the back of the system indicates the electrical requirements.

The Vevo 2100 Imaging System uses a combination power switch/circuit breaker for protection in case of electrical overload. If the circuit breaker is tripped, the switch is toggled to a position that is in between the ON and OFF position.

WARNING: If the switch is positioned between the ON and OFF position it is tripped. Unplug the machine immediately and contact a Technical Support Representative at 1-866-416-4636 (North America, toll-free), +800 0751 2020 (Europe, toll-free) or by email at support@visualsonics.com.

Plug

Your Vevo 2100 Imaging System is equipped with the appropriate plug for a wall outlet. See Power plug to ensure that the plug is ideally suited for the configuration of a wall outlet.

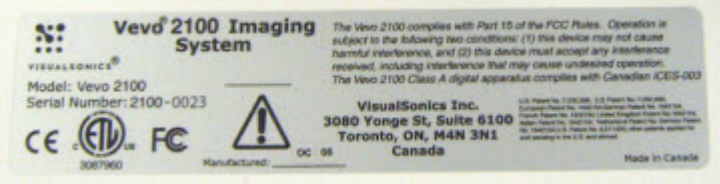
For optimal system performance, use a dedicated, interference-free grounded/earthed wall outlet.

The power cable is securely connected to the Vevo 2100 Imaging System with a cable retainer. If you need to remove the power cable from the cart, loosen the screw at the top of the cable retainer.

WARNING: Do not modify the attachment plug or use an adapter. This could cause an electrical hazard. If you need to use a different plug, contact a Technical Support Representative at 1-866-416-4636 (North America, toll-free), +800 0751 2020 (Europe, toll-free) or by email at support@visualsonics.com.

CAUTION: Before connecting the system ensure the voltage is correct. Ensure the power cable is undamaged before plugging the system directly into the wall outlet. Use of an extension cord or a power bar is discouraged.

The voltage is specified on the power connection plate on the rear panel of the system.



Related information

- *Rear panel* (page 21)

Vevo 2100 Workstation Software description

VisualSonics offers an optional Vevo 2100 Workstation Software package which includes all the software tools and features that you will find on the Vevo 2100 Imaging System excluding the image acquisition tools features.

Vevo 2100 Workstation Software running on a laptop

Related information

- *Workstation analysis (optional)* (page 157)

Available configurations

VisualSonics offers several configurations of the Vevo 2100 Imaging System, as described in the following table.

Configuration	Description
Standard Configuration	Vevo 2100 Imaging System Vevo software, including: ▪ Analytic software package for B-Mode (2D) image capture and analysis ▪ Cine loop image capture, display, and review ▪ Software analytics for Advanced Measurements and Annotations ▪ Physiological Data on-screen trace
Flow Analysis Option	PW Doppler Mode (for rapid flow applications) and Power Doppler (for slow blood flow applications)
3D Analysis Option	3D acquisition and visualization
Cardiac Analysis Option	M-Mode Tissue Doppler Imaging (TDI) for assessing diastolic dysfunction Automated LV Analysis for semi-automated analysis and quantification of LV function Integrated Blood Pressure with Pressure-Volume Analysis Advanced Cardiovascular Measurements Capability
Molecular Imaging Option	Contrast Mode acquisition and analysis

Related information

- For a complete list of accessories and optional components, see *Accessories* (page 422)

Chapter 3

Quick Start Tutorial

This chapter is a high-level procedure for acquiring and analyzing an image and then exporting your analysis.

You will find this quick start tutorial useful:

- If you are familiar with how ultrasound systems work and you want to jump in and give it a try
- If you haven't used the system in a while and want a refresher tutorial

Before you begin

- Ensure that you have connected a transducer to the transducer port on the front of the cart.
- If you are imaging an animal, ensure that the animal is properly prepared on the animal platform and ensure that the animal is connected to the physiological data monitoring system.

WARNING: Before using the VEVO 2100 any operator must read and observe the Safety Warnings and Precautions in *Safety* (page 429).

To acquire and analyze a B-Mode image and export your analysis:

1. On the back of the cart, turn on the **Main Power.**
2. On the left side of the cart press the **Computer Standby** toggle.

   The computer operating system starts and then the Vevo 2100 Imaging System software starts and displays the **VisualSonics Vevo® 2100** dialog.
3. In the **Application** box select the type of imaging application: General Imaging or Cardiology.

   The system initializes the transducer and opens the **Study Browser** window.
4. Press B-Mode.

   The **B-Mode** imaging window appears and the system begins acquiring B-Mode data.
5. Refine your image using the various control panel controls such as the Image Depth toggle control, the 2D Gain dial and the Invert button.
6. Press Scan/Freeze to stop the data acquisition.
7. Press Cine Store to save the sequence of images in the system buffer. In the background:

- The system creates a date-stamped new study for you as well as the first image series set, **Series 1**.
- The system stores a date-stamped cine loop of the B-Mode data you are acquiring

8. Press Scan/Freeze again to resume the data acquisition.
9. Continue freezing and storing as required.
10. Press Study Management.

    The **Study Browser** window appears and displays the new date-stamped study, new date-stamped study series and the new time-stamped images.

    You can now analyze the image data.
11. In the **Name** column, double-click the **Series 1** row.

    The review panel displays thumbnails of the images you stored.
12. Double-click the first thumbnail.

    The B-Mode window appears and plays the cine loop you stored.
13. Using the Cine Loop Review dial:
    a. Turn the dial counter-clockwise to slow the loop down until you reach your desired playback rate
    b. Press down on the dial to toggle the cine loop to stop.
    c. Turn the dial one way or the other to control the movement of the cine loop frame by frame.
14. Press Measure.

    The measurement tools appear near the top of the left panel.
15. In the measurement packages list box:
    d. Click the appropriate measurement package for your study. For example, click **Embryology Package**.

       The system displays the list of available measurement protocols.
    e. Click the appropriate protocol. For example, click **Placenta**.

       Under the protocol label, the system displays the list of predefined protocol measurements.
    f. Click the appropriate measurement. For example, click **Placenta Sag**.

       The list box becomes a preview panel and the system highlights the icon for the measurement tool that the system uses for the protocol measurement. For the Placenta Sag measurement, the system uses the **Linear** tool.
16. In the image area, place and complete your measurement.

When you have completed your measurement, the system applies a label or index number to your measurement based on the preferences you set in the Measurement tab of the Preferences window.

The system also displays the value in the **Measured Values** list.

17. Press Study Management.

    The **Study Browser** appears. The thumbnail of the image you have been adding measurements to displays the most recent frame you worked on, including the measurements.

18. Click the **Series 1** row and click **Report**.

    The **Analysis Browser** appears and displays a report of the measurements you made for that series, listed in order by application package.

19. Click **Export**.

    The **Export Report** window appears.

20. In the **Export Report** window:

    a. Browse to the folder where you want to export your report.

    b. If you want to create a new folder, select the folder that will hold the new folder, click **New Folder**, type the folder name in the **New Folder Name** dialog box, and then click **OK**.

    c. In the **Options** area, modify the title of the report in the **Save As** box if required.

    d. Click **OK**.

    The system exports your report.

You have successfully acquired and analyzed an image, and exported your report.

Related information

- *Vevo 2100 Imaging System workspaces* (page 44)
- *Managing your studies* (page 125)
- *Acquiring image data* (page 100)
- *Analyzing image data* (page 156)

Section 2

Vevo fundamentals

This section introduces you to the fundamentals of the Vevo 2100 Imaging System and shows you how they work.

In This Section

Chapter 4

How the Vevo 2100 Imaging System works

The Vevo 2100 Imaging System is easy to work with and understand because you work with three simple concepts:

- Image acquisition modes
- Operators
- Studies

WARNING: Before using the VEVO 2100 any operator must read and observe the safety warnings and precautions in *Safety* (page 429).

This chapter shows you how these concepts work together to help you generate useful image data.

In this chapter

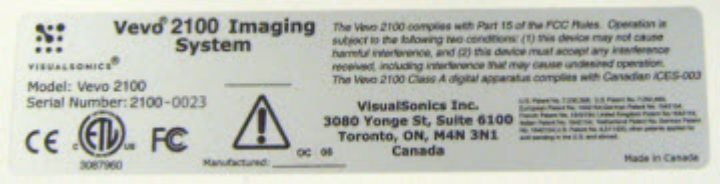
Turning your system On and Off

Before you power up your system, ensure that the the AC power cord is plugged into the wall outlet using the proper plug. See *Plug* (page 27) for more information.

WARNING: Do not modify the attachment plug or use an adapter. This could cause an electrical hazard. If you need to use a different plug, contact a Technical Support Representative at 1-866-416-4636 (North America, toll-free), +800 0751 2020 (Europe, toll-free) or by email at support@visualsonics.com.

> **CAUTION:** Before connecting the system ensure the voltage is correct. Ensure the power cable is undamaged before plugging the system directly into the wall outlet. Use of an extension cord or a power bar is discouraged.

The voltage is specified on the power connection plate on the rear panel of the system.



To turn your system ON:

1. On the rear panel, push up the **Main Power** switch. This connects the system to the power source and turns on the internal fans, but it does not turn on the control
2. On the left side of the control panel module, press the **Computer Standby** switch. This is a toggle switch, so when you press it, it does not stay pushed in like a light switch. Instead it returns to its original position. This is normal.

The system starts the control panel backlights, the display monitor and the computer operating system.

To turn your system OFF:

1. Ensure that you have stored all the image data that you are working on.
2. Press the **Computer Standby** switch.

   The computer shuts down, the monitor powers down, and the control panel backlights turn off. The fans continue to run.
3. If you need to turn off all power to the system:
   a. Let the fans run for 10 minutes to safely cool down the internal components.
   b. Push down the **Main Power** switch.

Related information

- *Plug* (page 27)

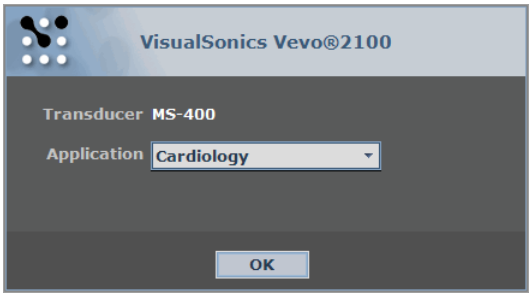
Application packages

Application packages are predefined groups of image acquisition settings. This way you can quickly get an optimal image to work with, and when you're ready to take your measurements, you can quickly cycle through the pre-ordered measurements protocol for your application.

The system includes two default application packages:

- General imaging
- Cardiology

When you start your system, you select the application package for the work you are doing.



For example, if you are doing cardiology imaging you select the Cardiology package. Then The system configures the imaging acquisition parameters for optimal cardiology imaging.

Operators

Operators are the people — or, more precisely, the user profiles — that use the system. You can set a password for an operator to restrict other operators from unlocking and deleting a study that an operator owns.

Related information

- *Working with operator profiles* (page 61)

Studies, series and images

Studies in the Vevo 2100 Imaging System are like studies in a paper based system. They work much like a file directory and hold all the series of images that are part of your study.

Studies are composed of one or more grouped image sets called series, and the series are composed of one or more images (individual frames and/or multiple-frame cine loops).

Related information

- *Creating a study* (page 127)
- *Creating a series* (page 132)
- *Acquiring data in an image mode* (page 120)

Image acquisition modes

The Vevo 2100 Imaging System provides a range of high-resolution micro-ultrasound imaging modes to achieve different imaging objectives.

B-Mode overview

B-Mode is the imaging mode you will work with most often because it is the most effective mode for locating anatomical structures. If you have seen a conventional ultrasound image then you are already familiar with B-Mode.

B-Mode is also used:

- In other imaging modes as the background orientation image over which the active mode data is applied
- As a real-time orientation window in other imaging mode windows so you can visually guide the transducer to the right location to acquire the most useful data in your active imaging Mode

Related information

- *Mode window workspace* (page 44)
- *Acquiring B-Mode images* (page 190)
- *Analyzing B-Mode images* (page 202)

M-Mode overview

M-Mode is used primarily to measure the movement and dimensions of cardiac structures such as chambers and walls.

M-Mode works fundamentally differently than B-Mode. Where B-Mode uses multiple scanning beams to create its image, M-Mode uses just one.

So, when you have guided your transducer beam to the depth that gives you a proper cross-section of the heart, you can then set M-Mode to lay its single beam across that cross-section. In effect, it is like positioning a tight string through the heart, and recording the movement of the heart structure cross-sections along that string.

This way, the movement of the heart structures move up and down that single line so you can then take measurements along that line over time. These movements over time are the waves that you see in the M-Mode image.

Related information

- *Mode window workspace* (page 44)
- *Acquiring M-Mode images* (page 225)
- *Analyzing M-Mode images* (page 235)

PW (Pulsed Wave) Doppler Mode overview

PW Doppler Mode (Pulsed Wave Doppler) is an ultrasound mode you can use to measure the velocity and direction of flow. The Vevo software presents the detected PW Doppler signal as both a spectral image in the display window as well as an audio output through the system speakers.

Related information

- *Mode window workspace* (page 44)
- *Acquiring PW Doppler Mode images* (page 246)
- *Acquiring PW Tissue Doppler Mode images* (page 260)
- *Analyzing PW Doppler Mode images* (page 262)

Color Doppler Mode overview

Color Doppler Mode uses Doppler principles to determine the mean velocities of blood within the region of interest. The system then applies *color* that represents these various velocities under the convention of BART (Blue=Away Red=Toward).

This mode is useful for bloodflow applications such as:

- Distinguishing non-vascular tissue structures from vascular tissue structures

- Identifying vascular structures that can be more difficult to identify in other ultrasound mode image data

Related information

- *Mode window workspace* (page 44)
- *Acquiring Color Doppler Mode images* (page 305)
- *Analyzing Color Doppler Mode images* (page 315)

3D-Mode overview

3D-Mode provides a three-dimensional view of an area of interest. The system acquires the 3D data by creating a rapid series of B-Mode slices, then combining these slices into a whole image.

You can then use the analysis tools to manipulate the three-dimensional renderings and make volumetric measurements of the structures you are interested in.

Related information

- *Mode window workspace* (page 44)
- *Acquiring 3D-Mode images* (page 275)
- *Analyzing 3-D Mode images* (page 288)

Power Doppler Mode overview

Power Doppler Mode provides tools to visualize and measure flow in 2D and/or 3D. This mode is useful for applications such as detecting vascularity in and around orthotopic and subcutaneous tumors and producing a measure of relative quantification.

Related information

- *Mode window workspace* (page 44)
- *Acquiring Power Doppler Mode images* (page 321)
- *Analyzing Power Doppler Mode images* (page 333)

Contrast Mode overview

Contrast Mode imaging provides tools to detect and quantify vascular structures and dynamics at the molecular level in two dimensions or three dimensions.

This mode is useful in cancer, vascular and cardiology research for real-time in vivo applications such as:

- Targeted molecular imaging for visualizing and quantifying the expression of intravascular molecular markers — for example: angiogenesis and inflammation
- Tumor perfusion and relative quantification of vascular volume and structure
- Assessment of myocardial perfusion and area of infarction

Related information

- *Mode window workspace* (page 44)
- *Acquiring Contrast Mode images* (page 338)
- *Analyzing Contrast Mode images* (page 352)

Chapter 5

Logging on

This chapter walks you through the procedures for logging on to the system and selecting yourself as the active operator.

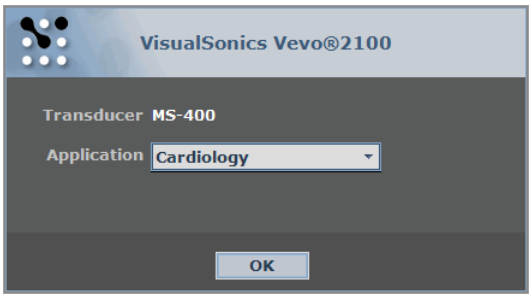
In this chapter

Logging on the very first time the system is used

When you are the first person ever to log on to the Vevo 2100 Imaging System, the logon procedure is different than the standard logon for a typical session. This is because no-one has added any administrator profiles or operator profiles yet.

To log on the very first time the system is used:

1. On the back of the control panel module turn on the **Main Power** switch.
2. On the left side of the control panel module turn on the **Computer Standby** switch.
   - The control panel lights turn on.
   - The Vevo 2100 Imaging System software starts and displays the acquisition **Presets** dialog box



3. In the **Application** list, select the application package you want to work with.
4. Click **OK**.

You can now start a new acquisition session.

You should add an administrator now and then add the operators.

CAUTION: If you do not create at least one **Administrator** operator as part of your operator group, any operator can add or delete other operators' studies.

Next steps

- *Adding an administrator* (page 62)
- *Adding an operator* (page 63)

Related information

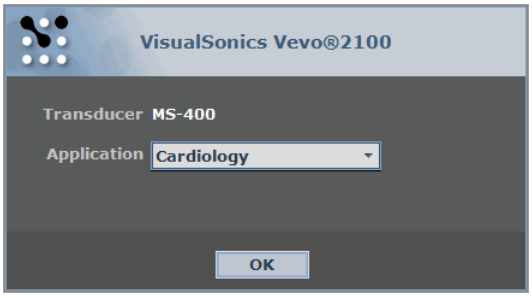
- *Logging on for a typical session* (page 42)
- *Application packages* (page 36)

Logging on for a typical session

Use the following procedure after the administrator has created your operator profile.

To log on for a typical session:

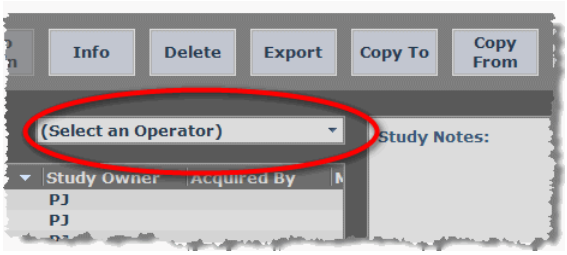
1. On the back of the control panel module turn on the **Main Power** switch.
2. On the left side of the control panel module turn on the **Computer Standby** switch.
   - The control panel lights turn on
   - The Vevo 2100 Imaging System software starts and displays the dialog box to select an application.



3. In the **Application** list, select the application package you want to work with and click **OK**.

The system initializes the transducer and opens the **Study Browser** window.

4. In the **Study Browser** window, select your operator name.



Any acquisition work you do – such as creating a new study, or a new series, or creating new images – is recorded by the system as being completed by this operator.

Related information

- *Changing the active operator* (page 67)
- *Application packages* (page 36)

Chapter 6

Vevo 2100 Imaging System workspaces

This chapter describes the primary software workspaces that you use when you work with the Vevo 2100 Imaging System.

In this chapter

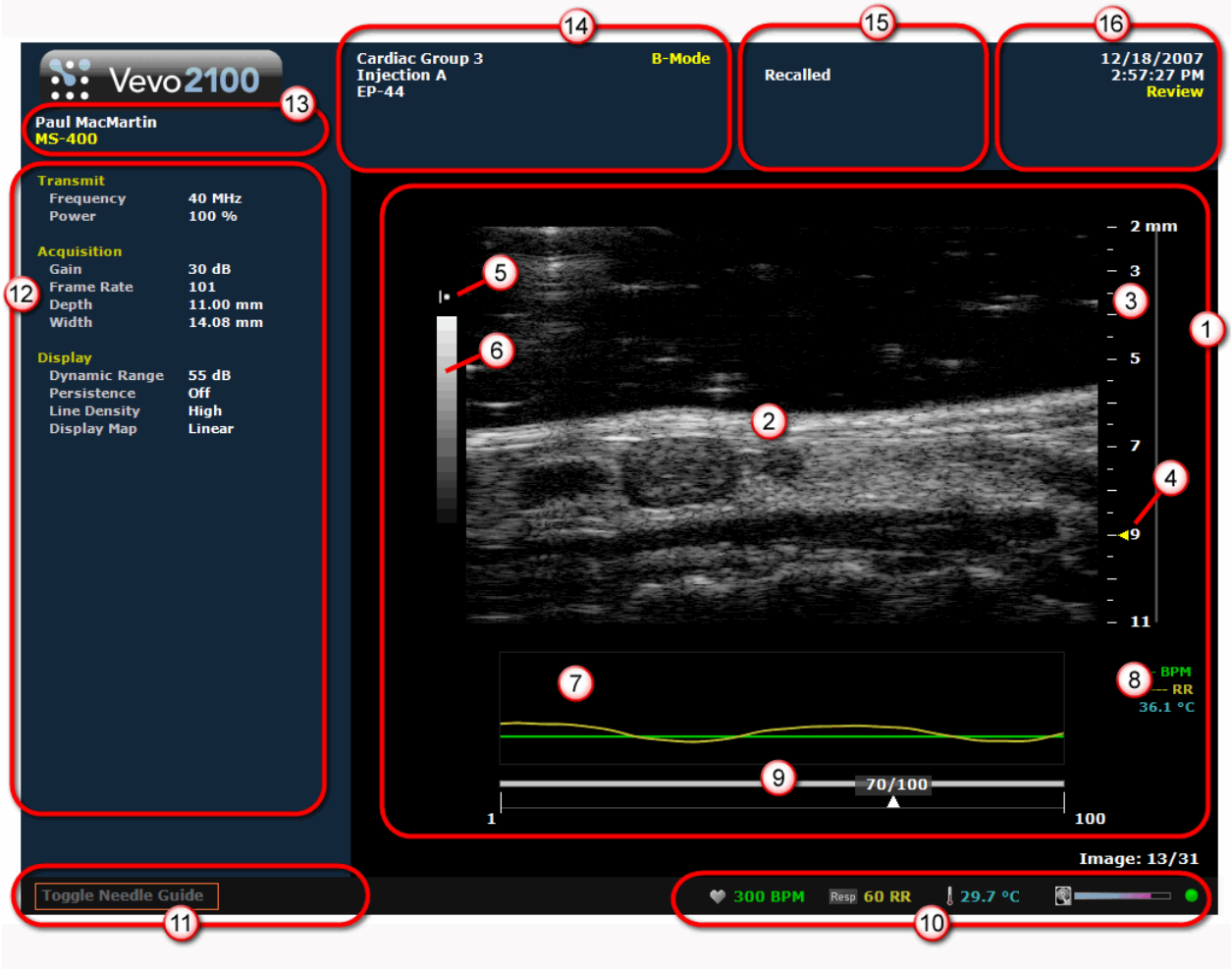
Mode window workspace

The Mode window is the workspace you use whenever you view image data in any ultrasound imaging mode.

To open a Mode window:

- On the control panel, press one of the Mode keys. For example, press B-Mode. The system displays the **Mode** window and begins acquiring B-Mode image data.
- If you are in the **Study Browser**, expand a study row, select a series in the study. Next, either double-click one of the thumbnails or expand one of the series and double-click one of the image rows.

The following illustration and table describes the information and features in the Mode window.



A typical Mode window workspace. This example is a B-Mode window displaying a stored cine loop.

Area	Description
1	**Image data panel**. Displays the image data that the transducer produces, and displays the physiological data if you are acquiring it. When you export a stored image and configure your export to send only the **Image Area**, this is the image area that the system exports.
2	**Micro-ultrasound image**. Displays the data that the transducer acquires. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.
3	**Depth ruler**. Indicates the depth from the transducer face. The triangular arrow indicates the focal length(s) of the transducer. When you acquire image data, use the **Depth** control on the control panel to increase or decrease the depth that you can see.
4	**Focal depth indicator**. When you acquire data in B-Mode, use the **Focal Zones** control on the control panel to add up to three focal zones.
5	**Transducer orientation indicator**. The line in this icon corresponds to the orientation ridge on the transducer and indicates the orientation of the probe relative to the image. If your transducer is acquiring at 180 degrees the wrong way, you can click the indicator to flip the image.

Area	Description
6	**Dynamic range bar**. Indicates the dynamic range of the display. When you acquire data, use the **Dynamic Range** control on the control panel to change the range.
7	**Physiological data trace panel**. Displays your animal's dynamic heart rate, temperature, respiration rate and blood pressure data. This information comes from the Advanced Physiological Monitoring Unit that connects to the Vevo Imaging Station.
8	**Physiological data values**. Appears only on a stored image or when you pause the system. Can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature.
9	**Cine loop range control**. Appears only on a stored or acquired cine loop. Displays the length of the cine loop range. The triangular white marker identifies the individual frame number within the cine loop. You can drag the left and right vertical markers to display only the image frames in that range.
10	**Physiological live display**. Appears in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system.
11	**Dynamic control panel feedback**. ▪ Displays the changing setting values while you use a control panel control until you stop and the system redraws the image. Then the system displays the setting value in the Mode settings panel. ▪ Displays confirmation messages when you store an image.
12	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).
13	**Operator details** ▪ Displays your institution name if you added it in the **Preferences** window. ▪ Displays your operator name if you selected it for your session. ▪ Identifies the model number of the transducer that is acquiring imaging data (if you are in an image acquisition session) or the transducer that acquired the data (if you are in an image analysis session).

Area	Description
14	**Image details** ▪ Displays the system default study name and series name (unless you have customized them in the **Study Information** section of the **Study Information** window). ▪ Displays the **Animal ID** if you added it in the **Series Information** section of the **Study Information** window. ▪ Displays the image label if you added it by pressing Image Label.
15	**Image status** The top (yellow) line identifies the ultrasound mode that the image was acquired in (for example **B-Mode**). The lower (white) line identifies the state of the image: ▪ **Acquired**. Confirms that the system has acquired the image after you press Scan/Freeze. Note that this does not mean that the image is saved. You must press Cine Store or Frame Store to store the image. ▪ **Stored**. Confirms that the system stored the image after you press Cine Store or Frame Store. ▪ **Recalled**. The image was opened from the **Study Browser**. ▪ Nothing appears below the yellow mode label while you are in the process of acquiring data.
13	**Time stamp/system status**. The top two (white) lines display the actual time when the system acquired the visible frame. The lower (yellow) line identifies the current state of the system: ▪ **System Active**. The system is acquiring image data. ▪ **System Paused**. The system is displaying the acquired image after you press Scan/Freeze. ▪ **Review**. The system is displaying a stored image.

Related information

- *Control panel* (page 57)
- *Setting up your Vevo 2100 Imaging System* (page 101)
- *Working with physiological data* (page 109)
- *Typical acquisition session workflow* (page 120)

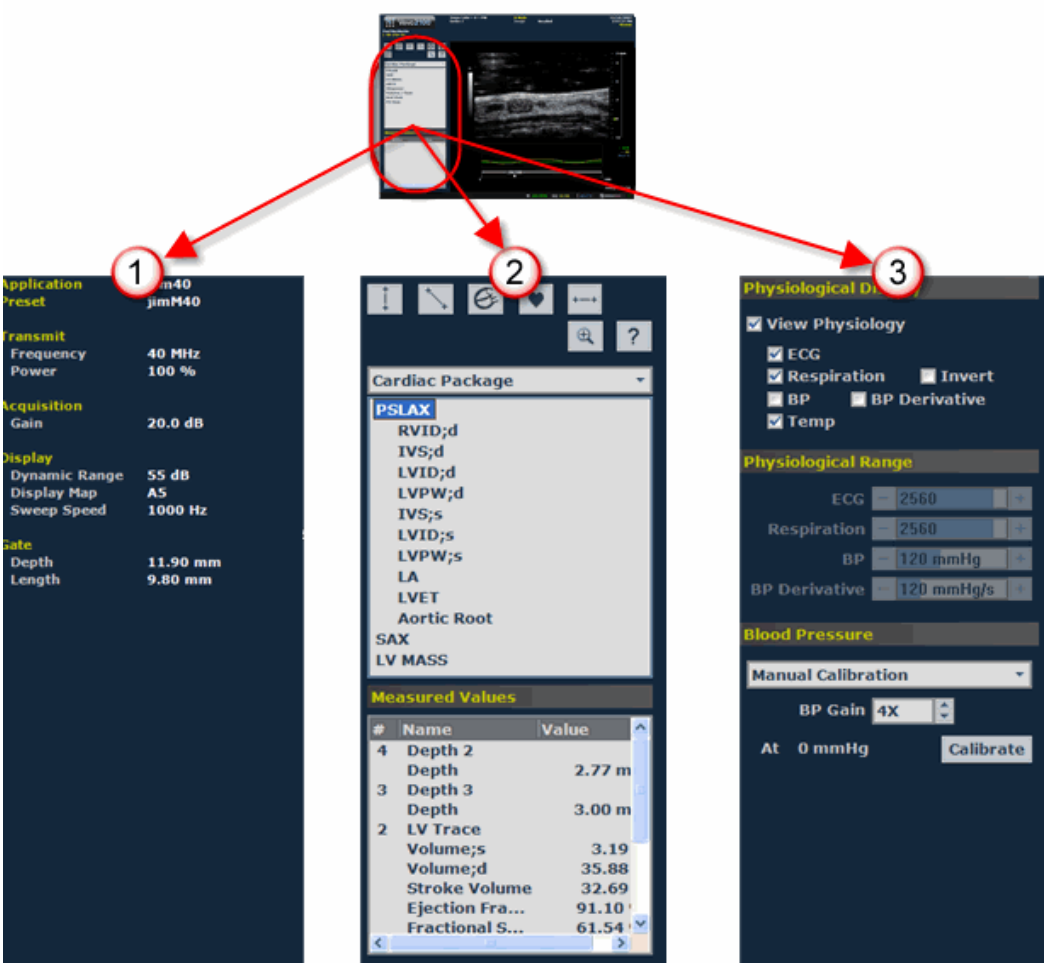
Left panel workspace

You can set the left panel to display one of the following workspaces:

- Mode settings
- Measurements tools
- Physiological data options (not applicable in 3D-Mode)

To select the panel workspace you want to work with:

Press the appropriate key on the control panel as described in the following illustration and table.



Area	Description
1	**Mode Settings** panel workspace. Read-only. Press Mode Settings.
2	**Measurements** panel workspace. Tools are only available when you are reviewing an individual frame and you pause the playback. During image acquisition, the tools are not available. Press Measure (or click **Measurements** on the workstation).
3	**Physiological** data options panel workspace. The **Physiological Range**, **Respiration Gating** and **ECG Trigger** sections are only available during image acquisition. Press Physio Settings (or click **Physiological** on the workstation).

Related information

- *Mode window workspace* (page 44)
- *Viewing physiological data* (page 110)

Study Browser window workspace

The Study Browser window is the exploration workspace you use to manage your studies, study series, and individual images.

The Study Browser works in many ways like the Explorer window on your Windows PC:

- Expand a study listing to view the study series that are in the study
- Expand a study series listing to view the images that are in the study series
- Double-click an image listing to view the image in a Mode window

To open your Study Browser:

Press Study Management. The system displays the **Study Browser** window.

The following illustration and table describes the information and features in the **Study Browser**.

Study Browser window highlighting the study, series and image items in the list

Area	Description
1	**Studies list**. Lists all the available studies, the series groupings that you create within each study, and the individual images that you create within each study series.
2	**Study listing**.

Area	Description
3	**Series listing** within a study.
4	**Image listing** within a series.
5	**Operator selection list**.
6	**Study Browser** window commands.
7	**Image thumbnails** or study notes for the selected series.

Related information

- *Creating a study* (page 127)
- *Creating a series* (page 132)
- *Adding images to a study series* (page 122)

Study Information window workspace

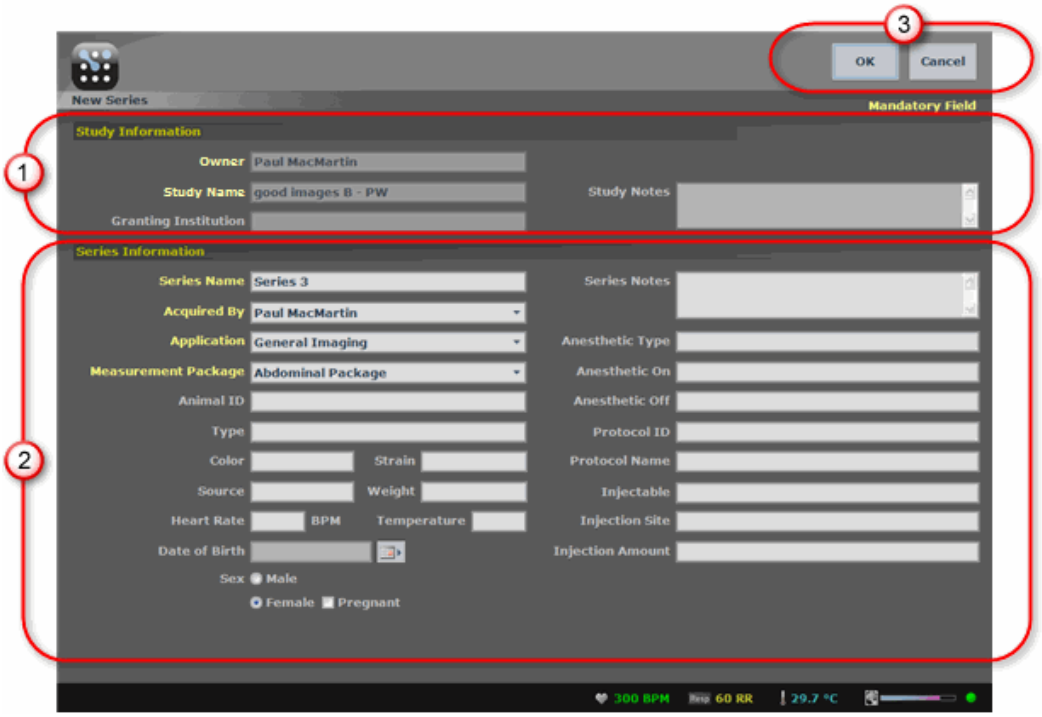
Use the **Study Information** window to:

- Display or manage the description information for a study
- Display or manage the description information for a series within a study

To open the Study Information window:

- When you are in the **Study Browser** and you have selected a study listing or series listing, press Study Info. If you select the row for a series, the system displays the information for the series and the study that contains the series. If you select the row for a study, the system only displays the information for the study.
- When you are in the **Study Browser**, press New. You can create and describe a new study.
- When you are in a **Mode** window acquiring or reviewing image data, press Study Info.

The following illustration and table describes the information and features in the **Study Information** window.



Study Information window displaying the view when you select a series and then press Study Info.

Area	Description
1	**Study Information** section. Includes the information boxes that describe a study.
2	**Series Information** section. Includes the information boxes that describe a series within a study.
3	**Study Information** window commands.

Related information

- *Modifying the information properties of a study* (see page 129)

Preferences window workspace

The **Preferences** window provides a series of tabs you can use to configure default values for a range of operational settings.

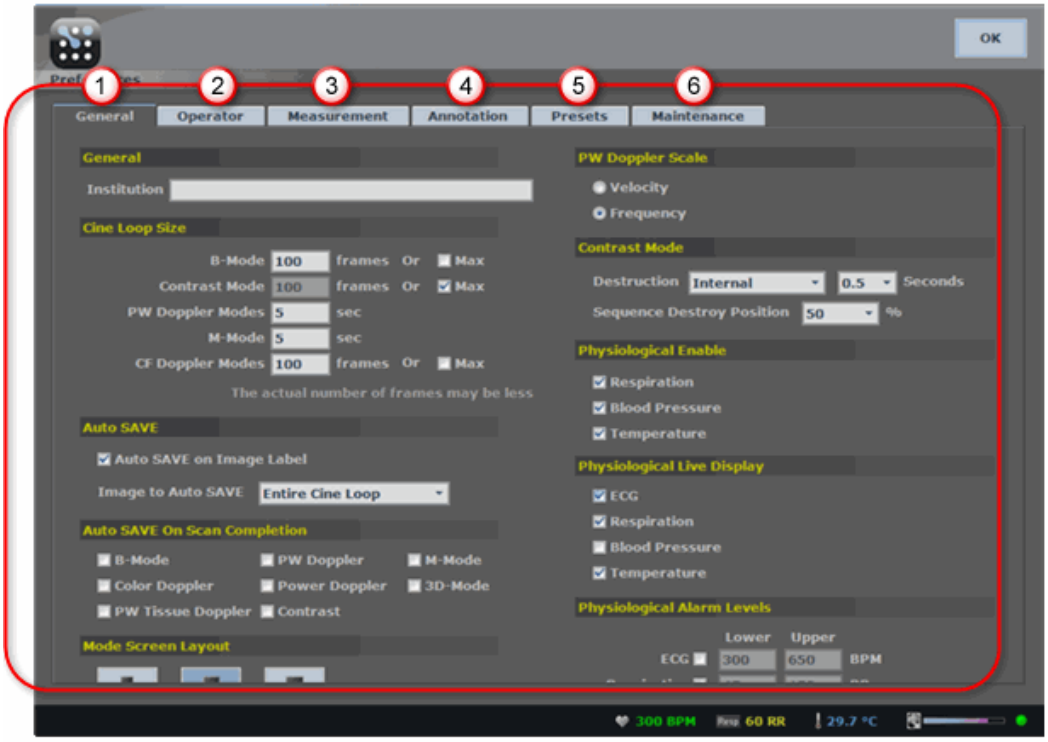
Use the **Preferences** window to configure defaults that are available to all operators on the system.

To open the Preferences window:

- Press Prefs.

- In the **Study Browser**, click **Prefs**.
- If you are analyzing data in a Mode window on the workstation, click the  icon in the image tools icon panel.

The following illustration and table describes the information and features in the **Preferences** window.



Preferences window, displaying the General tab preference sections

Area	Description
1	**General** preferences tab. Use this tab primarily to specify your acquisition settings.
2	**Operator** preferences tab. Use this tab to add, modify, delete and manage the profiles and rights for the operators and administrators who access the system.
3	**Measurement** preferences tab. Use this tab to customize the measurement packages you want the system to display, as well as specify which protocol and protocol measurements you want the system to display.
4	**Annotation** preferences tab. Use this tab to customize the way you view and add annotations when you analyze the image data that you have acquired.
5	**Presets** preferences tab. Use this tab to create custom acquisition presets.
6	**Maintenance** tab. Use this tab to manage system level features.

Related information

- *Setting your operating preferences* (page 69)

- *Responsibilities for administrators, owners and operators* (page 61)

Analysis Browser window workspace

The **Analysis Browser** window displays a report of the measurements and calculations for one or more studies or just the study series you select in the **Study Browser**.

To open the Analysis Browser window:

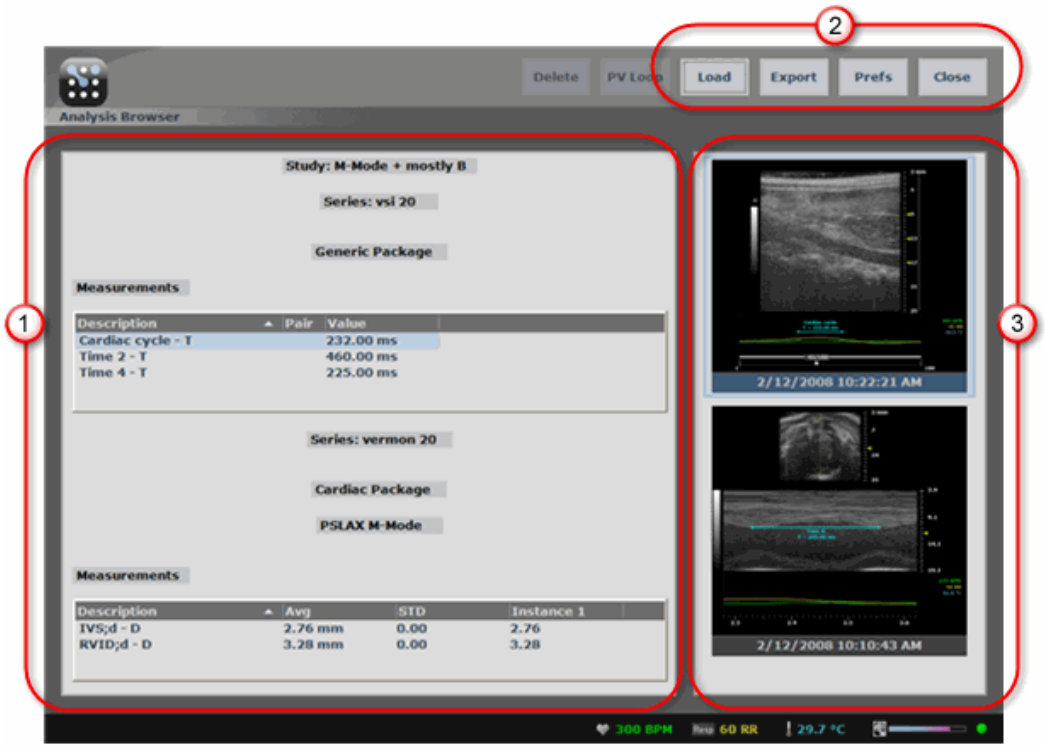
1. Press Study Management.

   The system displays the **Study Browser**.

2. Select a study listing or study series listing and click **Report**.

   The system displays a report of the measurements and calculations for the study or the study series.

The following illustration and table describes the information and features in the Analysis Browser.



Analysis Browser displaying a report of the measurements and calculations for a study

Area	Description
1	**Report details**. ▪ If you select a study listing in the **Study Browser** before you click **Analysis**, the report details display all the measurements and calculations for all images in all series in the study. ▪ If you select a series listing in the **Study Browser** before you click **Analysis**, the report details displays only the measurements and calculations for the images in that series.
2	**Analysis Browser** window commands.
3	**Image thumbnails**. Select a measurement to display a thumbnail of the image that contains the measurement. Double-click the thumbnail to review the full-size image in the Mode window.

Related information

- *Exporting an image analysis report* (page 185)

Export and Copy To windows workspaces

The system provides a common workspace environment for transferring data from your Vevo 2100 Imaging System. You see this workspace when you are:

- Copying studies from the **Study Browser**
- Exporting images from the **Study Browser**
- Exporting report data from the **Analysis Browser**

To open the Copy To window:

1. Press Study Management. The system displays the **Study Browser**.
2. Select one or more studies and click **Copy To**.

To open the Export Image window:

1. Press Study Management. The system displays the **Study Browser**.
2. Select one or more studies and/or series and click **Export**.

To open the Export Report window:

1. Press Study Management. The system displays the **Study Browser**.
2. Select one or more studies and/or series and click **Analysis**. The system displays the **Analysis Browser**.
3. Click **Export**.

The following illustration and table describes the information and features in the Export window.

Export Image *window displaying the export information and setup options for an image*

Area	Description
1	**Folder browser**. Functions the same way your Explorer window works on your Windows PC: browse the folders to find your destination folder.
2	**File transfer information and options**. ▪ The **Export Type** section only appears when you are exporting series images or analysis reports ▪ The **Selected** section is read-only and shows you how many items you are exporting or copying, and the space required and available on your data storage device In the **Export Type** section, when you select an export type, the **Options** section dynamically displays the specific file type options for the type of content you are exporting.
3	**Export** window commands. ▪ If you need to create a new folder to hold the file you are exporting, click **New Folder**. The system adds a new folder inside the selected folder in the folder browser window. ▪ When you have set up your export location and your file transfer options, click **OK**.

Related information

- *Exporting images* (page 139)
- *Exporting measurements and calculations* (page 185)

Chapter 7

Control panel

This chapter describes the physical controls on the cart's control panel that you use to complete your image acquisition and image analysis tasks.

In this chapter

Control groupings

The keys, dials, toggles, sliders and rocker switches on the panel are situated so that the image acquisition keys you will use most often are grouped as closely as possible to the trackball.

Related information

- For a functional description of each control on the control panel, see *Descriptions of control panel controls* (page 406)
- *Control panel controls for B-Mode* (page 194)
- *Control panel controls for M-Mode* (page 229)
- *Control panel controls for PW Doppler Mode* (page 251) (includes PW Tissue Doppler Mode controls)
- *Control panel controls for Color Doppler Mode* (page 309)
- *Control panel controls for 3D-Mode* (page 281)
- *Control panel controls for Power Doppler Mode* (page 327)
- *Control panel controls for Contrast Mode* (page 345)

NOTE: In the procedures in this manual all controls on the control panel are displayed in Control Block format, and software commands and labels are displayed in **Bold**. For example:

"Press Study Management. The **Study Browser** appears."

Chapter 8

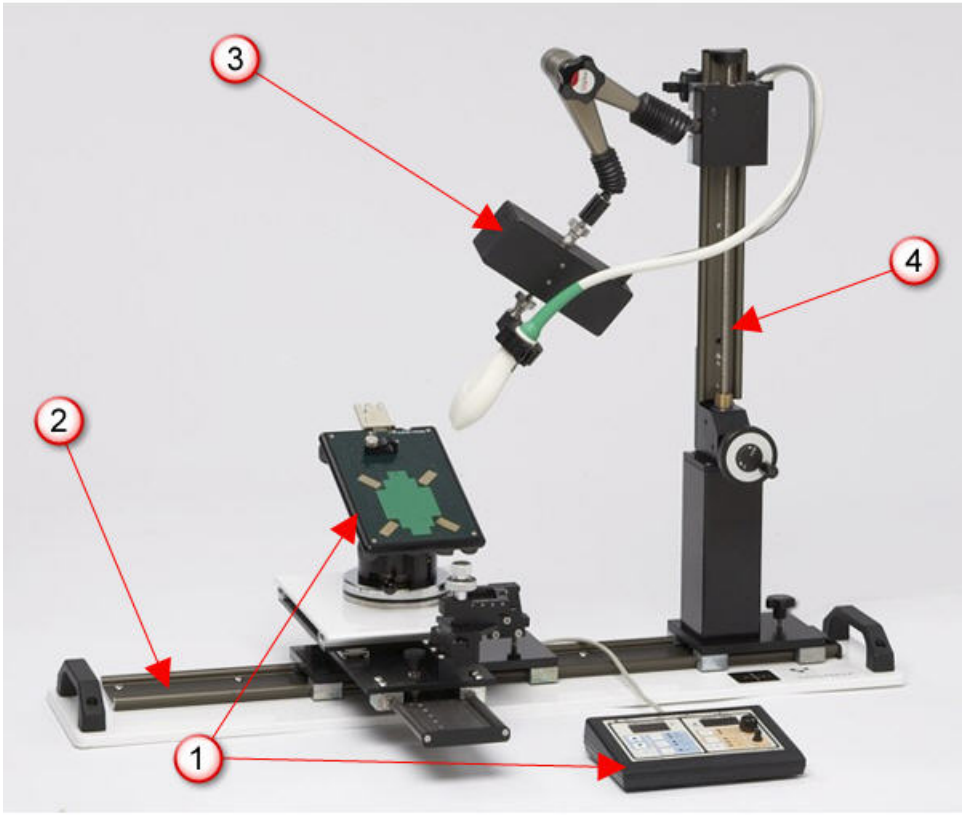
Vevo Imaging Station

The Vevo® Imaging Station is VisualSonics' advanced system for handling, monitoring and managing mice and rats during imaging procedures.

This component-based apparatus helps you position the anesthetized animal in a stable position in relation to the transducer so you can:

- Maintain the correct image plane during an imaging session
- Monitor and maintain the animal's ECG, heart rate, and core body temperature and display and record this data in the Vevo 2100 Imaging System in real time
- Manipulate the animal for image-guided injection and embryonic aspiration procedures

The following illustration and table describes the components of the Vevo® Imaging Station.



Vevo Imaging Station Operator Manual including the injection system and 3D motor system

Area	Description
1	**Animal handling and physiological monitoring system**. Use this system to secure the subject animal, support the manipulation of the animal during imaging, ensure the comfort of the animal during the imaging session, and monitor the animal's blood pressure, ECG, temperature and heart rate.
2	**Integrated rail base**. Provides the stable rail for attaching, sliding and securing the animal platform system, injection system and transducer mounting system. You can interchange these systems and set them up for left-handed or right-handed people.
3	**3D motor system** (optional). Captures data sets for 3D volumetric measurements. The transducer connects to the bottom of the system. The system moves the transducer from one side to the other as the transducer acquires cross section slices. The slices combine to create the 3D image.  **WARNING**: The 3D motor stage could cause a hazard to fingers during a 3D scan as the motor stage moves. Ensure that fingers are kept away from the 3D motor stage during a 3D scan.
4	**Transducer mounting system**. Secures the transducer in a stationary position when you position it at the desired image plane. In this configuration, the 3D motor system is attached to the mounting system and the transducer clamp is connected to the connector on the bottom of the 3D motor system.

Related information

- *Vevo Imaging Station Operator Manual* (see your printed manual)
- *Setting up your Vevo 2100 Imaging System* (page 101)
- *Working with physiological data* (page 109)

Section 3

Managing operator access

The Vevo 2100 Imaging System provides tools for administrating your operators' access to the system. This section shows you how to use these tools.

In This Section

Chapter 9

Working with operator profiles

An operator is any person who works with the image data on the system. An operator profile is the access and privilege settings that apply to an operator.

This chapter shows you how to set up an access and privilege profile for each person who can operate the system.

In this chapter

Responsibilities for administrators, owners and operators

Individual users can be operators, owners and administrators. These roles are described in the following table.

User role	Description
Standard operator	A standard operator can: ▪ Acquire and review image data ▪ Lock or unlock their own studies, and lock or unlock studies owned by other operators that are not password protected ▪ Change their own operator password, if they have one
Owner	The name of the operator who assigned their name to a specific study

User role	Description
Administrator	An administrator is an operator with additional privileges. An administrator can: ▪ Create new operators and administrators ▪ Delete any operator or administrator ▪ Assign, remove or change a password to an operator or administrator ▪ Lock or unlock any study

After VisualSonics delivers the Vevo 2100 Imaging System, every operator you create maintains full administrator rights until someone assigns administrator rights to themselves or to someone else.

Related information

- *Working with operator passwords* (page 65)
- *How passwords and study locks work* (page 130)

Adding an administrator

An administrator is an operator with additional privileges. An administrator can:

- Create new operators and administrators
- Delete any operator or administrator
- Assign, remove or change a password to an operator or administrator
- Lock or unlock any study

Important conditions

Because every operator has full administrator rights until someone assigns themselves or someone else as an administrator, you should assign an administrator to the system as soon as you can after VisualSonics installs your Vevo 2100 Imaging System.

CAUTION: If you do not create at least one **Administrator** operator as part of your operator group, any operator can add or delete other operators' studies.

You can create any number of administrators, but remember that each administrator can modify the settings of another administrator, so be careful.

To add an administrator:

1. Press Prefs. The **Preferences** window appears.

2. Click the **Operator** tab and then click **Add**.
3. In the **Operator Properties** dialog box:
   a. In the **Name** box, type a name for the operator. Typically this is the user's personal name.

   > **Notes**: You cannot type the same name for two operators. Also, you cannot modify the name after you have added the operator, so make sure you type the correct name.

   b. In the **Type** choice, select **Administrator**.
   c. Select the **Password Protected** check box.

      The **Password** boxes become active.

   d. In the **Password** box, type the password, then tab to the **Retype Password** box and retype it.
4. Press **OK**.

   The system creates the new administrator profile and lists it in the **Operator** list.
5. Click **OK**.

Related information

- *Adding a standard operator* (page 63)
- *How passwords and study locks work* (page 130)

Adding a standard operator

Only an administrator can add an operator or another administrator.

A standard operator can:

- Acquire and review image data
- Lock or unlock their own studies, and lock or unlock studies owned by other operators that are not password protected
- Change their own operator password, if they have one

To create an operator:

1. Press Prefs. The **Preferences** window appears.
2. Click the **Operator** tab and then click **Add**.
3. In the **Operator Properties** dialog box:

a. In the **Name** box, type a name for the operator. Typically this is the user's personal name.

> **Notes**: You cannot type the same name for two operators. Also, you cannot modify the name after you have added the operator, so make sure you type the correct name.

b. In the **Type** choice, select **Standard**.

c. If you want to give this operator password protection to prevent non-administrators from deleting their studies, select the **Password Protected** check box.

The **Password** boxes become active.

d. In the **Password** box, type the password, then tab to the **Retype Password** box and retype it.

e. Press **OK**.

4. Enter your password and click **OK**.

The system creates the new operator profile and lists it in the **Operator** list.

5. Click **OK**.

> **CAUTION**: If you do not create at least one **Administrator** operator as part of your operator group, any operator can add or delete other operators' studies.

Next step

- *Adding an administrator* (page 62)

Related information

- *How passwords and study locks work* (page 130)

Modifying an operator

An operator profile is the information that describes:

- The identity of an operator
- The operator's user type (standard or administrator)
- The operator's password, if they have one

Important conditions

- Only an administrator can modify the profile of another operator

- A standard operator can only change their own password.

To modify an operator profile:

1. Press Prefs and then click the **Operator** tab.
2. In the list of operators, select the operator you want to modify and click **Modify**.

   The **Operator Properties** dialog box appears.
3. Modify the properties and click **OK**.

   The system stores your modifications and returns you to the **Preferences** window.
4. Click **OK**.

Deleting an operator

When you delete an operator, the system only deletes the operator profile. The system does not affect the operator's studies in any way.

Important conditions

Only an administrator can delete another operator or their own administrator profile.

To delete an operator:

1. Press Prefs and then click the **Operator** tab.
2. In the list of operators, select the operator you want to delete, press DEL and confirm the deletion.

   The system deletes the operator profile and returns you to the **Preferences** window.
3. Click **OK**.

Working with operator passwords

Operator passwords prevent non-administrators from deleting studies that were created and locked by another operator. If you have a password and you select the lock check box for your studies, only you or an administrator can delete them.

CAUTION: If you do not create at least one **Administrator** operator as part of your operator group, any operator can add or delete other operators' studies.

Important conditions

- You can modify your own password
- Only an administrator can modify the password of another operator

To add a password to an operator:

1. Press Prefs and then click the **Operator** tab.
2. Select the name of the operator and then click **Modify**.
3. In the **Operator Properties** window:
   a. Select the **Password Protected** check box.

      The **Password** boxes become active.

   b. In the **Password** box type the password, then tab to the **Retype Password** box and retype it.

   c. Click **OK**.

   The system stores the password and returns you to the **Operator** list.

To change an operator password:

1. Select the name of the operator and then click **Modify**.
2. In the **Operator Properties** window:
   a. In the **Password** box select and delete the existing password, then type the new password.

   b. Tab to the **Retype Password** box and type the new password over the old one.

   c. Click **OK**.

   The system stores the new password and returns you to the **Operator** list.

To remove password access for an operator:

1. Select the name of the operator and then click **Modify**.
2. In the **Operator Properties** window:
   a. Clear the **Password Protected** check box.

   b. Click **OK**.

The system stores the password and returns you to the **Operator** list.

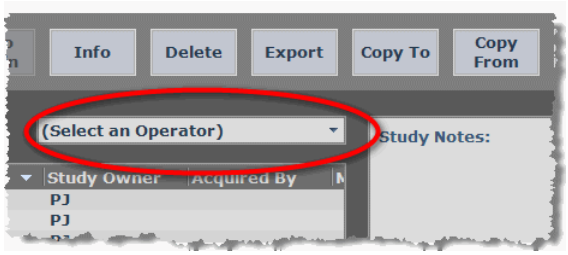
Related information

- *Locking a study* (page 131)
- *How passwords and study locks work* (page 130)

Changing the active operator

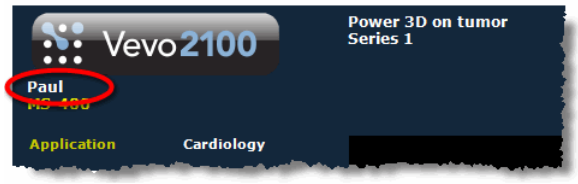
The active operator is the operator who is listed:

- In the operator box located above the list of studies in the **Study Browser**.



When you click **New** *to create a new study, the operator you select here is the default owner of the new study*

- In the upper-left corner of the **Imaging Mode** window.



Any work you do – such as creating a new study, or working on an existing or new series, or creating new images – is recorded by the system as being completed by this operator.

To change the active operator:

1. Press Study Management. The **Study Browser** appears.
2. In the operator box select the name you want to be active.
3. If your new operator name requires a password, in the **Password** box type the password.
4. Click **OK**.

   The system displays the new active operator name.

Sorting the list of operators

To sort the list of operators:

1. Press Prefs and then click the **Operator** tab.
2. Click the column heading of the column you want to sort the entries by.
   - For the **Name** column, the system sorts the entries in alphabetical order. Click the heading to switch the sort order from ascending to descending.
   - For the **Type** column, the system sorts the entries by type. Click the heading to switch the sort order from **Administrator** entries first to **Standard** operator entries first.

Section 4

Setting the operating preferences

The **Preferences** window provides a series of tabs you can use to customize the way you work with the Vevo 2100 Imaging System.

In This Section

Chapter 10

Setting the General tab preferences

Use the **General** preferences tab to customize a range of frequently used features.

In this chapter

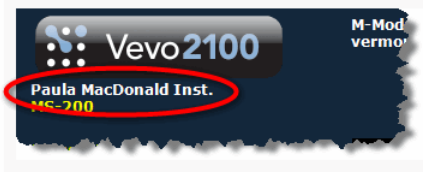
General preferences

Use the **General** preferences section to describe your facility.

To display the name of your institution in the Mode window:

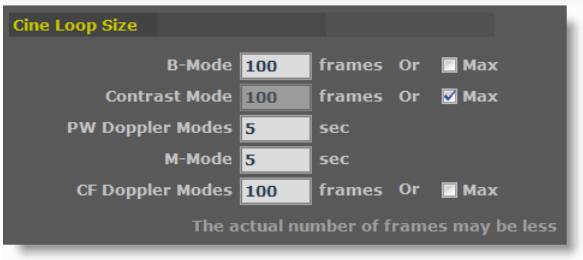
1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Institution** box, type the name of your institution.
3. Click **OK**.

   The system displays the name beneath the VisualSonics logo in the **Mode** window when you acquire or review image data.



Cine Loop Size preferences

Use the **Cine Loop Size** section to specify the amount of continuous image data you want the system to keep in memory when you acquire a cine loop.



Cine Loop Size section displaying the default cine loop size values for each Mode that supports cine loops

While you acquire data, the system's playback memory holds your most recent image data in a buffer. The size of the buffer is determined by the **Cine Loop Size** preference you specify.

Examples:

- If you set your B-Mode cine loop size to 100 frames and you scan in B-Mode for two minutes, when you press Cine Store or Scan/Freeze the system records only the last 100 frames of image data that you acquired.
- If you set your **M-Mode** cine loop size to 5 seconds and you scan in M-Mode for two minutes, when you press Cine Store or Scan/Freeze the system records only the last 5 seconds of image data that you acquired.

To set the number of frames or seconds for a cine loop:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Cine Loop Size** section, type a value in the appropriate box.
3. If you select **Max** for B-Mode, Contrast Mode or CF Doppler Modes, the system sets the cine loop to acquire the maximum number of image frames based on the current configuration of the system.
4. Click **OK**.

   The system saves your preferences.

Auto SAVE preferences

Use the **Auto SAVE** feature when you want to save a cine loop or an image frame without using the **Cine Store** or **Frame Store** controls.

To set the system to automatically save an image when you label an acquired image:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Auto SAVE** section, set your preference settings as described in the following table.

Preference	Description
Auto SAVE on Image Label	Activates the feature. Select the check box.
Image to Auto SAVE	Specifies what type of image the system saves after you label your image. In the list, select one of the following types: ▪ Entire Cine Loop ▪ Current Frame

3. Click **OK**.

To Auto SAVE an image when you are scanning:

1. During your image acquisition scan, press Scan/Freeze.
2. Press Image Label, type the label name and click **OK**.

   The system saves either an entire cine loop or a single frame based on what you set as your preference in the **Auto SAVE** section.
3. Press Scan/Freeze to continue scanning, or press Study Management to see the listing of the new image in the **Study Browser**.

Auto SAVE On Scan Completion preferences

Use the **Auto SAVE On Scan Completion** options when you want the system to instantly apply the Auto SAVE (page 72) feature when an operator presses Scan/Freeze or Pre Trigger to complete a scan.

To set the Auto SAVE On Scan Completion options:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.

2. In the **Auto SAVE On Scan Completion** section, select the check boxes for the applicable imaging modes.
3. Click **OK**.

Mode Screen Layout preferences

Use the **Mode Screen Layout** preference to change the relative size of the B-Mode scout window to the mode data window when you are in the following dual window modes: M-Mode, PW Doppler Mode and Tissue Doppler Mode.

To set the Mode Screen Layout preferences:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the Mode Screen Layout section, click the appropriate layout graphic.
3. Click **OK**.

Image Export preferences

Use the **Image Export** preference to include or not include the date and time stamp in the header area of any image you export.

To include the date and time stamp in the header area of your image export:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Image Export** section click the **Show Date/Time on Image Header** check box.
3. Click **OK**.

PW Doppler Scale preferences

Use the **PW Doppler Scale** preference section to select the scale type for the spectral display (either velocity or frequency) when you acquire or analyse PW Doppler image data.

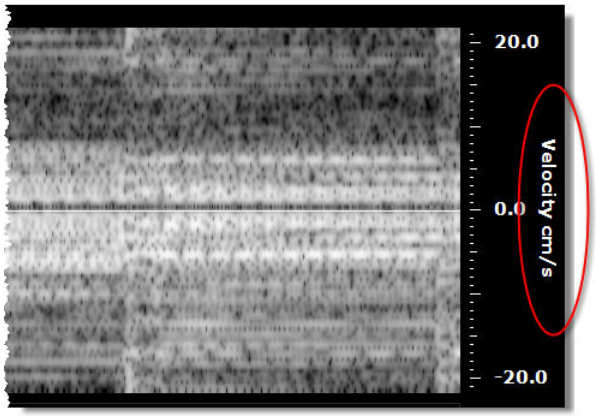
To set the PW Doppler scale:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **PW Doppler Scale** section, select the scale you want to work with:

- Select **Velocity** to set the scale to measure the data in mm/s
- Select **Frequency** to set the scale to measure the data in kHz

3. Click **OK**.

   The system applies the selected scale on the Y axis.



PW Doppler Y axis scale set to **Velocity**

Contrast Mode preferences

Use the Contrast Mode section to set the default parameters for a pre-triggered destruction burst event for an injected contrast agent.

To set the default burst event parameters:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Contrast Mode** section, configure the settings as described in the following table:

Preference	Description
Destruction	From the drop-down list select one of the following two options. ▪ **Internal.** The system applies the ultrasound burst through the array that you connect to the front panel of the Vevo 2100 Imaging System ▪ **External.** The system applies the burst through the *external* Vevo SoniGene transducer that you connect to the **Parallel** port on the rear panel of the Vevo 2100 Imaging System.
Seconds	From the drop-down list select the appropriate length of the destruction burst. ▪ For internal bursts, you can select 0.1, 0.25, 0.5, 1.0 seconds ▪ For external bursts, you can select 1, 2.5, 5, 10, 15 seconds

Preference	Description
Sequence Destroy Position	From the drop-down list select the moment in the pre-triggered cine loop when the system begins the destruction burst. The value is set as a percentage. For example, if your cine loop is set to 200 frames and you set the value to 25%, the system will run the destroy burst at frame 50.

3. Click **OK**.

Physiological Enable preferences

Use the **Physiological Enable** options to globally enable or disable the system's ability to save the Respiration, Blood Pressure and Temperature physiological signal inputs along with the ultrasound image.

How physiological data inputs work

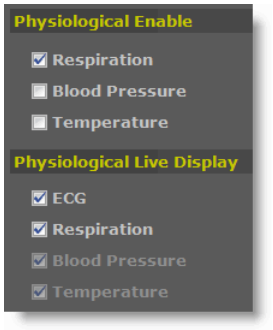
The system receives the physiological signal inputs from the Advanced Physiological Monitoring Unit through the **Physio Data** port on the rear panel of the cart.

Enabling or disabling an input determines whether or not you can work with it in other workspaces in the system.

When you select an input, you can control whether or not to control the display of the real-time physiological data in two places:

- The **Physiological Live Display** section of the General tab in the Preferences window.

  For example, as illustrated below, if you select the Respiration check box but clear the Blood Pressure and Temperature check boxes, you will only see the Respiration display control check box. (**Note:** The ECG signal input cannot be disabled, so you will always be able to control whether or not to display it.)



  In this example, you would only be able to show or hide the Respiration data in the physiological live display strip at the bottom right corner of the screen.

- The **Physiological Display** section in the Physio Options left panel display in a mode window.

For example, as illustrated below, if you select the Respiration check box but clear the Blood Pressure and Temperature check boxes, you will only see the Respiration display control check box. (**Note:** The ECG signal input cannot be disabled, so you will always be able to control whether or not to display it.)

To enable or disable a physiological data input:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Physiological Enable** section select or clear the appropriate check box.

Related information

- *Physiological Live Display preferences* (page 76)
- *Physiological Alarm Levels* (page 77)

Physiological Live Display preferences

While you scan your animal, the live data monitor panel at the bottom of the screen displays the real-time numeric data input values for the animal's live ECG, core body temperature, respiration rate and blood pressure (if an external blood pressure device is connected to the Advanced Physiological Monitoring Unit).

Use the **Physiological Live Display** preferences section to specify which data inputs you want to show or hide. If one or more of the input options is dimmed and unavailable, look in the **Physiological Enable** preferences section directly above it, and select the check box for that input to make the check box selectable.

To show or hide specific trace values in the live data monitor panel:

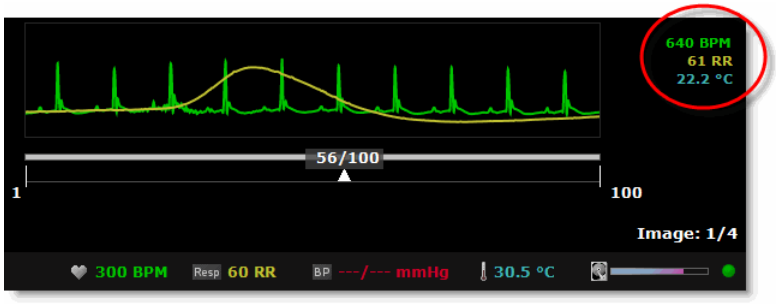
1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Physiological Live Display** section, select or clear the required check boxes as described in the following table.

Preference	Description
View ECG	Displays the green numeric beats-per-minute value
View Respiration	Displays the yellow numeric respiratory value

Preference	Description
View Blood Pressure	Displays the red numeric blood pressure value
View Temperature	Displays the blue numeric temperature value

3. Click **OK**.

   The live data monitor panel displays the real time vital signs of the animal based on the preferences you selected.



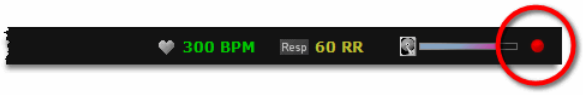
Live data monitor panel highlighting the real-time values for the selected traces

Related information

- *Physiological Enable preferences* (page 75)
- *Physiological Alarm Levels* (page 77)

Physiological Alarm Levels

Use the **Physiological Alarm Levels** preferences section to set the low and high physiological data limits beyond which the system displays the pulsing red alarm signal as shown in the following illustration.



You can specify the limits for ECG, respiration and temperature.

To set the physiological data threshold levels:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **General** tab.
2. In the **Physiological Alarm Levels** section:
   a. If you want to activate the alarm for one of the data inputs, select the appropriate check box.
   b. Type your desired limit values in the **Lower** and **Upper** boxes.
3. Click **OK**.

Related information

- *Physiological Enable preferences* (page 75)
- *Physiological Live Display preferences* (page 76)

Chapter 11

Setting the Operator tab preferences

The **Operator** tab is the workspace you use to create and manage the operator profiles for the people who use the Vevo 2100 Imaging System.

Administrating your operators (page 60) provides complete instructions on how to work with operator profiles.

Related information

- *Adding a standard operator* (page 63)
- *Adding an administrator* (page 62)
- *Modifying an operator's properties* (page 64)
- *Deleting an operator* (page 65)
- *Working with operator passwords* (page 65)
- *Changing the active operator* (page 67)
- *Sorting the list of operators* (page 68)

Chapter 12

Setting the Measurement tab preferences

A measurement package is a set of protocol measurements that are related to a specific application. This makes it easier and faster to apply measurements to an image.

The system includes five permanent measurement packages:

- Abdominal Package
- Cardiac Package
- Embryology Package
- Ophthalmology Package
- Vascular Package

Use the **Measurement** preferences tab to customize the way you work with the measurements you create when you analyze acquired image data.

In this chapter

Measurement Package preferences

Use the **Measurement Package** section to manage your group of measurement packages.

Creating custom measurement packages

A custom measurement package is a copy of an existing measurement package that you customize to include the protocols that you want to work with.

> **Note:** The system does not alter or delete custom measurement packages when you update the system software.

To create a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.

2. In the **Measurement Package** section select a measurement package that closely relates to the type of analysis you routinely perform for the respective imaging.
3. Click **Save As**, type a name for your new package in the **New Measurement Package** box and then click **OK**.
4. Beside the **Measurement Package** section:
   - Select the **Enable Package** check box so that the measurement package will appear in the list of available packages when you are selecting measurements in the left panel
   - Clear the check box to hide the measurement package
5. In the middle panel:
   a. Select or clear the check boxes to set the protocols you want the system to display in the measurement panel (page 164).
   b. Expand individual protocols and then select or clear the check boxes to set the measurements you want the system to display in the measurement panel.
6. In the **Measurement Parameters** list expand the generic measurement types and select or clear the parameters that you want the system to display as part of each measurement label.
7. Click **Save**.

Modifying and deleting custom measurement packages

You can modify or delete custom measurement packages. You cannot modify or delete the default system-defined measurement packages.

To modify a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.
2. In the **Measurement Package** drop-down list select the package you want to modify.
3. In the middle panel:
   a. Select or clear the check boxes to set the protocols you want the system to display in the measurement panel (page 164).
   b. Expand individual protocols and then select or clear the check boxes to set the measurements you want the system to display in the measurement panel.
4. In the **Measurement Parameters** list expand the generic measurement types and select or clear the parameters that you want the system to display as part of each measurement label.

5. Click **Save**.

To delete a custom measurement package:

1. In the **Measurement Package** drop-down list select the package you want to delete.
2. Click **Delete** and then click **OK**.

Exporting and importing custom measurement packages

You can export or import *custom* measurement packages. However, you cannot export or import the *default* measurement packages that are included with the system.

To export a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.
2. In the **Measurement Package** section, in the drop-down list select the custom measurement package you want to export and then click **Export**.
3. In the **Export Package File** window, browse to the directory in the external storage location where you want to export the package and then click **OK**.

To import a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.
2. In the **Measurement Package** section click **Import**.
3. In the **Import Package File** window:
   a. Browse to the directory in the external storage location where the package you want to import is located.
   b. Expand the directory, select the custom measurement package and then click **OK**.
4. Beside the **Measurement Package** section:
   - Select the **Enable Package** check box so that the measurement package will appear in the list of available packages when you are selecting measurements in the left panel
5. Clear the check box to hide the measurement package

Activating measurement packages

To activate a measurement package when you create a new study or series:

1. Press New and then click **New Study** or **New Series**.
2. Complete the required fields including the **Measurement Package** field and then click **OK**.

To activate a measurement package from a mode window:

1. Open an existing image from the Study Browser or start imaging.
2. Press Measure to view the measurement tools.
3. In the **Measurement Package** drop-down list select the package you want to activate.

To activate a measurement package from the Preferences window:

1. Press Prefs and then click the **Measurement** tab.
2. In the **Measurement Package** drop-down list, select the package you want to activate.
3. Ensure that the **Enable Package** check box is selected.
4. Click **Activate** and then click **OK**.

When you analyze an image, the measurement package you selected is active when you begin to add measurements.

Showing/hiding measurement packages in a mode window

To show or hide a measurement package when you are working in a mode window:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.
2. Beside the **Measurement Package** section:
   - Select the **Enable Package** check box so that the measurement package will appear in the list of available packages when you are selecting measurements in the left panel
   - Clear the check box to hide the measurement package

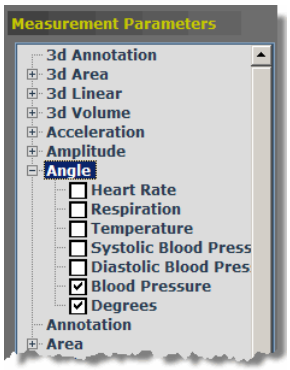
Measurement Parameters preferences

Use the **Measurement Parameters** section to select the measurement parameters that you want the system to display when you add a measurement to an image for a specific measurement package.

You can customize the measurements and measurement parameters for *custom* measurement packages. You cannot customize the measurements and measurement parameters for the *default* measurement packages that are included with the system.

To select the measurement parameters to display:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Measurement** tab.
2. Expand the appropriate measurement and then select the parameter check boxes that you want the system to display.



In this example, for the **Angle** *measurement, the operator selects the following parameters:*

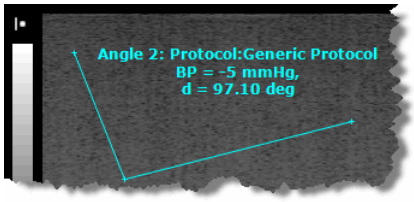
- *Blood Pressure*
- *Degrees*

3. Set the parameters for any other measurements you want to customize.
4. Click **OK**.

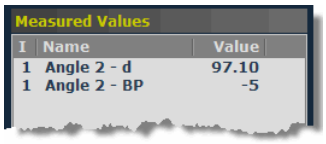
   The system saves your measurement parameters preferences.

When you add a measurement

- In the **Mode** window, on the ultrasound image the system displays only the measurement parameters you selected in the **Measurement Parameters** section



- In the **Mode** window, on the **Measured Values** section in the measurements panel the system lists only the selected measurement parameters



Related information

- *Modifying the properties of a measurement* (page 170)

Measurement Display preferences

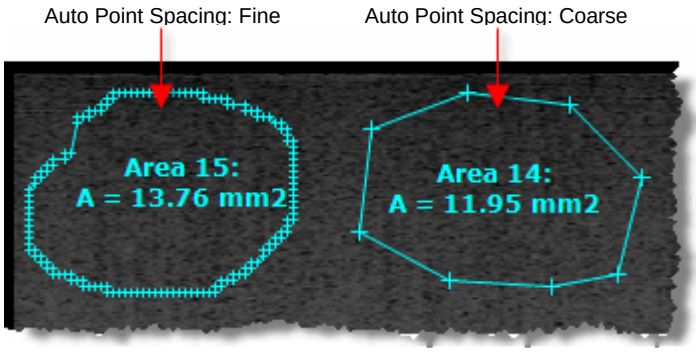
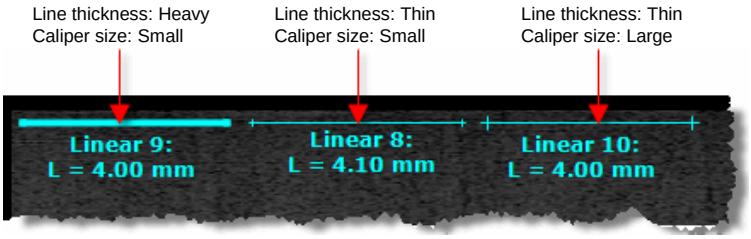
Use the **Measurement Display** preference section to customize how you want your measurements to appear on the images you create for a specific measurement package.

You can customize the measurement display style for *custom* measurement packages. You cannot customize the measurement display style for the *default* measurement packages that are included with the system.

To customize the measurement display settings:

1. Press Prefs and then click the **Measurement** tab.
2. In the **Measurement Package** section, in the drop-down list select the custom measurement package you want to customize.
3. In the **Measurement Display** section configure the measurement display style options as described in the following table.

Preference	Description
Show Measurements	**When you select the check box..** The system makes the list of measurement protocols available so you can add measurements to your image. **When you clear the check box...** The system: ▪ Hides any measurements that have already been made in the image but not in the list of measured values. ▪ Dims the list of measurements so you can see the list items but you cannot work with them. **IMPORTANT**: You must select this check box to add measurements to your image data.

Preference	Description
Show Values and Labels on Image	**When you select the check box...** When you apply a protocol measurement in the image area, the system displays the name of the protocol measurement and all the the parameter values that you specified in the **Measurement Parameters** preferences section. **When you clear the check box...** The system: ▪ Displays only the measurement index number in the image area ▪ Displays measurement labels and values in the **Measured Values** list
Show Embryo Index	Displays the index of the embryo specified by **horn: number** field
Show Protocol Name	When you apply a protocol measurement in the image area, the system adds the name of the protocol to the name of the measurement.
Numeric Precision	Sets the number of digits to display after the decimal for non-integer measurement values.
Auto Point Spacing	Sets how densely you want the system to add caliper points when you add a measurement using the Traced Distance ROI or the Polygon ROI trace tool. Drag the slider to set the caliper density. 
Caliper Size Line Thickness	These two drop-down lists control the appearance of the lines that appear when you add a measurement. 
Font Font Size	These two drop-down lists control the style of text that appears on your image when you add a measurement or an annotation.

4. In the **Measurement Package** section click **Save**.

   The system applies your new settings to the next measurements you add. The settings do not alter the appearance of any existing measurements.

To modify the properties of an existing measurement, right-click the measurement, select **Properties**, then complete your changes in the **Measurement Properties** box.

Related information

- *Modifying the properties of a measurement* (page 170)

Chapter 13

Setting the Annotation tab preferences

An annotation is a text label that you add directly to an acquired image. Use the **Annotations** preferences tab to customize the content and style of the available annotations for a specific application package.

In this chapter

Measurement Package preferences

Use the **Measurement Package** section to manage your group of measurement packages. This section is similar in both the **Annotation** tab and the **Measurement** tab.

For detailed information on how to use the tools in this section see Measurement Package preferences (page 80).

Annotation Display preferences

Use the **Annotation Display** preferences section to customize how you want your annotations to appear on the images you create for a specific measurement package.

You can customize the annotation style for custom measurement packages. However, you cannot customize the annotation style for the default measurement packages that are included with the system.

To set the annotation style for a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Annotation** tab.
2. In the **Measurement Package** section, in the drop-down list select the custom measurement package you want to customize.
3. In the **Annotation Display** section configure the style preferences as described in the following table.

Preference	Description
Show Annotations	**When you select the check box...** You can press Update and select or create an annotation. **When you clear the check box...** The system: ▪ Hides any annotations that have already been made ▪ Cannot make any annotations **IMPORTANT**: You must select this check box to add annotations to your image data.
Line Style	Select the line style that you want the system to use for the line that you can extend from the annotation.

4. In the **Measurement Package** section click **Save**.

Annotations preferences

Use the **Annotations** preferences section to customize the list of available annotations you can use when you are annotating an image for a specific measurement package.

You can customize the list of annotations for custom measurement packages. You cannot customize the list of annotations for the default measurement packages that are included with the system.

To customize the list of available annotations for a custom measurement package:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Annotation** tab.
2. In the **Measurement Package** section, in the drop-down list select the custom measurement package you want to customize.
3. In the **Annotations** section:
   a. Select a top level list item or expand the top level item and select a second level item.
   b. On the right side of the Annotations list, click the commands described in the following table to manage the revisions to your list.

Command	Description
Add Image Group	Adds an item at the bottom of the top-level list. Type the custom name for the image group and press ENTER.
Add Physiological Group	Adds an item at the bottom of the top-level list. Type the custom name for the image group and press ENTER.

Command	Description
Add Annotation	Adds an item at the bottom of the second-level list under the selected top level item. **Note**: You cannot create a third level list by adding a sub item to a selected sub item.
Edit label	Selects the text of the selected item in the list. To rename the item, type the new name and press ENTER.
Delete	Deletes the selected item. **CAUTION**: When you delete a top-level item the system also deletes all the sub-items.
Move Up	Moves the selected item above the previous item in the list.
Move Down	Moves the selected item below the next item at the same level in the list.

4. In the **Measurement Package** section click **Save**.

Chapter 14

Setting the Presets tab preferences

Use the **Presets** preferences tab to change a default transducer application or to change a default Mode preset.

In this chapter

Transducer preferences

A transducer application contains the imaging Mode presets you use to instantly optimize your image during an acquisition session.

Use the **Transducer** preferences section to select the transducer you are going to use to acquire image data. This section lists all the transducers that the Vevo 2100 Imaging System supports.

To specify the default application for a transducer:

1. From the **Study Browser** (page 49) click **Prefs** and click the **Presets** tab.
2. In the **Transducer** section, in the drop-down list select the appropriate transducer as described in the following table.

Transducer	Collar color	Description
MS-200	Orange	Rabbit, general and abdominal imaging
MS-250	Yellow	Rat cardiology and abdominal imaging
MS-400	Red	Optimized for mouse cardiovascular imaging with frame rates greater than 300 frames per second
MS-550D	Blue	Mouse cancer and abdominal imaging
MS-550S	Gray	Optimized for mouse embryology imaging and injection

3. In the **Applications** list click the button beside the name of the application you want to be the default.

> **TIP**: Be sure to click the round button, not the row listing. If you click the row listing, you only display the Mode preset parameters for that application, you do not actually activate the application. You must click the button beside the row to activate it as the default.

4. Click **OK**.

   This application remains active until you either disconnect the transducer or return to the Presets tab and activate a different application.

▶ To activate the default transducer application:

- Create a new study (page 127)
- Create a new series (page 132)
- Connect a new transducer (page 106)

Applications preferences

A transducer application contains the imaging Mode presets you use to instantly optimize your image during an acquisition session.

Use the **Applications** preferences section to create and manage these applications.

Creating a custom application

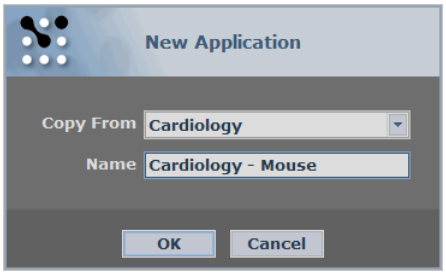
Each transducer includes factory default applications that contain the imaging Mode presets you use to instantly optimize your image during an acquisition session.

You cannot modify these factory default applications. However, you can create custom applications based on existing applications.

▶ To create a custom transducer application:

1. From the **Study Browser** (page 49) click **Prefs** and click the **Presets** tab.
2. In the **Applications** section below the list click **New**.
3. In the **New Application** box:

a. In the **Copy From** drop-down, select an existing application that contains the Mode presets that are similar to what you want to create.



b. In the **Name** box type the name of the custom application.

c. Click **OK**.

The new application appears in the Applications list in the **Presets** tab.

To activate the custom transducer application:

- Create a new study (page 127)
- Create a new series (page 132)
- Connect a new transducer (page 106)

Exporting a transducer application

To export a transducer application:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Presets** tab.
2. Select the transducer from the **Transducer** list.
3. In the **Applications** list click the button beside the name of the application you want to export.

> **TIP**: Be sure to click the round button, not the row listing. When you click the row listing, you display the Mode presets for that application, you do not select the application for export.

4. Click **Export**.

   The **Presets Export** window appears.
5. In the folder browser, browse to the location where you want to export your cine loops and select the folder.
6. If you need to create a new folder to contain the cine loops you are exporting:

   a. Click **New Folder**.

   b. Type the name of the new folder and click **OK**.

The system adds a new folder inside the selected folder in the folder browser window.

c. Select the new folder.

7. Click **OK**.

The system exports the application as an AXML file along with a folder that contains the PXML files for all the Mode settings presets that are associated with the application.

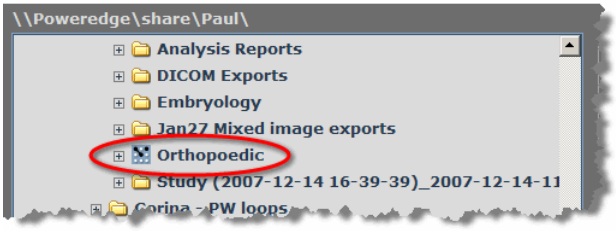
Importing a transducer application

To import a transducer application:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Presets** tab.
2. In the **Transducer** section select the transducer from the **Transducer** list.
3. Click **Import**.

   The **Presets Import** window appears.
4. In the folder browser:

   a. Browse to the folder that contains the application. Application files appear with the VisualSonics symbol.



   b. Select the application and click **OK**.

The system returns to the **Presets** tab. The application you imported appears in the Applications window in alphabetical order.

Deleting a transducer application

To delete a transducer application:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Presets** tab.
2. Select the transducer from the **Transducer** list.

3. In the **Applications** list click the name of the application you want to delete.
4. Click **Delete** and click **Yes** at the confirmation prompt.

Mode Settings Presets preferences

A mode preset is the group of control panel control levels that are optimized for a specific imaging task.

Use the **Mode Presets Settings** preferences section to:

- View the parameters for a mode preset
- Set the default preset for an imaging mode

Related information

- *Selecting a preset during image acquisition* (page 107)
- *Creating a custom Mode settings preset* (page 107)
- *Modifying a custom Mode settings preset* (page 108)

Selecting the default preset for a mode

A default preset for a mode is the set of saved acquisition parameters that is instantly applied to image data when an operator begins scanning in that mode.

To specify the default preset for a mode:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Presets** tab.
2. In the **Transducer** section select the transducer from the drop-down list.
3. In the **Applications** section select the appropriate application.
4. In the **Select a Mode** section select the mode for which you want to set the default preset.

   The system populates the Mode Presets list below it with the presets for that mode.
5. In the **Mode Presets** section, click the button beside the name of the preset you want to be the default.

   TIP: Be sure to click the round button, not the row listing.
6. Click **OK**.

To activate the default preset:

- Create a new study (page 127)

- Create a new series (page 132)
- Connect a new transducer

Related information

- *Selecting a preset during image acquisition* (page 107)
- *Creating a custom Mode settings preset* (page 107)
- *Modifying a custom Mode settings preset* (page 108)

Deleting a mode settings preset

You can delete any preset in any custom application, but you cannot delete a default preset.

To delete a mode settings preset:

1. From the **Study Browser** (page 49) click **Prefs** and click the **Presets** tab.
2. Select the transducer from the **Transducer** list.
3. In the **Applications** list click the application that includes the mode with the preset you want to delete.
4. In the **Select A Mode** list, select the mode that contains the preset you want to delete.
5. In the **Mode Settings Presets** list click the name of the preset you want to delete.
6. Click **Delete** and click **Yes** at the confirmation prompt.

Preset Settings section

The **Preset Settings** section displays the parameters of the preset you select in the **Mode Presets** subsection.

Chapter 15

Setting the Maintenance tab preferences

Use the **Maintenance** preferences tab to manage system level features.

In this chapter

Monitor preferences

Use the **Monitor** preferences section to calibrate the settings on the system's wide-screen display so the display will be optimized for the location in your facility.

The objective of the calibration is to ensure that each of the two boxes (the dark box on the left and the light box on the right) display the smaller box inside the larger outline. The section steps you through the procedure to calibrate your monitor properly.

Systems Log preferences

The Vevo 2100 Imaging System creates an error log file when a significant error occurs. The system log file appears as a line item in the **Systems Log** section.

Use this preferences section to export the system log data to VisualSonics for troubleshooting analysis.

To export a system log file:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Maintenance** tab.
2. In the **System Log** section select the error log you want to export and then click **Export**.
3. In the **Export System Log** window, browse to the directory in the external storage location where you want to export the error log and then click **OK**.

Upgrade preferences

When VisualSonics issues a software upgrade, the Company sends you a CD-ROM disk that includes the software upgrade files.

Use the **Upgrade** section to launch the procedure to install the upgrade on your Vevo 2100 Imaging System or Vevo 2100 Workstation.

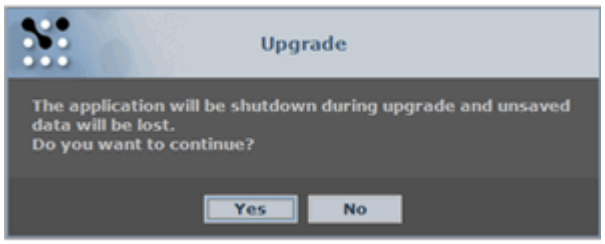
To install a software upgrade:

1. Insert the Vevo® 2100 System Upgrade Version CD-ROM disk into the DVD drive on the left side of the system.
2. From the **Study Browser** (page 49) click **Prefs** and then click the **Maintenance** tab.
3. In the **Upgrade** section click **Upgrade**.

   The **Upgrade** window appears.

4. In the file browsing panel on the left, click (in this example) the **PN 12038 (E:\)** in the DVD drive. In the **Available Upgrades** section the system lists the available upgrades.
5. Select the upgrade from the description table and click **Upgrade**.

The **Upgrade** prompt appears.



6. In the Upgrade box:
   - If you are not sure that you have saved your work, click **No** to cancel the install, save your work and then run the installation process again.
   - If you know that all your work is saved, click **Yes** to continue the install.

7. The system installs the upgrade and then restarts.

Section 5

Acquiring image data

This section walks you through all the steps you need to take so you can start an image acquisition session.

WARNING: The Vevo 2100 is not to be used on any living human being.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In This Section

Chapter 16

Setting up your Vevo 2100 Imaging System

This chapter walks you through the steps for setting up your Vevo 2100 Imaging System and your subject for an image acquisition session.

In this chapter

Working with transducers

This chapter shows you how to set up and work with the array transducer that acquires the micro-ultrasound images.

Selecting the appropriate transducer for your study

VisualSonics offers a range of transducers with frequencies ranging from 12.5MHz to 45MHz to serve a broad range of applications as described in the following table.

Transducer	Collar color	Description
MS-200	Orange	Rabbit, general and abdominal imaging
MS-250	Yellow	Rat cardiology and abdominal imaging
MS-400	Red	Optimized for mouse cardiovascular imaging with frame rates greater than 300 frames per second
MS-550D	Blue	Mouse cancer and abdominal imaging
MS-550S	Gray	Optimized for mouse embryology imaging and injection

Next step

- *Connecting and disconnecting the transducer* (page 106)

Related information

- *Array transducer* (page 19)

Storing the transducer

You can store the transducer in the transducer and gel holder attached to the side of the Vevo 2100 Imaging System, nose upward and with the cable directed toward the front of the cart.

Use the spring-loaded cable holder to ensure that the cable does not get twisted.

When you move the transducer from one facility to another, always use the dedicated case that is provided with the cart.

Follow these guidelines when you store the transducer in its case:

- Make sure that the transducer is clean and dry before you store it in the case.
- Place the transducer in the case carefully so the cable doesn't kink.
- Don't store the transducer in areas of extreme temperatures or in direct sunlight.
- Store the transducer separately from other instruments so it won't get damaged accidentally.

Related information

- *Front view of the Vevo 2100 Imaging System* (page 17)

Working with the 3D motor stage (optional)

VisualSonics provides a 3D motor stage for customers who need to perform 3D volumetric measurements. The 3D motor stage connects to the Vevo Imaging Station.

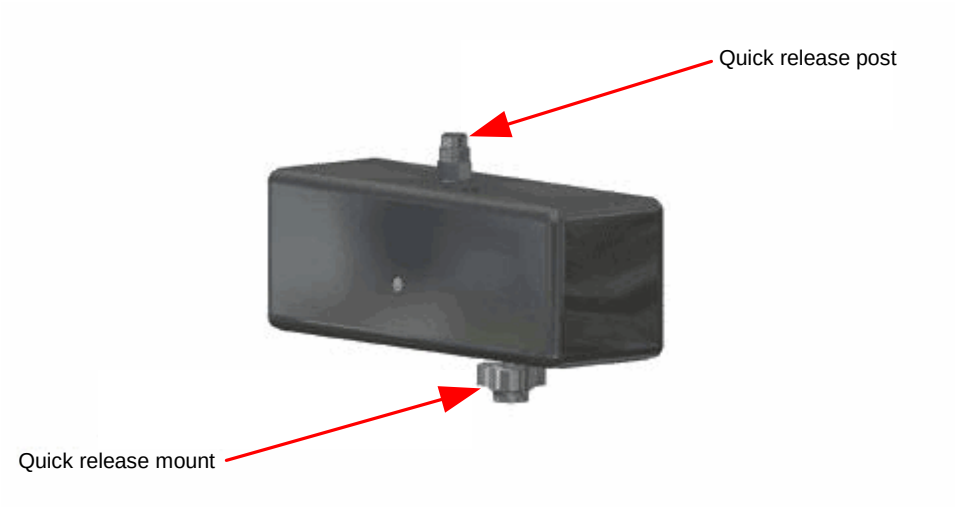
IMPORTANT: During 3D data acquisition, ensure that the animal under the transducer is flat in relation to the 3D scan direction to prevent unintended contact with the animal when the transducer moves.

Connecting the 3D motor stage to the Vevo Imaging Station

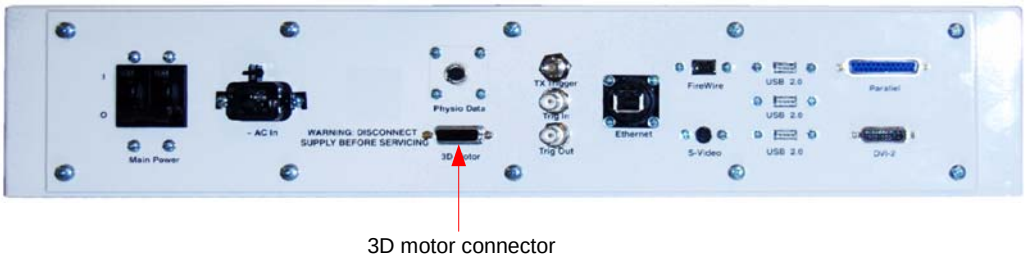
The 3D motor stage features a Quick Release post on the top to connect to the Vevo Imaging Station, and a Quick Release mount on the bottom to affix the transducer clamp.

To connect the 3D motor stage to the Vevo Imaging Station:

1. Insert the quick release post into the quick release mount located on the Imaging Station arm.



2. Carefully line up the holes on the post with the pins on the quick release mount.
3. Finger tighten the knob on the quick release mount.
4. Connect the 3D motor cable to the **3D Motor** connector on the rear panel of the Vevo 2100 Imaging System.

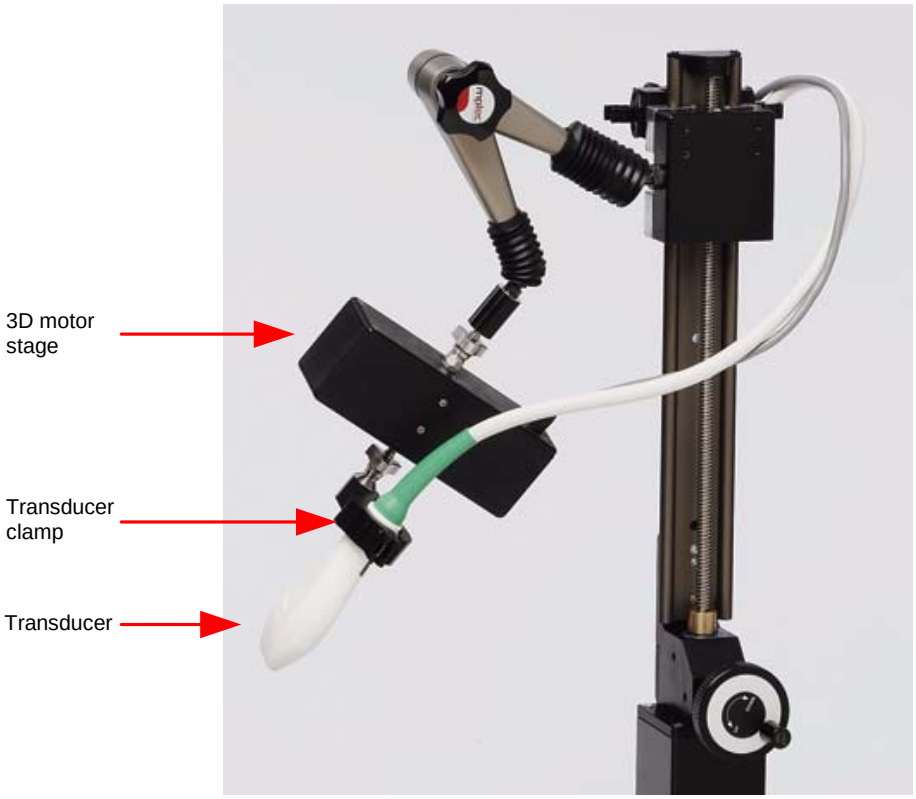


Connecting the transducer to the 3D motor stage

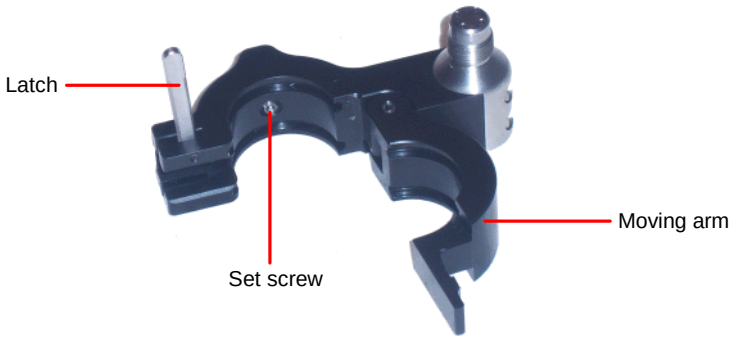
When you use the Vevo Imaging Station, you must secure the transducer within the transducer clamp.

To connect the transducer to the 3D motor stage:

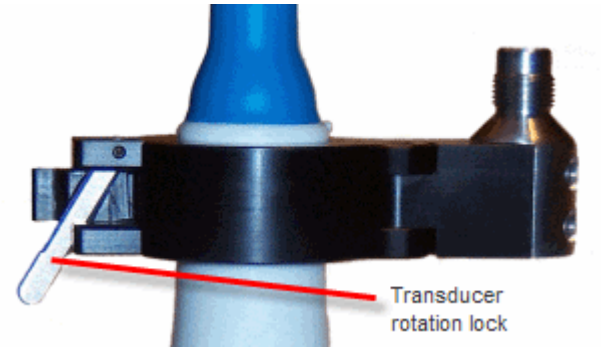
1. Insert the Quick Release post on the transducer clamp into the Quick Release mount on the 3D motor stage unit so that the pins on the mount fit into the holes on the Quick Release post.
2. Tighten the Quick Release mount until it is finger tight.



3. Lift the latch to open the clamp and then place the collar of the transducer in the clamp.

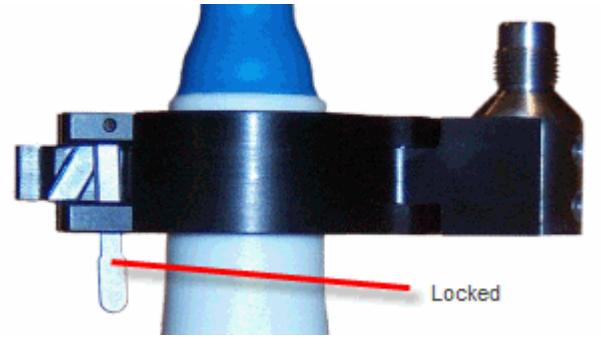


4. Close the moving arm of the clamp and then pull the latch down to the 45° notch. This transducer rotation lock setting holds the transducer but provides enough freedom for your to rotate it.



5. To set the transducer to any of the at the desired 90-degree angle in the clamp turn the transducer until you feel the collar snap into position.

6. Close the clamp and push the latch down until it locks into place as shown in the following illustration.

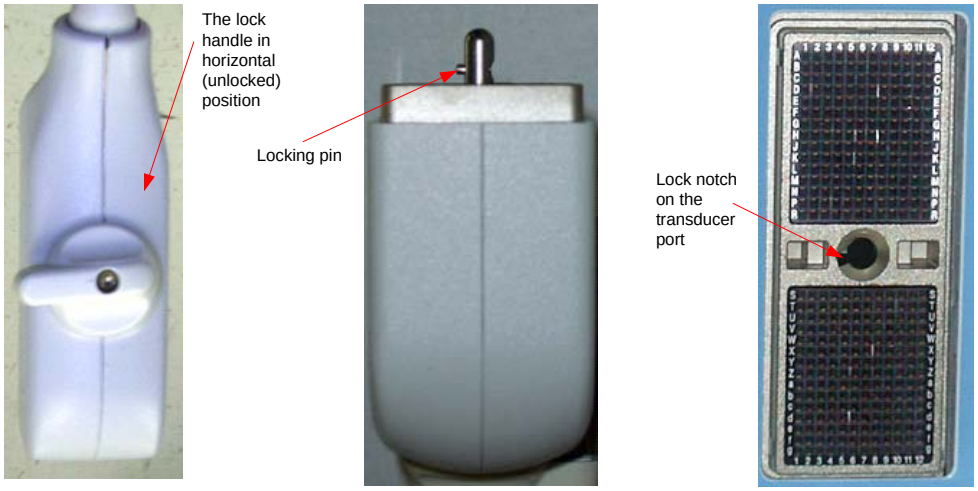


Connecting the transducer to the Vevo 2100 Imaging System

WARNING: Before connecting or disconnecting any transducer the Vevo 2100 Imaging System must be switched off or the transducer cable disconnected from the rear panel to avoid physical contact with hazardous acoustic transmissions.

To connect the transducer connector to the transducer port:

1. Turn the lock handle to the horizontal (unlocked) position.
2. Line up the locking pin on the transducer connector with the lock notch on the transducer port.
3. Push in the connector and then turn the lock handle to the vertical (locked) position.



To disconnect the transducer:

Turn the lock handle to the horizontal (unlocked) position and pull the connector out.

Related information

- *Array transducer* (page 19)

Chapter 17

Setting up Mode settings presets

If you often use a particular imaging Mode in a similar way, you can optimize your acquisition settings on the control panel and then save them as a single preset.

This chapter shows you how to use and manage these presets.

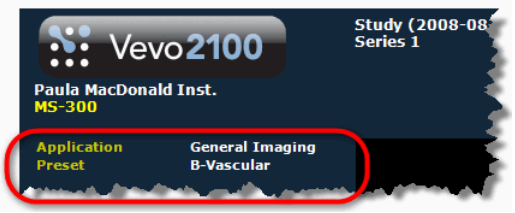
In this chapter

Selecting a preset during image acquisition

To select a Mode settings preset:

1. Begin acquiring data.
2. While the system is acquiring data push the Presets control up or down to scroll through the list of stored presets for the Mode you are imaging in.

   The preset name appears in the left panel (press Mode Settings to set the left panel to display the mode settings).



   The system applies the preset to your image data.

Creating a custom Mode settings preset

Every transducer application includes factory presets for each imaging Mode. You can create custom presets that store your own settings.

IMPORTANT REMINDER: When you create a custom preset, it only applies to that specific mode in that specific application for that specific transducer.

To create a custom Mode settings preset:

1. Begin acquiring image data in the imaging mode for which you want to create a preset.
2. Use the control panel controls to optimize your image.
3. Press Save Preset.
4. In the **Save Preset Settings** box type the name of your preset and click **OK**.

   The new preset appears in the Mode-specific list box below the **Mode Settings Presets** list box in the **Preferences** window **Presets** tab for that specific application and that specific transducer.

Related information

- *Acquiring data in an image mode* (page 120)

Modifying a custom Mode settings preset

To modify a custom Mode settings preset:

1. Begin acquiring image data in the imaging mode for which you want to create a preset.
2. Use the control panel controls to optimize your image.
3. Press Save Preset.
4. In the **Save Preset Settings** box:
   a. In the drop-down list select the preset you want to update.
   b. Click **OK**.

The system updates the preset with the new settings.

Chapter 18

Setting up to acquire physiological data

The Advanced Physiological Monitoring Unit tracks your animal's heart rate, temperature, respiration rate and blood pressure (optional with a third-party blood pressure device).

NOTE: The system is only compatible with the THM-150 Advanced Physiological Monitoring Unit. The THM-100 is not supported.

This chapter walks you through the steps for setting up the unit so you can acquire accurate, reliable physiological data.

In this chapter

Physiological data sources

The Vevo 2100 Imaging System can monitor, display and record the physiological data from a subject when the subject is connected to the Advanced Physiological Monitoring Unit. The data source connections for this data are described in the following table.

Physiology	Description
ECG	The animal's ECG signal is captured through the electrode pads on the Advanced Physiological Monitoring Unit. The pads transmit the animal's ECG to a controller box. Connect the ECG cable to the controller box, and connect the keyed end of the cable to the rear panel of the Vevo 2100 Imaging System.
Respiration	The animal's respiration rate is monitored through the electrode pads on the Advanced Physiological Monitoring Unit and is derived from the ECG signal.
Blood pressure	The animal's blood pressure can be monitored by a third-party blood pressure monitoring system. The signal is sent through the Advanced Physiological Monitoring Unit to the Vevo system and the blood pressure trace viewed on screen within the software.
Body temperature	The animal's temperature is monitored through the rectal probe connected to the Advanced Physiological Monitoring Unit.

Related information

- For detailed information on preparing your animal and the animal platform, refer to your *Vevo Imaging Station Operator Manual*.
- *Setting the General tab preferences* (page 70)
- *Connecting the blood pressure equipment* (page 110)
- *Configuring the physiology data display settings* (page 110)

Connecting the blood pressure equipment

The Vevo Imaging Station provides a BNC connector as part of its Advanced Physiological Monitoring Unit as shown in the following illustration.

Configuring the physiology data display settings

When you are acquiring image data, click Physio Settings to display the options for controlling the individual physiology data inputs that appear in the physiology window. This section describes how to configure these options.

Physiological Display section

Use the **Physiological Display** section in the left panel to activate or deactivate the display controls for the individual physiological data inputs.

The selections you make in this section apply both when you are acquiring image data and when you are reviewing it.

To activate or deactivate the display controls for the individual physiological inputs:

1. Open an image mode window by beginning to acquire data in any imaging mode or opening any image from the Study Browser.
2. Press Physio Settings.

   The left panel displays the physiological display setting sections.
3. In the **Physiological Display** section select or clear the required check boxes as described in the following table.

Preference	Check box selected	**Check box cleared**
View Physiology	Activates all the individual data input display controls in the section. You can only access this check box when you have frozen your scan or paused a cine loop review.	Dims all the available physiological controls in the left panel so you cannot access them.
ECG	Displays the green ECG trace line (and numerical data values when you stop imaging) in the physiological trace window. During imaging, activates the ECG waveform slider control in the Physiological Range section in the left panel. Displays the ECG Trigger section in the left panel.	Hides the ECG trace line and data. Dims the ECG waveform slider control. Hides the ECG Triggering section.
Respiration	Displays the yellow respiration trace line (and numerical data values when you stop imaging) in the physiological trace window. During imaging, activates the Respiration waveform slider control.	Hides the trace line and data. Dims the waveform slider control.
Invert	Flips the display of the Respiration trace line vertically.	Flips back the display of the Respiration trace line vertically.
BP	Displays the red BP trace line (and numerical data values when you stop imaging) in the physiological trace window. During imaging, activates the BP waveform slider control.	Hides the trace line and data. Dims the waveform slider control.

Preference	Check box selected	Check box cleared
BP Derivative	Displays the purple blood pressure derivative trace line. This data displays the velocity of change in the BP value. During imaging, activates the blood pressure derivative waveform slider control.	Hides the trace line and data. Dims the waveform slider control.
Temp	Displays the Temp trace line (and numerical data values when you stop imaging) in the physiological trace window.	Hides the trace line and data.

4. Click **OK**.

The system applies your settings the next time you begin acquiring image data.

Troubleshoot

If one of the data input options does not appear in the section, it has been disabled in the Physiological Enable preferences section in the General tab of the Preferences window.

Related information

- *Physiological Enable preferences* (page 75)

Physiological Range section

If you are acquiring physiological data, the system can display the data values in the physiological data window located below the mode data window.

Use the **Physiological Range** section to optimize the display scale for an individual trace so you can make the most use of the height of the physiological display window.

IMPORTANT: You can only optimize the scale for each trace while you are acquiring data. You cannot optimize the scales when you review an image.

Troubleshooting before you begin

- If an **ECG**, **Respiration** or **BP** slider control is visible but dimmed and you cannot access it, select the check box for that data stream in the **Physiological Display** section at the top of the left panel.
- If an **ECG**, **Respiration** or **BP** slider control does not appear in this section, enable the check box for the data input in the **Physiological Enable** preferences section of the General tab in the Preferences window.

To increase or decrease the amplitude of the waveform:

1. Begin acquiring data in an imaging mode.
2. Press Physio Settings.

   The left panel displays the physiological display setting sections.
3. In the **Physiological Range** section:
   - To make the waveform for the selected trace smaller, increase the range value in the slider.
   - To make the waveform for the selected trace larger, decrease the range value.

Related information

- *Graphical Display preferences* (page 111)
- *Physiological Enable preferences* (page 75)

Blood Pressure section

As a best practice, calibrate the Vevo 2100 Imaging System software for your blood pressure monitoring device before you begin acquiring blood pressure data.

However, you can run the calibration procedure at any time even when you are reviewing image data, as long as the blood pressure monitoring device is connected to the system. This only affects the physiological live display values, not the blood pressure values that are already acquired.

The following manual and import calibration procedures assume that your blood pressure monitoring system includes a built-in calibration function.

Blood Pressure Calibration options

Use the **Blood Pressure** section to set your preferences for calibrating your pressure scale as described in the following table.

Preference	Description
Manual Calibration	Select this option if the Vevo 2100 Imaging System does not support your blood pressure instrument.
Import Calibration	Select this option if the Vevo 2100 Imaging System does support your blood pressure instrument.

Related information

- Manually calibrating any blood pressure instrument (page 114)
- Auto-calibrating your Vevo-supported blood pressure instrument (page 114)

Auto-calibrating your Vevo-supported blood pressure instrument

The Vevo 2100 Imaging System includes pre-configured calibration settings for the Millar PCU-2000 Pressure Control

To calibrate a Vevo-supported blood pressure instrument:

1. Connect the pressure instrument to the Advanced Physiological Monitoring Unit and ensure that the Advanced Physiological Monitoring Unit is connected to the Vevo 2100 Imaging System at the Physio Data connector on the rear panel of the system. Ensure that all three systems are powered on.
2. Open an image mode window by beginning to acquire data in any imaging mode or opening any image from the Study Browser.
3. Press Physio Settings.

   The left panel displays the physiological display setting sections.
4. In the **Blood Pressure** section:
   a. In the upper drop-down list select **Import Calibration**.
   b. In the lower drop-down list select the preconfiguration for your pressure monitor.
   c. Click **Calibrate**.
5. The system:
   - Calibrates your pressure scale.
   - Retains the calibration settings between imaging sessions. You only need to repeat the calibration procedure if you connect a different blood pressure monitor or if you think there might be a problem with the calibration accuracy.

Manually calibrating any blood pressure instrument

The Vevo 2100 Imaging System can calibrate any blood pressure scale manually, as long as it includes a built-in calibration function.

To calibrate any blood pressure instrument:

1. Connect the pressure instrument to the Advanced Physiological Monitoring Unit and ensure that the Advanced Physiological Monitoring Unit is connected to the Vevo 2100 Imaging System at the Physio Data connector on the rear panel of the system. Ensure that all three systems are powered on.
2. Open an image mode window by beginning to acquire data in any imaging mode or opening any image from the Study Browser.
3. Press Physio Settings.

The left panel displays the physiological display setting sections.

4. Adjust the blood pressure monitoring system so that the output is 0 mmHg.
5. In the **Blood Pressure** section:
   a. In the upper drop-down list select **Manual Calibration**.
   b. Click **Calibrate**.

      The blood pressure trace (red) should move to coincide with the 0 mark on the blood pressure scale.
6. Adjust the blood pressure monitoring system to output a known level, and note the numeric value of this level.
7. In the **Blood Pressure** section:
   a. Set the BP Gain value to either 1X or 4X. The default value is 4X, which is the typical setting for most devices.
   b. Type the numeric value of the output level into the At mmHg box.
   c. Click **Calibrate**.
8. The system:
   - Calibrates your pressure scale.
   - Retains the calibration settings between imaging sessions. You only need to repeat the calibration procedure if you connect a different blood pressure monitor or if you think there might be a problem with the calibration accuracy.

Respiration Gating section

Respiration gating is a tool you can use to effectively suppress the artifacts coming from respiration and cardiac movement.

When you are acquiring image data along with physiological data, the physical movement of the subject's chest cavity may move the region of interest you want to study. This can cause artificial variations in measurements you add to saved images.

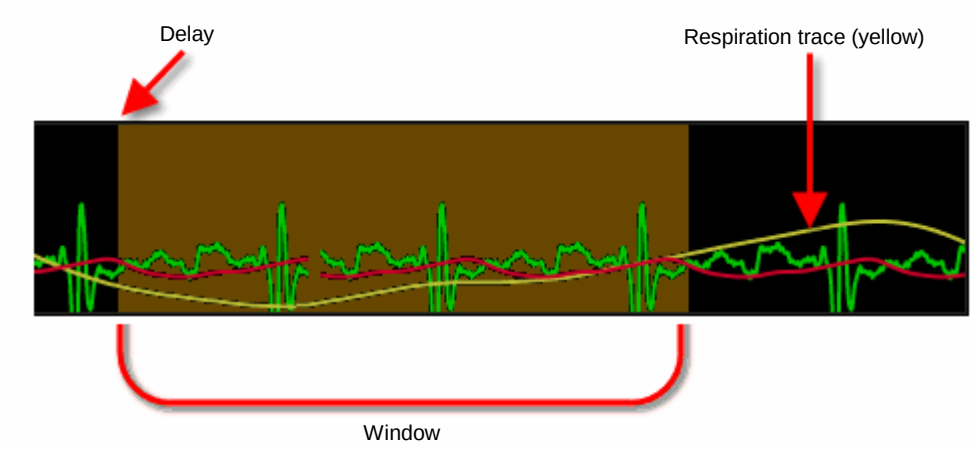
Respiration gating suppresses this effect.

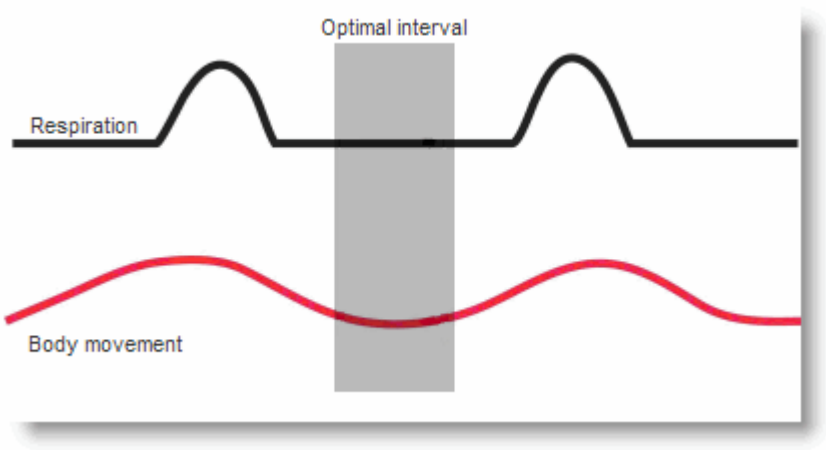
How respiration gating works

To suppress the effect of respiration on your image data, you use the **Respiration Gating** tools to select the period of time between breaths – when the body is least affected by the breathing motion. This brief period of time is called the respiration gate. The system records image data only during the respiration gate period.

As shown in the following illustration, you work in the physiological trace window to create the respiration gate along the yellow respiration data trace line. The beginning of the respiration gate is called the *delay* point and the length of the

gate period is called the *window* and is defined by a dark yellow background that follows the trace across the screen.





Before you begin:

- Your animal must be connected to the Advanced Physiological Monitoring Unit.
- In the **Physiological Enable** section of the **General** tab in the **Preferences** window, the **Respiration** check box must be selected

IMPORTANT: You can only activate and control respiration gating while you are acquiring data. You cannot access these options when you review an image.

To activate respiration gating:

1. Begin acquiring data.
2. Press Physio Settings.

The left panel displays the physiological display setting sections.

3. In the **Physiological Range** section, adjust the **Respiration** slider so that the trace line is a) short enough that the peaks and valleys do not extend above or below the window and b) tall enough that you can clearly define those peaks and valleys.
4. In the **Respiration Gating** section:
   a. Select the **Respiration Gating** check box to activate the slider controls.
   b. Adjust the **Delay** slider to set the start of the gate period, after the waveform has returned to the baseline.
   c. Adjust the **Window** slider to set the duration of the data acquisition before the next breath occurs.
5. Press Pre Trigger to create your cine loop.

Because Pre Trigger records data for a set period after you press the key, the system acquires only a portion of data during each cardiac cycle, so it takes longer to acquire the cine loop.

Related information

- *Acquiring image data* (page 120)
- *Physiological data sources* (page 109)
- *ECG Trigger section* (page 117)

ECG Trigger section

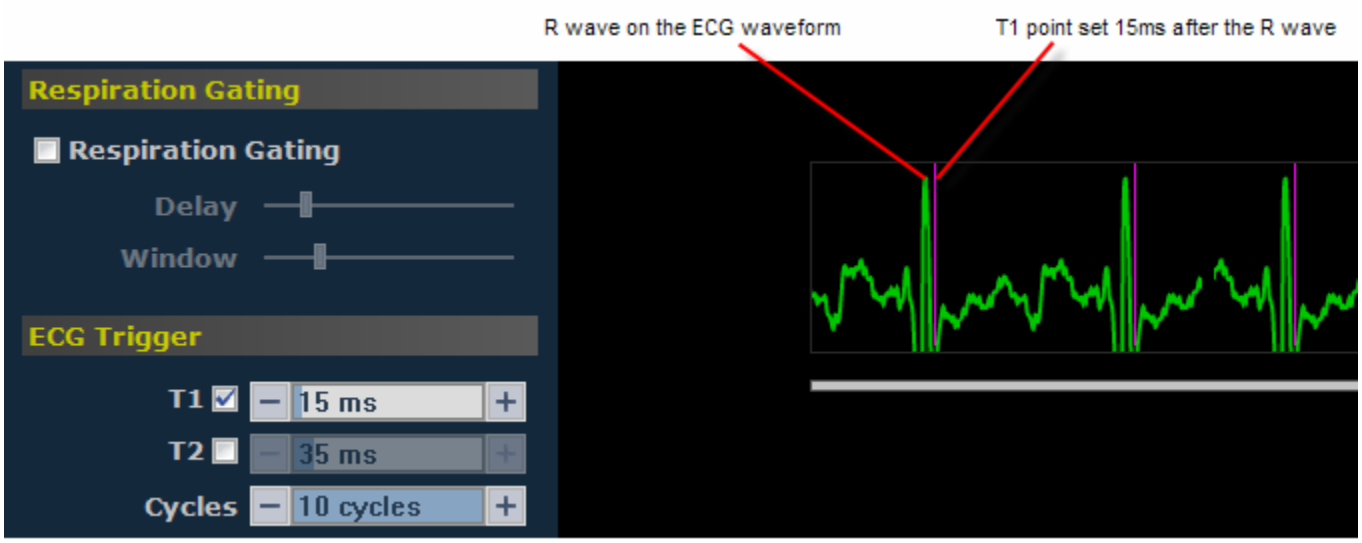
ECG triggering is a feature you can use to effectively acquire imaging frames at a specific time during the heart cycle.

ECG triggering suppresses this effect.

Use ECG triggering when you intend to add measurements at a specific time.

How ECG triggering works

ECG triggering acquires one single frame of image data during each cardiac cycle, at precisely the same time point after the R wave peak, as shown in the following illustration.



Before you begin

- Your animal must be connected to the Advanced Physiological Monitoring Unit.

IMPORTANT: You can only activate and control ECG triggering while you are acquiring data. You cannot access these options when you review an image.

To set the ECG triggering:

1. Begin acquiring data and then press.
2. Press Physio Settings.

   The left panel displays the physiological display setting sections.
3. In the **Physiological Display** section, select the View Physiology check box and then select only the ECG check box. This displays only the ECG waveform in the physiological trace window, which makes it easier to work with.
4. In the **Physiological Range** section, adjust the **ECG** slider so that the trace line is tall enough to clearly define the peak of the R wave.
5. In the **ECG Trigger** section:

a. In the **T1** row select the check box to activate the time slider control as well as the Cycles slider control at the bottom of the section.

b. Watch the B-Mode image as you adjust the slider until you find the image within the cardiac cycle that displays the tissue characteristics that you want to study (typically systole or diastole). The system sets the time point after the R wave where it will continue to acquire one single frame of image data during each cardiac cycle.

c. Adjust the **Cycles** slider to set the number of cycles (in a range from 1-10) in which the system will acquire the set number of cardiac cycles.

6. If you want to study a second image point within the cardiac cycle, select the **T2** check box and follow the same procedure to place a second trigger.

7. Press Cine Store to create your cine loop.

The system acquires one frame of image data for each cardiac cycle. When the selected number of cycles are completed, the cine loop is created.

Related information

- *Acquiring image data* (page 120)
- *Physiological data sources* (page 109)
- *Respiration Gating section* (page 115)

Chapter 19

Acquiring image data

This chapter shows you how to start acquiring micro-ultrasound image data.

Before you begin

- Ensure that you have connected a transducer to the transducer port on the front of the cart.
- Ensure that the animal is properly prepared on the animal platform and ensure that the animal is connected to the physiological data support system.

To acquire a micro-ultrasound image:

1. With the Study Browser or a Mode window open, press the key for the Mode you want to image in. For example, press B-Mode.

   The the system begins acquiring B-Mode data.

B-Mode window. The outlined area includes the ultrasound image data and the physiological trace data.

To switch from one image acquisition Mode to another:

1. While you are acquiring image data in one mode, press Scan/Freeze.

2. On the control panel, press the key for the new imaging mode. For M-Mode press M-Mode a second time to display the M-Mode image in the lower image panel and the B-Mode scout image in the upper image panel.

   The **Mode** window displays the image data in the new imaging Mode.

Next steps

- *Saving your image data* (page 122)
- *Analyzing image data* (page 156)
- *Managing your studies* (page 125)

Related information

- *Connecting the transducer to the Vevo 2100 Imaging System* (page 106)
- *Logging on* (page 41)
- *Image acquisition modes* (page 37)
- *Quick start tutorial* (page 30)

Chapter 20

Saving image data

You can save your image data in one of two ways:

- Save your data as a multiple frame animation of your image frames. This ultrasound image is called a *cine loop*.
- Save your data as a single frame ultrasound image called an *image frame*.

In this chapter

Saving a cine loop (multiple-frame animation)

A cine loop is a multiple -frame animation of your image frames. You can save your image data as a cine loop in every image Mode other than 3D-Mode.

B-Mode based cine loops are measured by number of frames. M-Mode and PW Doppler Mode cine loops are measured in seconds.

How cine loops work

While you acquire data, the system's playback memory holds your most recent image data in a buffer. The size of the buffer is determined by the **Cine Loop Size** preference you specify in the **Preferences** window on the **General** tab.

When you save your image as a cine loop, the system saves this buffered data as an image. The buffer saves the latest acquired data.

▶ To review your cine loop content before you save it:

1. Press Scan/Freeze.
2. Use the Cine Loop Review dial to review the current, but unsaved, cine loop frames.
3. If you don't want to save the content, press Scan/Freeze again and continue to acquire new image data.

▶ To save your image as a cine loop:

1. Press Scan/Freeze to stop acquiring data.

2. Review the image as required and then press Cine Store.
3. Your **Mode** window dims and the system pauses the image acquisition.

   During this image acquisition pause:

   - The system captures the last number of acquired frames based on your **Cine Loop Size** preference and creates a new cine loop image
   - In the bottom left of your **Mode** window, the system briefly displays the **Cine Stored** confirmation message

   - The system adds your new image as an unnamed list item within the active series row in the study that you selected in the **Study Browser** before you started acquiring your data
4. The pause ends and the system continues to acquire image data.

Next steps

- *Labeling an image* (page 136)
- *Opening an image* (page 136)
- *Adding generic measurements* (page 166)
- *Adding protocol measurements* (page 168)

Related information

- *Cine Loop Size preferences* (page 71)
- *Saving an image frame* (page 123)

Saving an image frame

An image frame is a single non-animated image. You can save an image frame in every imaging Mode other than 3D-Mode.

How image frames work

While you acquire data, the system's playback memory holds your most recent image data in a buffer. The size of the buffer is determined by the **Cine Loop Size** preference you specify in the **Preferences** window on the **General** tab.

When you save your image as an image frame, the system saves the frame that is currently displayed in the Mode window.

To save your image as an image frame:

1. Press Scan/Freeze and then Cine Store to create a cine loop.
2. Turn the Cine Loop Review dial forward and back until you see the frame you want to store.
3. Press Frame Store.
4. Your **Mode** window pauses for a moment. During this pause:
   - The system captures the current image frame and creates a new image
   - In the monitor bar of your **Mode** window, the system briefly displays the **Frame Stored** confirmation message
   - The system adds your new image as an unnamed list item within the active series row in the study that you selected in the **Study Browser** before you started acquiring your data
5. The brief pause ends and the system continues to acquire image data.

Next steps

- *Labeling an image* (page 136)
- *Opening an image* (page 136)

Related information

- *Cine Loop Size preferences* (page 71)
- *Saving an image frame* (page 123)

Section 6

Managing images, series and studies

Studies in the Vevo 2100 Imaging System are like studies in a paper based system. They work much like a file directory and hold all the series of images that are part of your study.

Studies are composed of one or more grouped image sets called series, and the series are composed of one or more images (individual frames and/or multiple-frame cine loops).

When you acquire and save an image, the Vevo 2100 Imaging System lists the image in the **Study Browser**. This section shows you how to use the **Study Browser** when you want to work with your saved images.

In This Section

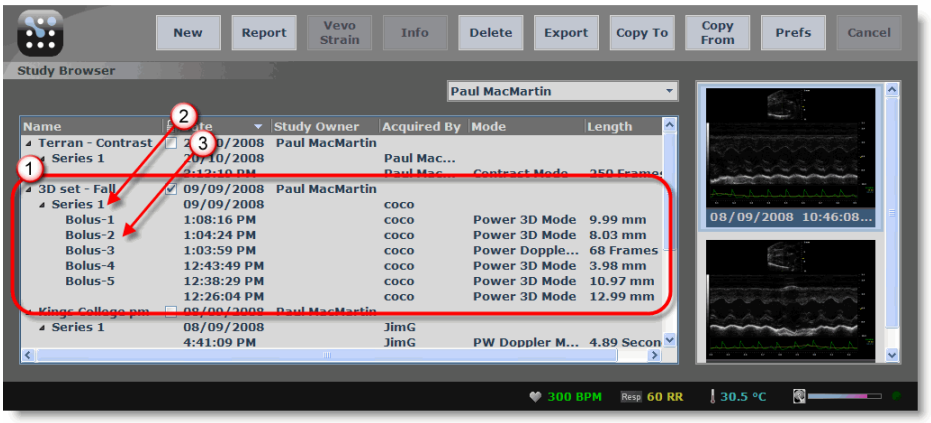
Chapter 21

About studies, series and images

The **Study Browser** organizes your work into studies, series and images and displays them in the following hierarchy:

- Study
  - Series
    - Image

The following illustration and table describes how the hierarchy of Study / Series / Image works and how it appears in the software.



Study Browser window featuring the study, series and images of a selected study

Area	Description
1	**Study**. A study contains one or more grouped image sets called series. In this example, the highlighted study is named **3D set - Fall** and it contains one series.
2	**Series**. A series is the group of one or more images that you acquire during an acquisition session. A series in a study functions much like a sub-folder of a parent folder. In this example, the specified series is named **Series 1** and it contains six images.
3	**Image**. An image is either a multiple frame video-like image called a cine loop, a single image frame, or a 3D-Mode image. In this example, the specified image is named **Bolus-2**.

Chapter 22

Working with studies

Studies are the largest grouping you can work with in the Study Browser. Studies contain your images. And these images are grouped into series which list all the images you create during an acquisition session.

You can organize your studies any way you want, based on the type of study you are working on. Sometimes you will create a study that tracks a specific set of images of one animal over a period of time. Other times you will create a study that tracks a specific set of images of a series of animals at one time.

In this chapter

Creating a study

You can create a study in one of two ways:

- Press a mode key to start acquiring image data, then press Scan/Freeze
- From the **Study Browser** press New on your control panel or click **New** and then click **New Study**

Creating a study by acquiring image data

When you begin imaging in a mode, the system automatically creates a new system-named study and series. This is typically the fastest way to create a study.

▶ To create a study by acquiring image data:

1. Press the appropriate Mode key for your acquisition session.
2. The system creates a study.

The mode window appears and displays the system-generated study name and series name.

You have successfully created a study.

3. Store images to your series and then close the series.

> **BE CAREFUL:** If you don't store images to the first and only series of a study, the system removes both the series as well as the study when you close the series.

The **Study Information** window appears.

4. Complete the required fields and any optional fields as needed and click **OK**.

Related information

- *Modifying the information properties of a study* (see page 129)

Creating a study by using the New key or New button

To create a study by using the New key:

1. From the **Study Browser** press New on your control panel or click **New** and then click **New Study**.
2. In the **New Study** window:
   - The name of the current operator appears in the **Owner** box as well as the **Acquired By** box
   - The **Series Name** defaults to Series 1
   - The currently selected application appears in the **Application** box
   - The currently selected measurement package appears in the **Measurement Package** box
3. In the **Study Name** box type a name for the study.
4. (Optional) Customize additional property details (see page 129) in the boxes that are labeled in gray, then click **OK**.
5. The system creates the study and opens the mode acquisition window in B-Mode.

   You have successfully created a study.
6. Store images to your series and then close the series.

> **BE CAREFUL:** If you don't store images to the first and only series of a study, the system removes both the series as well as the study when you close the series.

Finding a study

When your list of studies is long and you need to find a specific study, use the Study Browser sorting features.

To find a study:

1. Press Study Management.

   The Study Browser appears.

2. Click a column heading to sort the list of studies.
   - Click **Name** heading to display the list in alphanumeric order based on the name of the study. Click the heading again to switch the sort order of the column between ascending order and descending order.
   - Click the lock icon heading to display the locked studies first. Click the heading again to display the unlocked studies first.
   - Click the **Date** heading to display the list in chronological order. Click the heading again to switch the sort order of the column between ascending order and descending order.
   - Click the **Study Owner** heading to display the list in alphabetical order based on the name of the operator who owns the study. Click the heading again to switch the sort order of the column between ascending order and descending order.
3. Scroll through the list to find your study.

Modifying the information properties of a study

You can use the **Study Information** window to customize the property details of a study.

To customize the information properties for a study:

1. Open the **Study Browser** window.
2. Select the study you want to work with and then click **Info**.

   The **Study Information** window appears and displays the **Study Information** section fields.
3. Add or modify content in the boxes as described in the following table.

Box	Description
Owner	Read-only
Study Name	Required. Type your information.
Granting Institution	Optional. Type your information.
Study Notes	Optional. Type your information.

4. Click **OK**. The **Study Browser** returns.

Related information

- *Study Browser window workspace* (page 49)
- *Study Information window workspace* (page 50)

How passwords and study locks work

You can review any images in any study on your Vevo 2100 Imaging System at any time. And if the study is not locked you can complete any of the following tasks at any time:

- Review the study
- Add a new series
- Add new images
- Delete an image
- Delete a series
- Delete a study
- Add/edit measurements and annotations
- Delete measurements and annotations
- Edit an image or series or study name
- Edit series information or study information

Before you can delete a study or series or image within a study, unlock the study. If the owner or an administrator added a password to their operator profile, you must contact the owner or administrator and request the password.

Related information

- *Locking a study* (page 131)
- *Working with operator passwords* (page 65)

Locking a study

Any operator can lock any study. When you lock a study, all the operators on the system can still review and manage the images in the study. Before you can delete a study or series or image within a study, unlock the study.

To lock a study:

1. In the **Study Browser**, in the lock column select the check box for the study that you want to lock.
2. The system adds a check mark in the lock column.

To delete a locked study:

1. Select the study and click **Delete**.
2. If the operator or study owner who applied the lock has a password, the system prompts you to type the password before you can complete the deletion.
3. The system deletes the study.

Related information

- *Study Browser window workspace* (page 49)
- *How passwords and study locks work* (page 130)

Chapter 23

Working with series

Series are sub-groupings within studies that list all the images you create during acquisition. Use series to create useful image groupings within your study.

Whenever you create a new study, in the **Study Browser** the system automatically creates the first series.

Typical uses for series

Let's say your study tracks a specific set of images of one animal over a period of time. Create a new series each time you reach a time point in the study when you need to acquire images and take measurements. Add all your images for that animal to a series.

If your study tracks a specific set of images of a series of animals at specific times, create a new series at each time point and add your images for each animal to that series.

In this chapter

Creating a new series

You can create a series in one of two ways:

- Create a new study and the system automatically creates the first series in the study
- In the **Study Browser**, add a new series to an existing study

▶ To create a series by creating a new study:

Create a new study using either of two methods:

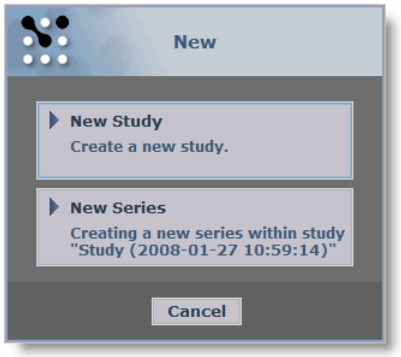
- *Create a study by acquiring image data* (page 127)
- *Create a study by using the New key or New button* (page 128)

The system creates the new study and automatically creates the first series in the study.

To add a new series to an existing study:

1. In the **Study Browser**, select the study that will contain the new series.
2. Press New.

   The system prompts you to create either a new study or a new series.



3. Click **New Series**.

   The **New Series** window appears.
4. In the **Series Information** section, modify the series parameters as required.
5. Click **OK**.

   The system starts acquiring image data in B-Mode.

Modifying the information properties of a series

You can use the **Study Information** window to customize the property details of a series within a study.

To customize the information for a specific series:

1. Access the **Study Information** window:
   - From a mode window press Study Info
   - From the Study Browser, select the series row (not the study row) and then click Info or press Study Info

   The **Study Information** window appears and displays the information about the study in the **Study Information** section, and information about the series in the **Series Information** section.
2. Add or modify content in the boxes as described in the following table.

Box	Description
Series Name	Required.
Acquired By	Required.
Date of Birth	Optional. Click the calendar icon and select the date that the animal was born.
Sex	When you select **Female**, the system displays the **Pregnant** option.
Pregnant	Optional. Select the check box. The system displays an optional **Date Mated** calendar field. If you want to add that data, click the calendar icon and select the date. **Important:** If you want to add embryology measurements to any image in the series you must select this check box.
(All other fields)	Optional. Type in your information.

Related information

- *Study Information window workspace* (page 50)

Closing an active series

When you are in an acquisition session adding images to your study, the series you are working with is the active series.

To close a series:

1. Press Close. Use this key:
   - When you are in a **Mode** window acquiring images)
   - When you are in the **Study Browser** (or click **Close Series**)
2. If you created your current series by starting an acquisition session, the system displays the **Study Information** window so you can define the study owner.

Note: Until you define the owner of the study you cannot close the study or series.

BE CAREFUL: If you don't store images to the first and only series of a study, the system removes both the series as well as the study when you close the series.

Deleting a series

You can delete a series from any unlocked study.

To delete a series:

1. In the **Study Browser**, select the series you want to delete:
   - Click to select one series
   - CTRL+click to select a collection of individual series
   - Click+SHIFT+click to select a range of series
2. Press DEL or click **Delete** in the **Study Browser**.

   The **Delete Confirmation** window appears.

   DATA LOSS WARNING: When you delete items from the **Study Browser**, the system completely removes the data from your system. You cannot retrieve it.

3. Click **Yes**.

Chapter 24

Working with image items in a study series

Images are saved cine loops and image frames that are listed in a series within a study.

In this chapter

Opening an image

To open an image:

In the **Study Browser**, expand the study and series and then select the image you want to open:

- In the list of studies, double-click the image row
- In the thumbnails panel, double-click the image thumbnail

The system opens the image in the **Mode** window.

Labeling an image

You can label a saved image while you are reviewing it in the **Mode** window, or when you are working with it as a list item in the **Study Browser**.

To label an image from the Mode window:

1. Press Image Label.

   The **Image Label** dialog box appears.
2. Type the image label name and click **OK.**

   The system:
   - Displays the name in the **Image Label** field above the image
   - Stores the image as either a cine loop or image frame if:

a. **AutoSAVE on Image Label** is selected in the General tab of the Preferences window
-or-

b. The image has not been saved previously

To label an image from the Study Browser:

Method A (Vevo 2100 Imaging System control panel):

1. Expand the study and series and select the image you want to label.
   - In the list of studies, select the image row.
   - In the thumbnails panel, scroll to view the image and select the image.
2. Press Image Label.

   The **Image Label** window appears.
3. Type the image label name and click **OK**.

   The system displays the name in the **Name** column.

Method B (Vevo 2100 Workstation):

1. Expand the study and series and right-click the row of the image you want to add a label to.

   The **Image Label** window appears.
2. Type the image label name and click **OK**.

   The system displays the name in the **Name** column.

Storing an image

You can store a cine loop or individual frame either while you are acquiring image data or reviewing image data.

To store a cine loop:

1. Begin acquiring data in an imaging Mode, or review a stored cine loop from the Study Browser.
2. Press Cine Store.

The system saves the cine loop frames as a single image item and lists the image in the Study Browser.

To store a single-frame image:

You can use Frame Store to a single-frame image in B-Mode, Color Doppler Mode, Power Doppler Mode and Contrast Mode.

For M-Mode, PW Doppler Mode and PW Tissue Doppler Mode, this key stores the complete cine loop.

1. Begin acquiring data in an imaging Mode, or review a stored cine loop from the Study Browser.
2. Press Frame Store.

   The system saves the frame as an image item and lists the image in the Study Browser.

> **Note:** When you store a frame from a previously stored cine loop, the frame includes the same image label as the original cine loop.

Chapter 25

Exporting studies, series or images

The **Export** function:

a. Translates your images from the proprietary Vevo 2100 Imaging System file format into industry formats you can work with on another computer.

b. Transfers the translated files to a network location or an external storage device that you connect to the USB ports or the Firewire port on the rear panel of the Vevo 2100 Imaging System.

In this chapter

Exporting cine loops from the Study Browser

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export cine loops from the Study Browser:

1. Press Study Management.

   The **Study Browser** appears.

2. Select the cine loops you want to export.

   Note: You cannot export 3D-Mode images as a cine loop.

   - If you want to export a single cine loop, expand the study and series that contains the cine loop and select it.
   - If you want to export multiple cine loops, expand and select the study rows or series rows that contain the cine loops you want to export.

> **Important tip:** When you select a series or a study that includes image frames as well as cine loops, the system only exports the selected cine loop images. You do not have to de-select the image frames. You can just select the series row or even the whole study and the system will export only the cine loops.

- Press Select to select one row
- Press CTRL+Select to select a collection of individual rows
- Press Select+SHIFT+scroll+Select to select a range of rows

3. Press Export.

   The **Export Image** window appears.

4. In the folder browser, browse to the location where you want to export your cine loops and select the folder.
5. If you need to create a new folder to contain the cine loops you are exporting:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.
   c. Select the new folder.
6. In the **Export Type** section click **Cine Loop**.
7. In the **Options** section:
   a. In the top box:
      - If you are exporting a single image, the system labels this box **Save As**. You can keep the system defined date and time stamp file name or type a new file name.
      - If you selected to export multiple images, the system labels this box **File Name Prefix**. Type in text that will be added to the start of all the individual image files that you have selected to export. This way you can identify and group these exported files more easily in your export folder.

   b. In the **File Type** box select the AVI format based on your requirements.

AVI format	Description
Uncompressed AVI	Largest file size. Original image quality.
Compressed AVI MS Video 1	Smallest file size. Good image quality.
Compressed AVI MS Media Video 9	Smaller file size. Best image quality. **Attention: Apple Macintosh users** - Use this format to export as compressed AVI.
Windows Audio Wave File	Saves the audio from a PW Doppler or PW Tissue Doppler cine loop.

c. In the **Quality** row, click **High** or **Medium** based on your requirements.

Quality	Description
Medium	Slightly lower resolution
High	Highest resolution

8. Click **OK**.

   The system exports the images to the folder you selected and then presents the **Image Export Report**.

9. Click **OK**.

   The system returns you to the **Study Browser**.

Related information

- *Rear panel* (page 21)
- *Export and Copy To windows workspaces* (page 54)

Exporting a cine loop from the Mode window

If you are analyzing an image frame in the **Mode** window, you don't have to return to the **Study Browser** to export it. You can export it directly from the **Mode** window.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export a cine loop from the Mode window:

1. Press Export.

   The **Export Image** window appears.

2. Continue the export procedure as detailed in *Exporting cine loops from the Study Browser* (page 139).

Exporting image frames from the Study Browser

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export image frames from the Study Browser:

1. Press Study Management.

   The **Study Browser** appears.

2. Select the image frames you want to export.
   - If you want to export a single image frame, expand the study and series that contains the image frame and select it.
   - If you want to export multiple image frames, expand and select the study rows or series rows that contain the image frames you want to export.
   - Press Select to select one row
   - Press CTRL+Select to select a collection of individual rows
   - Press Select+SHIFT+scroll+Select to select a range of rows

   Important tip: When you select a series or a study that includes cine loops as well as image frames, the system exports the last frame of any cine loop as an image frame. Or, if you have added a measurement, the system exports the frame that includes the measurement. This means that if you want to export the entire cine loop, you must click to de-select the cine loop items from your multiple selections, then configure another export to export them as cine loops.

3. Press Export.

   The **Export Image** window appears.

4. In the folder browser, browse to the location where you want to export your data and select the folder.

5. If you need to create a new folder to contain the image frames you are exporting:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.

6. In the **Export Type** section click **Image**.

7. In the **Options** section:

a. In the top box:

- If you are exporting a single image, the system labels this box **Save As**. You can keep the system defined date and time stamp file name or type a new file name.
- If you selected to export multiple images, the system labels this box **File Name Prefix**. Type in text that will be added to the start of all the individual image files that you have selected to export. This way you can identify and group these exported files more easily in your export folder.

b. In the **File Type** box select the TIFF or BMP file format in either full screen or image area.

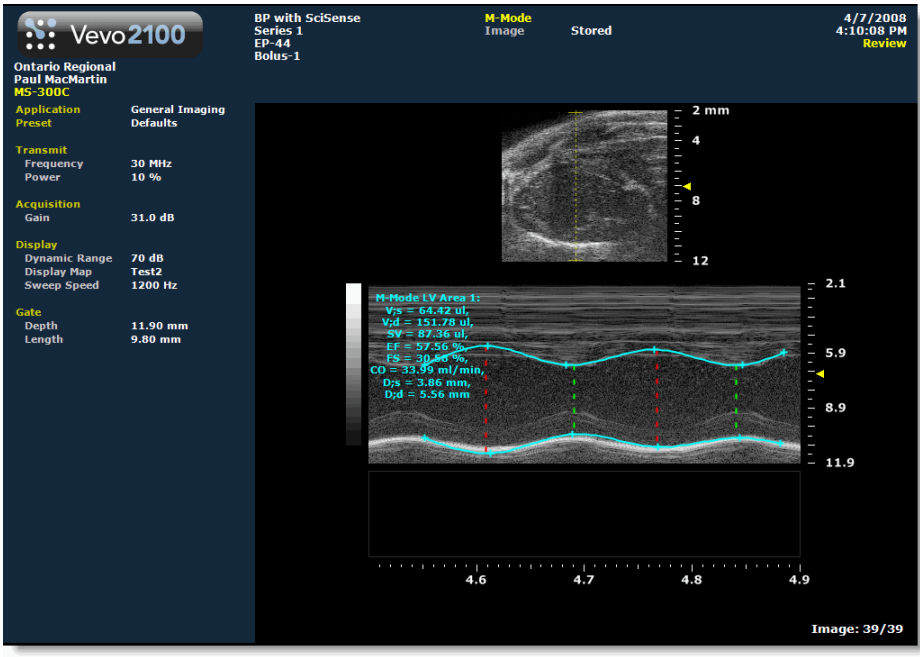
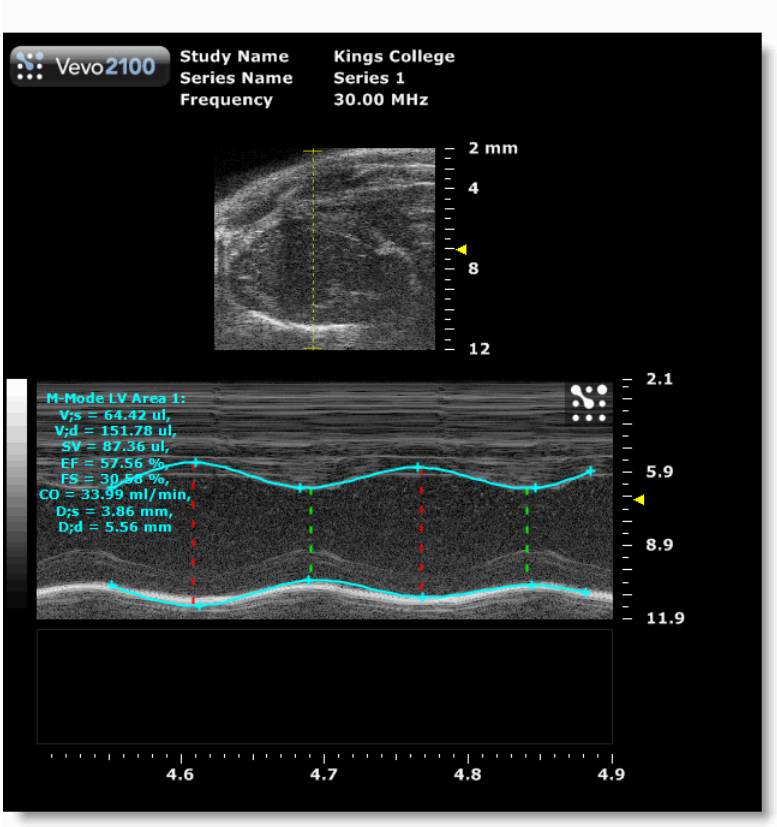


Image exported as full screen BMP file



Same image exported as image area BMP

c. If the system detects that the file names of any images you selected for export are identical to any file names in your export folder, the system prompts you to choose how to proceed:

   - Click **Yes** to overwrite the files
   - Click **No** to return to the **Export Image** window

8. Click **OK**.

   The system exports the images to the folder you selected and then presents the **Image Export Report**.

9. Click **OK**.

   The system returns you to the **Study Browser**.

Related information

- *Rear panel* (page 21)
- *Export and Copy To windows workspaces* (page 54)

Exporting an image frame from the Mode window

If you are analyzing an image frame in the **Mode** window, you don't have to return to the **Study Browser** to export it. You can export it directly from the **Mode** window.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export an image frame that you are analyzing in the Mode window:

1. Press Export.

   The **Export Image** window appears.

2. Complete the export procedure as detailed in *Exporting image frames from the Study Browser* (page 142).

Exporting images to DICOM from the Study Browser

You can export saved cine loop or image frame images as DCM files that you can import into a DICOM compatible workstation. This feature supports all ultrasound modes except **3D-Mode**. If you select only 3D-Mode images for export, the system disables the **Export** button.

You can export your saved images from the **Study Browser** or while you are reviewing them in the **Mode** window.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export images to DICOM format from the Study Browser:

1. Press Study Management.

   The **Study Browser** appears.

2. Select the image frames you want to export.

   - If you want to export a single cine loop image or image frame image, expand the study and series that contains the image and select it.

- If you want to export multiple single cine loop images or image frame images or a combination of both image types, expand and select the study rows or series rows that contain the images you want to export.
- Press Select to select one row
- Press CTRL+Select to select a collection of individual rows
- Press Select+SHIFT+scroll+Select to select a range of rows

3. Press Export.

   The **Export Image** window appears.

4. In the folder browser, browse to the location where you want to export your data and select the folder.
5. If you need to create a new folder to contain the image frames you are exporting:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.

      The system adds a new folder inside the selected folder.
6. In the **Export Type** section click **DICOM**.
7. In the **Options** section:
   a. In the top box:
      - If you are exporting a single image, the system labels this box **Save As**. You can keep the system defined date and time stamp file name or type a new file name.
      - If you selected to export multiple images, the system labels this box **File Name Prefix**. Type in text that will be added to the start of all the individual image files that you have selected to export. This way you can identify and group these exported files more easily in your export folder.
   b. In the **File Type** box select the compression level for your DCM export file, as described in the following table.

Header text	Header text
Implicit VR Little Endian	Image pixel data is not compressed. The Tag type is determined by the context.
Explicit VR Little Endian	Image pixel data is not compressed. The Tag type is explicitly defined in the file.
JPEG Baseline	Image pixel data is encoded with JPEG coding Process 1 (non-hierarchical with Huffman coding). This setting produces the smallest file sizes, but with some loss of image quality.
RLE Lossless	Image pixel data is encoded with RLE compression which compresses with no image loss.

c. If your DICOM system supports regions:

- Select the **Export regions** check box to export the file with separate calibration data for the main image area as well as the B-Mode scout window.
- Clear the **Export regions** check box to export the file with only the calibration data for the main image area.

d. If the system detects that the file names of any images you selected for export are identical to any file names in your export folder, the system prompts you to choose how to proceed:

- Click **Yes** to overwrite the files
- Click **No** to return to the **Export Image** window

8. Click **OK**.

   The system exports the images as individual DCM files to the folder you selected and then presents the **Image Export Report**.

9. Click **OK**.

   The system returns you to the **Study Browser**.

Exported files

- If you selected any series that only contain **3D-Mode** images, the system does not export any of the images.
- If you selected multiple images including **3D-Mode** images, the system exports all the images except for the **3D-Mode** images.

Exporting images to DICOM from the Mode window

If you are analyzing either a cine loop or an image frame in the **Mode** window, you don't have to return to the **Study Browser** to export it to DICOM. You can export it directly from the **Mode** window.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

▶ To export an image to DICOM from the Mode window:

1. Press Export.

The **Export Images** window appears.

2. Complete the export procedure as detailed in *Exporting to DICOM from the Study Browser* (page 145).

Exporting the Study Browser list view as a text file

The **Study Browser** list view is the exact representation of what appears in your **Study Browser** when you scroll from the top to the bottom.

When you export the **Study Browser** list view using the **Table** option, the system generates a snapshot of this view and exports it as a TXT text format file. You can then open the file in a text editor.

Before you begin

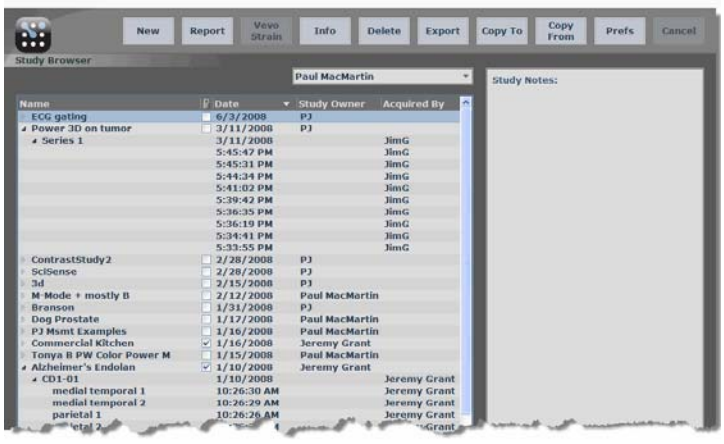
Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export the Study Browser list view as a text file:

1. Press Study Management.

   The **Study Browser** appears.

2. Expand the study rows and series rows as required to create the view you want to export.



Study Browser list view

3. From the **Study Browser**, press Export.

The **Export Image** window appears.

4. In the folder browser, browse to the location where you want to export your data and select the folder.
5. If you need to create a new folder:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.

      The system adds a new folder inside the selected folder.
6. In the **Export Type** section click **Table**.
7. (Optional) In the **Options** section type a unique name to replace the default time stamp.
8. Click **OK**.

   The system:

   - Exports the **Study Browser** list view as a TXT text file.
   - Returns you to the **Study Browser**.

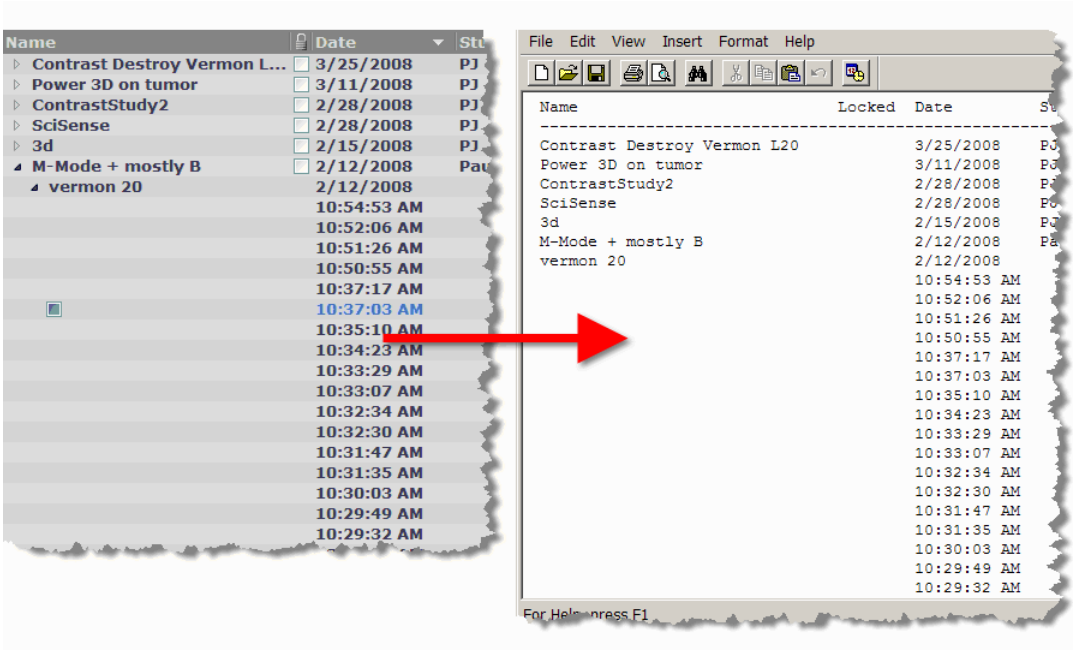
To view the Study Browser list view table:

Open the TXT file in a text editor.

Exporting the Study Browser window content

When you want to take a snapshot summary of your activity over a set period of time use the export Table feature. Export Table exports the Study Browser window content precisely as it appears, but as a TXT file.

For example if your Study Browser includes 50 studies and you expand only the sixth study and its series and images, your export will include all the listing information for the one study that you expanded completely, and include only the study rows for the other 49 studies.



Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export the Study Browser window contents:

1. Open the Study Browser window (page 49).
2. Expand the studies and series you want to view.
3. Click **Export**.

   The **Export Image** window appears.
4. In the folder browser, browse to the location where you want to export your cine loops and select the folder.
5. In the **Export Type** section click **Table**.
6. (Optional) In the **Options** section type a unique name to replace the default time stamp.
7. Click **OK**.

The system exports the Study Browser window contents as a TXT file to the location you specified.

Chapter 26

Copying, deleting and importing

The Vevo 2100 Imaging System provides a range of features for copying, deleting and importing study data.

In this chapter

Copying studies, series or images

You can copy any number of studies from your Vevo 2100 Imaging System to a location on your network or to an external storage device.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected to the external storage location through the appropriate ports on the rear panel of the system.

To copy a study:

1. In the **Study Browser**, select the names of the studies that you want to copy.
   - Press Select to select one row
   - Press CTRL+Select to select a collection of individual rows
   - Press Select+SHIFT+scroll+Select to select a range of rows
2. Press Copy To.

   The **Copy Study To** window appears.
3. In the folder browser, browse to the location where you want to copy the study and select the folder.
4. If you need to create a new folder to contain the file you are copying:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.

The system adds a new folder inside the selected folder in the folder browser window.

5. In the **Options** section, in the **Save As** box, if you want to change the name of the study, type the new name.
6. Click **OK**.

   The system:

   a. Copies the studies to the folder you selected.

   b. Displays the **Copy Study Report** box to summarize the details of the copy process. Click **OK** to complete the process.

   c. Returns you to the **Study Browser**.

Related information

- *Rear panel* (page 21)
- *Export and Copy To windows workspaces* (page 54)

Deleting studies, series or images

In the **Study Browser** list of study items, series items and image items, you can delete any combination of list items.

To delete studies, series or images:

1. In the **Study Browser**, select the studies that you want to delete.

   a. Expand the individual study rows and then series rows if you need to view the sub items under those rows.

   b. Select the study, series or image items you want to delete.

   - Press Select to select one row
   - Press CTRL+Select to select a collection of individual rows
   - Press Select+SHIFT+scroll+Select to select a range of rows

2. Press DEL.

   DATA LOSS WARNING: When you delete items from the **Study Browser**, the system completely removes the data from your system. You cannot retrieve it.

   The system:

   a. Deletes the studies you selected.

> **Note:** If one or more of the studies are locked, the system will not delete them.

b. Displays the **Delete Confirmation** box to summarize the details of the deletion process.

3. Click **Yes**.

   The system returns to the **Study Browser**.

Importing studies

Use this command to copy studies acquired on another Vevo 2100 Imaging System or from another storage location.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

▶ To import a study:

1. From the **Study Browser** press Copy From.

   The **Copy Study From** window appears.

2. In the **Owner Operator** box, select your name from the list.

> **ALERT: CANNOT PROCEED** If you do not select your name in the list, the system disables the **OK** button.

3. Select the studies you want to import to your **Study Browser**.

   To preview the images in an external study:

   In the folder browser browse to the folder that contains the study, expand the folder, expand the study and select a series. The system displays the thumbnails of the images.

   To select an individual study:

   - In the folder browser browse to the folder that contains the study, expand the folder and select the study.
   - Click the transfer button  . The study name appears in the **Selected Studies** list.

4. If you want to remove a study from the **Selected Studies** list, select the study and then click **Remove**.
5. Click **OK**.

   The system:

   a. Imports the studies that you selected.

   b. Displays the **Copy Study Report** box to summarize the details of the import process. Click **OK** to complete the process.

   c. Returns you to your previous workspace.

Section 7

Analyzing image data

This section walks you through the typical tasks you will complete when you are analyzing your images.

In This Section

Chapter 27

Vevo Imaging Workstation

VisualSonics offers an optional Vevo 2100 Workstation Software package which includes all the software tools and features that you will find on the Vevo 2100 Imaging System excluding the image acquisition tools features.

Chapter 28

Working with cine loops

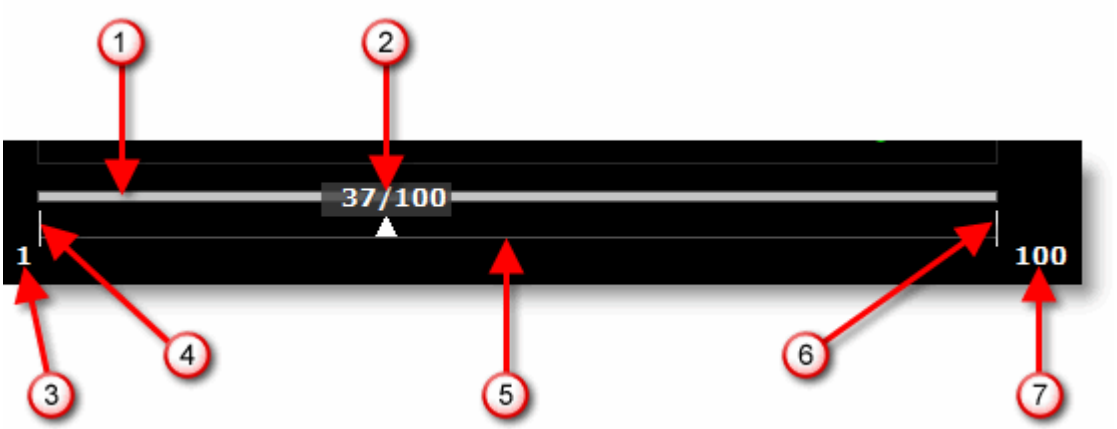
A cine loop is the trailing series of acquired images that the system holds in its memory buffer as you acquire image data.

- In B-Mode, the cine loop is a set of frames.
- In PW Doppler Mode and M-Mode, the cine loop is the data acquired over a time interval.

In this chapter

Cine loop workspace

The following illustration and table describes the information and features in a frame-based cine loop.



Area	Description
1	**Cine loop length bar**. Represents the full length of the cine loop.

Area	Description
2	**Frame counter**. Indicates the location of the current frame. The counter indicates the frame number and the total number of frames located within the buffer. To view another frame in the cine loop, click on the triangular frame indicator and drag it to the desired frame.
3	**Range start frame number**.
4	**Range start bracket**. Defines the start of the cine loop range you want to review. You can create a range within the full cine loop. Drag the bracket and then click to define the start of a subset range.
5	**Range length bar**. Represents the full length of the defined range.
6	**Range end bracket**. Defines the end of the cine loop range you want to review. You can create a range within the full cine loop. Drag the bracket and then click to define the end of a subset range.
7	**Range end frame number**.

Cine loop review controls

You can review a cine loop using either the dial controls on the Vevo 2100 Imaging System control panel or the on-screen controls on the Vevo Imaging Workstation on a PC.

Reviewing a cine loop on the Vevo 2100 Imaging System

When you are playing a cine loop on the Vevo 2100 Imaging System these are the controls you use.

1

Cine Loop Review

Controls all cine loop review functions.

To use this dial control:

- To stop and start the cine loop, press the dial
- To view a cine loop frame by frame, press the dial to stop the cine loop and then turn the dial one click at a time clockwise or counterclockwise
- To change the review playback speed, press the dial to start the cine loop and then turn the dial clockwise to speed up or counterclockwise to slow down

② Scan/Freeze

During image acquisition, toggles between acquiring image data and freezing the acquisition. When you freeze the acquisition the system stores cine loop data if you select **Auto SAVE on Image Label** in the General tab of the Preferences window.

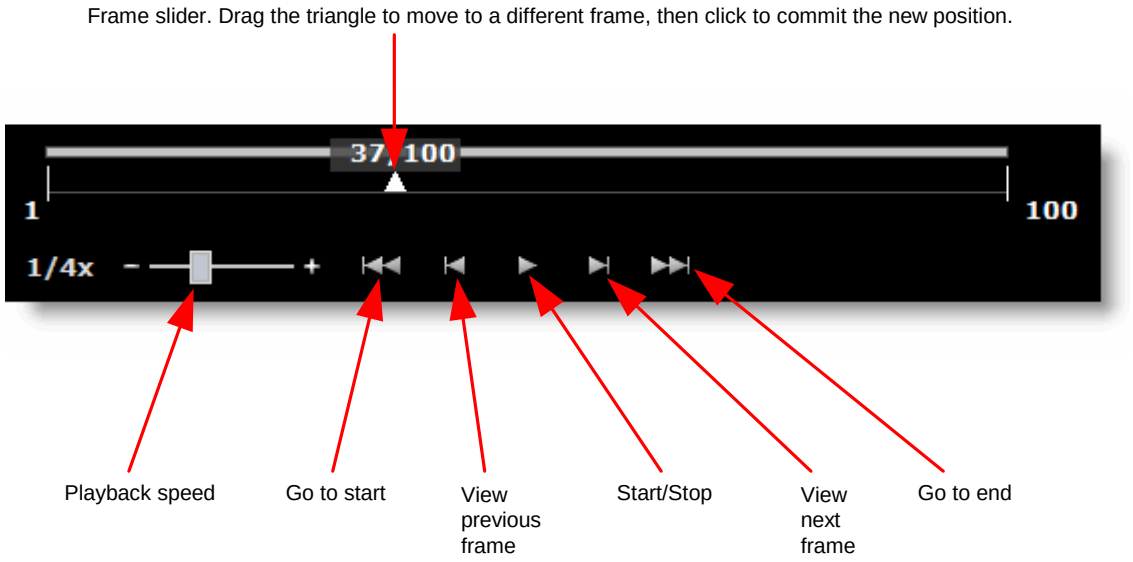
During image analysis, starts and stops data playback.

③ **Trackball**. Roll the ball with your hand to:

- Move a pointer or cursor around the screen
- Move forward or backward in a cine loop

Reviewing a cine loop on the Vevo Imaging Workstation

When you are playing a cine loop on the Vevo Imaging Workstation these are the controls you use.



Creating cine loops

To create a cine loop:

- While you are acquiring image data, press Scan/Freeze to pause your data acquisition. This creates a temporary cine loop that you can review to determine if you want to save it as an image.

- Press Cine Store after you have acquired your image or at any time while you are acquiring image data. This stores the buffered cine loop frames as an image that appears in your Study Browser.
- Pause an acquired cine loop, drag the left or right cine loop range bracket to isolate a range of image frames within the original cine loop and then press Cine Store to store the range of image frames as a cine loop.

Creating a cine loop subset from a full cine loop

You can use the start and end range brackets to create a cine loop subset from a full cine loop. This is useful when you want to review only a portion of the original cine loop.

To create a cine loop subset from a full cine loop:

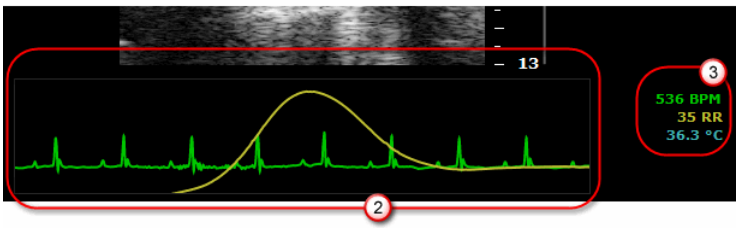
1. From the Study Browser, open a cine loop.
2. Drag the start bracket and then click to define the start of the subset range.
3. Drag the end bracket and then click to define the end of the subset range.
4. Use the cine loop review controls to view the cine loop subset.
5. If you want to store the cine loop subset, press Cine Store.

   This sets the playback range in the stored data. The playback range can be changed and then stored again. The original data in unaffected.

Viewing saved physiological data

When you are analyzing your saved images, you can view the the heart rate, temperature, respiration rate and blood pressure data that that the system recorded along with the image data.

The system displays this physiological data in three areas of the **Mode** window. The following illustration and table describes the features of each area.



Physiological data elements when you are analyzing saved image data

Area	Description
1	Physiological trace graph
2	Current frame data values

Before you begin

Ensure that you select the desired physiological inputs in the **Physiological Enable** section of the General tab in the Preferences window.

To show or hide individual traces in the graph:

1. Press Physio Settings.
2. In the **Physiological Display** section:
   - To show or hide the entire graph, select or clear the **View Physiology** check box
   - To show or hide individual traces in the graph, select or clear the check boxes for the required traces

   The system shows only the traces you selected.

Chapter 29

Measurement basics

This chapter describes where to find the measurement tools, and the the types of measurements you can add to an image.

In this chapter

Measurement panel workspace

The measurement panel is the workspace you use when you add measurements to a stored image or an image that you have acquired but not yet stored.

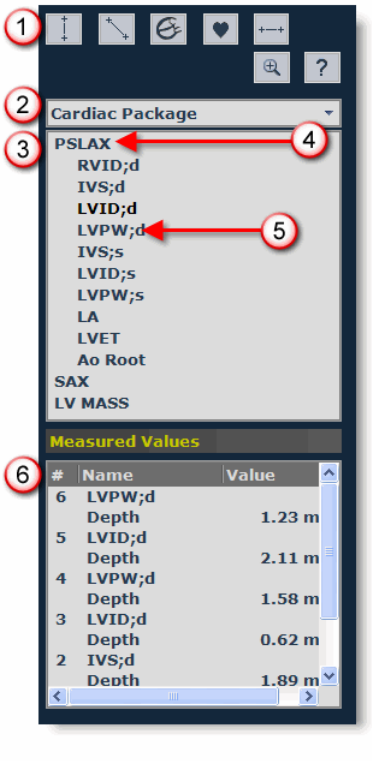
To view the measurement panel:

1. Open a stored image from the Study Browser or pause an image acquisition.
2. Click  (Workstation) or press Measure (control panel).

The measurement panel appears on the left side of the window.

Measurement panel workspace

The following illustration and table describes the information and features in the measurement panel.



Area	Description
1	**Generic measurement tools**. Each imaging Mode provides a unique set of tools. Click the tool and then apply the measurement on the ultrasound imaging area.
2	**Measurement package**. Select the appropriate measurement package from the drop-down box and then expand a protocol to access the measurements you want to apply.
3	**Protocols list**. Displays the list of protocols related to the selected measurement package.
4	**Protocols list item**. Click the protocol to expand the list and display the list of measurements within that protocol.

Area	Description
5	**Protocol measurement item**. A measurement for a specific protocol. Each protocol measurement uses one of the generic measurement tools that are displayed for the active imaging Mode. Click the measurement item and then apply the measurement on the ultrasound imaging area.
6	**Measurement values list**. Displays the measurements that have been applied to the image. The index # identifies the measurement on the image if the **Show Values and Labels** option is selected in the Measurement tab of the Preferences window.

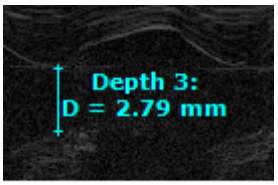
Related information

- *Creating custom measurement packages* (page 80)
- *Modifying and deleting custom measurement packages* (page 81)

Generic measurements

Generic measurements can be applied to an image that does not belong to a protocol in a measurement package.

The label for each generic measurement consists of the generic measurement name and a number suffix that shows the chronological order of that measurement type on any image in that series.



Depth generic measurement.

Complete procedure for adding a generic measurement

To add a typical measurement:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.

2. Click the measurement button you want to use. If you are not sure which button you need, hover your cursor over the button to view the pop-up button label.

   For example, for a linear distance measurement, click  . The button remains selected until the measurement is completed.

   While you apply the measurement, you can look in the measured values list area at the bottom of the left panel to see a magnified view of your cursor area.

3. Click to apply your caliper points.

   For example, for a linear distance measurement, click on your image to place the initial caliper, then trackball to the location where you want to end your measurement and then click to place the end caliper. This completes your measurement.

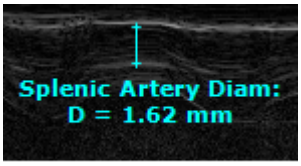
4. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement in the format **<Measurement name> #**, where **#** is the sequential number of that type of generic measurements in the series.

5. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.

6. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.

Protocol measurements

Protocol measurements are uniquely labeled measurements that belong to a set of measurements that are required for a particular protocol. Each protocol measurement applies one of the generic measurement tools that are provided for the imaging Mode, and then labels the measurement with its unique name.



Splenic Artery Diam measurement for the **Spleen** protocol within the **Abdominal** measurement package.

Adding protocol measurements

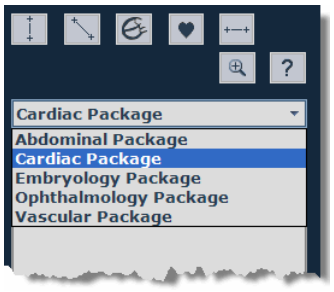
Protocol measurements are labeled uniquely for a specific measurement protocol.

To access the protocol measurement tools and measurements list

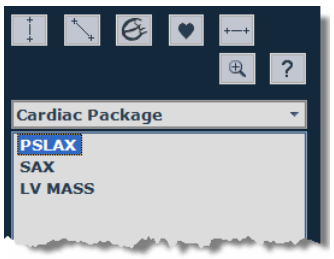
- If you are in an image acquisition session press Scan/Freeze to acquire an image and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

To place a protocol measurement:

1. In the measurement packages drop-down list click the appropriate package.



2. In the list of protocols, select the appropriate protocol.



3. In the list of measurements, select the measurement you want to add.

The system automatically activates the appropriate measurement tool and highlights the generic button for that tool.

4. On the image, add your measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Protocol measurements* (page 167)

Measurement units

The system includes the following measurement types and units:

Measurement type	Measurement unit
Length / Distance	millimeters (mm)
Area	square millimeters (mm^2)
Velocity	millimeters per second (mm/s)
Acceleration	millimeters per second per second (mm/s^2)
Time	milliseconds (ms)
Heart rate	beats per minute (BPM)
Velocity Time Integral (VTI)	centimeters per second integrated over the time interval in seconds (cm)
Volume	millimeters cubed (mm^3)
RR Interval	milliseconds (ms)
Pressure gradient	millimeters of Mercury (mmHg)
Temperature	degrees Celsius

Note: If the unit value includes more than four digits before the decimal point, the unit of measure changes in order that the value will have less than four digits before the decimal point.

Chapter 30

Working with measurements

This chapter shows you how to complete measurement tasks that are used for many measurements in many imaging Modes.

In this chapter

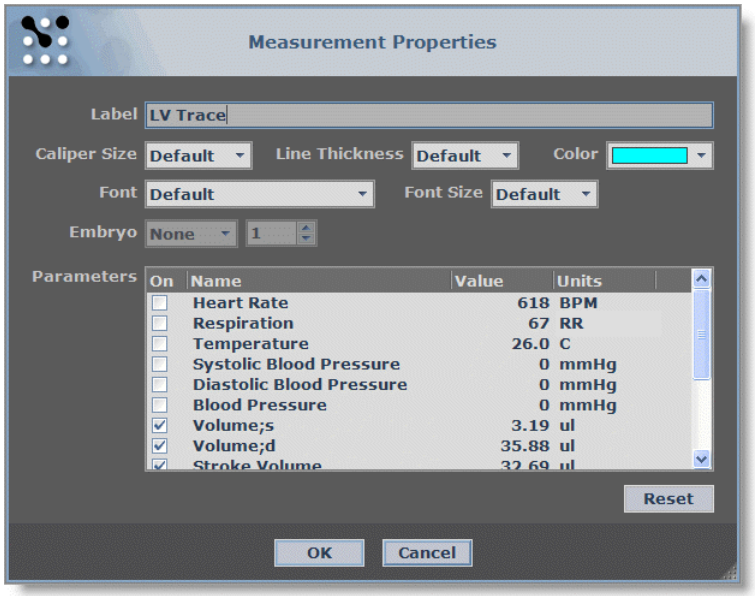
Modifying the properties of a measurement

The properties of a measurement are initially defined by the settings you configure in the Measurement Display Options preferences (page 85) on the Measurement tab in the Preferences window. You can override these settings for individual measurements.

▶ To modify the properties of an individual measurement:

1. Right-click the measurement and select **Properties**.

The **Measurement Properties** box appears.



2. Modify the properties as required and click **OK**.

Related information

- *Measurement Display Options preferences* (page 85)
- *Measurement Parameters preferences* (page 84)

Modifying points on a contour measurement

To modify points on a contour:

- **To move a point**, drag it to a new position, then click again to commit the point
- **To add a point**, click the contour, move the cursor to a new position, then click again to commit the new point
- **To delete a point**, right-click the point and select **Delete Point**

Modifying contour measurements

To modify a contour:

- **To move the contour** (all the caliper points as a group) click the center point of the trace, trackball to the new position, then click again to commit the contour.
- **To resize the contour**, click the contour, trackball the cursor inward or outward to change the size, then click to commit the resized contour.
- **To delete the contour**, right-click the curve and select **Delete**.

Adding embryo measurements

A pregnant animal typically carries multiple embryos. The same measurement can be applied to each embryo in utero when performing developmental studies. The Vevo software assumes that these embryos are enumerated along the left and right uterine horns.

When you add an embryonic measurement the measurement label includes an *embryo* index that follows the View *suffix*. For example, for a crown rump length measurement on the third embryo on the left uterine horn, the system labels this `Crown Rump Length:Emb:LE3`.

You can disable the suffix by selecting **Show Embryo Index** in the Measurement Display Options (page 85) preferences in the Measurement tab of the Preferences window.

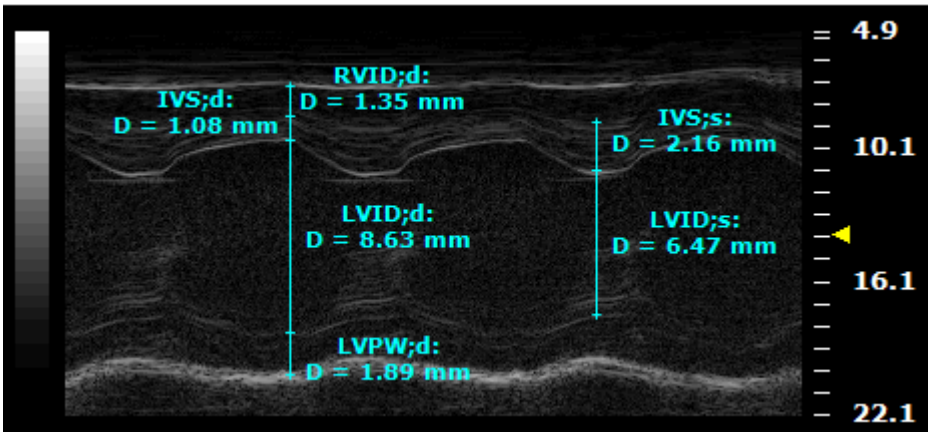
To add an embryo measurement:

1. Ensure that the Study Information (page 50) window specifies that the animal is pregnant.
2. From the Study Browser, open the image that includes the embryo image data.
3. Click  (Workstation) or press Measure (control panel).
4. In the measurement packages list select **Embryology Package**.
5. In the protocols list click **Uterine Horn**.
6. In the **Horn** drop-down select which horn you are analyzing: Left or Right.
7. In the **Number** box select the embryo number.

8. In the protocols list select the protocol measurement you want to work with and then add the measurement on the image.

M-Mode measurement chains

In M-Mode, you can complete the following sequenced measurements in automatic chains, as shown in the following diagram:



M-Mode image displaying the measurement chains beginning with RVID;d and IVS;s

In the sequence of chained measurements, the final caliper of the first measurement in the chain automatically becomes the first caliper of the second measurement. This linking continues for the remainder of the caliper points.

The labeling for all measurements occur at the same time and only when you add the last caliper of the final measurement in the chain. The image is stored as each of the measurements is completed.

To complete an M-Mode chained measurement:

1. In the measurement packages list select **Cardiac Package**.
2. In the protocols list, click the protocol and then click the first measurement in the chain. For example, click **PSLAX > RVID;d**.
3. Click the top point of the first measurement of the chain and move the cursor toward the bottom point. For example, click the top point of the RVID;d measurement.

   The system displays and labels the measurement if the **Show Values and Labels** option is selected in the Measurement tab of the Preferences window.
4. Click the bottom point of the first measurement. The system commits the measurement value for the first measurement and stores the image.

This bottom point of the first measurement automatically becomes the top point of the second measurement in the chain, for example, the IVS;d measurement.

5. Click the bottom point of the second measurement. The system measures and labels the second measurement and stores the image.
6. Click the remaining bottom points of the next measurements in the chain.

   The system measures and labels each measurement until the final measurement is completed.

Copying measurements on Contrast Mode images

On Contrast Mode images you can copy contrast region measurements and cardiac region measurements.

To copy a Contrast Mode contour measurement:

1. Right-click a measurement, and select **Copy**.
2. Right-click anywhere on the image and click **Paste**.

   The copied measurement is applied directly over the existing measurement.
3. Modify the contour measurement as required.

Related information

- *Modifying a contour measurement* (page 172)

Deleting measurements

To delete a measurement:

- Right-click a measurement, and select **Delete**.
- Select a measurement in the list of measured values and press DEL.

Chapter 31

Working with annotations

Annotations are text labels that you can add to any ultrasound image.

When you store an image or cine loop, the system includes any annotations as part of the image or cine loop.

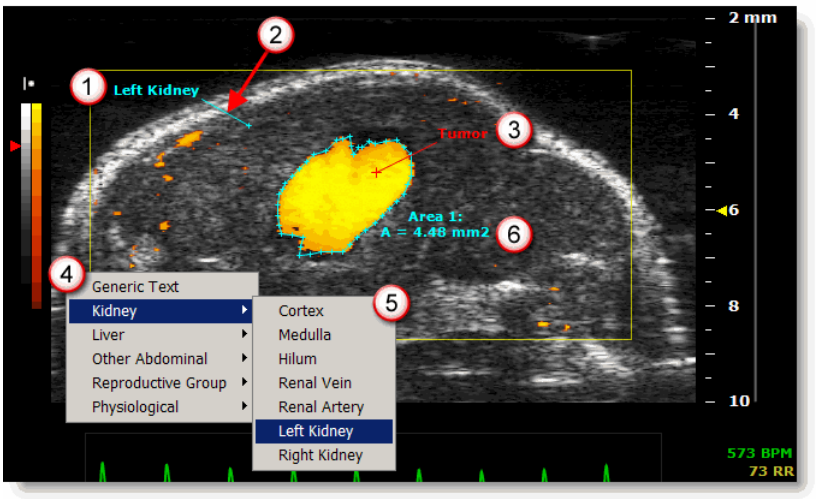
> **Note:** The system does not include annotations when you export M-Mode, PW Doppler Mode, or PW Tissue Doppler Mode images. However, if the annotations are in the B-Mode scout window, they are exported.

This chapter describes how to work with annotations when you are analyzing an acquired ultrasound image in an image Mode window.

In this chapter

Annotation workspace

The following illustration and table describes the information and features you use when you add an annotation to the ultrasound image area.



Area	Description
1	**Predefined annotation**. A default or custom annotation. To add a predefined annotation right-click on the image > select a package category > select an annotation.
2	**Anchor line.** Appears when you drag the annotation text. Visually links the annotation text to the caliper point on the image where you added the annotation.
3	**Generic Text annotation - modified**. An annotation that you type in manually on the image. To add a generic annotation right-click on the image > select **Generic Text** > type your custom annotation. You can also modify the properties of any annotation (page 181).
4	**List of annotation categories.** A unique list of package categories that are set for the measurement package you select in the drop-down list. To display this list right-click on the image.
5	**Annotation text list.** A unique list of predefined annotations that are set for a package category. To display this list right-click on the image > select a package category.
6	**Measurement label**. For detailed information see *Adding annotations* (page 180).

Predefined annotations

The system activates a unique set of predefined annotations when you select a measurement package in the measurement panel.

- You can add, reorder or delete annotation categories and annotation names (page 88).
- Predefined annotations are not available in 3D-Mode.

This section lists the default predefined annotations that are available.

Abdominal Package annotations

Category	Annotation text
Generic	Annotation text

Category	Annotation text
Kidney	Cortex
	Medulla
	Hilum
	Renal Vein
	Renal Artery
	Left Kidney
	Right Kidney
Liver	Hepatic Artery
	Hepatic Vein
	Portal Vein
	Lobe
	Right Lobe
	Left Lobe
	Liver
Other Abdominal	Adrenal Gland
	Intestines
	Bladder
Reproductive Group	Ovary
	Uterus
	Uterine Horn
	Testicle
	Seminal Vesicle
	Prostate
Physiological	Inspiration
	Expiration
	Electrical Systole
	Electrical Diastole
	Mechanical Systole
	Mechanical Diastole
	Max dP/dT

Cardiac Package annotations

Category	Annotation text
Generic Text	Annotation text

Category	Annotation text
Cardiology	Left Ventricle
	LV PW
	Right Ventricle
	RV AW
	Left Atrium
	Right Atrium
	Intra-Ventricular Septum
	Infarct
	Respiratory Motion
	Coronary Artery
	Aortic Valve
	Mitral Valve
	Tricuspid Valve
	Pulmonary Artery
	Pulmonary Valve
Physiological	Inspiration
	Expiration
	Electrical Systole
	Electrical Diastole
	Mechanical Systole
	Mechanical Diastole
	Max dP/dT

Embryology Package annotations

Category	Annotation text
Generic text	Annotation text

Category	Annotation text
Embryology	Placenta
	Umbilical Cord
	Embryo
	Neural Tube
	Heart Tube
	Heart
	Aorta
	Eye
	Lens
	Retina
	Liver
	Somite
	Lungs
	Lateral Ventricle
	Third Ventricle
	Fourth Ventricle
Fetal/Maternal Blood Flow	Umbilical Vein
	Umbilical Artery
	Vitelline Artery
	Vitelline Vein
	Placenta
Reproductive	Ovary
	Uterus
	Uterine Horn
	Testicle
	Seminal Vesicle
	Prostate
Physiological	Inspiration
	Expiration
	Electrical Systole
	Electrical Diastole
	Mechanical Systole
	Mechanical Diastole
	Max dP/dT

Ophthalmology Package annotations

Category	Annotation text
Generic Text	Annotation text

Category	Annotation text
Ophthalmology	Cornea
	Iris
	Lens
	Sclera
	Corneo-scleral junction
	Cataract
	Normal angle
Physiological	Inspiration
	Expiration
	Electrical Systole
	Electrical Diastole
	Mechanical Systole
	Mechanical Diastole
	Max dP/dT

Vascular Package annotations

Category	Annotation text
Generic Text	Annotation text
Vascular Group	Innominate Artery
	Right Common Carotid Artery
	Left Common Carotid Artery
	Left Subclavian Artery
	Abdominal Aorta
	Inferior Vena Cava
Physiological	Inspiration
	Expiration
	Electrical Systole
	Electrical Diastole
	Mechanical Systole
	Mechanical Diastole
	Max dP/dT

Adding annotations

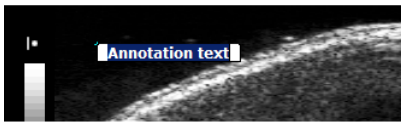
You can add custom annotations in addition to predefined annotations.

To add a custom annotation:

Method 1

1. Right-click on the ultrasound image.
2. Select **Generic Text**.

   The system adds an editable text field.



3. Type your custom annotation and press ENTER.
4. If you want to move the annotation, drag the annotation. The label moves and maintains a line to the initial point where you added the annotation.

Method 2 (Vevo 2100 Imaging System)

1. Press Cursor to toggle the cursor off.
2. Press Annotate.

   The system adds an editable text field.
3. Type your custom annotation and press ENTER.

To add a predefined annotation:

1. Right-click on the ultrasound image.
2. Select an annotation category.
3. Select an annotation.

Modifying annotations

To move an annotation:

- To move the annotation label and line, select anywhere in the middle of the line, drag the label and line to the new position, then click to commit the move.
- To move the annotation label only, drag it to the new position, then click to commit the move.
- To move the origin of the annotation line, drag the caliper point to the new position, then click to commit the move.

To delete an annotation:

Right-click the annotation and select **Delete**.

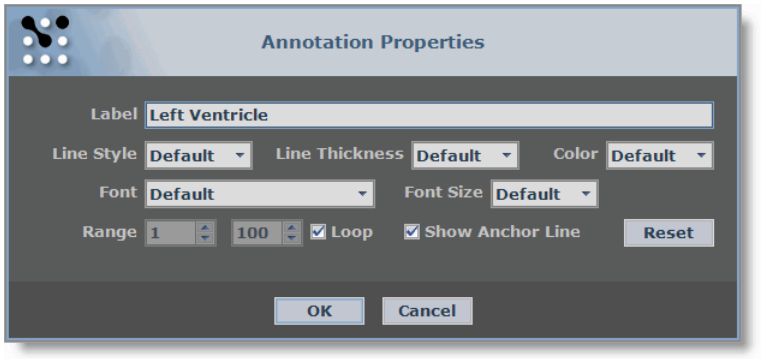
To show/hide annotations:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Annotations** tab.
2. In the Annotations Display section, select or deselect the **Show Annotations** check box.

To modify the properties of an annotation:

1. Right-click the annotation and select **Properties**.

   The **Annotation Properties** box appears.



2. Modify the properties as described in the following table.

Property	Description
Label	Annotation text. Type in new text.
Line Style	Select from a plain line or three arrow-head lines.
Line Thickness	Modifies the thickness of the anchor line. Select from Thin, Medium, Heavy.
Color	In the drop-down box select one of 25 colors.
Font	Select from the available fonts on your system.
Font Size	Select a font size between 8-48 points.
Range	Specifies the range of frames in the cine loop that display the annotation. Only available if you de-select the **Loop** check box.
Loop	Applies the annotation to the entire cine loop or to a specific frame range in the loop.
Show Anchor Line	Select or de-select the check box to show or hide the anchor line between the annotation text and the initial caliper point.
Reset	Click to return all properties to the default values.

3. Click **OK**.

To modify the list of predefined annotations:

1. From the **Study Browser** (page 49) click **Prefs** and then click the **Annotations** tab.
2. Add, reorder or delete package categories and category annotations as detailed in *Setting the Annotation tab preferences* (page 88).

Chapter 32

Reporting your analysis results

This chapter describes how to work with the measurements, calculations and annotations that you add to the image data.

In this chapter

Creating an analysis report

An analysis report is the collection of measurements and calculations for a collection of series or studies.

You cannot create an analysis report for an individual cine loop or image frame. If you select an image row in the Study Browser and try to create an analysis report for it, the system builds a report for the entire series that includes that one image.

Analysis report guidelines

- You can create analysis reports for studies or individual series.
- You cannot create a report for the measurements and calculations for an individual image.
- When you select a study for a report, the report includes all measurements for all series in the study.
- When you select multiple studies for a report, the report includes all measurements in all the studies you selected.

To report your analysis results:

1. Open the Study Browser.
2. Select the images, series or studies that contain the measurements you want to compile into a report.

   If you want to report the measurements and calculations for a combination of items, select the rows that contain the items you want to export:

   - Press Select to select one row

- Press CTRL+Select to select a collection of individual rows
- Press Select+SHIFT+scroll+Select to select a range of rows

3. Click **Report**.

   The system compiles your selections into a single report.

Reviewing the image that contains a report measurement

To review the image that contains a report measurement:

1. In the analysis report, select a measurement row.

   In the right column the system displays the thumbnails for all the images that contains the measurements and highlights the thumbnail for the selected measurement. It also displays thumbnails for each measurement in the series.

2. Click **Load**, or double-click the measurement. or double-click the thumbnail.

   The system displays the image that contains the selected measurement.

Exporting an image analysis report

You can export report files that list all measurements and calculations as well as the physiological data for any combination of studies, series and images.

You cannot create an analysis report for an individual cine loop or image frame. If you select an image row in the Study Browser and try to create an analysis report for it, the system builds a report for the entire series that includes that one image.

The system exports your analysis report as a CSV file which you can load into third party tools such as spreadsheet software so you can complete additional statistical analysis.

The system supports three ways to export your analysis report:

- Export your report from the **Study Browser**
- Export your report from the **Analysis Browser**
- Export your report from the **Mode** window

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export your analysis report from the Study Browser

1. Press Study Management.

   The **Study Browser** appears.

2. Select the studies, series and images you want to include in your export.
   - All the measurements for the entire series will be reported, not just the measurements for the selected images
   - If you want to export multiple single cine loop images or image frame images or a combination of both image types, expand and select the study rows or series rows that contain the element rows you want to include in your report
   - Press Select to select one row
   - Press CTRL+Select to select a collection of individual rows
   - Press Select+SHIFT+scroll+Select to select a range of rows

3. Press Export.

   The **Export Report** window appears.

4. In the folder browser, browse to the location where you want to export your data and select the folder.

5. If you need to create a new folder to contain the image frames you are exporting:

   a. Click **New Folder**.

   b. Type the name of the new folder and click **OK**.

The system adds a new folder inside the selected folder in the folder browser window.

6. In the **Export Type** section click **Report**.
7. (Optional) In the **Options** section type a unique name to replace the default time stamp.
8. Click **OK**.

   The system exports your report to the folder you selected and returns you to the **Study Browser**.

To export your analysis report from the Analysis Browser:

1. From the **Study Browser**, select the studies, series and images you want to include in your export.

   All the measurements for the entire series will be reported, not just the measurements for the selected images.
2. Click **Analysis**.

   The **Analysis Browser** appears and displays a preview of the report.
3. Press Export.

   The **Export Report** window appears.
4. In the folder browser, browse to the location where you want to export your data and select the folder.
5. In the **Export Type** section click **Report**.
6. In the **Options** section, in the **Save As** box, type the name of your report.
7. Click **OK**.

To export your analysis report from the Mode window:

1. Open a saved image or acquire a new image.

   The **Mode** window displays the image.
2. Add any measurements or annotations to the image.
3. Press Export.

   The **Export Report** window appears.
4. In the folder browser, browse to the location where you want to export your data and select the folder.
5. In the **Export Type** section click **Report**.
6. In the **Options** section, in the **Save As** box, type the name of your report.
7. Click **OK**.

8. The system exports the analysis report for the image you are viewing.

Exporting an analysis report

You can export measurements and calculations as a CSV file that you can import into a spreadsheet or a database for further analysis.

Before you begin

Ensure that the Vevo 2100 Imaging System is connected through the appropriate ports on the rear panel of the system to a data storage location on your network or to an external storage device.

To export an analysis report:

1. Create the analysis report (page 184).
2. Click **Export**.

   The **Export Report** window appears.
3. In the folder browser, browse to the location where you want to export your report and select the folder.
4. If you need to create a new folder to contain the cine loops you are exporting:
   a. Click **New Folder**.
   b. Type the name of the new folder and click **OK**.

      The system adds a new folder inside the selected folder in the folder browser window.
   c. Select the new folder.
5. (Optional) In the **Options** section type a unique name to replace the default time stamp.
6. Click **OK**.

   The system exports all the measurements in the report as a CSV file to the folder you selected.

Section 8

B-Mode imaging and analysis

B-Mode is the imaging mode you will work with most often because it is the most effective mode for locating anatomical structures. If you have seen a conventional ultrasound image then you are already familiar with B-Mode.

B-Mode is also used:

- In other imaging modes as the background orientation image over which the active mode data is applied
- As a real-time orientation window in other imaging mode windows so you can visually guide the transducer to the right location to acquire the most useful data in your active imaging Mode

Related information

- *Mode window workspace* (page 44)
- *Acquiring B-Mode images* (page 190)
- *Analyzing B-Mode images* (page 202)

In This Section

Chapter 33

Acquiring B-Mode images

This chapter shows you how to acquire B-Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical B-Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

To acquire a B-Mode image:

1. Press B-Mode.

   The **B-Mode** imaging window appears and the system begins storing cine loop data in the acquisition buffer.
2. Position the transducer and locate your region of interest.
3. If the image orientation looks backward to you, click the image orientation icon or (on the control panel press Invert) to flip the image view horizontally.

The icon indicates the position of the orientation ridge of your transducer in relation to your image.

4. Adjust the Image Width control to remove image content outside the region of interest to optimize the image data for analysis.
5. Press Presets to cycle through the available presets and then select an appropriate set of optimized image acquisition settings.
6. On the control panel, adjust the B-Mode controls (page 194) to refine your image acquisition settings if required.
7. Press the Scan/Freeze toggle control to stop the data acquisition so you can review the data in the acquisition buffer.
8. Roll the trackball side to side to scroll through the cine loop.
9. If you are satisfied with the cine loop or an individual image frame, store your image data.
   - To save a cine loop press Cine Store.
   - To save and label a cine loop, press Image Label.
   - To save the displayed image frame press Frame Store.
10. Press Scan/Freeze toggle control to resume scanning.
11. Save images as required.
12. Press Close. The system closes the series you are working on and displays the **Study Information** window.
13. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

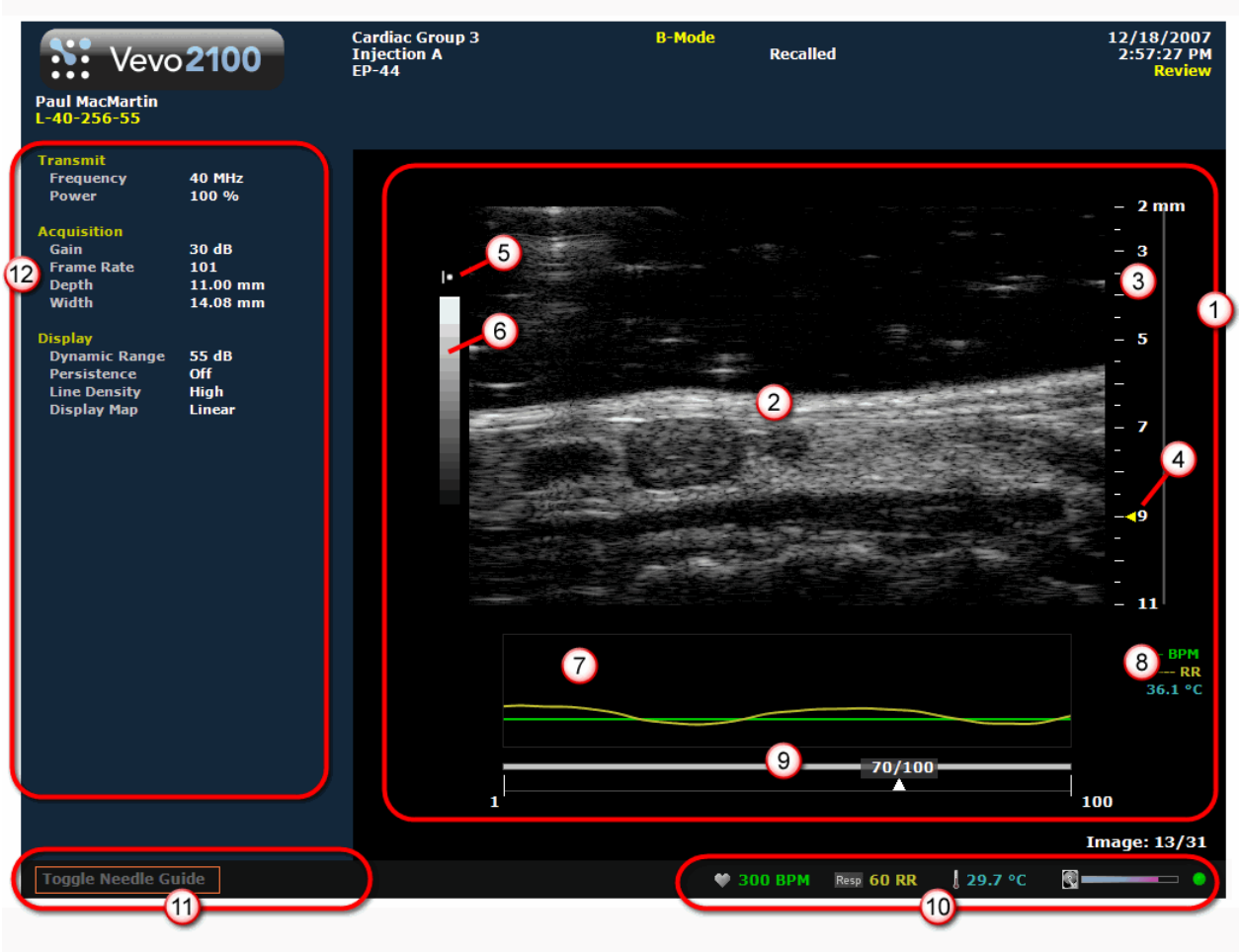
You have successfully acquired B-Mode image data.

Next step

- *Adding generic B-Mode measurements* (page 202)
- *Adding protocol measurements* (page 168)

B-Mode window workspace

The B-Mode window is the workspace you use whenever you view image data in B-Mode. The following illustration and table describes the information and features in the B-Mode window.



Area	Description
1	**Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**Micro-ultrasound image**. Displays the B-Mode data that the transducer acquires. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.
3	**Image scale.** Indicates in *mm* the distance from the face of the transducer.

Area	Description
4	**Focal depth indicator**. When you acquire data, use the **Focal Zones** control on the control panel to add up to three focal zones.
5	**Transducer orientation indicator**. The line in this icon corresponds to the orientation ridge on the transducer and indicates the orientation of the probe relative to the image.
6	**Dynamic range bar**. Indicates the input signal strength that is mapped into the gray scale of the display. When you acquire data, use the **Dynamic Range** control on the control panel to change the range.
7	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station. During an image review you can add time and ECG amplitude measurements in this window.
8	**Live physiological data values**. Displays the recorded numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature.
9	**Cine loop range control**. Displays the length of the cine loop range. The triangular white marker identifies the individual frame number within the cine loop. You can drag the left and right vertical markers to display only the image frames in that range.
10	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
11	**Screen keys display** ▪ Displays the updated parameter and system information when you make adjustments on the control panel. ▪ Displays control options in the mode that you apply during image acquisition when you press the Screen Keys dial.
12	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).

Control panel controls for B-Mode

When you are acquiring B-Mode image data, these are the controls you use to optimize the image you see on the screen.

1

Image Width

Adjusts the physical width of the area the transducer is imaging. Push up to increase the width. Pull down to decrease the width.

Tip: The closer you can reasonably narrow the width of your image around your target structure, the higher the system sets the acquisition frame rate. This is especially helpful when you are studying cardiac tissue movement.

2

Display Map

Cycles you through a predefined set of optimization maps that you can apply either while you are acquiring or reviewing image data.

Push up or pull down to cycle through the available maps for the active imaging mode.

③ **Image Depth**

Adjusts how deep in *mm* you want to display the ultrasound signal. Pull down to increase the depth. Push up to decrease the depth. The available depth is transducer dependent.

④ **Focus Depth**

Adjusts the depth of the B-Mode focal zone or focal zones on your image. When you have more than one focal zone this control moves the depth of all the focal zones as a group. Push up to decrease the depth. Pull down to increase.

⑤ **Focal Zones**

This control adjusts the number and configuration of focal zones on your B-Mode based image.

Focal zones enhance the resolution across your image, while slightly reducing the acquisition frame rate. The system always displays at least one focal zone, and you can apply a maximum of two additional zones depending on the transducer. When you add focal zones the system maximizes the resolution for a larger area of your image, and reduces the acquisition frame rate.

To use this rocker switch control:

1. Push the rocker switch forward to cycle through the following focal zone application sequence:
   - Single zone
   - Two zones, narrow
   - Two zone, wide
   - Three zones, narrow
   - Three zones, wide
2. Pull the rocker switch back to cycle back through the focal zone options in reverse.

6

Presets

Active during image acquisition in all modes except 3D-Mode. This rocker switch cycles you through all the preset groups of acquisition parameters for the active imaging Mode. The list of presets include the transducer-specific presets as well as any custom presets that other operators added to the system.

All presets are both mode dependent, transducer dependent and application dependent.

7

Transmit Power

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

8

Depth Offset

Available during all acquisition sessions for all modes that are based on B-Mode or include a B-Mode scout window. Adjusts, in 1mm increments, the distance from the face of the transducer at which the system begins to display the ultrasound image.

To use this rocker switch control:

- Pull down to remove a 1mm strip of image data from the top. For example, if your transducer is set to acquire data from 2mm to 12mm, when you pull the control down once, the display will only show the data between 3mm and 12mm. The minimum depth varies by transducer.
- Push up to add a 1mm strip of image data to the top.

9

Line Density

Adjusts the resolution of your image by adjusting how many lines of image data the transducer acquires over your image area. Push up to increase the line density. Pull down to decrease.

The higher you set your line density, the lower the system sets the acquisition frame rate. Because of this trade off, you might find that higher line density is most useful for examining features in tissues that don't move very much such as liver, spleen, pancreas, and prostrate.

For cardiology applications, you will tend to keep the line density lower so you can increase the frame rate to measure more tissue movements over the time span of a complete cardiac cycle.

10

Persist

Applies a pixel averaging algorithm to the most recently acquired frames to produce a more uniform view of the faster moving areas in the image data.

To use this rocker switch control:

Push up or down to cycle through the persistence levels. In the bottom-left corner of the screen the status bar briefly displays the name of the persistence label as you select.

In B-Mode: Reduces distracting artifacting such as shimmering effects. Levels: Off, Low, Med, High. This is most useful when you are imaging uniform tissues such as the liver, kidney and prostate.

11

Dynamic Range

Adjusts the input signal strength that is mapped into the spectral display. Range: 5-100dB.

- Push up to increase the range by 5dB and lower contrast. Higher dynamic ranges are often used in cardiac imaging.
- Pull down to decrease the range by 5dB and increase contrast. Lower dynamic ranges are often used in abdominal imaging.

12

B-Mode

Activates B-Mode acquisition and begins displaying the acquired B-Mode data in the B-Mode window.

13

2D Gain

Adjusts the strength of the ultrasound signal when it returns to the face of the transducer. Range values for the control are specific to each individual transducer.

Turn clockwise to add gain and brighten your entire image. Turn counterclockwise to reduce gain and darken your image.

B-Mode acquisition settings

To view the B-Mode acquisition settings:

Press Mode Settings.

The B-Mode acquisition settings panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.

Acquisition

Parameter	Description
Gain	The strength of the ultrasound signal in *dB* increments when it returns to the face of the transducer. Adjust with the 2D Gain control.
Frame Rate	The number of image frames per second that the system is acquiring.
Depth	The distance, measured in mm, from the face of the transducer. Adjust with the Image Depth control.
Width	The width of the acquired image area, measured in *mm*. Adjust with the Image Width control.

Display

Parameter	Description
Dynamic Range	The contrast of your image, measured in dB. Adjust with the Dynamic Range control.
Persistence	The state of the Persistence feature: Off, Low, Med, High, Max. Adjust with the Persist control.
Line Density	The line density level. One of four settings: Quarter, Third, Half, Full. Adjust with the Line Density control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.

Adding focal zones

Focal zones enhance the resolution across your image, while slightly reducing the acquisition frame rate. The system always displays at least one focal zone, and you can apply a maximum of two additional zones depending on the transducer. When you add focal zones the system maximizes the resolution for a larger area of your image, and reduces the acquisition frame rate.

To add a focal zone:

1. Press Focal Zones to add one or two additional focal zones to the initial focal zone.
   - Push once to add a second focal zone at the standard spread
   - Push twice to add the second focal zone at the minimum spread
   - Push three times to add a third focal zone and set the zones at the standard spread
   - Push four times to add the third focal zone and set the zones at the minimum spread
   - Push one more time to return to a single focal zone
2. Press Focus Depth down or up to increase or decrease the depth of all focal zones.

Visualizing injections with a needle guide overlay

When you are injecting an animal the needle guide overlay feature helps you visualize the alignment of your needle with your injection target.

To ensure that your needle appears in the image area, you must submerge the needle in water (for externalized targets) or insert it in the anatomy of the animal.

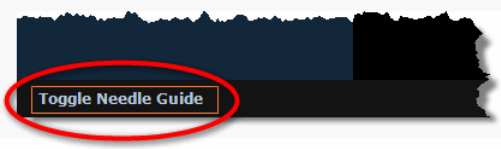
Before you begin

If you intend to save a cine loop of your injection, make sure that you have set your B-Mode cine loop size to a sufficient length to capture the event.

To perform a typical image-guided needle injection:

1. Begin acquiring image data in B-Mode.

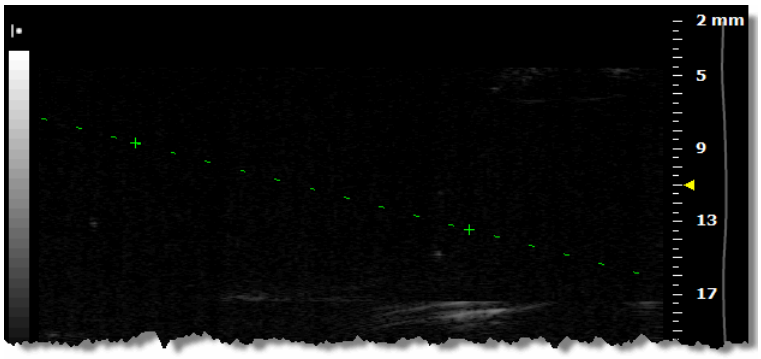
2. With the injection target below focus or out of the plane, using the *Vevo 2100 Imaging Station* physically extend the needle into the image, toward the expected target location. Bring the needle tip as close to the focal depth as possible.
3. Turn the Screen Keys dial to highlight the **Needle Guide Overlay** option that is displayed at the bottom left corner of the window.



4. Turn Screen Keys to activate the **Needle Guide Overlay** feature.
5. Turn Screen Keys again to display the caliper cursor.
6. Position the caliper cursor on the tip of the needle (where it appears on the screen), then click to apply the first caliper.
7. Trackball to the location where the needle enters the edge of the image window.

   As you move the cursor, the system applies a green dashed overlay line that follows your cursor.
8. Click to apply the second caliper.

   The system applies the caliper and extends the needle guide overlay through both calipers and across the B-Mode image area.



9. To toggle the needle guide overlay on and off, press Screen Keys.
10. Using the *Vevo 2100 Imaging Station* physically retract the needle. Ensure that the needle moves along the needle guide overlay.
11. Bring the target into the image plane and line up the target with the needle guide that indicates the needle tip.
12. Physically bring the needle into the image plane.
13. Advance the needle tip to the tissue target and start your guided injection.
14. When the needle tip is within the target area inject the sample.

15. To save a cine loop of the injection event, press Cine Store.
16. Physically retract the needle using the *Vevo 2100 Imaging Station*.

Related information

- *Cine Loop Size preferences* (page 71)
- *Typical B-Mode image acquisition* (page 190)
- *Saving a cine loop* (page 122)

Chapter 34

Analyzing B-Mode images

This chapter shows you how to analyze B-Mode images that are saved to a study.

In this chapter

Adding generic B-Mode measurements

B-Mode provides seven generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

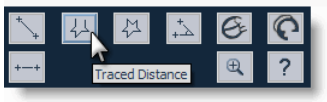
Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for B-Mode:

- If you are acquiring B-Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.



  Hover over a tool to see the description label.

Linear distance measurement

Linear distance is measured in *mm*.

To place a linear distance measurement:

1. Click the linear distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Traced distance measurement

Traced distance is measured in *mm*.

To place a traced distance measurement:

1. Click the traced distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place the final caliper of your trace. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

2D Area measurement

2D Area is measured in mm^2.

To place a 2D area measurement:

1. Click the 2D area measurement button  .
2. Click on your image to place the initial caliper.

3. Trackball along the contour of your target tissue and then right-click to place your last caliper.

   If the position of the trackball cursor is within five pixels of the previous caliper when the right-click occurs, the system sets the previously placed caliper as the last caliper and auto-closes the measurement. This feature applies to 2D area measurements in B-Mode, 3D-Mode, and Contrast Mode as well as for 3D-Mode volume contours.

4. The system adds the final line segment to connect your last caliper with your first. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Angle measurement

Angles report interior angle values and are therefore always less than 180 degrees Angles are measured in *deg*.

To place an angle measurement:

1. Click the angle measurement button  .
2. Click on your image to place the initial caliper. This is the outside end of the first ray of your angle.
3. Trackball to where you want to position the vertex of your angle and then click to place the caliper. This completes the first ray.
4. Trackball to the position where you want to end the second ray and then click to place the final caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

LV Area long axis measurement

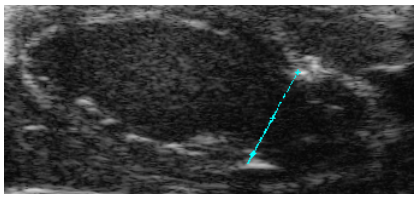
Use the LV wall trace measurement to trace the endocardial wall through multiple cardiac cycles, semi-automatically or manually.

This is an optional function, and is available only if the Automated LV Analysis package is purchased.

To place an LV area long axis measurement semi-automatically:

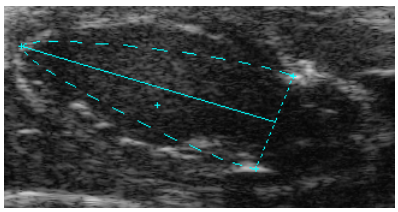
1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Click the LV area long axis measurement button . The system highlights the button until you complete your measurement.
3. Click the upper wall of the aortic annulus and then the bottom wall of the annulus.

   The system places a straight line between these points to define the top of the LV precisely, as shown in the following long axis example.

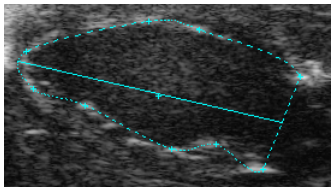


   If you selected the short axis view for analysis, the system does not insert an annulus line

4. Click a point toward the apex on the interior wall. This creates the basic curve.



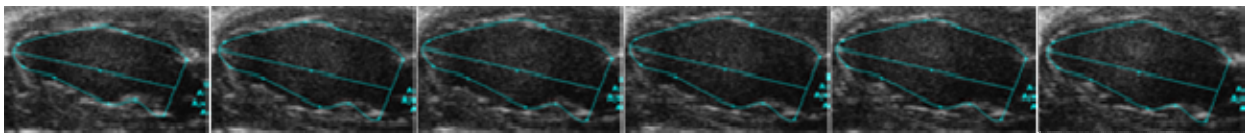
5. Continuing to click along the wall to create a contour that traces the area of the wall.



In this example, six wall points have been added to the trace curve

Right-click the final point on the contour to complete the measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement **B-Mode LV Area #**, where **#** is a sequential number.

6. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.
7. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.
8. Move to another frame in the cine loop and place another LV area long axis measurement.
9. Right-click the contour and select **Replicate Forward** or **Replicate Reverse** with additional options to define how many cycles: either 2 or 3. The system automatically traces the wall forward or backward through the frames.



Frame 1: traced manually *The system traces the remaining frames automatically*

10. Modify the contour or points on the contour if required and then select **Replicate Forward** again to complete the automatic wall trace.
11. Press Cine Store to save the cine loop.

When you play the cine loop, the system displays the contour that represents the systolic LV in green, and the diastolic LV in red.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)

Modifying points on an LV area trace

To modify points on a contour:

- **To move a point**, drag it to a new position, then click again to commit the point
- **To add a point**, click the contour, move the cursor to a new position, then click again to commit the new point
- **To delete a point**, right-click the point and select **Delete Point**

Modifying the LV area trace

To modify a contour:

- **To move the contour** (all the caliper points as a group) click the center point of the trace, trackball to the new position, then click again to commit the contour.
- **To resize the contour**, click the contour, trackball the cursor inward or outward to change the size, then click to commit the resized contour.
- **To delete the contour**, right-click the curve and select **Delete**.

LV Area short axis measurement

To place an LV area short axis measurement:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Click the LV area short axis measurement button  . The system highlights the button until you complete your measurement.
3. Click to place a point along the myocardial wall in the center of the wall.
4. Continue to click and add additional points around the wall. The loop contour forms to the points that you add.
5. Right-click the final point on the contour to complete the measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
6. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.

7. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.
8. Right-click the contour and select **Replicate Forward** or **Replicate Reverse** and select the number of cycles. The system automatically traces the wall forward or backward through the frames.
9. Press Cine Store to save the cine loop.

When you play the cine loop, the system displays the contour that represents the systolic LV in green, and the diastolic LV in red.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button  . The system highlights the button until you complete your measurement.
2. In the physiology data trace window below the image mode data, click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Adding protocol measurements

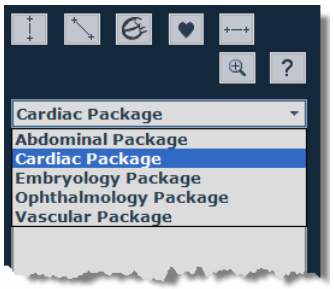
Protocol measurements are labeled uniquely for a specific measurement protocol.

To access the protocol measurement tools and measurements list

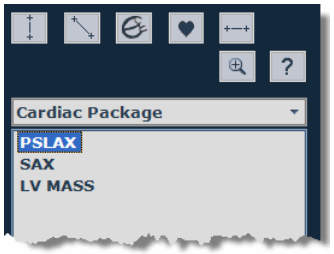
- If you are in an image acquisition session press Scan/Freeze to acquire an image and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

To place a protocol measurement:

1. In the measurement packages drop-down list click the appropriate package.



2. In the list of protocols, select the appropriate protocol.



3. In the list of measurements, select the measurement you want to add.

   The system automatically activates the appropriate measurement tool and highlights the generic button for that tool.

4. On the image, add your measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Protocol measurements* (page 167)

Lens radius measurement

The lens radius measurement is only available in the Ophthalmology measurement package for B-Mode images. Lens radius is measured in *mm*.

To place a lens radius measurement:

1. Open an existing eye image or begin acquiring an eye ultrasound image and then press Scan/Freeze.
2. Press Measure.
3. In the drop-down list of measurement packages select **Ophthalmology**.
4. In the list of measurements click **Lens Radius**.
5. Click on your image to place the initial caliper at one end of the radius.
6. Trackball along the contour of the lens to the center of your radius and then click to place the center caliper.
7. Trackball to the end of the radius and click to place the caliper.

   The system instantly transforms the angle rays to a curve. When you complete the measurement the system stores it.
8. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Creating pressure-volume loop measurements in B-Mode

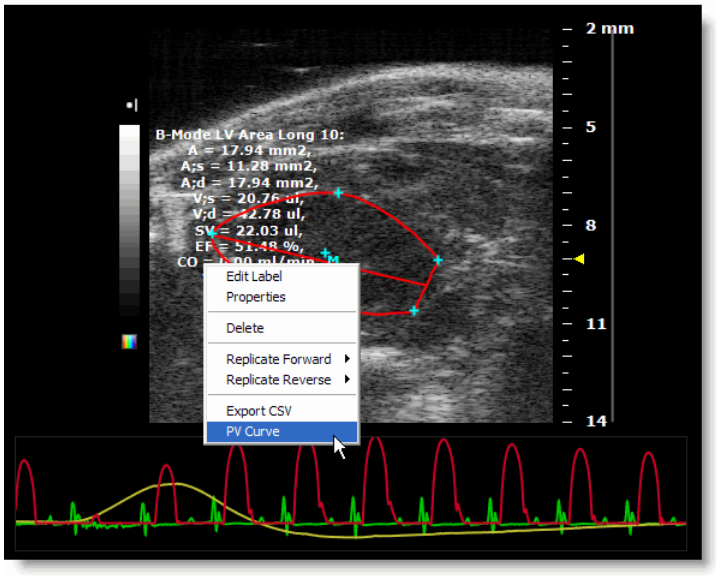
Pressure-volume (PV) loop measurements provide a graphical method of identifying and evaluating LV pressure-volume relationship changes related to dynamic levels of cardiac stress.

You can generate PV loops from LV area measurements on both B-Mode and M-Mode images that are accompanied by a continuous blood pressure trace. These traces are typically acquired from a blood pressure catheter.

To obtain PV loops from a B-Mode image:

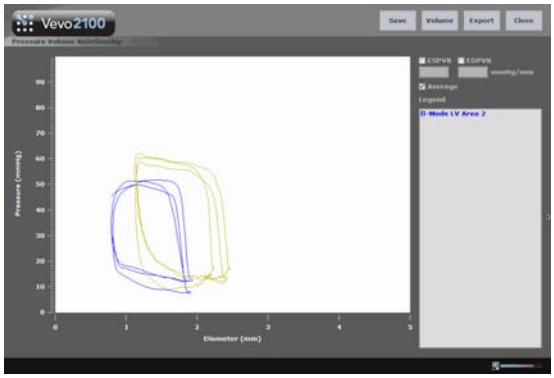
1. Create a B-Mode cine loop of the heart in a long-axis orientation.
2. Complete a B-Mode LV Area measurement (page 205) that includes at least two cardiac cycles.

3. Right-click the measurement and select **PV Curve**.



> **Note:** The PV Curve menu command is not available if the image does not include blood pressure data.

4. The system calculates the pressure-volumes of the cardiac cycles and plots them as a graph on the Pressure Volume Relationship window.



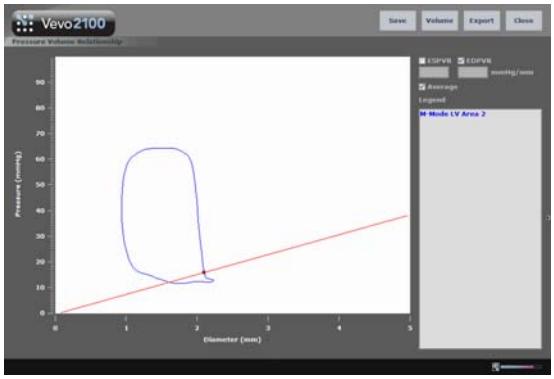
Pressure-Volume relationship graphs

When you have generated pressure-volume graph data, you can use the tools on the Pressure Volume Relationship window to:

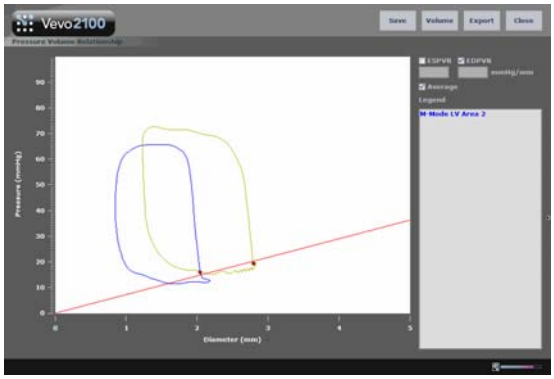
- Display the end systolic PV points
- Display the end diastolic points
- Display a loop that represents a virtual or averaged cardiac cycle
- Toggle the horizontal dimension between Volume and the basic dimension of the loops
- Export the pressure-volume relationship data

ESPVR check box

Check this box to display the end systolic PV points.



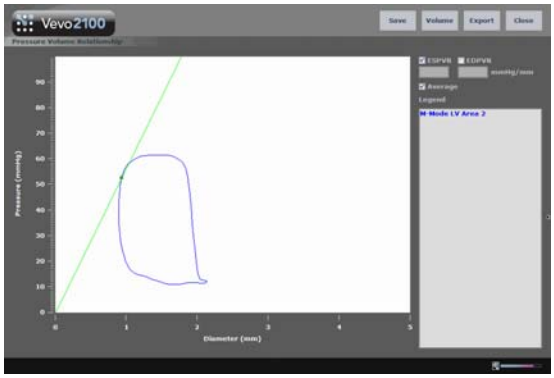
If the graph displays a single loop, the system plots a green dot on the curve at the End Systolic point.



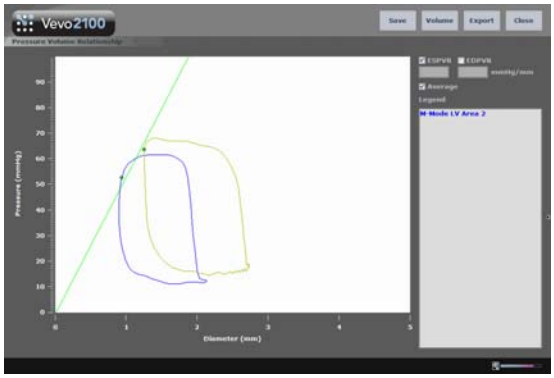
If the graph displays multiple loops, the system plots a best-fit line through the End Systolic points.

EDPVR check box

Check this box to display the end diastolic points.



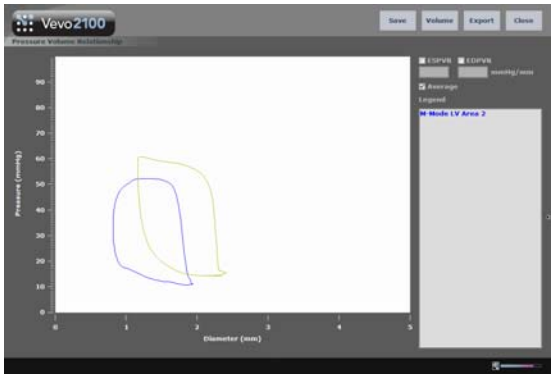
If the graph displays a single loop, the system plots a red dot on the curve at the End Diastolic point.



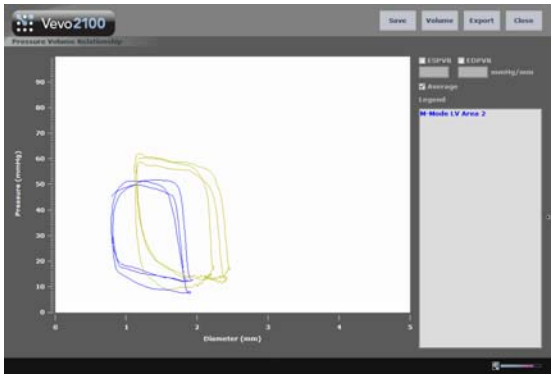
If the graph displays multiple loops, the system plots a best-fit line through the End Diastolic points.

Average check box

Check this box to display a loop that represents a virtual or averaged cardiac cycle, calculated from the aggregate cycles defined by each LV wall trace. Clear the check box to display all cardiac cycle instances. This check box is selected by default.



When the Average option is selected, the graph displays a single smooth loop.



When the Average option is cleared, the graph plots the cardiac cycle.

Volume command

Click this command to toggle the horizontal dimension between Volume and the basic dimension of the loops. For measurements made in M-Mode the dimension is Diameter in millimeters. For measurements made in B-Mode, the dimension is Area in square millimeters.

Export command

Click this command to export the data as one of three file formats:

- **CSV** file. Can be imported into a spreadsheet or database.
- **BMP** file. Exports the graph data as a bitmap image.
- **TIFF** file. Exports the graph data as a vector based image.

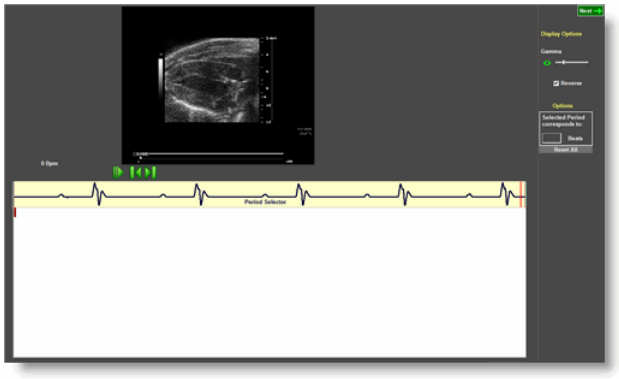
Strain rate step 1: Adding the LV wall trace

You measure strain rate using the system's VevoStrain™ application. Included within the Vevo 2100 Imaging System, this tool produces velocity strain and time-to-peak analyses on myocardial wall images.

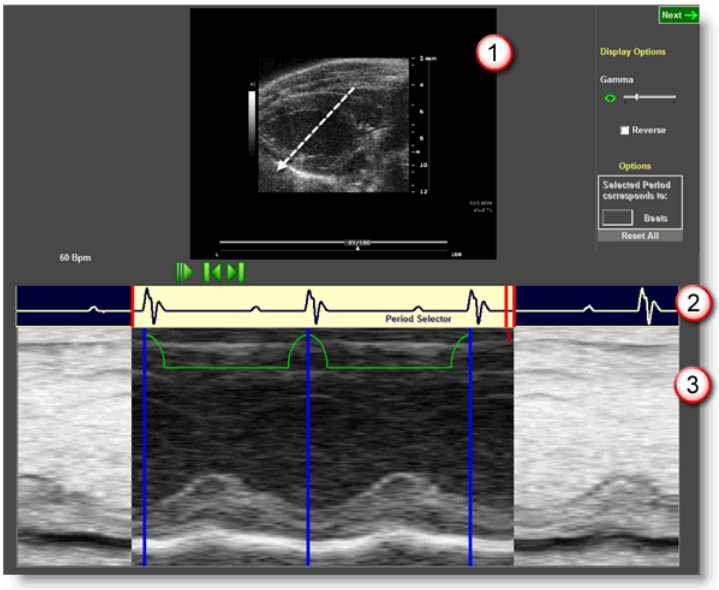
▶ To create the LV wall trace:

1. From the **Study Browser**, select the B-Mode cine loop you want to analyze and then click **Vevo Strain**.

The system processes the cine loop and then displays the cine loop in the VevoStrain workspace.



2. In the B-Mode panel (area ① as shown below):
   a. Use the playback controls below the B-Mode scout window to display the image frame you want to work with.
   b. Click above the LV wall, trackball across the chamber to beyond the opposite wall at whatever angle you prefer, and then right-click to set the AM-Mode cross-section.

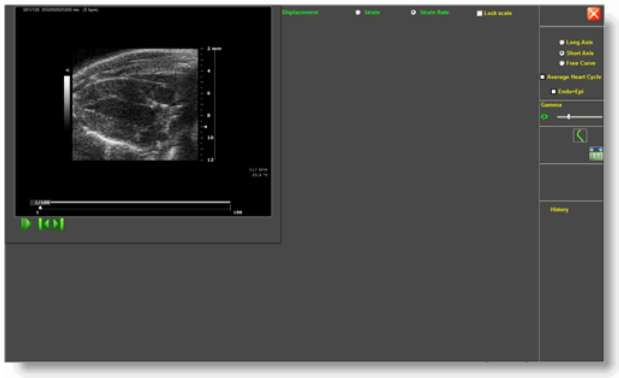


   c. Select the Reverse check box if you want to switch the grayscale contrast values for the background you will work with in the VevoStrain analysis window.
3. In the EKG panel (area ②):
   a. On the left side drag the single red slider to the position where you want the data period to begin.
   b. On the right side drag the double red slider to the end of your data period. In the example above, the period includes three R waves.

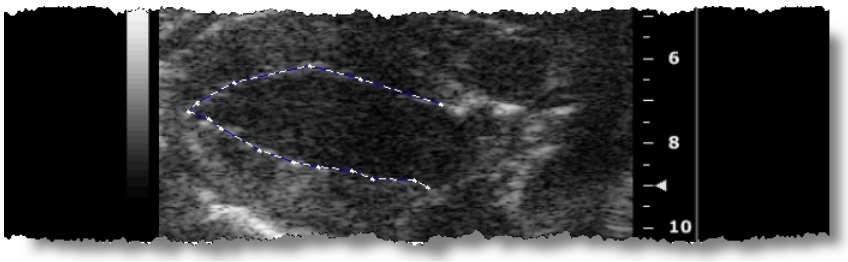
4. On the AM-Mode image (area ③):
   a. Click on the R wave where for the first cardiac cycle. The system applies a vertical blue line.
   b. Click on the other R waves to add the remainder of your cardiac cycles. The system applies a second blue line and connects the two lines with a green line.

      For the best results, create your selection period between one respiration cycle and the next.
   c. If you want to change the position of a line, click it to delete it, and then click again at the new position.
5. In the upper-right corner click **Next**.

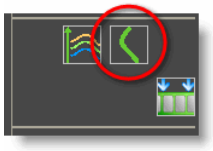
   The cine loop appears in the VevoStrain LV wall trace workspace.



6. At the top of the screen, select the appropriate strain measurement.
7. In the right panel:
   a. Select the type of trace you will create (Short Axis, Long Axis, Free Curve).
   b. Select whether you want the system to calculate the average heart cycle.
   c. Select if you want the system to simultaneously trace both the Endocardium as well as the Epicardium. (If you do select this option, use the control to expand or contract the automatic outer wall trace to fit the outer wall.)
8. Click to add points along the inner wall, and right-click to complete the trace.

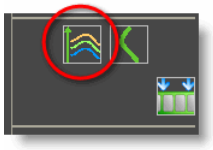


If you want to delete the trace and start again, delete the old trace from the History and select a new trace.

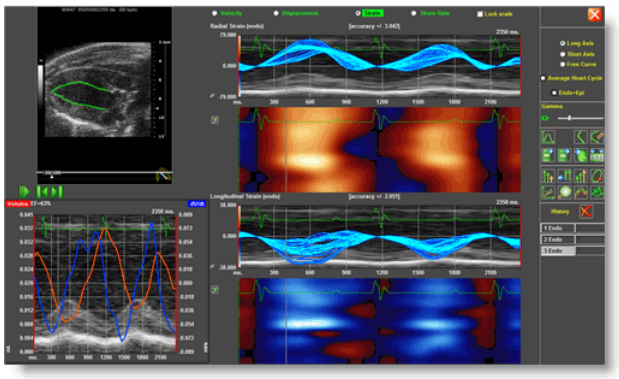


If you want to return to the AM-Mode view to select a new cardiac period, click the Sequence button below, create the new period and then click **Next** again.

9. Click the Start Analysis button.



10. VevoStrain builds the dynamic LV wall trace for all frames in the cine loop and graphs the results in the analysis workspace.



Next:

- *Strain rate step 2: Analyzing the data* (page 217)

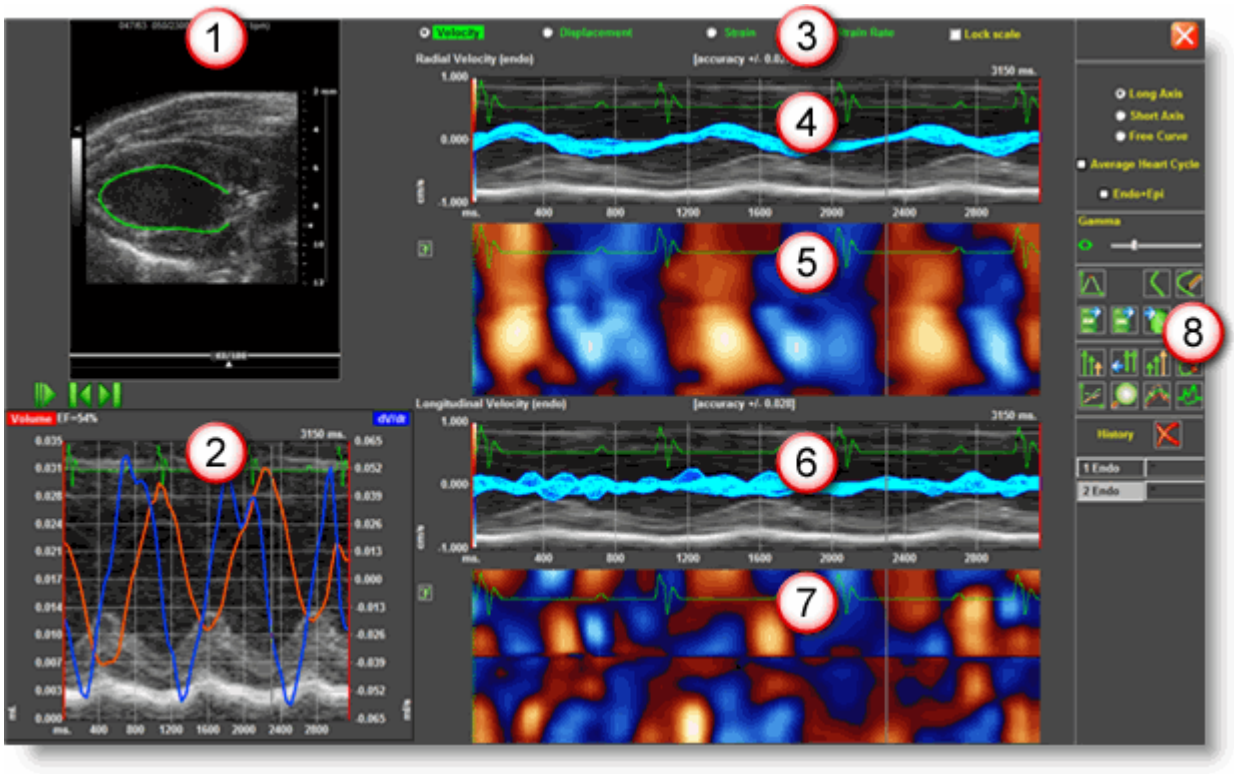
Strain rate step 2: Analyzing the data

Before you begin

- You must complete the procedure in *Strain rate step 1: Adding the LV wall trace* (page 213).

VevoStrain analysis window workspace

The following illustration and table describes the information and features in the VevoStrain analysis window workspace.



Area	Description
1	**LV wall trace on B-Mode cine loop.** Features the automatic endocardial wall trace through all frames. Use the playback controls to move through the cine loop frames. As you move through the cine loop, the time lines in the other graphs match the position.
2	**Derivative distribution graph.** For the long axis, the graph displays the volume and volume derivative. For the short axis, displays the area and area derivative.
3	**Graph type options.** Includes Velocity, Displacement, Strain, Strain Rate.
4	**Graph.** Velocity distribution along the radial axis.

Area	Description
5	**Graph.** Parametric distribution for the radial axis.
6	**Graph.** Velocity distribution along the longitudinal axis.
7	**Graph.** Parametric distribution along the longitudinal axis.
8	**Analysis tools group.** Includes: ▪ Row 1 (top row): Time to Peak Analysis, New Trace, Edit Trace. ▪ Row 2: Export AVI, Export Picture, Export Data, Sequence/M-Mode Selection. You can export modalities from the VevoStrain™ package, independently from the Vevo 2100 Imaging System, in TIFF and JPEG image formats, AVI formats for cine loops - compressed and uncompressed, and data export to TXT format. ▪ Row 3: Decrease Vector Size, Reset Vector Size, Increase Vector Size, Toggle contour/vector/orbit line/B-Mode. ▪ Row 4: Reset Graphs Display, Zoom In/Out, Toggle Filtered/Unfiltered Plots, Bkg M-Mode Display ▪ Row 5: Delete Selected Contour.

Visualizing wall trace tendencies in VevoStrain

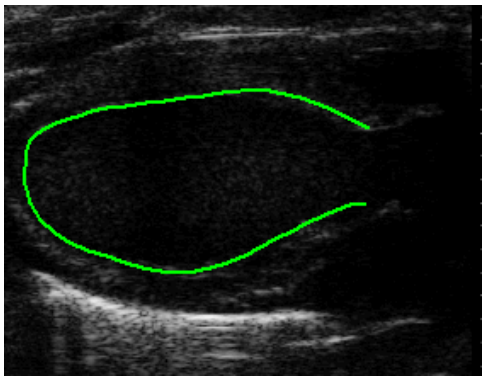
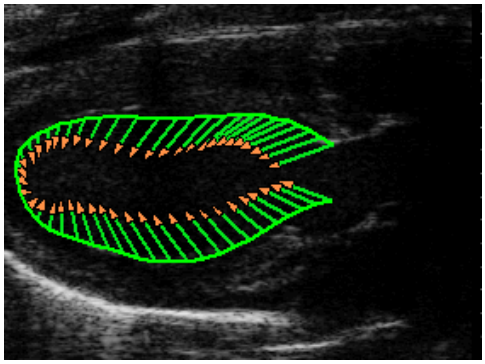
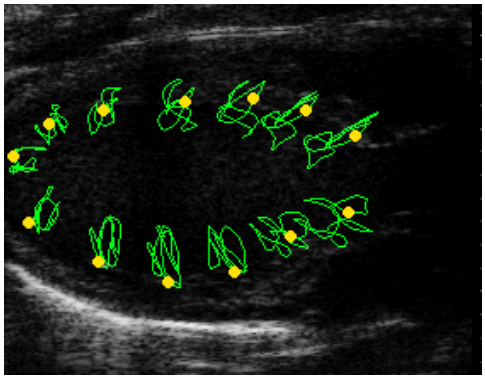
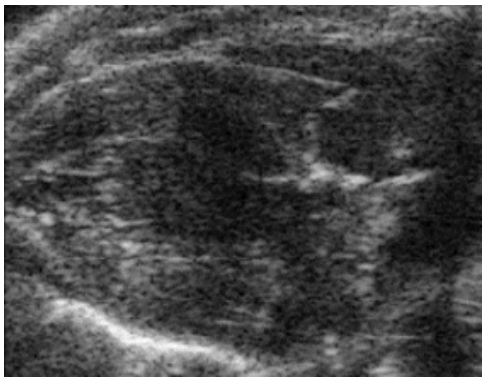
Before you begin

- You must complete the procedure in *Strain rate step 1: Adding the LV wall trace* (page 213).

Every point used for calculations is displayed with an associated vector. As you play back the cine loop you can visualize the directional tendencies for different parts of the cardiac contour in different points of the cardiac cycle.

To view the directional tendencies of the LV wall trace:

1. Click the contour/vector/orbit line/B-Mode button  . Toggle the button as illustrated in the following table.

Image	Toggle description
	Contour
	Vector
	Orbit line
	B-Mode

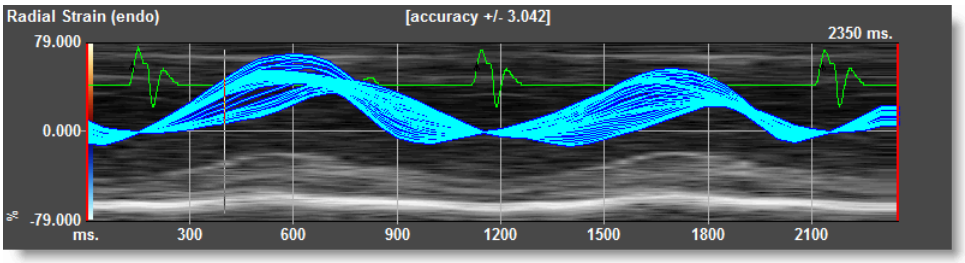
2. To modify the size of the vector use the Decrease Vector Size, Reset Vector Size or Increase Vector size buttons on row three of the analysis tools group.

Displaying individual curves for specific points on the trace in VevoStrain

Before you begin

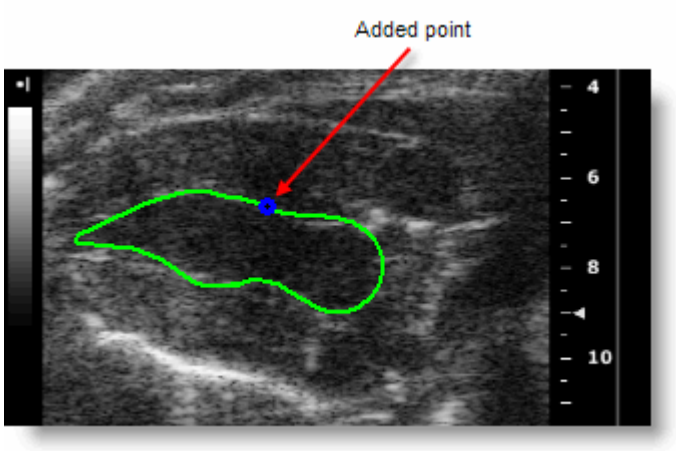
- You must complete the procedure in *Strain rate step 1: Adding the LV wall trace* (page 213).

By default the system displays all the curves for the individual points along the trace.

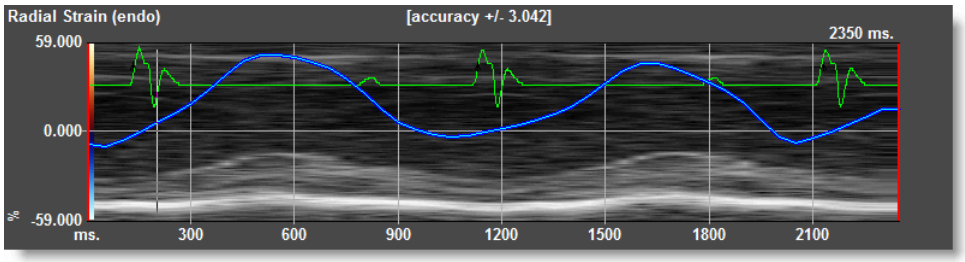


To display the curve for a specific point on the trace:

1. Click on the contour to create a point.

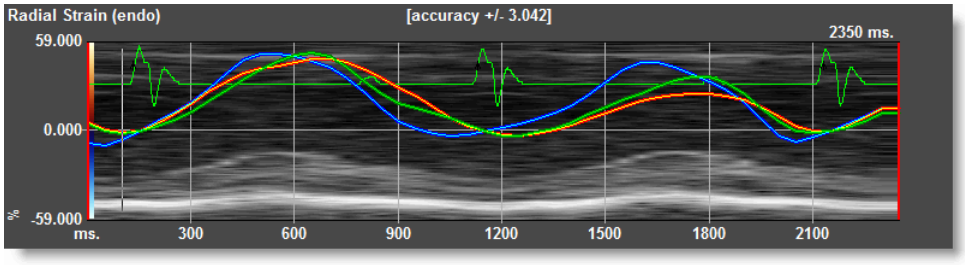


2. The graph displays the curve for the individual point.



3. If required, add more points onto the trace.

4. The system applies unique colors to the additional points on the trace and the corresponding curves on the graph.



Analyzing time-to-peak in VevoStrain

Before you begin

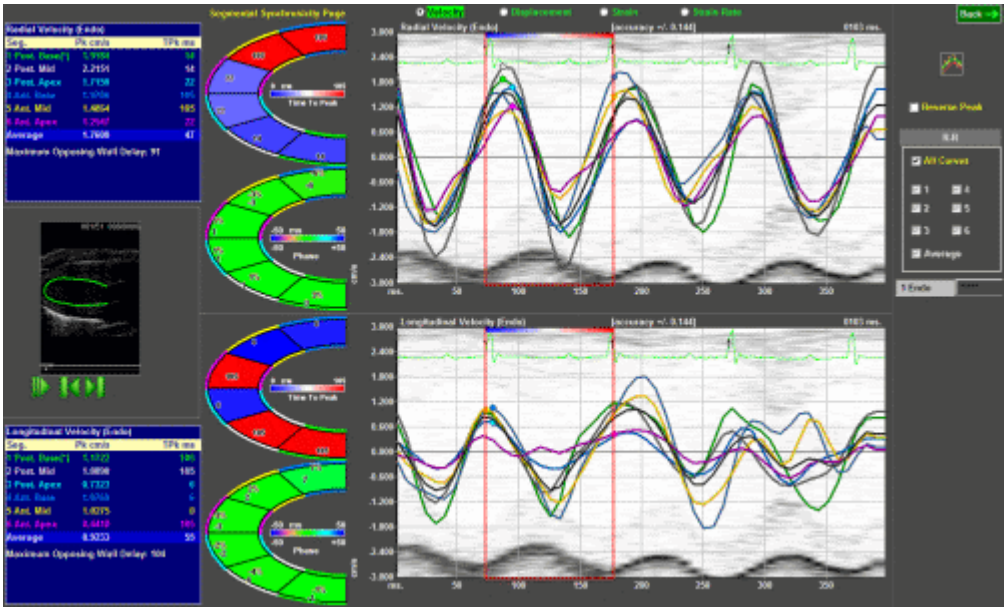
- You must complete the procedure in *Strain rate step 1: Adding the LV wall trace* (page 213).

Time-to-peak analysis displays the synchronicity and phase for different segments of the heart. The display for the segments varies depending on the view of the heart: long/short axis or apical.

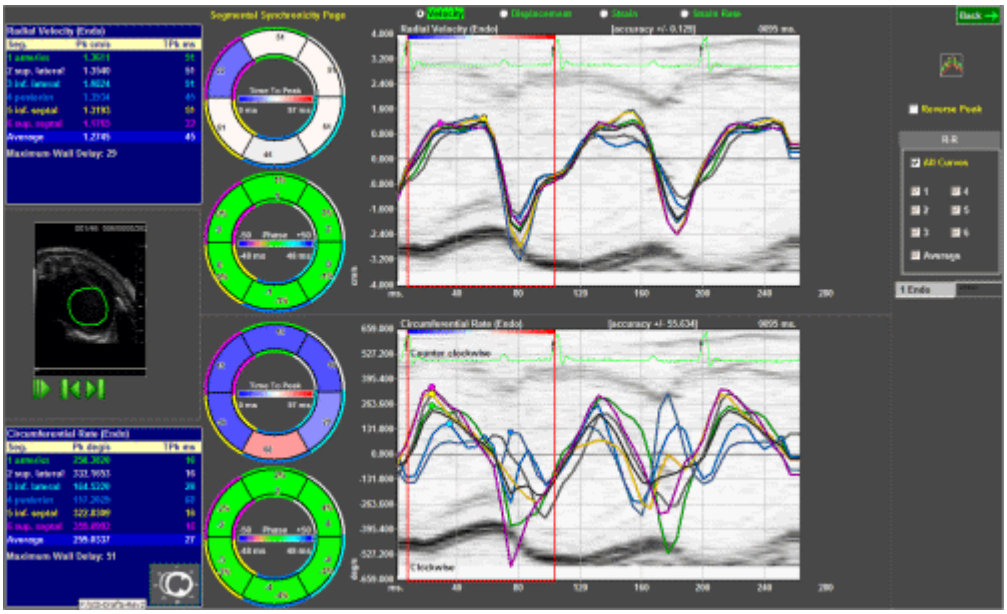
To view the time-to-peak analysis:

Click the Time-to-Peak button  .

The time-to-peak window for your selected cardiac period appears.



Time-to-peak window for long axis wall data



Time-to-peak window for short axis wall data

Features

- Time-to-peak is calculated as the time from the reference axis, 0.000, to the maximum peak (negative or positive), for each of the segments of the heart in the specific view.
- Low time-to-peak comes displayed in blue and high in red.
- The phase measures the synchronicity located between regions of the heart for a selected time interval. As a method of analysis, the phase in this case is defined as the first fundamental Fourier harmonic, each one of the curves is compared to the average curve, and expressed in time delay and percentage of heartbeats.
- Each of the heart sectors is represented by a corresponding graph and a designated color. You can display all the curves simultaneously or select them separately.
- The parameters time-to-peak and phase are quantified on the color wheel keys displayed to the left of the charts. The minimum and maximum range is calculated based on the contour that you trace on the B-Mode image.
- You can apply time-to-peak analysis to Velocity, Displacement, Strain and Strain Rate.
- In the right panel, turn all curves or individual curves on or off.

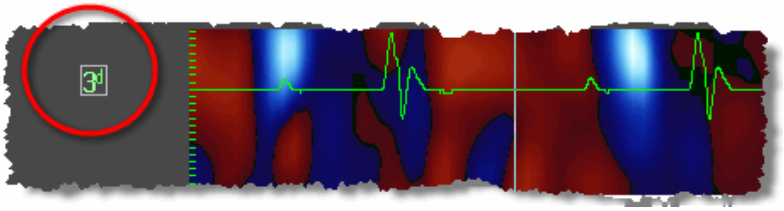
Viewing strain data in 3D in VevoStrain

Before you begin

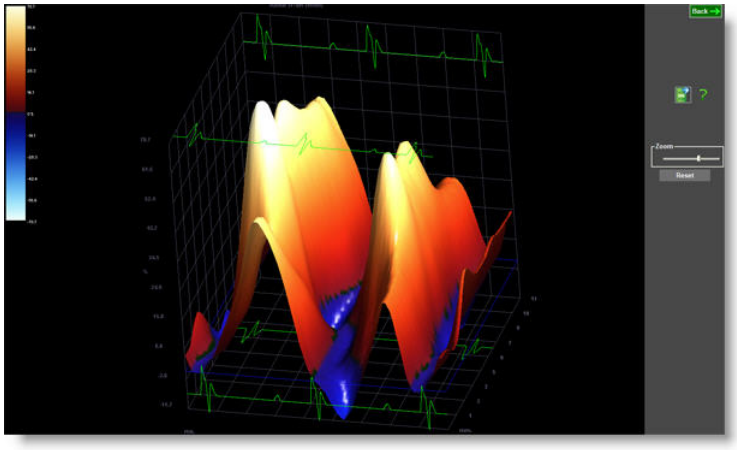
- You must complete the procedure in *Strain rate step 1: Adding the LV wall trace* (page 213).

To view strain data in 3D:

1. From the VevoStrain analysis window, click the 3d button that is located to the left of the parametric distribution graph.



2. The system displays the strain rate data in three dimensions.



3. Modify your view of the data.
   - Drag the image to rotate the image on any axis
   - Move the **Zoom** slider as needed
4. If you want to save the image, click the Export Picture button located above the Zoom slider.

Section 9

M-Mode imaging and analysis

M-Mode is used primarily to measure the movement of structures in the heart such as valves, chambers, and walls.

In This Section

Chapter 35

Acquiring M-Mode images

This chapter shows you how to acquire M-Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical M-Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

To acquire an M-Mode image:

1. Start imaging in B-Mode and position the transducer to situate your region of interest in the center of the image area.
2. Adjust the Image Width control to remove image content outside the region of interest to optimize the image data for analysis.
3. Press M-Mode.

The system begins acquiring B-Mode image data and displays the yellow M-Mode sample gate overlay on the B-Mode image.

4. Press Update or press M-Mode again.

   The dual-window **M-Mode** image area workspace appears. The M-Mode window is on the bottom, the B-Mode scout window is on the top.

   The system begins storing cine loop data in the acquisition buffer, and live acquisition data appears in both windows.

5. (Optional) To display a larger B-Mode window so you can guide the position of your transducer more precisely:

   a. Press Update to display the full B-Mode window.

   b. When you have positioned your transducer, press Update again to return to the dual-window workspace.

6. Press Presets to cycle through the available presets and then select an appropriate set of optimized image acquisition settings.

7. On the control panel, adjust the M-Mode controls (page 229) to refine your image acquisition settings if required.

8. Press the Scan/Freeze toggle control to stop the data acquisition so you can review the data in the acquisition buffer.

9. Roll the trackball side to side to scroll through the cine loop.

10. If you are satisfied with the cine loop or an individual image frame, store your image data.

    - To save a cine loop press Cine Store.
    - To save and label a cine loop, press Image Label.

11. Press Scan/Freeze toggle control to resume scanning.

12. Save images as required.

13. Press Close. The system closes the series you are working on and displays the **Study Information** window.

14. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

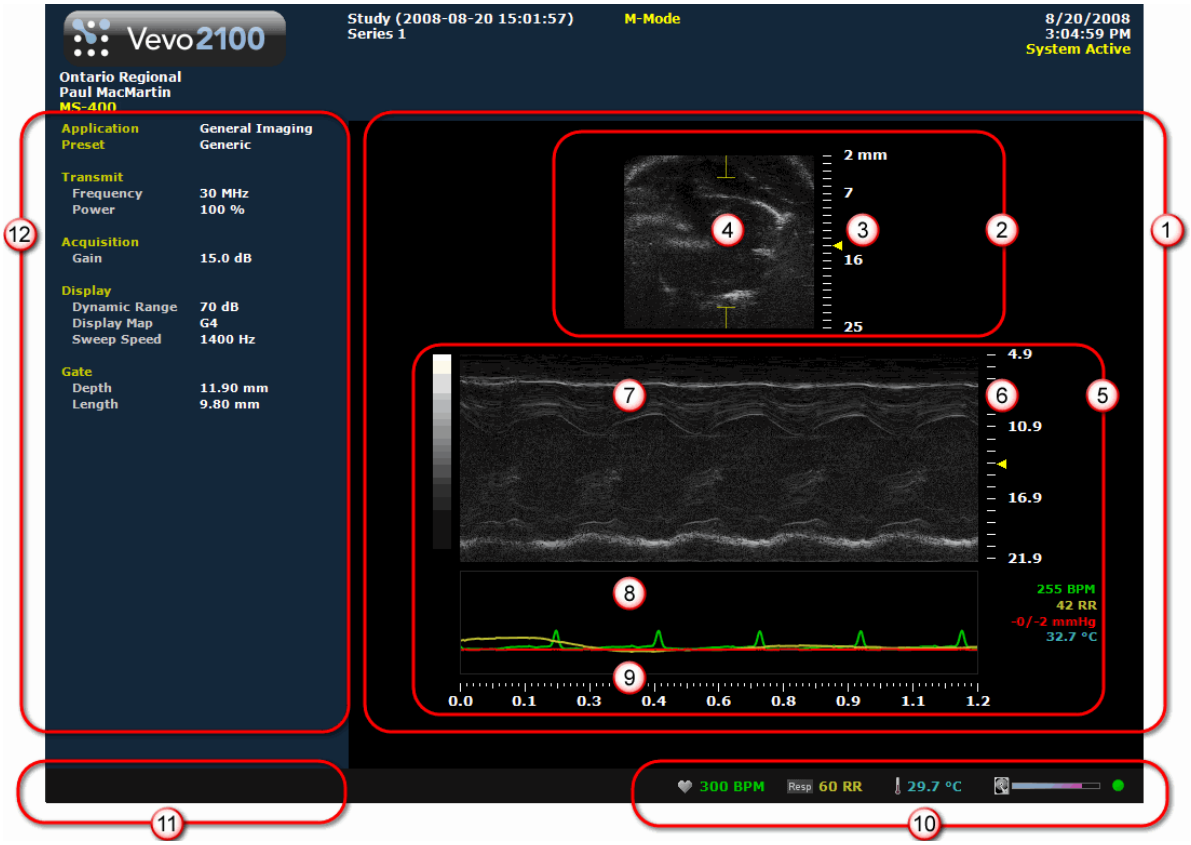
You have successfully acquired M-Mode image data.

Next step

- *Adding generic M-Mode measurements* (page 235)
- *Adding protocol measurements* (page 168)

M-Mode window workspace

The M-Mode window is the workspace you use whenever you view image data in M-Mode. The following illustration and table describes the information and features in the M-Mode window.



Area	Description
1	**M-Mode Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**B-Mode scout window**. Shows you precisely where the region of interest is. The region of interest is located between the yellow wireframe brackets set. Use this window to reposition your transducer and the wireframe brackets set so you can acquire the most useful data.
3	**Image scale**. Indicates in mm the distance from the face of the transducer.

Area	Description
4	**Sample gate overlay in B-Mode scout window**. Shows you precisely where the region of interest is. The region of interest is located between the yellow wireframe brackets set. Use this window to reposition your transducer and the wireframe brackets set so you can acquire the most useful data.
5	**M-Mode image data.** Displays the cardiac cross-section image data acquired along the sample gate line in the B-Mode scout window. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.
6	**Image scale**. Indicates in mm the distance from the face of the transducer.
7	**Region of interest image window**. Displays the sample gate image data that is defined in the B-Mode scout window above. The most current data begins at the right side of the window. The trailing data in the cine loop acquisition buffer extends to the left.
8	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station.
9	**Cine loop time scale**. In milliseconds. Use the Sweep Speed rocker switch to adjust the range of the scale so you can place more or less cine loop data into the window.
10	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
11	**Screen keys display** ▪ Displays the updated parameter and system information when you make adjustments on the control panel. ▪ Displays control options in the mode that you apply during image acquisition when you press the Screen Keys dial. When you display the B-Mode image with the M-Mode overlay, press to place a needle guide within the image.
12	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).

Control panel controls for M-Mode

When you are acquiring M-Mode image data, these are the controls you use to optimize the M-Mode image data you see in the lower window of the image area.

① **M-Mode**

Activates M-Mode image acquisition.

To use this key control:

1. Press to begin displaying the M-Mode sample volume overlay on the full-window B-Mode acquisition data.
2. Press M-Mode again (or press Update) to display the live M-Mode data in the lower window and the live B-Mode data with the sample volume overlay data in the scout window.

2

Transmit Power

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

3

Frequency

Adjusts the transmit frequency of the transducer between the higher and lower frequency levels that are supported by the specific transducer. When you increase the frequency you can improve detail at the focus depth but the system tends to lose detail at deeper tissues.

Push forward to increase the frequency. Pull back to decrease the frequency.

4

Focal Zones

This control adjusts the number and configuration of focal zones on your B-Mode based image.

Focal zones enhance the resolution across your image, while slightly reducing the acquisition frame rate. The system always displays at least one focal zone, and you can apply a maximum of two additional zones depending on the transducer. When you add focal zones the system maximizes the resolution for a larger area of your image, and reduces the acquisition frame rate.

To use this rocker switch control:

1. Push the rocker switch forward to cycle through the following focal zone application sequence:
   - Single zone
   - Two zones, narrow
   - Two zone, wide
   - Three zones, narrow
   - Three zones, wide
2. Pull the rocker switch back to cycle back through the focal zone options in reverse.

5

Invert

Flips the image.

In M-Mode: In the dual window view, press to flip the B-Mode scout image left/right.

6

Display Map

Cycles you through a predefined set of optimization maps that you can apply either while you are acquiring or reviewing image data.

Push up or pull down to cycle through the available maps for the active imaging mode.

7

Dynamic Range

Adjusts the input signal strength that is mapped into the spectral display. Range: 5-100dB.

- Push up to increase the range by 5dB and lower contrast. Higher dynamic ranges are often used in cardiac imaging.
- Pull down to decrease the range by 5dB and increase contrast. Lower dynamic ranges are often used in abdominal imaging.

In M-Mode: applies to the images in both the M-Mode window as well as the B-Mode scout window.

8

2D Gain

Adjusts the strength of the ultrasound signal when it returns to the face of the transducer. Range values for the control are specific to each individual transducer.

Turn clockwise to add gain and brighten your entire image. Turn counterclockwise to reduce gain and darken your image.

In M-Mode: Applies to the images in both the M-Mode window as well as the B-Mode scout window.

9

Update

Function 1: display control

Alternates the display from the dual view (B-Mode scout window on top, Mode image window on the bottom) to the B-Mode image plus overlay so you can position your sample gate more precisely.

To use this toggle control:

1. Press to view the dual view.
2. Press again to display the B-Mode window and overlay.

Function 2: right-click button

When the manual directs you to right-click, press Update.

10

SV/Gate

Push up to increase. Pull back to decrease.

In M-Mode: This control adjusts the size of the sample *gate*, measured in *mm*. The control adjusts the distance of the vertical line between the two yellow calipers.

In the dual window view, the system displays the M-Mode sample gate image data. Current data is on the right side, trailing data extends to the left.

11

Sweep Speed

Adjusts the cine loop playback speed parameter so that you can stretch out or compress the cine loop data in the review window. Push up to increase the speed and compress the cine loop image. Pull down to decrease the speed and expand the cine loop image.

When you are reviewing the cine loop you can also use the Cine Loop Review control to adjust the sweep speed.

In M-Mode: Set the sweep speed parameter in a range from 200 Hz to 4000 Hz in increments of 100 Hz. The system displays the updated values in the status bar in the lower left area of the screen.

In cardiac applications you might want to decrease the M-Mode sweep speed so you can view more wall movements over more cardiac cycles in the window, or increase the speed so you can view more wall detail over one cycle.

M-Mode acquisition settings

To view the M-Mode acquisition settings:

Press Mode Settings. The left panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.

Acquisition

Parameter	Description
Gain	The strength of the ultrasound signal in *dB* increments when it returns to the face of the transducer. Adjust with the 2D Gain control.

Display

Parameter	Description
Dynamic Range	The contrast of your image, measured in dB. Adjust with the Dynamic Range control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.
Sweep Speed	The cine loop playback speed, measured in Hz in a range from 200 to 4000 Hz. Adjust with the Sweep Speed control.

Gate

Parameter	Description
Depth	The distance, measured in mm, from the face of the transducer. Adjust with the Image Depth control.
Length	The length, measured in mm, of the gate. Adjust with the SV/Gate control.

Setting the M-Mode region of interest

In M-Mode, the region of interest is the image data that the transducer acquires along the vertical line between the brackets of the yellow wireframe in the B-Mode image. This line is called the *sample gate*.

To set your M-Mode sample gate:

1. Begin acquiring data in M-Mode and position your transducer to display your region of interest in the center of the B-Mode scout window.
2. Watching the B-Mode scout window, trackball to move the yellow wireframe to your region of interest.
3. Adjust the SV/Gate control forward or back to increase or decrease the length of the gate.

   After you change the position or distance of the gate:

   a. The system pauses briefly to reset.

   b. The system starts acquiring data again.

> **Note:** If the mode settings are not displayed in the left panel press Mode Settings.

The mode settings panel displays the following **Gate** parameters.

Parameter	Description
Depth	The distance in mm from the face of the transducer to the center of the gate.
Length	The length in mm of the gate.

Chapter 36

Analyzing M-Mode images

This chapter shows you how to analyze M-Mode images.

In this chapter

Adding generic M-Mode measurements

M-Mode provides five generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for M-Mode:

- If you are acquiring M-Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.

  Hover over a tool to see the description label.

Depth interval measurement

Depth interval is measured in *mm*.

To place a depth interval measurement:

1. Click the depth interval measurement button  . The system highlights the button until you complete your measurement.
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Velocity measurement

Use the velocity measurement tool to determine the velocity of vascular flow. Velocity is measured in *mm/s*.

To place a velocity measurement:

1. Click the velocity measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Heart rate measurement

Use the heart rate measurement tool for measuring the average heart rate (in *BPM*) of an animal by measuring the distance over time between the displayed cardiac cycles.

To place a heart rate measurement:

1. Click the heart rate measurement button  .
2. Click on your image to place the initial caliper at a specific point in the cardiac cycle.

3. Trackball to the same location on the next cardiac cycle and click to place the next caliper.
4. Continue placing calipers on the cardiac cycles and then right-click on the last heart beat of the sequence to place your final caliper.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

M-Mode LV wall trace measurements

Use the LV trace measurement tool to:

- Trace the position of the upper and lower inner walls of the ventricle through a heart cycle so you can measure the parameters of the left ventricle inner area
- Add a trace of the outer walls to the inner walls that you traced so you can measure the parameters of the outer walls of the left ventricle

To trace the inner LV walls

1. Click the LV Area button  . The system highlights the button until you complete your measurement.
2. Adjust the sweep speed to compress or expand the cine loop so you can see the number of heart cycles you want to measure. Decrease the speed to show more cycles, increase the speed to show fewer cycles.
3. On the upper wall:
   a. Start on either the left or right side of the image window (it doesn't matter which side you start on) and click to place your first caliper along the inside of the wall at either the diastolic or systolic peak or valley.
   b. Continue to click and place caliper points at the diastolic and systolic peaks and valleys until you have traced the number of cycles you want the system to measure.
   c. Right-click to complete the trace.
4. On the lower wall:
   a. Add caliper points the same way.
   b. Right-click to complete the trace.
   c. Right-click a second time to complete the measurement and display the measurements.
5. Work with your trace as required:
   - Modify the trace (page 238)

- Refine the trace (page 238)

To trace the outer LV walls as well as the inner LV walls:

Use the same peak and valley caliper points tracing method, but also trace the outer LV walls using the following procedure:

1. On the upper wall, trace the outside wall along the number of cycles you want to measure and then right-click to complete the trace. The outside wall is far less dynamic than the inner wall.
2. On the upper wall, trace the inside peaks and valleys and right-click to complete the trace.
3. On the lower wall, trace the inside peaks and valleys and right-click to complete the trace.
4. On the lower wall, trace the outside wall and then right-click just once to complete the trace and display the measurements.

Modifying the trace

You can modify the caliper points on your trace after you complete the trace.

To move a caliper point:

1. Position the cursor over the point until the point becomes a pink cross.
2. Drag the point to a new position, then click again to set the new position.

To add a point:

1. Position your cursor where you want to place a new point.
2. Click twice.

To delete an individual point:

1. Position the cursor over the point until the point becomes a pink cross.
2. Right-click and select **Delete Point**. If more than one point is located within the five-pixel radius, the system deletes the point that is closest point to the cursor.

Refining the trace

After you complete a trace, you can use the system's Refine feature to automatically adds points along a tissue layer to contour the trace more precisely to the wall.

To refine one trace line in your LV trace:

1. Right-click on the line and select **Refine Current**.

2. The system automatically adds points along the tissue layer.
3. Depending on the placement of the initial points, the Refine feature might produce less than optimal results. To return to the initial trace, right-click the trace and select **Undo Last Action**.

To refine all the trace lines in your LV trace:

1. Right-click on any of the lines on your trace and select **Refine All**.
2. The system refines the contours of all the lines in your trace.
   - If you created a two-line trace of the internal LV wall, the system refines the contours along the upper and lower wall
   - If you created a four-line trace of the LV walls, the system refines the contours along the the two outer walls and the two inner walls
3. To return to the initial trace, right-click the trace and select **Undo Last Action**.

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button  . The system highlights the button until you complete your measurement.
2. In the image mode data, click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Adding protocol measurements

Protocol measurements are labeled uniquely for a specific measurement protocol.

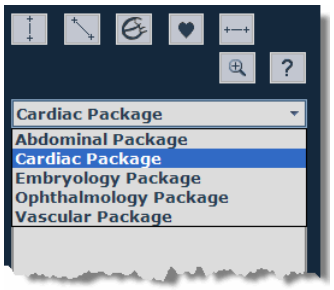
To access the protocol measurement tools and measurements list

- If you are in an image acquisition session press Scan/Freeze to acquire an image and then press Measure.

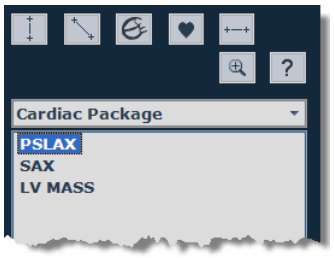
- If you are in the Study Browser, open an image and then press Measure.

To place a protocol measurement:

1. In the measurement packages drop-down list click the appropriate package.



2. In the list of protocols, select the appropriate protocol.



3. In the list of measurements, select the measurement you want to add.

   The system automatically activates the appropriate measurement tool and highlights the generic button for that tool.

4. On the image, add your measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Protocol measurements* (page 167)

Adding M-Mode measurement chains

In M-Mode, the most precise way to create diastole and systole measurement sets is to stack your measurements.

To automate this procedure the system automatically links the following measurements into chained sequences. For example, if you select the **Cardiac Package** and then select the **SAX** (short axis) protocol, you can create the following diastole and systole measurement chains:

Diastole measurement chains

- IVS --> LVID --> LVPW
- LVAW --> LVID --> LVPW

Systole measurement chains

- IVS --> LVID --> LVPW
- LVAW --> LVID --> LVPW

To add a complete chained measurement:

1. In the protocol measurements list, click the first measurement in the chain.
2. Click the top point of the first measurement of the chain and move the cursor toward the bottom point.

   The system labels the measurement and displays the measurement value dynamically as the cursor is moved toward the bottom point.
3. Click the bottom point of the first measurement. The system commits the measurement value for the first measurement.

   This bottom point of the first measurement automatically becomes the top point of the second measurement in the chain.
4. Click the bottom point of the second measurement. The system measures and labels the second measurement.
5. Click the remaining bottom points of the next measurements in the chain. The system measures and labels each measurement until the final measurement is completed.

To add individual measurements from a chain:

1. In the protocol measurements list, click any one of the measurements in the chain.
2. Press ESC to cancel the chain but keep the completed measurements.

To see the label for any measurement you must either:

- Complete the remaining measurements in the chain
- Complete another measurement
- Return to the Study Browser and open the image

Creating pressure-volume loop measurements in M-Mode

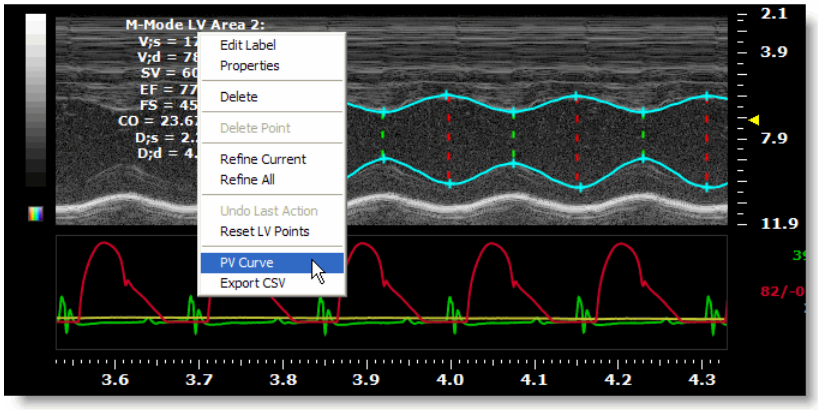
Pressure-volume (PV) loop measurements provide a graphical method of identifying and evaluating LV pressure-volume relationship changes related to dynamic levels of cardiac stress.

You can generate PV loops from LV area measurements on both B-Mode and M-Mode images that are accompanied by a continuous blood pressure trace. These traces are typically acquired from a blood pressure catheter.

This section describes how to obtain PV loops from M-Mode images.

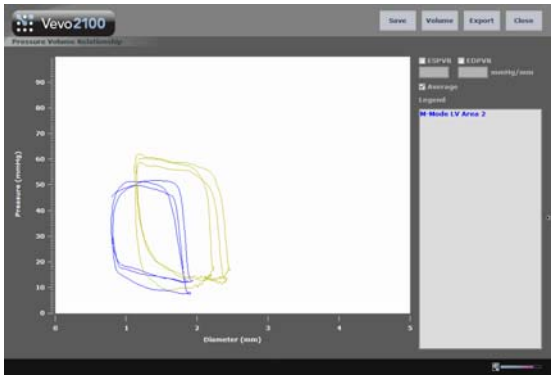
To obtain PV loops from an M-Mode image:

1. Create an M-Mode cine loop of the heart in a long-axis orientation.
2. Complete an M-Mode LV Area wall trace measurement (page 237) that includes at least two cardiac cycles.
3. Right-click the measurement and select **PV Curve**.



Note: The PV Curve menu command is not available if the image does not include blood pressure data.

4. The system calculates the pressure-volumes of the cardiac cycles and plots them as a graph on the Pressure Volume Relationship window.



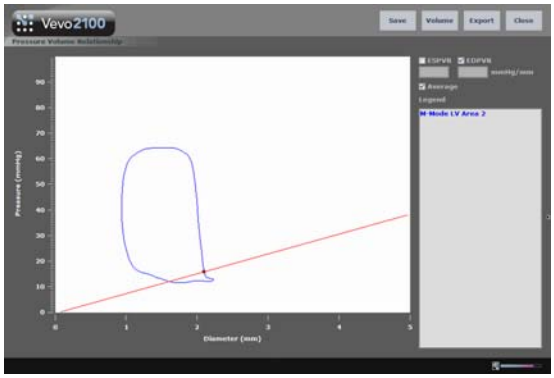
Pressure-Volume relationship graphs

When you have generated pressure-volume graph data, you can use the tools on the Pressure Volume Relationship window to:

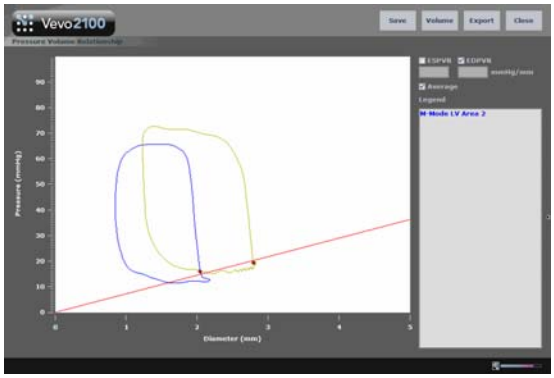
- Display the end systolic PV points
- Display the end diastolic points
- Display a loop that represents a virtual or averaged cardiac cycle
- Toggle the horizontal dimension between Volume and the basic dimension of the loops
- Export the pressure-volume relationship data

ESPVR check box

Check this box to display the end systolic PV points.



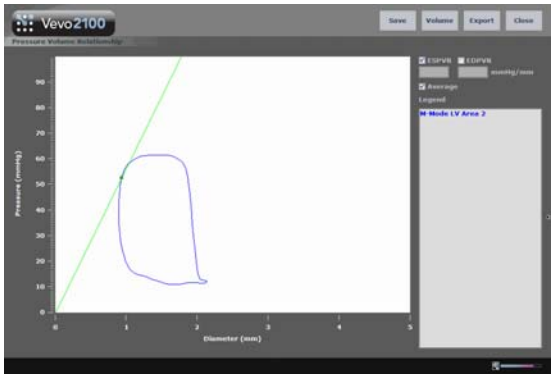
If the graph displays a single loop, the system plots a green dot on the curve at the End Systolic point.



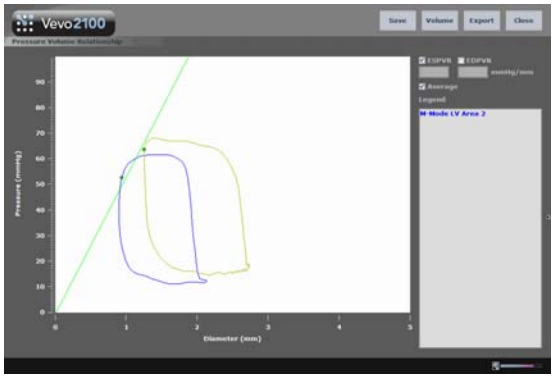
If the graph displays multiple loops, the system plots a best-fit line through the End Systolic points.

EDPVR check box

Check this box to display the end diastolic points.



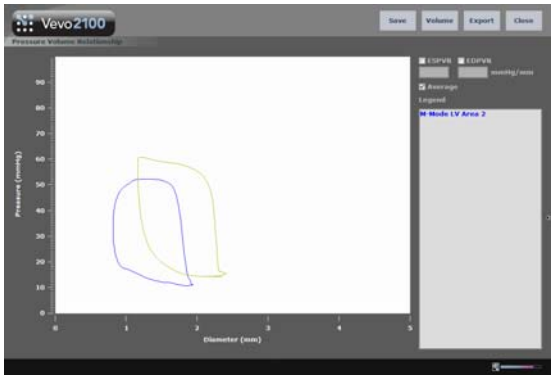
If the graph displays a single loop, the system plots a red dot on the curve at the End Diastolic point.



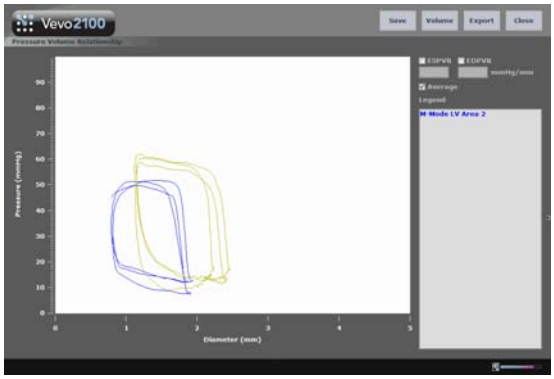
If the graph displays multiple loops, the system plots a best-fit line through the End Diastolic points.

Average check box

Check this box to display a loop that represents a virtual or averaged cardiac cycle, calculated from the aggregate cycles defined by each LV wall trace. Clear the check box to display all cardiac cycle instances. This check box is selected by default.



When the Average option is selected, the graph displays a single smooth loop.



When the Average option is cleared, the graph plots the cardiac cycle.

Volume command

Click this command to toggle the horizontal dimension between Volume and the basic dimension of the loops. For measurements made in M-Mode the dimension is Diameter in millimeters. For measurements made in B-Mode, the dimension is Area in square millimeters.

Export command

Click this command to export the data as one of three file formats:

- **CSV** file. Can be imported into a spreadsheet or database.
- **BMP** file. Exports the graph data as a bitmap image.
- **TIFF** file. Exports the graph data as a vector based image.

Section 10

PW Doppler Mode imaging and analysis

PW Doppler Mode (Pulsed Wave Doppler) is an ultrasound mode you can use to measure the velocity and direction of flow. The Vevo software presents the detected PW Doppler signal as both a spectral image in the display window as well as an audio output through the system speakers.

In This Section

Chapter 37

Acquiring PW Doppler Mode and PW Tissue Doppler Mode images

This chapter shows you how to acquire PW Doppler Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical PW Doppler Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

To acquire a PW Doppler Mode image:

1. In B-Mode, position the transducer to situate your region of interest in the center of the image area.
2. Set the PW Doppler sample volume (page 257).

3. Adjust the Image Width control to remove image content outside the region of interest to optimize the image data for analysis.
4. Press PW.

   The system displays the yellow sample volume overlay on the B-Mode image.
5. Press PW again.

   The dual-window **PW Doppler Mode** workspace appears. The PW Doppler Mode window is on the bottom, the B-Mode scout window is on the top.
6. The system begins storing cine loop data in the acquisition buffer.
7. Press Presets to cycle through the available presets and then select an appropriate set of optimized image acquisition settings.
8. On the control panel, adjust the PW Doppler Mode controls (page 251) to refine your image acquisition settings if required.
9. Press the Scan/Freeze toggle control to stop the data acquisition so you can review the data in the acquisition buffer.
10. Roll the trackball side to side to scroll through the cine loop.
11. If you are satisfied with the cine loop, store your image data.
    - To save a cine loop press Cine Store.
    - To name the image you just stored, press Image Label.
12. Press Scan/Freeze toggle control to resume scanning.
13. Save images as required.
14. Press Close. The system closes the series you are working on and displays the **Study Information** window.
15. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

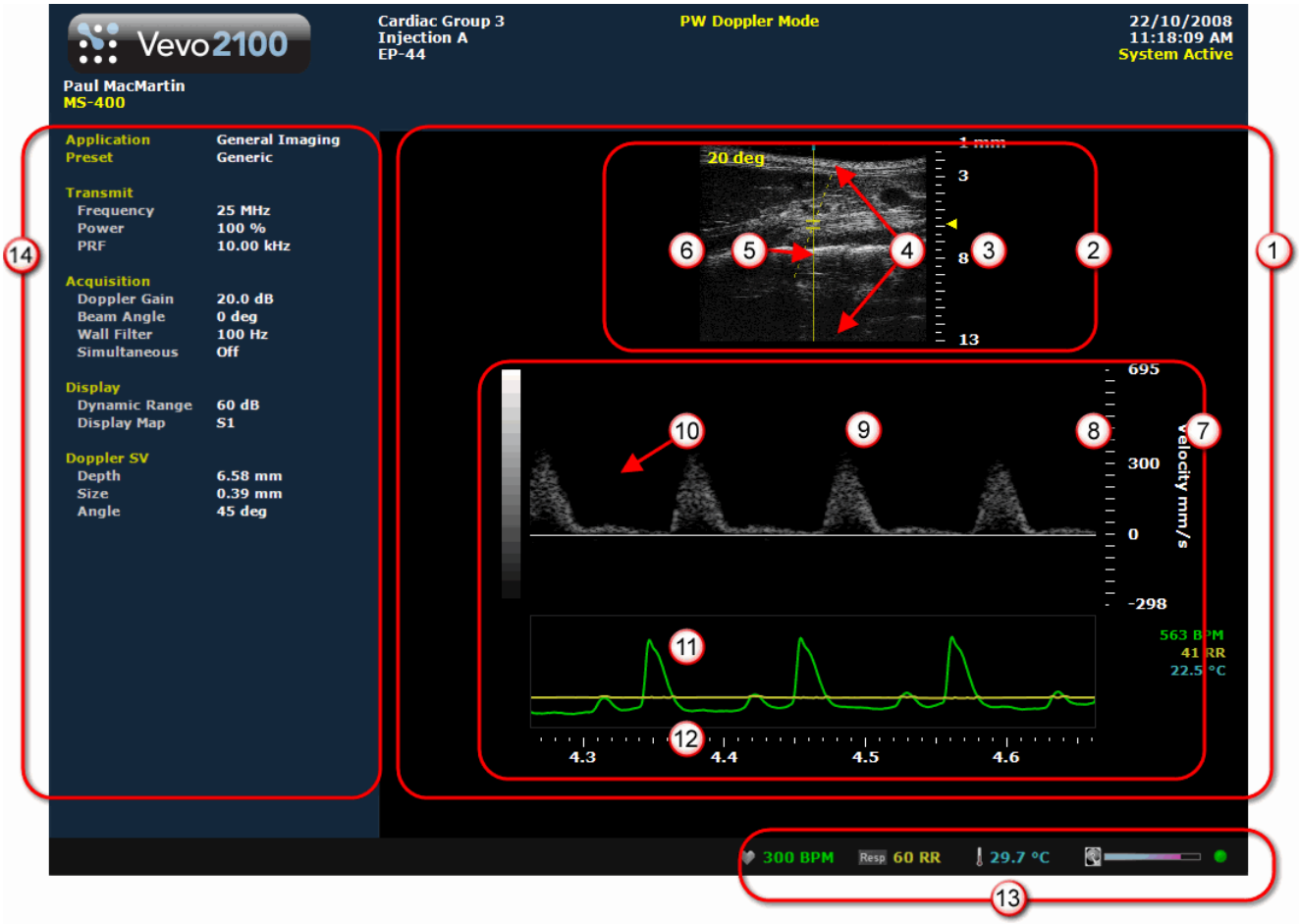
You have successfully acquired PW Doppler Mode image data.

Next step

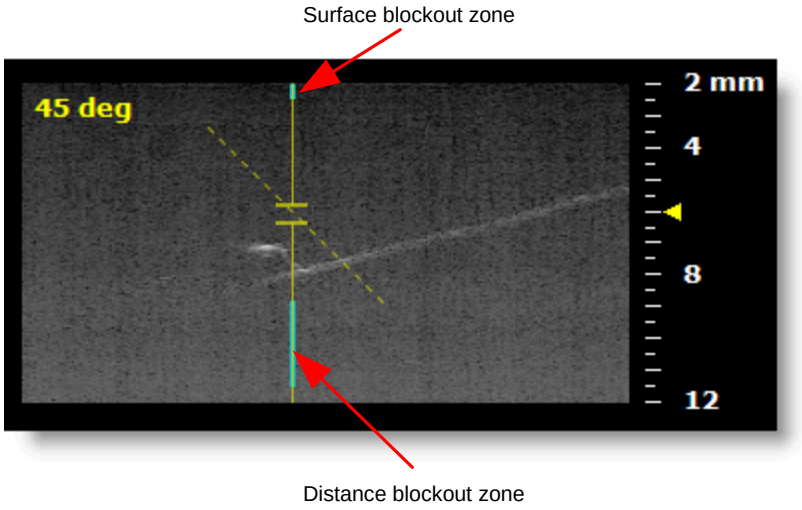
- *Adding generic PW Doppler Mode measurements* (page 262)
- *Adding protocol measurements* (page 168)

PW Doppler Mode window workspace

The PW Doppler Mode window is the workspace you use whenever you view image data in PW Doppler Mode. The following illustration and table describes the information and features in the PW Doppler Mode window.



Area	Description
1	**PW Doppler Mode Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**B-Mode scout window**. Shows you precisely where the region of interest is. The region of interest is located between the yellow wireframe brackets set. Use this window to reposition your transducer and the wireframe brackets set so you can acquire the most useful data.
3	**Image scale**. Indicates in mm the distance from the face of the transducer.

Area	Description
4	**Blockout zones**. In PW Doppler Mode, the system processes reliable ultrasound signals it receives from just beyond the face of the transducer and extending until the distance is too far to produce reliable data. The surface blockout zone is the very small distance just beyond the transducer face. The distance blockout zone is the region beyond the sample zone where the system does not sufficiently process the signal data. The system assigns a blue bar to these zones, as shown in the following diagram.  If you set the sample volume in a blockout zone the system will move it out of the blockout zone and as close as possible to your target location.
5	**Sample volume**. This region of interest is the image data that the transducer acquires along the vertical line between the brackets of the yellow wireframe in the B-Mode image.
6	**Scout window B-Mode sample gate**. Displays a smaller scale version of the complete B-Mode image, along with the volume brackets. If you want to change the relative size of the scout window and the spectrum data, see the **Mode Screen Layout** section in the General tab of the Preferences window.
7	**PW Doppler Mode data.** Displays the spectral display of the velocity data.
8	**Scale indicator.** Indicates the velocity of blood flow. You can set it to Velocity or Frequency in the General tab of the Preferences window.
9	**Region of interest image window**. Displays the sample volume image data that is defined in the B-Mode scout window above. The most current data begins at the right side of the window. The trailing data in the cine loop acquisition buffer extends to the left.
10	**Baseline**. The horizontal zero line that divides the spectral display into positive velocities (flow moving toward the transducer) and negative velocities (flow moving away from the transducer).

Area	Description
11	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station.
12	**Cine loop time scale**. In milliseconds. Use the Sweep Speed rocker switch to adjust the range of the scale so you can place more or less cine loop data into the window.
13	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
14	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).

Control panel controls for PW Doppler Mode

When you are acquiring PW Doppler Mode image data, these are the controls you use to optimize the image you see on the screen.

1 **Transmit Power**

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

2 Volume

Adjusts the speaker volume for the PW Doppler Mode and PW Tissue Doppler Mode audio data that the system acquires along with the spectral data.

To use this dial control:

- Turn clockwise to increase the volume.
- Turn counterclockwise to decrease the volume.

Active during: PW Doppler Mode and PW Tissue Doppler Mode image acquisition and review sessions.

3 Frequency

Adjusts the transmit frequency of the transducer between the higher and lower frequency levels that are supported by the specific transducer. When you increase the frequency you can improve detail at the focus depth but the system tends to lose detail at deeper tissues.

Push forward to increase the frequency. Pull back to decrease the frequency.

4 Invert

Flips the image.

In PW Doppler Mode and **PW Tissue Doppler Mode in the dual window view**: Press to flip the spectrum window vertically.

5 Dynamic Range

Adjusts the input signal strength that is mapped into the spectral display. Range: 5-100dB.

- Push up to increase the range by 5dB and lower contrast. Higher dynamic ranges are often used in cardiac imaging.
- Pull down to decrease the range by 5dB and increase contrast. Lower dynamic ranges are often used in abdominal imaging.

In PW Doppler Mode and **PW Tissue Doppler Mode**: Applies to the spectral display in the lower, spectral image data, window. Does not apply to the B-Mode scout window.

6 Doppler Gain

Adjusts the frequency shift in increments of 1.0 dB. Turn clockwise to add gain and brighten the Doppler data. Turn counterclockwise to reduce gain and darken the data.

Active during: PW Doppler Mode, PW Tissue Doppler Mode, Color Doppler Mode, Power Doppler Mode image acquisition sessions.

Unless the system is in simultaneous (duplex) mode, the B-Mode image remains constant with only a change displayed within the PW Doppler spectrum.

7 Baseline

Adjusts the vertical position of the horizontal zero frequency line (the *baseline*) that divides the image data coming toward the transducer face from the image data moving away from the transducer face. Push up to raise the line. Pull down to lower the line.

8 Beam Angle

Helps you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam.

This control applies a graduated series of transmission and reception delays to the ultrasound sound signals of each crystal in the transducer. These carefully calibrated sequences can effectively *steer* the ultrasound beam in order to detect minute frequency shifts.

In PW Doppler Mode and PW Tissue Doppler Mode, the current beam angle setting is displayed in the top-left corner of the B-Mode scout image.

In Power Doppler Mode and Color Doppler Mode, this changes the color box.

Active during Color Doppler Mode, Power Doppler Mode, PW Doppler Mode, PW Tissue Doppler Mode imaging sessions.

To use this rocker switch control:

Push up or pull down the control depending on the orientation of your transducer to steer the beam angle.

9 Simul

This toggle control sets the system to acquire live data simultaneously in both the B-Mode scout window as well as the PW Doppler image window.

In the dual window view, use this feature when you want to adjust your sample volume in the B-Mode scout window while you view the waveform data in the PW Doppler Mode window.

To use this toggle control:

1. Press to activate the simultaneous state.

   A black vertical strip scans across the spectrum from left to right.

2. To eliminate this striping, press the toggle again to freeze the scout window and return to PW Doppler image data only.

Active during: M-Mode, PW Doppler Mode and PW Tissue Doppler Mode image acquisition sessions.

10 Sweep Speed

Adjusts the cine loop playback speed parameter so that you can stretch out or compress the cine loop data in the review window. Push up to increase the speed and compress the cine loop image. Pull down to decrease the speed and expand the cine loop image.

When you are reviewing the cine loop you can also use the Cine Loop Review control to adjust the sweep speed.

In PW Doppler Mode and **PW Tissue Doppler Mode**: Set the sweep speed parameter in a range from 0.25 seconds at 4000 Hz to 5.1 seconds at 200 Hz. In some cases, if your imaging window is large and the Velocity is set high, the minimum speed may be greater. The system displays the updated values in the status bar in the lower left area of the screen.

11 Wall Filter

Filters out signals that correspond to low velocity axial motion. Typically these include vessel wall movement, cardiac wall movement and tissue movement caused by respiration. Push up to filter out more. Pull down to filter out less.

In PW Doppler Mode: Use this control to filter out the display of low velocity signal artifacting that appears as a horizontal black band along either side of the white baseline. Push up to reduce the lower velocity signals and bring the waveform of the spectral data closer to the baseline. Pull down to display more low velocity signals.

12 SV/Gate

Push up to increase. Pull back to decrease.

In PW Doppler Mode: This control adjusts the distance in *mm* of the vertical line between the two yellow calipers of the *sample volume*.

In the dual window view, the system displays the spectral data that the system acquires along this line. Current data is on the right side, trailing data extends to the left.

13 Doppler Angle

Adjusts the angle correction in 5-degree increments between the vertical line of the ultrasound pulse from the face of the transducer and the direction of vascular flow in the sample volume in a PW Doppler Mode image acquisition session. The dashed yellow line indicates the direction of flow.

When the system receives the return signal, it applies an algorithm to the signal data to correct for the delta. This produces usable PW Doppler Mode data.

To use this dial control:

1. Turn the dial to align the dashed yellow line with the direction of the vascular flow in your sample volume region.

   The system always displays the value of the resulting angle as a positive value between 0 degrees and 80 degrees, regardless of which side of the vertical line you align the dashed line.

   For angles between 60 degrees and 80 degrees, the system applies the color blue to the dashed line. This indicates that the angle is too great to correct.

2. Reposition your transducer and/or the animal to bring the angle of the vessel as parallel as you can to the vertical yellow line that represents the transducer beam.

14 Velocity

Adjusts the PRF (pulse repetition frequency). The higher you set the PRF, the lower the signal resolution. **In PW Doppler Mode**: Adjust the range of the scale of the Y axis on the Power Doppler Mode image window by adjusting the pulse rate frequency of the ultrasound signal. Use this control when the spectral waveform is either too compressed or too expanded for your purposes.

> **Note:** In the General tab of the Preferences window you can set the **PW Doppler Scale** (Y axis) to display either velocity or frequency.

Turn the dial clockwise to compress the waveform by increasing the range of the scale. Turn counterclockwise to expand the waveform by decreasing the range of the scale.

15 PW

Activates PW Doppler Mode acquisition. Press to begin displaying the yellow PW Doppler Mode sample volume, press Update to display the live PW Doppler Mode spectral data in the lower window and the live B-Mode data in the scout window, then press Simul.

PW Doppler Mode acquisition settings

To view the PW Doppler Mode acquisition settings:

Press Mode Settings.

The PW Doppler Mode acquisition settings panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.
PRF	The pulse repetition frequency (PRF) of the transmitted PW Doppler signal, measured in kiloHertz. This parameter defines the maximum observable PW Doppler frequency shift and flow velocity. Adjust with the Velocity control.

Acquisition

Parameter	Description
Doppler Gain	The PW Doppler frequency, measured in dB. Adjust with the Doppler Gain control.
Beam Angle	The number of degrees of steer to the ultrasound beam so you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam. Adjust with the Beam Angle control.
Wall Filter	The level of low velocity signals, measured in Hz, filtered out of the spectral display. Adjust with the Wall Filter control.
Simultaneous	The state (On or Off) of the *simultaneous* display of live acquisition data in both the B-Mode scout window and the PW Doppler Mode image window. Adjust with the Simul control.

Display

Parameter	Description
Dynamic Range	The contrast of your image, measured in dB. Adjust with the Dynamic Range control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.

Doppler SV

Parameter	Description
Depth	The distance, measured in mm, from the face of the transducer. Adjust with the Image Depth control.
Size	The length, measured in mm, of the sample volume. Adjust with the SV/Gate control.
Angle	The angle correction, measured in degrees, between the vertical line of the ultrasound pulse from the face of the transducer and the direction of vascular flow, as indicated by the dashed yellow line. This angle always displays a positive value between 0° and 80°, regardless of which side of the vertical line it is positioned on. Adjust with the Doppler Angle control.

Setting the PW Doppler Mode sample volume

In PW Doppler Mode, the region of interest is the image data that the transducer acquires along the vertical line between the brackets of the yellow wireframe in the B-Mode image. This line is called the *sample volume* (SV).

To set your PW Doppler SV:

1. Begin acquiring data in Power Doppler Mode and position your transducer to display your region of interest in the center of the B-Mode scout window.
2. If the PW Doppler Mode acquisition settings (page 256) are not displayed in the left panel press Mode Settings.
3. Watching the B-Mode scout window, trackball to move the yellow wireframe as close as possible to your region of interest.
4. Adjust the SV/Gate rocker switch forward or back to increase or decrease the size of the SV.

   After you change the position or size of the SV:

   a. The system pauses briefly to reset the SV and update the **Doppler SV** parameter values in the mode settings panel.

   b. The system restarts the acquisition.
5. If your target vessel is at or near perpendicular to the transducer face, adjust the Beam Angle to *steer* the beam to reduce the Doppler angle to a usable degree.
6. Adjust the Doppler Angle dial to align the dashed yellow line as parallel as you can to the axis of the vessel in the SV.

   In the mode settings panel and in the upper left corner of the B-Mode scout window, the system displays the updated angle degree value.

To update your PW Doppler SV:

1. Press Simul to activate live image acquisition in the B-Mode scout window.
2. In the scout window, trackball to the new location, adjust the SV/Gate and Doppler Angle controls to set the sample volume.
3. Press Simul to return the scout window to a static image.

Setting the PW Doppler Mode sample volume in a distance blockout zone

You cannot place an SV in a distance blockout zone because the frequency setting is too high to produce useful detail at that depth.

However, if you try to set the SV in the blockout zone, the system automatically lowers the frequency setting until there is enough detail to support the SV.

Tip: If your transducer supports beam angle adjustments, adjust the Beam Angle to *steer* the beam to reduce the angle enough that the SV is no longer in the blockout zone.

Exporting PW Doppler Mode cine loop audio

The system acquires PW Doppler Mode data as both visual and audio data. You can export this data as a cine loop as either an integrated audiovisual file using the AVI file format, or as audio-only using the WAV file format.

To export a PW Doppler Mode cine loop as an audiovisual file:

Complete the export procedure detailed in *Exporting cine loops from the Study Browser* (page 139) and in the **File Type** box select the appropriate AVI file format.

To export a PW Doppler Mode cine loop as an audio file only:

Complete the export procedure detailed in *Exporting cine loops from the Study Browser* (page 139) and in the **File Type** box select **Windows Audio Wave File**.

Related information

- *Exporting images to DICOM from the Study Browser* (page 145)

Chapter 38

Acquiring PW Tissue Doppler Mode images

PW Tissue Doppler Mode uses PW Doppler ultrasound to measure the velocity function of myocardial tissue, typically during the diastolic phase of the cardiac cycle.

This chapter shows you how to acquire PW Tissue Doppler Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical PW Tissue Doppler Mode image acquisition session

You acquire PW Tissue Doppler Mode images exactly the same way as you acquire PW Doppler Mode images. The only difference is that the Vevo 2100 Imaging System processes the data in a slightly different way.

In PW Doppler Mode the system requires higher frequency signals to display the fast-moving vascular flows. In PW Tissue Doppler, the system filters out higher frequency signals so it can more accurately display the lower frequency signals that define slower moving myocardial tissue.

To acquire a PW Tissue Doppler Mode image:

Follow the acquisition procedure defined in *Typical PW Doppler Mode image acquisition session* (page 246).

- Press Tissue instead of PW when you begin the acquisition.
- Set your sample volume as defined in *Setting the PW Doppler sample volume* (page 257).

Analyzing PW Tissue Doppler Mode images

You analyze PW Tissue Doppler Mode images using the same tools that you use to analyze PW Doppler Mode images.

For complete information, see *Analyzing PW Doppler Mode images* (page 262).

Chapter 39

Analyzing PW Doppler Mode and PW Tissue Doppler Mode images

This chapter shows you how to analyze PW Doppler Mode and PW Tissue Doppler Mode images that are saved to a study.

In this chapter

Adding generic PW Doppler Mode measurements

PW Doppler Mode provides seven generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

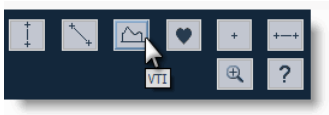
Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for PW Doppler Mode:

- If you are acquiring PW Doppler Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.



  Hover over a tool to see the description label.

Acceleration measurement

Use the acceleration measurement tool to determine the acceleration of heart tissue movement. Acceleration is measured in mm/s^2.

To place an acceleration measurement:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Click the Acceleration measurement button . The system highlights the button until you complete your measurement.
3. Click on your image to place the initial caliper.
4. Trackball to the location where you want to end your measurement and then click to place the end caliper.

   If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement **Acceleration #**, where **#** is a sequential number.
5. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.
6. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)

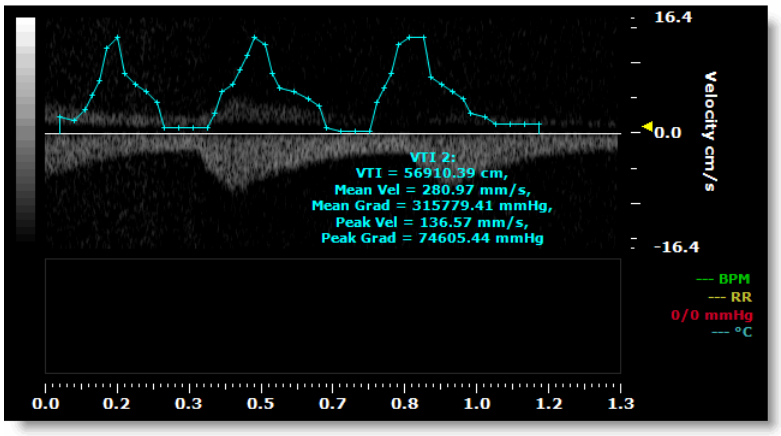
VTI measurement without real-time frequency trace enabled

The VTI (Velocity Time Integral) is measured through a manual trace when no real-time traces are selected.

To manually trace a VTI measurement:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Click the VTI button . The system highlights the button until you complete your measurement.

3. Click on your image to place the initial caliper at a specific point on the waveform.
4. Trackball along the contour of the waveform. The system automatically places points at the spacing density that you specify in the **Auto Point Spacing** section of the **Measurement** tab in the **Preferences** window.
5. Right-click to place your final caliper at the end of the last cardiac cycle. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement **VTI #**, where **#** is a sequential number.



The system constrains your VTI measurement to either the top or bottom side of the baseline, depending on the placement of the initial caliper. The system prevents your trace from crossing the baseline.

6. If you want to position points more accurately over regions where the signal changes rapidly, drag them into position.
7. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.
8. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)

VTI measurement with automatic frequency trace

When you want to measure VTI over a series of cycles, use the automatic frequency trace feature to instantly plot the caliper points on your frequency waveform before you apply the VTI measurement.

To place a VTI measurement with automatic frequency trace:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Select the appropriate auto trace option in the **Peak** or **Mean** drop-down boxes as described in *Applying automatic traces to the frequency waveform* (page 267).

   IMPORTANT You must select a **Peak** and **Mean** option other than **none** to activate the auto-trace functionality for an acquired image.

3. Click the VTI button  . The system highlights the button until you complete your measurement.
4. Along the frequency baseline click on the beginning of a cardiac cycle waveform to place the initial caliper, then click at the end of the cycle waveform.
5. Continue adding points at the start and end of cardiac cycle waveforms until you have selected the range of cycles you want to measure.
6. Right-click to apply your final caliper at the end of the last cycle.
7. The system plots individual caliper points along the range. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement **VTI #**, where **#** is a sequential number.
8. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.
9. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Applying automatic traces to the frequency waveform* (page 267)

Heart rate measurement

Use the heart rate measurement tool for measuring the average heart rate (in *BPM*) of an animal by measuring the distance over time between the displayed cardiac cycles.

To place a heart rate measurement:

1. Click the heart rate measurement button .
2. Click on your image to place the initial caliper at a specific point in the cardiac cycle.
3. Trackball to the same location on the next cardiac cycle and click to place the next caliper.
4. Continue placing calipers on the cardiac cycles and then right-click on the last heart beat of the sequence to place your final caliper.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Single point measurement

Use the linear distance measurement tool to place a caliper dot on the image. A single point measurement records the following properties of the dot:

- Cine loop time point measured in *ms*
- Doppler frequency measured in *KHz*
- Velocity measured in *mm/s*

To place a single point measurement:

1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Click the single point measurement button . The system highlights the button until you complete your measurement.

3. Click on your image to place the single caliper dot. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement **Doppler Point #**, where **#** is a sequential number.
4. If you want to rename the label and you have selected **Show Values and Labels** in the Measurement tab of the Preferences window, type a new name while the label text is selected, and then click outside the label to commit the label.
5. If you have selected **Show Values and Labels** in the Measurement tab of the Preferences window and you want to move the measurement or move the label, select either item and then drag and drop it.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button  . The system highlights the button until you complete your measurement.
2. In the spectrum window or the physiology data trace window click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Applying automatic traces to the frequency waveform

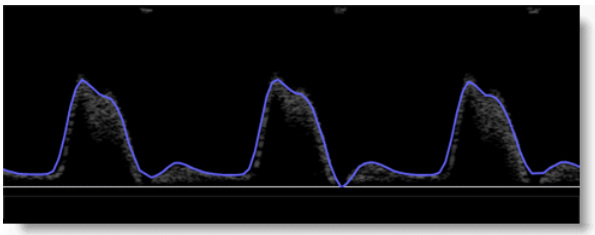
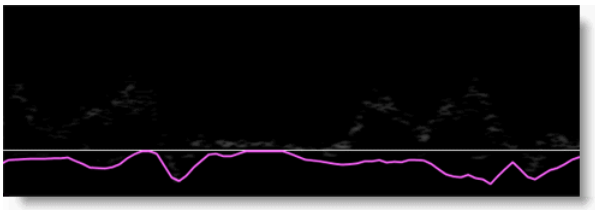
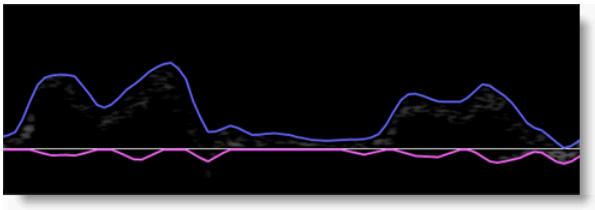
You can set the system to apply a range of peak and mean frequency traces to your PW Doppler spectral data.

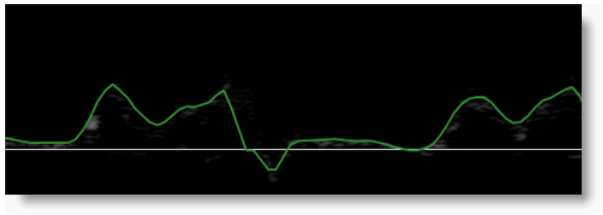
You can apply these traces in real-time to the data in your cine loop acquisition buffer or to an acquired cine loop.

To apply an automatic trace of the frequency waveform:

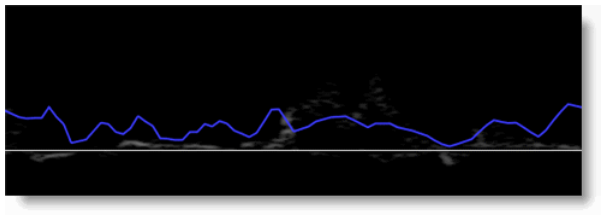
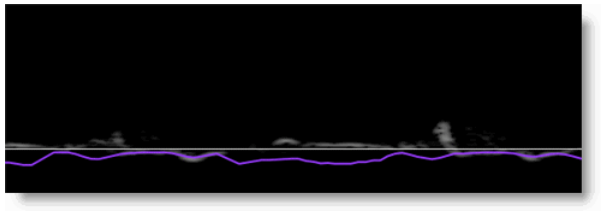
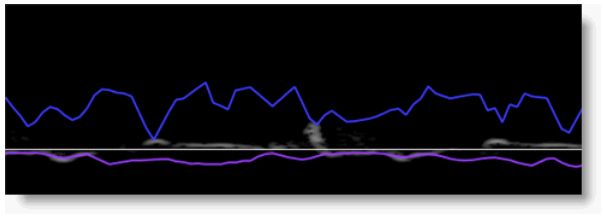
1. While you view a saved image from the Study Browser or an image that is acquired but not stored during an image acquisition session, press Measure and toggle to view the measurement tools panel.
2. Select the appropriate auto trace option in the **Peak** or **Mean** frequency drop-down boxes as described in the following tables.
3. To adjust the VTI threshold for a trace, press] to increase and [to decrease.

Peak

Option	Description
none	The system does not apply a trace.
+	Applies a blue trace to all positive peak frequency signal traces (flow moving toward the transducer face) along the entire cine loop. 
-	Applies a pink trace to all negative peak frequency signal traces along the entire cine loop. 
+ / -	Applies both the positive as well as the negative peak frequency traces. 

Option	Description
auto	Applies a green trace to the largest velocity values, positive and negative, along the entire cine loop. 

Mean

Option	Description
none	The system does not apply a trace.
+	Applies a blue trace to all positive mean frequency signal traces along the entire cine loop. 
-	Applies a purple trace to all negative mean frequency signal traces along the entire cine loop. 
+ / -	Applies both the positive as well as the negative mean frequency traces. 

Related information

- *VTI measurement with automatic frequency trace* (page 265)

Adding protocol measurements

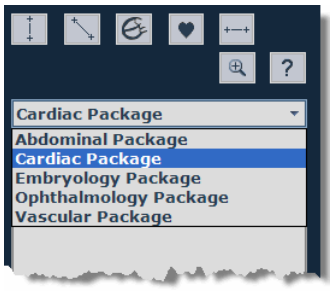
Protocol measurements are labeled uniquely for a specific measurement protocol.

To access the protocol measurement tools and measurements list

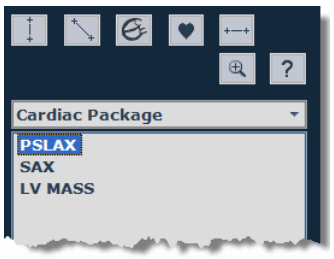
- If you are in an image acquisition session press Scan/Freeze to acquire an image and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

To place a protocol measurement:

1. In the measurement packages drop-down list click the appropriate package.



2. In the list of protocols, select the appropriate protocol.



3. In the list of measurements, select the measurement you want to add.

The system automatically activates the appropriate measurement tool and highlights the generic button for that tool.

4. On the image, add your measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Protocol measurements* (page 167)

Section 11

3D-Mode imaging and analysis

3D-Mode provides tools you can use to:

- Create and manipulate three-dimensional renderings
- Make volumetric measurements of objects viewed with high-resolution ultrasound

In This Section

Chapter 40

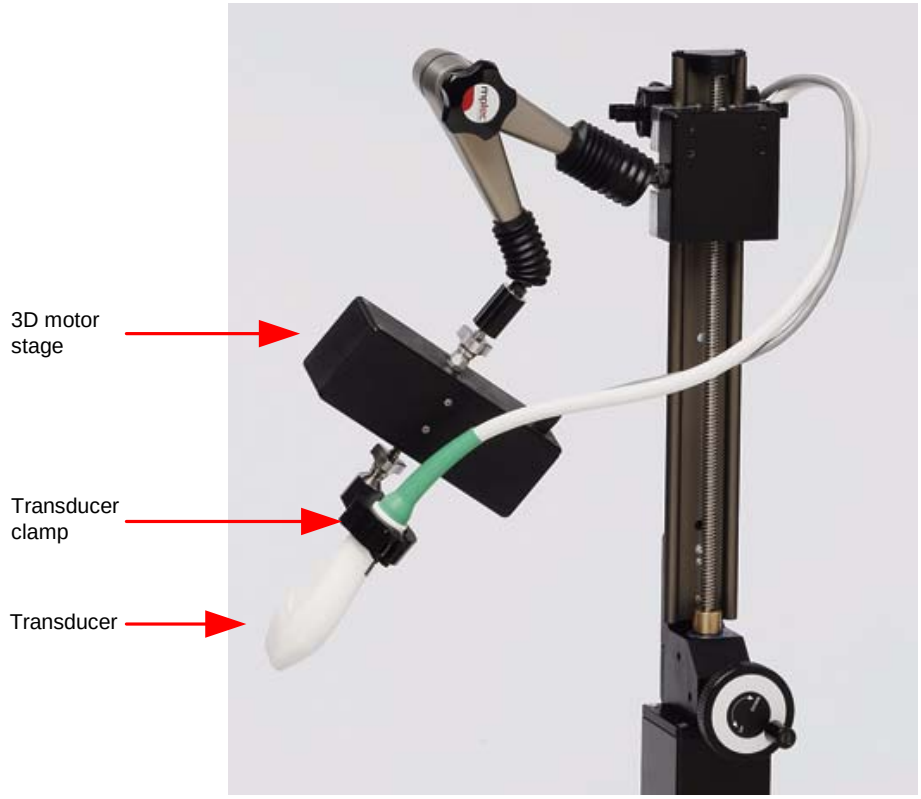
How 3D-Mode works

3D-Mode acquires a series of 2-dimensional “slices” and assembles them into a 3D data set. The 3D data set can then be visualized and manipulated. Targets (for example, tumor growth) can be segmented and volumetric measurements made. 3D imaging can be used in B-Mode, Power Doppler Mode and Contrast Mode imaging procedures.

3D-Mode hardware setup

The transducer is mounted on a Vevo Imaging Station equipped with a 3D motor stage.

The transducer connects to a clamp connected to the bottom of the 3D motor stage. The 3D motor stage connects to the mount on the Vevo Imaging Station.

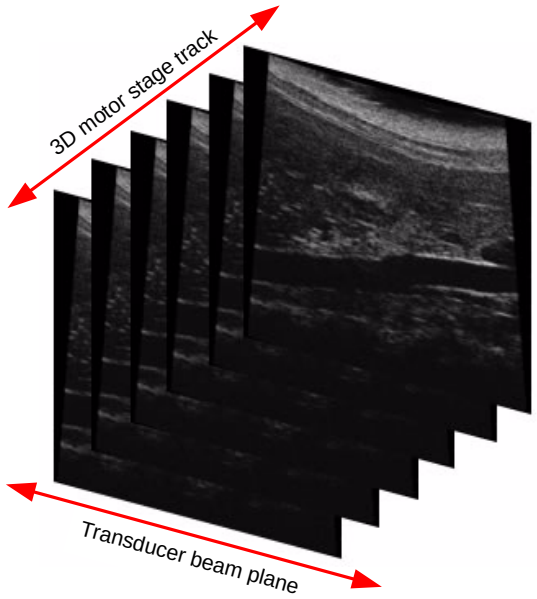


3D-Mode image acquisition

Based on operator-defined parameters, the 3D motor stage travels a set distance across the target object in a series of minute steps. The 3D motor stage, with the

attached transducer, travels in a direction perpendicular to the imaging orientation.

At each step, the transducer acquires a two-dimensional slice of the B-Mode, Power Doppler Mode, or Contrast Mode image.

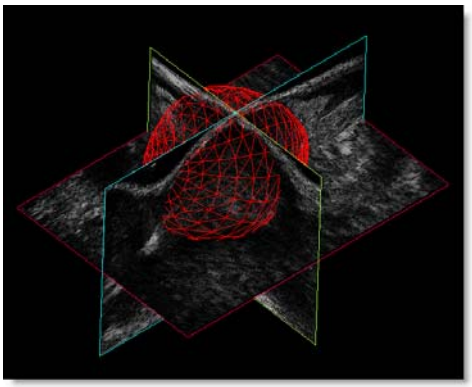


Each two-dimensional B-Mode, Power Doppler Mode, or Contrast Mode image slice is assembled with the other slices of acquired data and rendered by the Vevo software into a three-dimensional data set.

3D-Mode analysis

You can use the 3D analysis tools to:

- View and render objects of interest, such as target tumors
- Segment objects on any plane or across planes
- Measure lengths, areas and volume



Chapter 41

Acquiring 3D-Mode images

This chapter shows you how to acquire 3D-Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical 3D-Mode image acquisition session

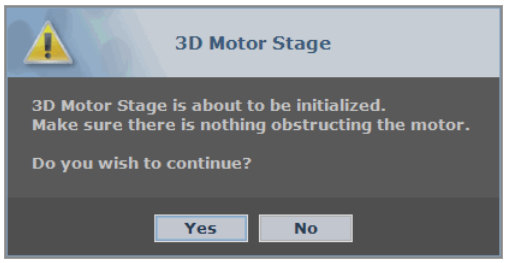
Before you begin

Prepare your animal on the animal platform. For detailed information refer to the *Vevo Imaging Station Operator Manual*.

To acquire a 3D-Mode image:

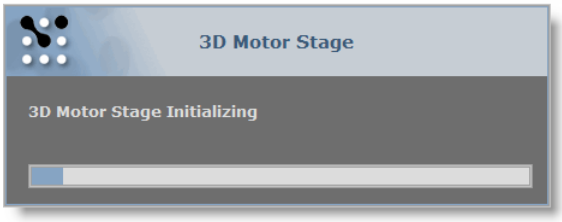
1. From B-Mode, Power Doppler Mode, Contrast Mode or the Study Browser press 3D to activate the 3D-Mode acquisition process.

   The system freezes the image acquisition and displays the **3D Motor Stage** initialization option box.

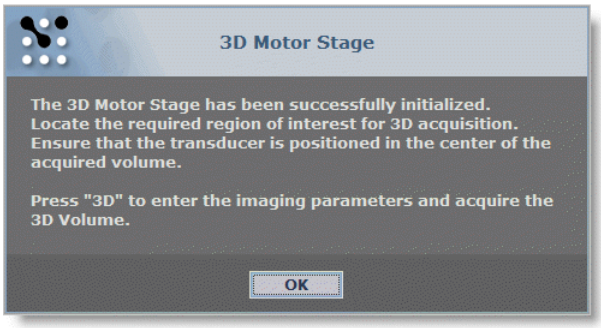


2. Click **Yes**. The system:

a. Initializes the motor stage.



b. Confirms the initialization and prompts you to start the 3D slices acquisition.

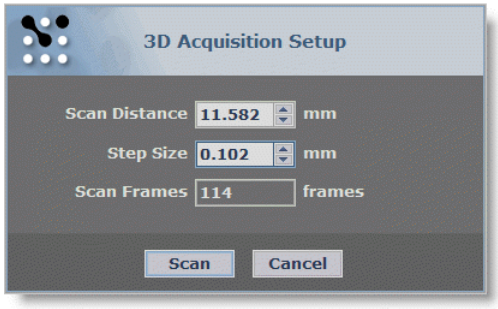


3. Click **OK**. The system returns to the base image acquisition Mode.
4. Activate the base imaging Mode for the type of 3D-Mode image you want to acquire:
   - Press B-Mode to acquire a B-Mode only 3D image. The system begins to acquire B-Mode image data.
   - Press Power to acquire Power Doppler Mode 3D image data over each B-Mode image slice. The system begins to acquire Power Doppler Mode image data.
5. Locate the object of interest and center it as closely as possible relative to the transducer using the platform controls on the Vevo Imaging Station.

   WARNING: Ensure that the lateral movement of the 3D motor stage cannot injure the subject and damage the transducer.

6. Press 3D.

The system displays the **3D Acquisition Setup** box.

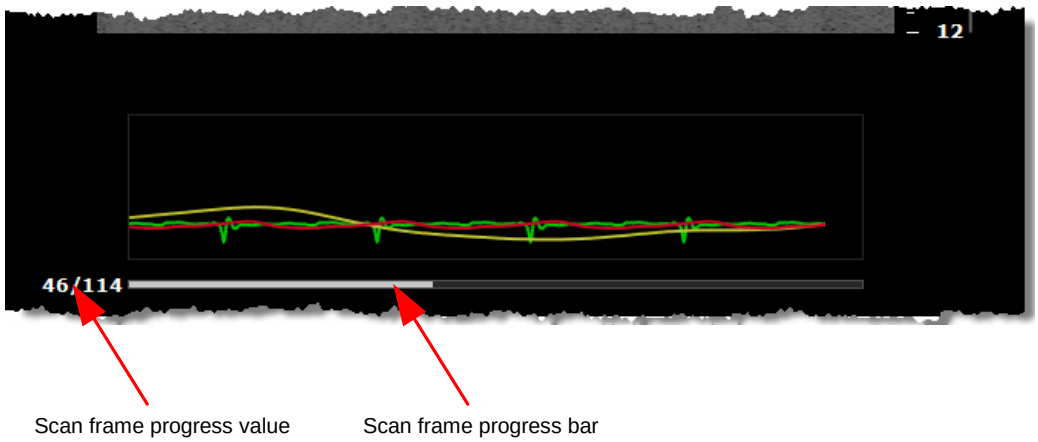


7. Set up your 3D-Mode image slices parameters as described in the following table.

3D parameter	Description
Scan Distance	Sets the distance (in millimeters) that the 3D motor stage will travel during the entire 3D image acquisition. Scan distance ranges between 0.5 mm and 38 mm.
Step Size	Sets the distance that the 3D motor stage travels between each B-Mode slice. Step sizes ranges between 0.03 mm and 0.5 mm. ▪ Smaller step size produces more image slices which generates a more detailed 3D image, typically useful for detailed evaluations of structures ▪ Higher step size produces fewer image slices which generates a less detailed 3D image, but typically suitable for quick evaluations of structure volumes
Scan Frames	Read-only display of the total number of 3D frames the system will acquire. The number of frames equals the Scan Distance value divided by the Step Size value.

8. Press **Scan**.

The system acquires the specified number of frames across the specified scan distance and displays the progress at the bottom of the image area.



When the 3D motor stage finishes acquiring the 3D slices:

- The system positions the transducer at the center of its range.
- The system assembles the 3D image data set and displays the data in the four-pane view.

9. Press Cine Store or Frame Store to save the 3D image data.
10. Press Close. The system closes the series you are working on and displays the **Study Information** window.
11. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

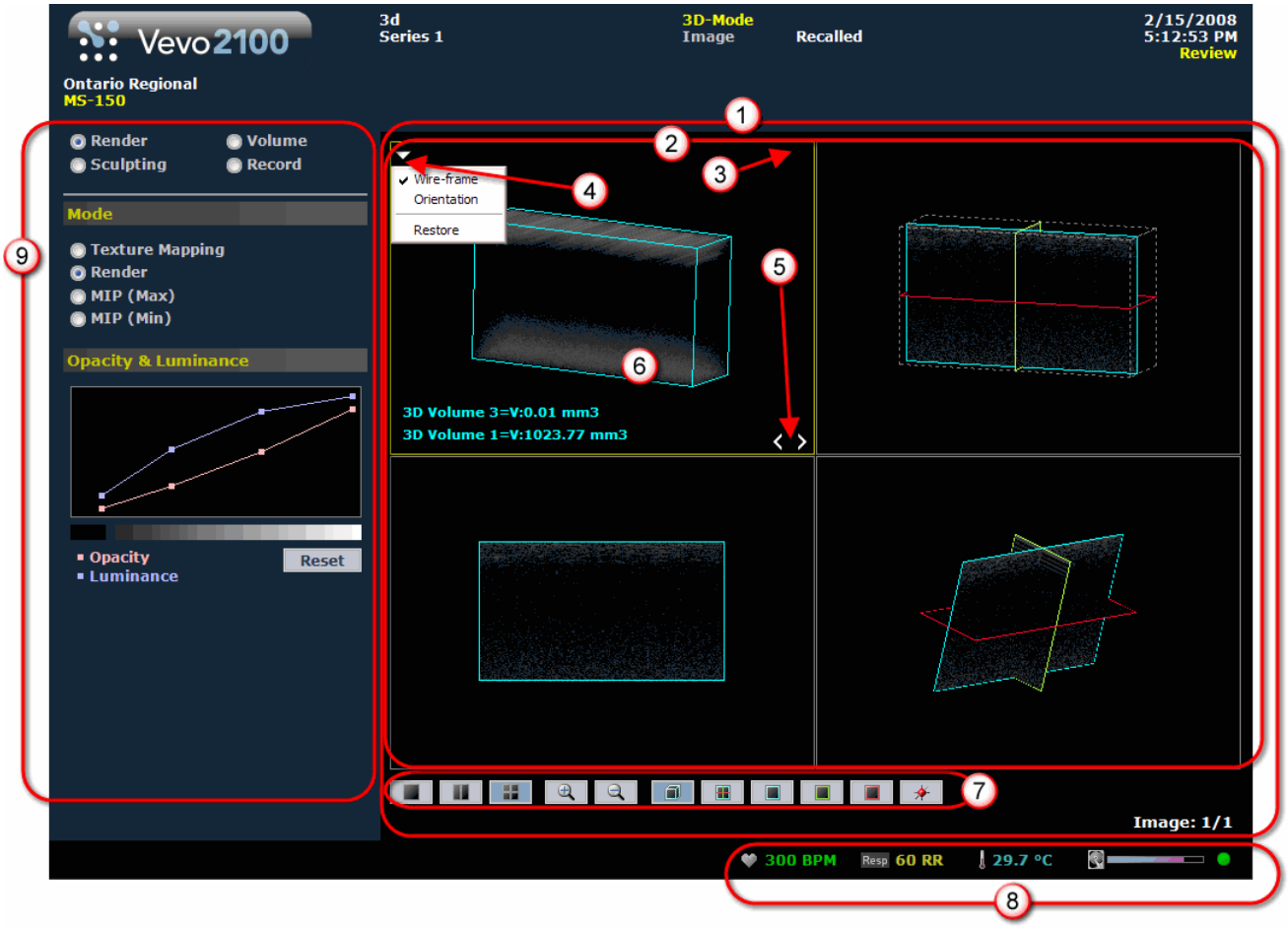
You have successfully acquired a 3D-Mode image.

Related information

- *Typical Power 3D-Mode image acquisition session* (page 323)
- *Typical Contrast 3D-Mode image acquisition session* (page 341)

3D-Mode window workspace

The 3D-Mode window is the workspace you use whenever you visualize acquired image data in 3D-Mode. The following illustration and table describes the information and features in the 3D-Mode window.



Area	Description
1	**Image data area**. Includes the view panes area and the visualization options tool bar.
2	**View panes area**. The system defaults to four view panes (Quad Pane view) , but you can select Dual Pane view or Single Pane view. When you export a stored image and configure your export to send only the Image Area, this is the area of the window that the system exports.
3	**Active pane yellow border**. When you select a view pane, the system applies a yellow border to that pane.

Area	Description
4	**Active pane menu drop-down icon**. When you are in the cube view, click to display the available commands that apply to the image in the active pane. Not all panes include the same commands. The following table describes all the available commands:

Command	Description
Wire-frame	Turns the image outline on/off
Orientation	Turns the orientation marker points on/off
Restore	Resets the original view of the 3D image including size, orientation, brightness and zoom values.

Area	Description
5	**Active pane previous/next slice tool**. Click **<** to view previous slices in your 3D image. Click **>** to view the next slices. You can use the following keyboard combinations to move forward or back one slice at a time, five at a time, or ten at a time, as detailed in the following table:

Command	Step size
>	1 slice
Shift + >	5 slices
Ctrl + >	10 slices

Area	Description
6	**Unique image view**. Each pane displays a unique view of the 3D image. When you click a different view icon in the image analysis tool bar to change the view, the system visualizes the same slice from a different perspective.
7	**Visualization options tool bar**. Click the appropriate analysis tool to change either the number of panes or the analysis view. For complete information on each tool see *3D-Mode image analysis tools* (page 288).
8	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.

Area	Description
9	**Image management panel**. Press the appropriate control to display the image management panel you want to work with.

- Press Mode Settings to toggle between the acquisition Mode settings and the 3D-Mode analysis tools.

  The 3D-Mode tools each provide a unique set of commands and controls for each tool. These appear beneath the tool buttons. Click the tool button to work with the commands and controls.

3D **Render** tools panel

3D **Sculpting** tools panel

3D **Volume** tools panel

3D **Record** tools panel

- Press Measure to display the measurement tools for 3D-Mode.

Control panel controls for 3D-Mode

Because the image acquisition process in 3D-Mode is automated, you optimize your settings before you run your 3D-Mode scan.

▶ To optimize your 3D-Mode image:

- If you are acquiring a 3D-Mode image:
  a. Start B-Mode and use the control panel controls for B-Mode (page 194) to optimize your image.
  b. Press 3D to set up the automated image acquisition.

- If you are acquiring a Power 3D-Mode image:
  a. Start Power Doppler Mode.
  b. Use the Control panel controls for Power Doppler Mode (page 327) to optimize your image.
  c. Press 3D to set up the automated image acquisition.

- If you are acquiring a Contrast 3D-Mode image:
  a. Start Contrast Mode.
  b. Use the Control panel controls for Contrast Mode (page 345) to optimize your image.
  c. Press 3D to set up the automated image acquisition.

Related information

- *Typical Power 3D-Mode image acquisition session* (page 323)
- *Typical Contrast 3D-Mode image acquisition session* (page 341)

Setting up for a 3D-Mode image acquisition

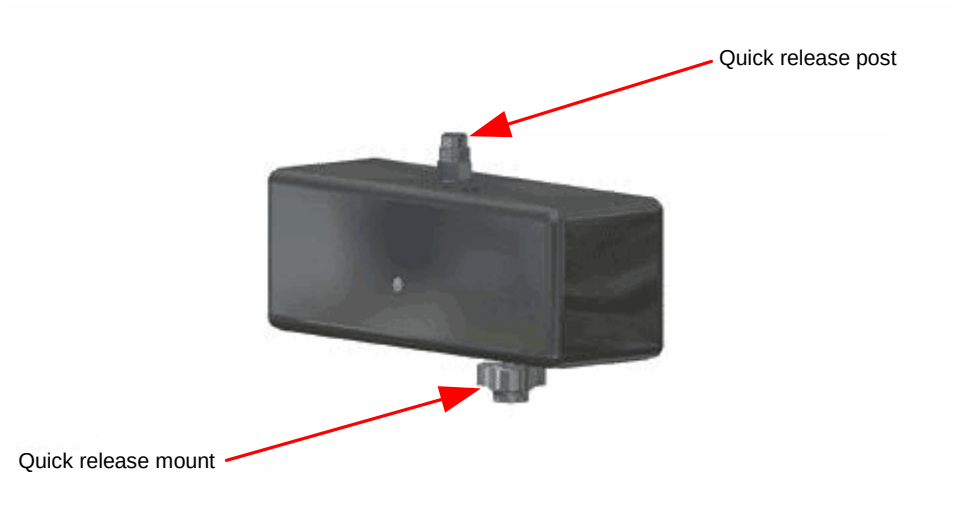
This section describes how to set up your 3D motor stage and your transducer for a 3D-Mode image acquisition session.

Connecting the 3D motor stage to the Vevo Imaging Station

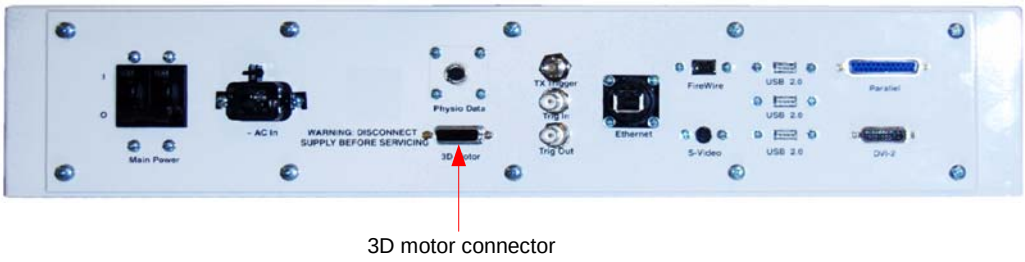
The 3D motor stage features a Quick Release post on the top to connect to the Vevo Imaging Station, and a Quick Release mount on the bottom to affix the transducer clamp.

To connect the 3D motor stage to the Vevo Imaging Station:

1. Insert the quick release post into the quick release mount located on the Imaging Station arm.



2. Carefully line up the holes on the post with the pins on the quick release mount.
3. Finger tighten the knob on the quick release mount.
4. Connect the 3D motor cable to the **3D Motor** connector on the rear panel of the Vevo 2100 Imaging System.

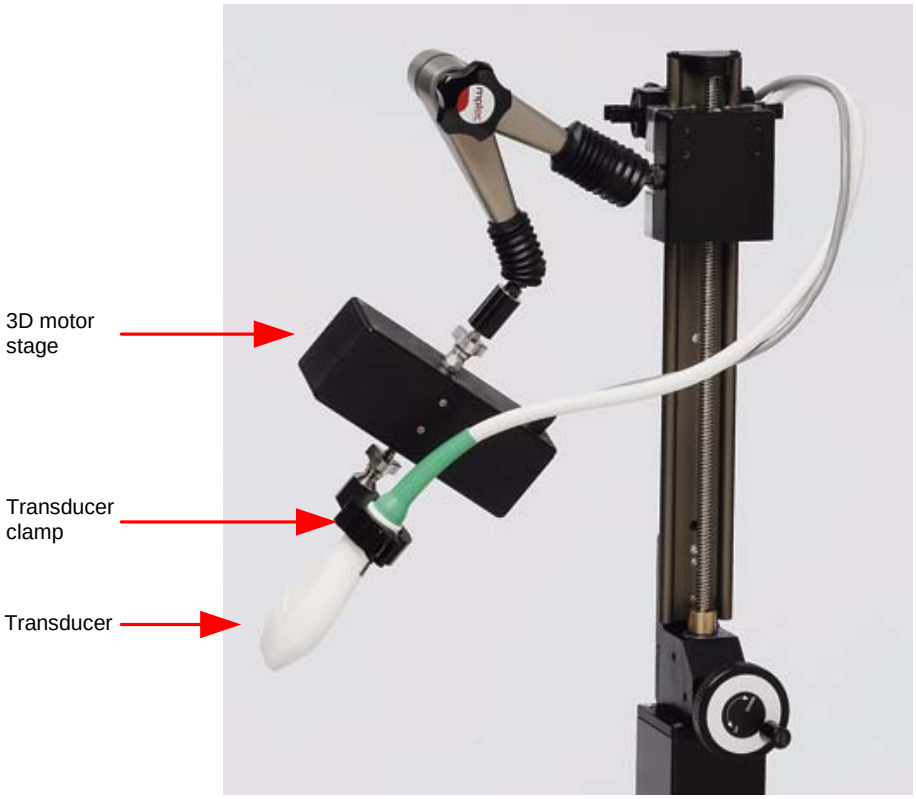


Connecting the transducer to the 3D motor stage

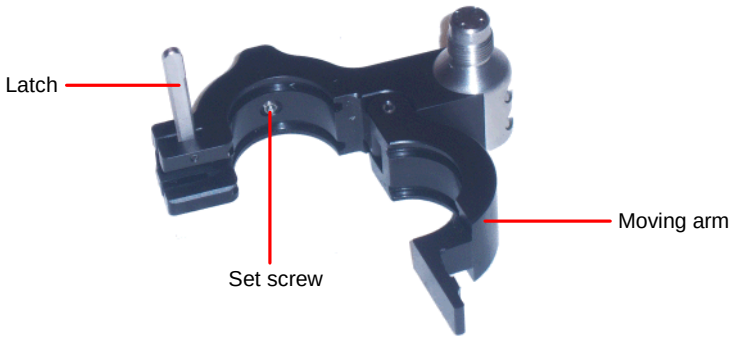
When you use the Vevo Imaging Station, you must secure the transducer within the transducer clamp.

To connect the transducer to the 3D motor stage:

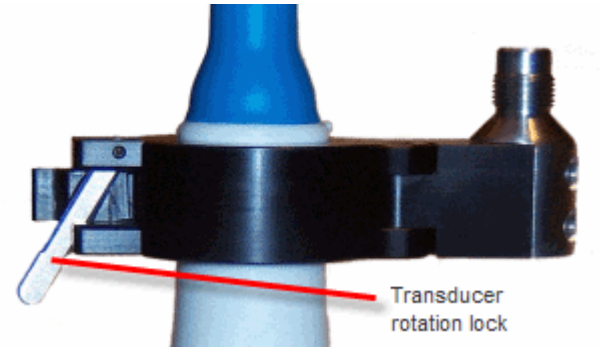
1. Insert the Quick Release post on the transducer clamp into the Quick Release mount on the 3D motor stage unit so that the pins on the mount fit into the holes on the Quick Release post.
2. Tighten the Quick Release mount until it is finger tight.



3. Lift the latch to open the clamp and then place the collar of the transducer in the clamp.

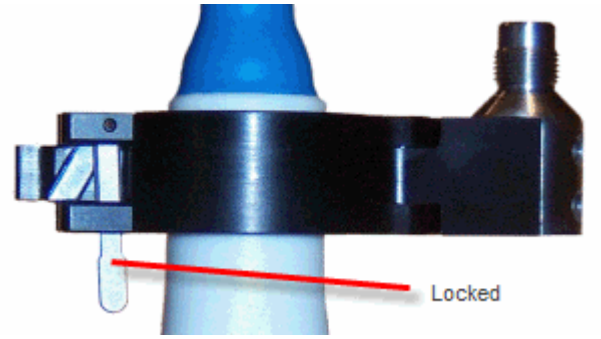


4. Close the moving arm of the clamp and then pull the latch down to the 45° notch. This transducer rotation lock setting holds the transducer but provides enough freedom for your to rotate it.



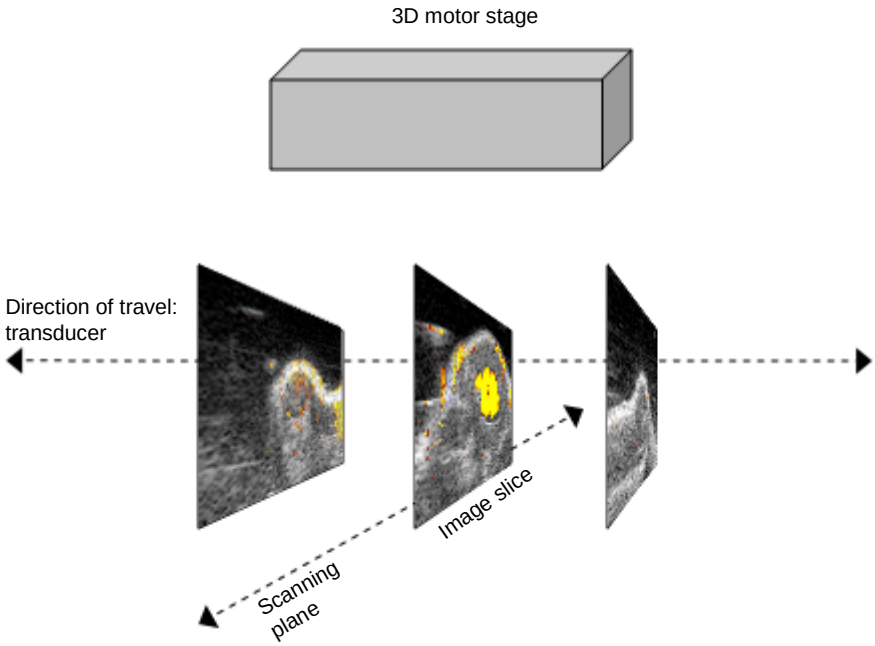
5. To set the transducer to any of the at the desired 90-degree angle in the clamp turn the transducer until you feel the collar snap into position.

6. Close the clamp and push the latch down until it locks into place as shown in the following illustration.



Orienting the transducer

As shown in the following illustration, the long axis of the 3D motor stage must be aligned in the direction that the transducer travels during data acquisition.



During the 3D data acquisition, the motor stage moves the transducer. Ensure that the animal under the transducer is flat in relation to the 3D scan direction to prevent unintended contact with the surface of the subject as the 3D motor stage moves the transducer.

WARNING: The 3D motor stage could cause a hazard to fingers during a 3D scan as the motor stage moves. Ensure that fingers are kept away from the 3D motor stage during a 3D scan.

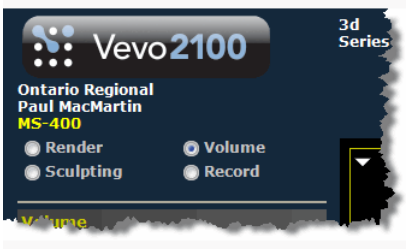
Recording a 3D-Mode analysis session

The **Record** tool creates a real-time AVI file of actions you perform on 3D image data in the active pane.

To record a 3D Mode analysis study session:

1. While you analyze your 3D-Mode image, to view the 3D-Mode tools set in the left panel:

- If you are on the Vevo 2100 Imaging System, press Mode Settings.
- If you are on the Vevo Imaging Workstation, click **3D Settings**.



2. Click **Record** and then click **Start Recording**.
3. In the **Save As** box:
   a. Browse to the directory where you want to save the recording.
   b. If you want to create a new folder for the recording, click **New Folder** and add the new folder.
   c. If you want to change the file name, in the **Save As** field, type a unique file name.
   d. In the **File Type** box select the appropriate AVI compression type.
   e. If the **OK** button is grayed out, the system has detected that the file name already exists in the selected folder. If you want to overwrite this file click **Overwrite Existing File**.
   f. Click **OK**.

   The system begins recording the activity occurring in the selected view pane.
4. Use the other 3D tools to analyze your 3D images.
5. When you are done your analyses click **Stop Recording**.

   The system saves the recording to the location you specified.

Chapter 42

Analyzing 3D-Mode images

This chapter shows you how to analyze 3D-Mode images that are saved to a study.

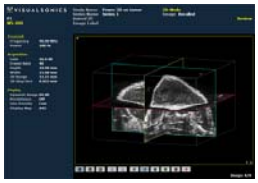
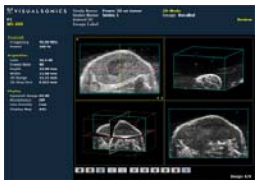
In this chapter

3D-Mode visualization tools

When you are in the cube view, the 3D-Mode image analysis tool bar provides a series of analysis tools you can use to change either the number of view panes in the area or the type of analysis view you want to work with.

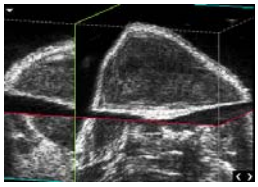
Visualization tools available for all 3D images

The image analysis tool bar includes the following tools:

Tool	Description	Example
 Single Pane	Click to display one 3D image view across the entire image area.	
 Dual Pane	Click to display two 3D image views across the image area.	
 Quad Pane	Click to display four image views across the image area.	

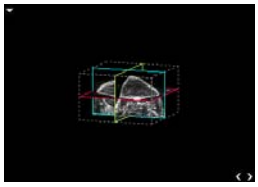
Zoom In

Click to magnify the view up to 20 levels of zoom.



Zoom Out

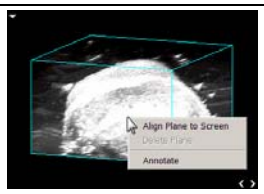
Click to minimize the view up to 20 levels of zoom.



Cube View

Click to display a three-dimensional view of the acquired data, constructed from the full set of B-Mode image slices. The cube displays a blue wire-frame by default.

As you trackball over a plane on the cube, the plane becomes “active” and the wire-frame for that plane is displayed in green.



Right-click commands

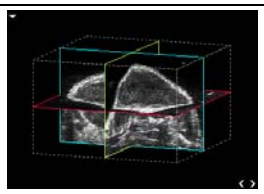
Right-click a pane to display the following commands:

Command	Description
Align Plane to Screen	Rotates the cube to display a head-on view of the active plane
Delete Plane	Removes a manually created plane
Annotate	Provides a text box in which to type an annotation

Cross View

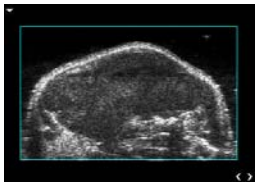
Click to display three single, slidable image slice views presented on the x, y, and z planes. Each plane presents its own color outline:

- Blue = x-y plane on the z axis
- Green = y-z plane on the x axis
- Red = x-z plane on the y axis



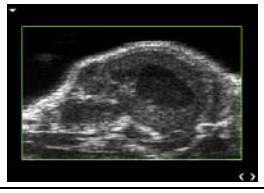
Transverse View

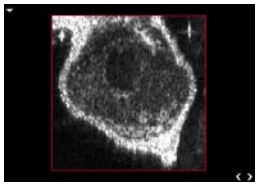
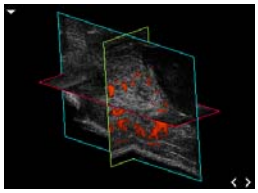
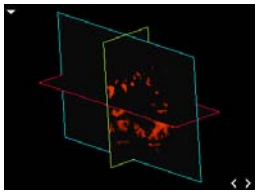
Click to display a straight-on perspective of the x-y plane image slice, displayed on the Cross view as the plane outlined in blue.



Sagittal View

Click to display a straight-on perspective of the y-z plane image slice, displayed on the Cross view as the plane outlined in green.



 Coronal View	Click to display a straight-on perspective of the x-z plane image slice, displayed on the Cross view as the plane outlined in red.	
 Surface View	Click to display a compilation view that uses the Cross view to map operator-generated volumes to the acquired data.	
 Toggle Overlay	Click to cycle through the three overlay states: ▪ Overlay + B-Mode ▪ Overlay ▪ B-Mode	

Manipulating 3D-Mode image data

This section describes how to use the 3D-Mode tools to better define and visualize specific areas in the image.

Rotating an image

You can rotate an image when you are in Cube view, Cross view and Surface view.

To rotate an image:

1. Position the trackball cursor outside the volume, and then left-click.
2. Drag in any direction.
3. Left-click to stop the rotation.

Panning an image

To pan an image:

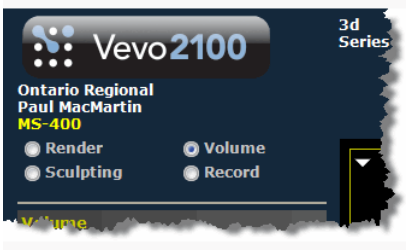
1. Position the trackball cursor in the image pane.
2. While pressing the Shift key, left-click and drag in any direction.
3. Left-click to stop the panning.

Rendering a 3D image

Use the Render tool in 3D-Mode to display the full 3D image. You can only use this tool when you are viewing your 3D image in the Cube view.

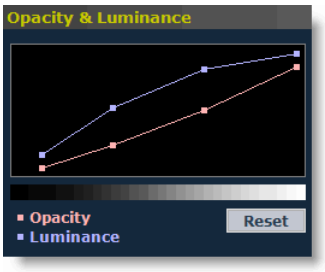
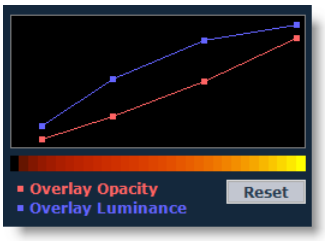
To render an image:

1. While you analyze your 3D-Mode image, to view the 3D-Mode tools set in the left panel:
   - If you are on the Vevo 2100 Imaging System, press Mode Settings.
   - If you are on the Vevo Imaging Workstation, click **3D Settings**.



2. Click **Render**.
3. Select from the four modes as described in the following table:

Render mode	Description
Texture Mapping	Texture Mapping mode displays the surface texture of the 3D image. Texture mapping mode is the default rendering mode for 3D acquisition. **To apply texture mapping to a 3D image:** Under Mode, click **Texture Mapping**. The Cube view displays data on the surface of each plane of the 3D image.

Render mode	Description
Render	Render mode displays the full 3D image in the Cube view. **To render a 3D image:** Under **Mode**, click **Render**. ▪ The Cube view traces each line of the data, perpendicular to the display for the full image. ▪ The left panel adds the **Opacity & Luminance** section for B-Mode image data under the **Mode** section.  Use the light-red **Opacity** curve to adjust the levels of transparency in the image. Use the light-blue **Luminance** to artificially adjust the light/dark contrast of the image. **To adjust opacity and luminance of a rendered image:** ▪ Left-click and drag a point along the curves and then left-click to lock the point to a new setting. ▪ Click **Reset** to return both curves to their default settings. **For Contrast 3D-Mode and Power 3D-Mode:** The system adds an overlay opacity and luminance tool that applies to the overlay data component of the image. The tools work in the same way as the B-Mode opacity and luminance tools. 
MIP (Max)	MIP (Maximum Intensity Persistence) enhances the contrast of an image by maximizing the brightest pixels in the image. Use this mode to better distinguish organs from their surrounding area when the organ objects are brighter than their surrounding structures. **To apply MIP (Max) to a 3D image:** Under Mode, click **MIP (Max)**.

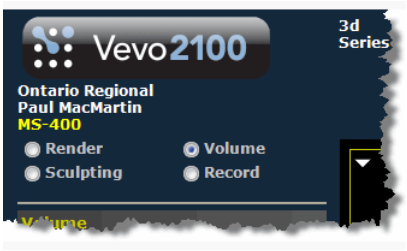
Render mode	Description
MIP (Min)	MIP (Min) (Minimum Intensity Persistence) enhances the contrast of an image by minimizing the brightest pixels in the image. Use this mode to better distinguish organs from their surrounding area when the organ objects are darker than their surrounding structures. **To apply MIP (Min) to a 3D image:** Under Mode, click **MIP (Min)**.

Sculpting an image

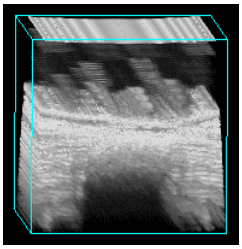
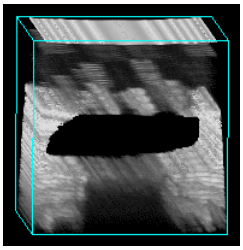
Use the Sculpting tool in 3D-Mode to cut away superfluous image data so you can view volumes of interest more easily. You can only use this tool when you are viewing your 3D image in the Cube view.

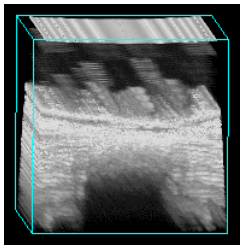
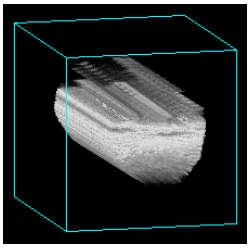
To sculpt an image:

1. While you analyze your 3D-Mode image, to view the 3D-Mode tools set in the left panel:
   - If you are on the Vevo 2100 Imaging System, press Mode Settings.
   - If you are on the Vevo Imaging Workstation, click **3D Settings**.



2. Click **Sculpting**.
3. Select from the three available modes as described in the following table:

Sculpting mode	Description
Shave	Shave gives you fine control over the amount of data you want to cut away. This mode functions like an eraser: set the depth that the tool can shave the target and then use the tool on the image in Cube view. **To shave a 3D image dataset:** 1. Under **Mode**, click **Shave**. 2. Under **Depth**, set the slider to the depth of shave required. Depth slider values are proportional. The Max setting represents the full distance through the image. When you set the slider to Max, the system shaves a hole completely through the image. 3. Step through the image slices to find the plane from which shaving should start. 4. Trackball in the target area. 5. Drag the cursor. 6. Release the trackball button to complete the shaving procedure.
Scalpel (Inside)	Scalpel (Inside) mode functions like a cookie cutter. Select a depth, then outline an area within which to remove data. **To scalpel inside a 3D image:** 1. Under Mode, click **Scalpel (Inside)**. 2. Under Depth, set the slider to the required depth. 3. Position the trackball cursor over the image. 4. Drag the trackball cursor to create the outline of the area to be scalpeled. 5. Release the trackball button. The outlined area is removed from the image.   *Image before scalpeling* *Image after scalpeling (inside)*

Sculpting mode	Description
Scalpel (Outside)	Scalpel (Outside) mode functions like a cookie cutter, much the same way as Scalpel (Inside). Select a depth, then outline an area outside of which to remove data. **To scalpel outside a 3D image:** 1. Under Mode, click **Scalpel (Outside)**. 2. Under Depth, set the slider to the required depth. 3. Trackball over the image. 4. Drag to create the outline of the area to be scalpeled. 5. Release the trackball button. Data outside the outlined area is removed from the image.   *Image before scalpeling* *Image after scalpeling (outside)*

Creating 3D volume measurements

In Cube view, the 3D-Mode Volume tool accurately measures object volumes within an image. Volumes are created by segmenting a series of contours and calculating the volume within the contoured region.

You can create 3D volumes in 3D-Mode, Power 3D-Mode, and Contrast 3D-Mode using Parallel or Rotational Segmentation.

Typically, rotational segmentation should be used when the volume resembles a spherical shape. Otherwise, use parallel segmentation.

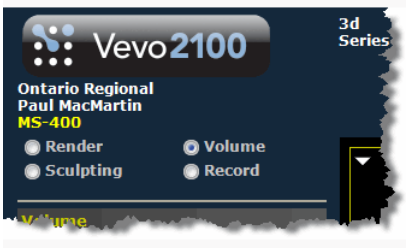
For parallel segmentation, the system can perform manual, semi-automated or automated segmentation of the volume. Rotational segmentation does not support manual segmentation.

- When you segment the volume manually (in parallel segmentation only) you manually draw each contour of the volume.
- When you segment the volume semi-automatically the system draws multiple contours.
- When you segment the volume automatically the system draws multiple contours.

Rotational segmentation

To create a volume measurement using rotational segmentation:

1. While you analyze your 3D-Mode image, to view the 3D-Mode tools set in the left panel:
   - If you are on the Vevo 2100 Imaging System, press Mode Settings.
   - If you are on the Vevo Imaging Workstation, click **3D Settings**.

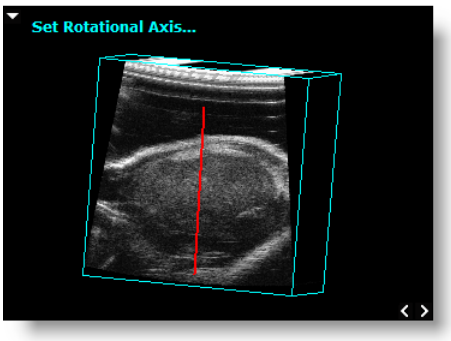


2. Click **Volume**.
3. Ensure that the 3D data is displayed in the Cube view.
4. In the Volume area:
   a. Select **Rotational**.

   b. If you want to assign a custom color to the contours of the volume click **Color**, select the appropriate color from the Color dialog, and then click **OK**.
   c. Click **Start**.
5. To create the first contour, start in the Cube view and then complete the following procedures:
   a. In the active pane use the **< >** tools to step to a slice that is not one of the outer slices of the cube.
   b. Click **Start**.

The system prompts you to set a Rotational Axis. You can set the axis of rotation by clicking once at one end of the axis of rotation and then clicking at the other end.

The axis of rotation should run through entire volume region as shown in the following illustration:



c. Click to create a point on the circumference of a contour.

d. Trace the contour. The system adds points as you trace.

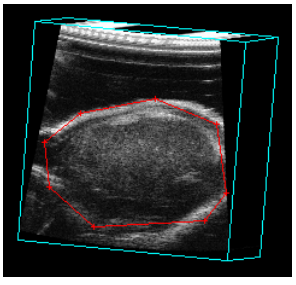
e. To complete the contour, right-click the last point, or left-click near the first point.

   The contour is displayed in the Contour List as `3D Volume 1 -- 001` if this is the first contour of the first volume measurement on the image. The contour color changes from blue to the specified color.

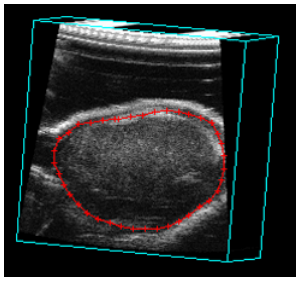
   If the position of the trackball cursor is within five pixels of the previous caliper when you right-click, the previously placed caliper is considered to be the last caliper for the measurement. This applies to 3D-Mode polygon measurements and for 3D-Mode volume contours.

f. Click **Refine** to initiate the edge detection algorithm. This function detects the edge of the vessel or volume wall and attempts to closely fit the line to the outside wall of the vessel or volume. The Refine function can be repeated to achieve the closest possible fit.

   The Refine function achieves the best results when the contour is drawn just outside the boundary of the anatomical structure.

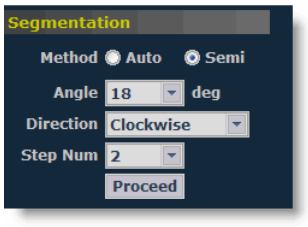


Initial contour



Refined contour

6. Select the preferred rotational segmentation parameters in the Segmentation section of the Volume tool.



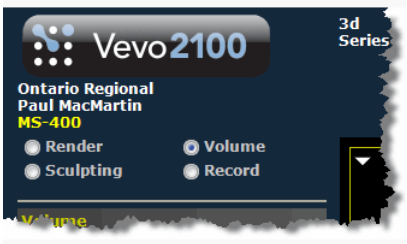
   - Set the desired Method of segmentation: Auto or Semi.
   - Set the Angle of rotation. The angle represents the degrees separating each contour. The default value is 18 degrees.
   - Set the Direction of rotation: Clockwise or Counterclockwise, relative to the axis of rotation.
   - If Semi was selected as the method of segmentation, select the Step Num value. This specifies the number of contours the system creates.

7. Click **Proceed** to draw subsequent contours.
   - If you select the Method **Auto** the system creates a sufficient number of contours to complete a full rotation around the volume. This completes the segmentation procedure and the volume calculation is displayed in the lower left corner of the cube view.
   - If you select the Method **Semi** the system creates the number of contours specified in the **Step Num** setting. Repeat the previous steps until you segment the full volume. Click **Finish** to complete the segmentation. The volume calculation is displayed in the lower left corner of the cube view.

Parallel segmentation

To create a volume using parallel segmentation:

1. While you analyze your 3D-Mode image, to view the 3D-Mode tools set in the left panel:
   - If you are on the Vevo 2100 Imaging System, press Mode Settings.
   - If you are on the Vevo Imaging Workstation, click **3D Settings**.



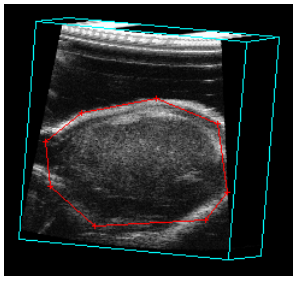
2. Click **Volume**.
3. Ensure that the 3D data is displayed in the Cube view.
4. In the Volume area:
   a. Select **Parallel**.

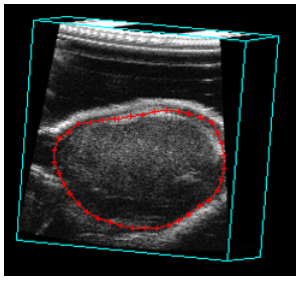
   b. If you want to assign a color to the contours of the volume click **Color**, select the appropriate color from the Color dialog, and then click **OK**.
   c. Click **Start**.
5. To create the first contour, start in the Cube view and then complete the following procedures:
   a. Click to create a point on the circumference of a contour.
   b. Position the cursor to a second point along the intended contour, and then click to set the second point.
   c. Continue creating points, and then right-click the last point, or left-click near the first point to complete the contour.

      The contour is displayed in the Contour List as `3D Volume 1 -- 001` if this is the first contour of the first volume measurement on the image. The contour color changes from blue to the specified color.

      If the position of the trackball cursor is within five pixels of the previous caliper when you right-click, the previously placed caliper is considered to be the last caliper for the measurement. This applies to 3D-Mode polygon measurements and for 3D-Mode volume contours.
   d. Click **Refine** to initiate the edge detection algorithm. This function detects the edge of the vessel or volume wall and attempts to closely fit the line to the outside wall of the vessel or volume. The Refine function can be repeated to achieve the closest possible fit.

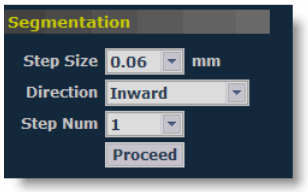
      The Refine function achieves the best results when the contour is drawn just outside the boundary of the anatomical structure.





Initial contour *Refined contour*

6. You can draw subsequent contours can be drawn manually or semi-automatically. Select the preferred parallel segmentation parameters in the Segmentation area of the Volume tool.



   a. Set the Step Size. The default step size is the scan step size.

   b. Set the Direction of segmentation: Inward, Outward, or Both.

   c. Set whether you are going to use manual or semi-automatic segmentation.

      - To use manual segmentation set the **Step Num** to 1
      - To use semi-automatic segmentation, set the **Step Num** to a value of two or more.

        When you use semi-automatic segmentation, the system generates the contours automatically. Each contour is refined before the next contour is drawn.

   d. To generate additional contours, click **Proceed**. If you use manual segmentation the system draws and refines the next contour. If you use semi-automatic segmentation the system creates the number of contours you specified in the Step Num field.

      The Contour List displays the second contour as 3D Volume 1 -- 002.

7. Repeat the previous step as necessary until the desired number of contours have been defined, and then click **Finish**.

You have successfully created the first calculated volume set for the image. If you need a second volume you can create an additional set of contours.

Editing a volume contour

After you create a volume you can edit one or more of the contours.

To modify a contour:

1. Select the contour in the Contour List.
2. Click a caliper point, drag it to a new position, then click to set the new location.
3. Repeat the procedure for any other contour caliper points you want to edit.

4. Click **Refine** to use the edge detection feature to fit the contour in line with the new point.

To move a contour:

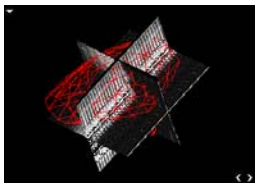
1. Click between the caliper points on the contour. This selects the entire contour.
2. Drag the contour to the new location.

Displaying a volume measurement as a 3D object

To display a volume measurement as a 3D object:

1. On the visualization tools tool bar, click the Surface View icon.

The system compiles a 3D representation of the volume in the Surface view, and then displays the measured volume as a red wire mesh overlay on the three planes.



2. Use the rotate, pan and zoom tools to modify the view of the object.

Adding generic 3D-Mode measurements

3D-Mode provides two generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for 3D-Mode:

- If you are acquiring 3D-Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

The system displays the measurement tools at the top of the left panel.

Hover over a tool to see the description label.

Linear distance measurement

Linear distance is measured in *mm*.

To place a linear distance measurement:

1. Click the linear distance measurement button .
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

2D Area measurement

2D Area is measured in mm^2.

To place a 2D area measurement:

1. Click the 2D area measurement button .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place your last caliper.

   If the position of the trackball cursor is within five pixels of the previous caliper when the right-click occurs, the system sets the previously placed caliper as the last caliper and auto-closes the measurement. This feature applies to 2D area measurements in B-Mode, 3D-Mode, and Contrast Mode as well as for 3D-Mode volume contours.
4. The system adds the final line segment to connect your last caliper with your first. If you selected the **Show Values and Labels** option in the Measurements

tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Section 12

Color Doppler Mode imaging and analysis

Color Doppler uses PW Doppler Mode ultrasound to produce an image of a blood vessel. In addition, the system converts the Doppler sounds into colors that are overlaid on the image of the blood vessel to represent the speed and direction of blood flow through the vessel.

In This Section

Chapter 43

Acquiring Color Doppler Mode images

This chapter shows you how to acquire Color Doppler Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical Color Doppler Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

To acquire a Color Doppler Mode image:

1. Press Color. In the image area:
   - The system begins storing cine loop data in the acquisition buffer
   - The system displays the region-of-interest (ROI) box overlay on the B-Mode background image
   - If your transducer is positioned almost parallel over a vessel, the system displays color data in the ROI box
2. To change the size and proportion of the color ROI box:
   a. Press Update. The color ROI box becomes a dashed-line box.

b. Trackball up or down to change the height of the box, or left and right to change the width of the box.

c. Press Update to return to the solid-lined color ROI box.

3. To change the position of the box, trackball to move the color ROI box.
4. Press Presets to cycle through the available presets and then select an appropriate set of optimized image acquisition settings.
5. On the control panel, adjust the Color Doppler Mode controls (page 309) to refine your image acquisition settings if required.
6. Press the Scan/Freeze toggle control to stop the data acquisition so you can review the data in the acquisition buffer.
7. Roll the trackball side to side to scroll through the cine loop.
8. If you are satisfied with the cine loop or an individual image frame, store your image data.
   - To save a cine loop press Cine Store.
   - To save and label a cine loop, press Image Label.
   - To save the displayed image frame press Frame Store.
9. Press Scan/Freeze toggle control to resume scanning.
10. Save images as required.
11. Press Close. The system closes the series you are working on and displays the **Study Information** window.
12. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

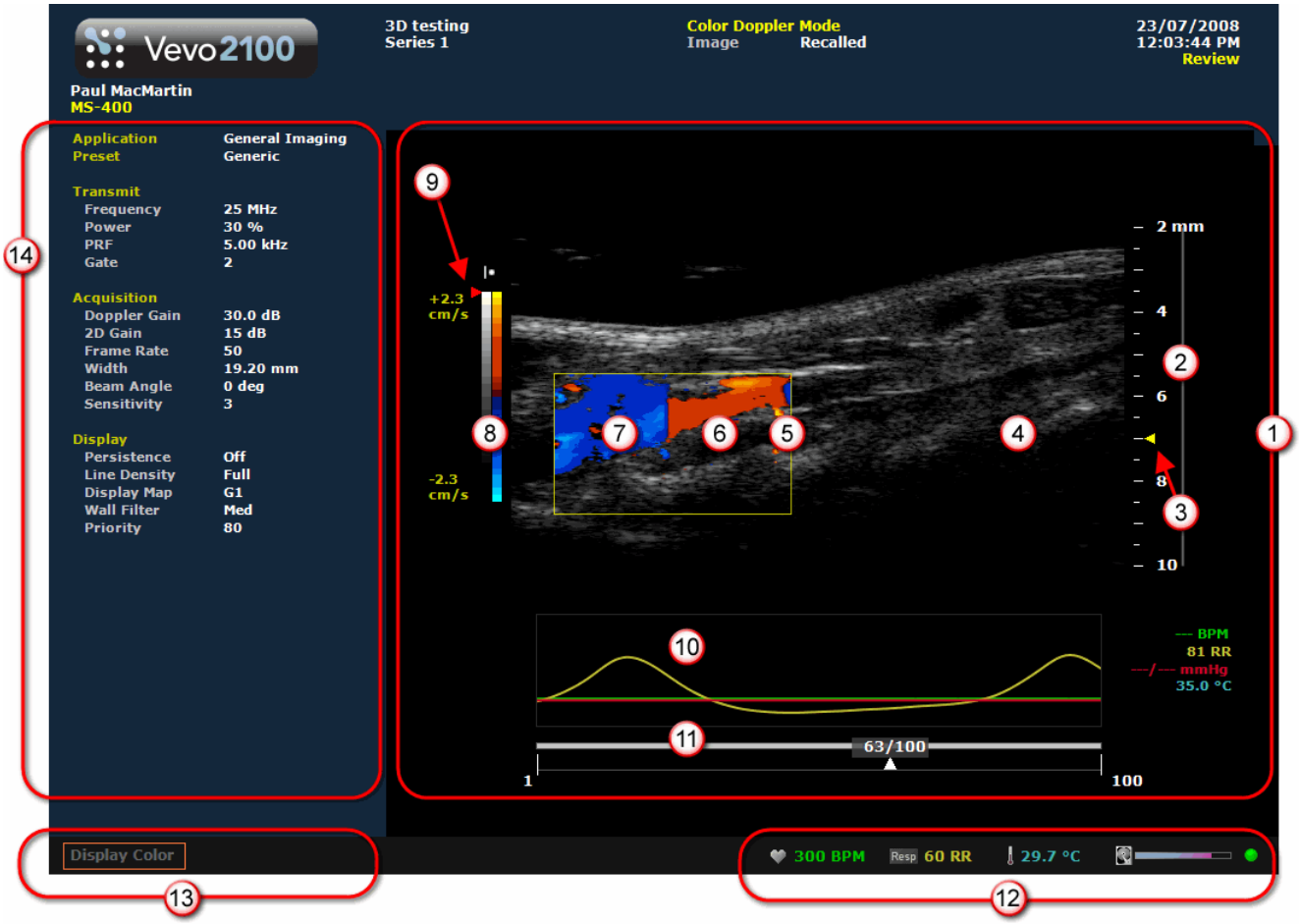
You have successfully acquired Color Doppler Mode image data.

Next step

- *Adding generic Color Doppler Mode measurements* (page 315)

Color Doppler Mode window workspace

The Color Doppler Mode window is the workspace you use whenever you view image data in Color Doppler Mode. The following illustration and table describes the information and features in the Color Doppler Mode window.



Area	Description
1	**Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**Image scale**. Indicates in mm the distance from the face of the transducer.
3	**Focus depth**. Indicates the distance from the face of the transducer where the system maximizes image resolutions.
4	**Micro-ultrasound image**. Displays the B-Mode data that the transducer acquires. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.

Area	Description
5	**Region of interest color box overlay**. The system applies the Color Doppler Mode based colors only to the image data within this box.
6	**Vascular flow moving toward the transducer**. Displayed in red colors.
7	**Vascular flow moving away from the transducer.** Displayed in blue colors.
8	**Color and velocity scale**. The right column of the scale is the color scale. It follows the acronym **BART** color principle for Doppler (**B**lue=**A**way from, **R**ed=**T**oward) positive vascular flows are indicated by colors in the red range, negative flows are in the blue range, and velocities for each direction increase from dark to light. The velocity range of the scale changes when you change the signal velocity or frequency. The left column of the scale is the standard gray scale that appears for all B-Mode based images.
9	**Priority indicator**. Tracks the priority level when you adjust the Priority control. This control adjusts the priority relationship between the overlay data and the background B-Mode data so you can eliminate false readings. For more information see *Priority* (page 415).
10	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station.
11	**Cine loop range control**. Displays the length of the cine loop range. The triangular white marker identifies the individual frame number within the cine loop. You can drag the left and right vertical markers to display only the image frames in that range.
12	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
13	**Screen keys display** ▪ Displays the updated parameter and system information when you make adjustments on the control panel. ▪ Displays control options in the mode that you apply during image acquisition when you press the Screen Keys dial. In Color Doppler Mode, press the dial to cycle through three image states: Color box overlay + B-Mode, B-Mode only, Color box only.

Area	Description
14	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).

Control panel controls for Color Doppler Mode

The following table describes the primary controls you use to optimize the image you see on the screen and reduce color artifacting when you are acquiring Color Doppler Mode image data.

1

Frequency

Adjusts the transmit frequency of the transducer between the higher and lower frequency levels that are supported by the specific transducer. When you increase the frequency you can improve detail at the focus depth but the system tends to lose detail at deeper tissues.

Push forward to increase the frequency. Pull back to decrease the frequency.

2

Screen Keys

Press the dial to cycle through three image states: Color box overlay + B-Mode, B-Mode only, Color box only.

3

Display Map

Cycles you through a predefined set of optimization maps that you can apply either while you are acquiring or reviewing image data.

Push up or pull down to cycle through the available maps for the active imaging mode.

4

Transmit Power

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

5

Persist

Applies a pixel averaging algorithm to the most recently acquired frames to produce a more uniform view of the faster moving areas in the image data.

To use this rocker switch control:

Push up or down to cycle through the persistence levels. In the bottom-left corner of the screen the status bar briefly displays the name of the persistence label as you select. **In Color Doppler Mode and Power Doppler Mode**: Applies to the color signal data only. It does not apply to the B-Mode background data. Levels: Off, Low, Med, High, Max. Helpful when you are studying abdominal organ tissue such as liver, kidney and pancreas.

6

Color

Activates Color Doppler Mode acquisition and begins displaying the color box overlay over the B-Mode background image.

7

Doppler Gain

Adjusts the frequency shift in increments of 1.0 dB. Turn clockwise to add gain and brighten the Doppler data. Turn counterclockwise to reduce gain and darken the data.

Active during: PW Doppler Mode, PW Tissue Doppler Mode, Color Doppler Mode, Power Doppler Mode image acquisition sessions.

8

Velocity

Adjusts the PRF (pulse repetition frequency). The higher you set the PRF, the lower the signal resolution.

9

SV/Gate

Push up to increase. Pull back to decrease.

In Color Doppler Mode: Adjusts the size of the multiple *sample volumes* that span the depth of the region of interest, indexed in a range from 1-6.

- Set your gate to 1 for the best axial resolution.
- Set your gate to 6 for the best sensitivity.

10

Wall Filter

Filters out signals that correspond to low velocity axial motion. Typically these include vessel wall movement, cardiac wall movement and tissue movement caused by respiration. Push up to filter out more. Pull down to filter out less. **In Color Doppler Mode and Power Doppler Mode**: Set as low as you can so that you don't lose any flow, but higher than any motion that creates low frequency artifacting.

11

Beam Angle

Helps you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam.

This control applies a graduated series of transmission and reception delays to the ultrasound sound signals of each crystal in the transducer. These carefully calibrated sequences can effectively *steer* the ultrasound beam in order to detect minute frequency shifts.

In PW Doppler Mode and PW Tissue Doppler Mode, the current beam angle setting is displayed in the top-left corner of the B-Mode scout image.

In Power Doppler Mode and Color Doppler Mode, this changes the color box.

Active during Color Doppler Mode, Power Doppler Mode, PW Doppler Mode, PW Tissue Doppler Mode imaging sessions.

To use this rocker switch control:

Push up or pull down the control depending on the orientation of your transducer to steer the beam angle.

12

Priority

Determines the threshold point on the gray scale above which the system does not apply color data. The red marker along the left side of the gray scale indicates the threshold point.

Push up to assign more priority to the color data. Pull down to assign less priority to the color data and more priority to the threshold on the B-Mode grayscale bar.

Useful when you suspect, for example, that color data is covering over the actual contour of a vessel wall. In this case you would lower the priority until the overlay data matches the actual tissue contour and properties.

13

Baseline

Adjusts the vertical position of the horizontal zero frequency line (the *baseline*) that divides the image data coming toward the transducer face from the image data moving away from the transducer face. Push up to raise the line. Pull down to lower the line.

Sensitivity

Adjusts the signal-to-noise ratio so that you can:

- Better identify weak-signal targets in the near field that are difficult to distinguish because they are very small
- Better identify large targets in the far field that are difficult to distinguish because the signal is so attenuated at depth.

The higher you set the sensitivity level, the lower the system sets the frame rate. Push up to increase sensitivity. Pull down to decrease.

Color Doppler Mode acquisition settings

To view the Color Doppler Mode acquisition settings:

Press Mode Settings.

The Color Doppler Mode acquisition settings panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.
PRF	The pulse repetition frequency (PRF) of the transmitted PW Doppler signal, measured in kiloHertz. This parameter defines the maximum observable PW Doppler frequency shift and flow velocity. Adjust with the Velocity control.
Gate	Number of transmit cycles in the ultrasound pulse. Adjust the value with the Sensitivity control. The range of values depends on the transducer. Higher gate values deliver more detail sensitivity, but lower image resolution.

Acquisition

Parameter	Description
Doppler Gain	The PW Doppler frequency, measured in dB. Adjust with the Doppler Gain control.
2D Gain	The strength of the ultrasound signal when it returns to the face of the transducer. Range values vary by transducer. Adjust with the 2D Gain control.
Frame Rate	The number of image frames per second that the system is acquiring.

Parameter	Description
Width	The width of the acquired image area, measured in *mm*. Adjust with the Image Width control.
Beam Angle	The number of degrees of steer to the ultrasound beam so you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam. Adjust with the Beam Angle control.
Sensitivity	The signal resolution level. Adjust with the Sensitivity control.

Display

Parameter	Description
Persistence	The state of the Persistence feature: Off, Low, Med, High, Max. Adjust with the Persist control.
Line Density	The line density level. One of four settings: Quarter, Third, Half, Full. Adjust with the Line Density control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.
Wall Filter	The level of low velocity signals, measured in Hz, filtered out of the spectral display. Adjust with the Wall Filter control.
Priority	The threshold level on the B-Mode gray scale, displayed as a percentage, above which the system does not apply color data. Adjust with the Priority control.

Chapter 44

Analyzing Color Doppler Mode images

This chapter shows you how to analyze Color Doppler Mode images that are saved to a study.

In this chapter

Adding generic Color Doppler Mode measurements

Color Doppler Mode provides seven generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

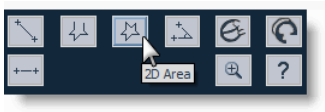
Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for Color Doppler Mode:

- If you are acquiring Color Doppler Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.



  Hover over a tool to see the description label.

Linear distance measurement

Linear distance is measured in *mm*.

To place a linear distance measurement:

1. Click the linear distance measurement button  .

2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Traced distance measurement

Traced distance is measured in *mm*.

To place a traced distance measurement:

1. Click the traced distance measurement button .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place the final caliper of your trace. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

2D Area measurement

2D Area is measured in mm^2.

To place a 2D area measurement:

1. Click the 2D area measurement button .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place your last caliper.

   If the position of the trackball cursor is within five pixels of the previous caliper when the right-click occurs, the system sets the previously placed caliper as the last caliper and auto-closes the measurement. This feature

applies to 2D area measurements in B-Mode, 3D-Mode, and Contrast Mode as well as for 3D-Mode volume contours.

4. The system adds the final line segment to connect your last caliper with your first. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Angle measurement

Angles report interior angle values and are therefore always less than 180 degrees Angles are measured in *deg*.

To place an angle measurement:

1. Click the angle measurement button  .
2. Click on your image to place the initial caliper. This is the outside end of the first ray of your angle.
3. Trackball to where you want to position the vertex of your angle and then click to place the caliper. This completes the first ray.
4. Trackball to the position where you want to end the second ray and then click to place the final caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button  . The system highlights the button until you complete your measurement.

2. In the physiology data trace window below the image mode data, click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Adding protocol measurements

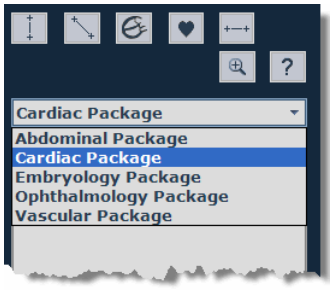
Protocol measurements are labeled uniquely for a specific measurement protocol.

To access the protocol measurement tools and measurements list

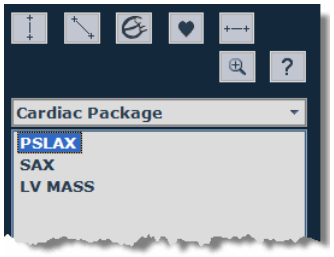
- If you are in an image acquisition session press Scan/Freeze to acquire an image and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

To place a protocol measurement:

1. In the measurement packages drop-down list click the appropriate package.



2. In the list of protocols, select the appropriate protocol.



3. In the list of measurements, select the measurement you want to add.

   The system automatically activates the appropriate measurement tool and highlights the generic button for that tool.

4. On the image, add your measurement. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.

Next step

- *Reporting your analysis results* (page 184)

Related information

- *Analyzing image data* (page 156)
- *Protocol measurements* (page 167)

Section 13

Power Doppler Mode imaging and analysis

Power Doppler Mode displays the energy from the returning Doppler signal and assigns a color range to the energy generated by moving blood flow. Power Doppler.

In This Section

Chapter 45

Acquiring Power Doppler Mode images

This chapter shows you how to acquire Power Doppler Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical Power Doppler Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

To acquire a Power Doppler Mode image:

1. Press Power. In the image area:
   - The system begins storing cine loop data in the acquisition buffer
   - The system displays the region-of-interest (ROI) box overlay on the B-Mode background image
   - If your transducer is positioned over a vessel, the system displays color data in the ROI box
2. To change the size and proportion of the color ROI box:

a. Press Update. The color ROI box becomes a dashed-line box.

b. Trackball up or down to change the height of the box, or left and right to change the width of the box.

c. Press Update to return to the solid-lined color ROI box.

3. To change the position of the box, trackball to move the color ROI box.
4. Adjust the Image Width control to remove image content outside the region of interest to optimize the image data for analysis.
5. Press Presets to cycle through the available presets and then select an appropriate set of optimized image acquisition settings.
6. If you need to refine your settings, on the control panel adjust the Power Doppler Mode controls (page 327).
7. Press the Scan/Freeze toggle control to stop the data acquisition so you can review the data in the acquisition buffer.
8. Roll the trackball side to side to scroll through the cine loop.
9. If you are satisfied with the cine loop or an individual image frame, store your image data.
   - To save a cine loop press Cine Store.
   - To save and label a cine loop, press Image Label.
   - To save the displayed image frame press Frame Store.
10. Press Scan/Freeze toggle control to resume scanning.
11. Save images as required.
12. Press Close. The system closes the series you are working on and displays the **Study Information** window.
13. Complete the required fields to define your study and click **OK**.

    The **Study Browser** appears.

You have successfully acquired Power Doppler Mode image data.

Next step

- *Adding generic Power Doppler Mode measurements* (page 333)
- *Adding protocol measurements* (page 168)

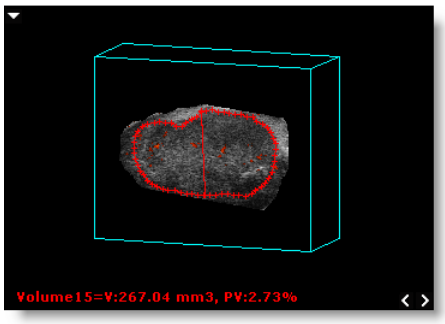
Segmentation in Power 3D-Mode

The segmentation feature is the only 3D image analysis tool in the system that can quantify vasculature.

To segment a volume in Power 3D-Mode:

1. Acquire your Power 3D-Mode image.
2. Follow the same procedures for segmenting a volume in 3D-Mode:
   - Create a volume using rotational segmentation (page 296)
   - Create a volume using parallel segmentation (page 298)

   The system displays a Percent Vascularity (PV) value below the image. This PV value quantifies the relative percentage of flow or other movement.



3. If you modify the volume click **PV Recalc** to update the PV value.

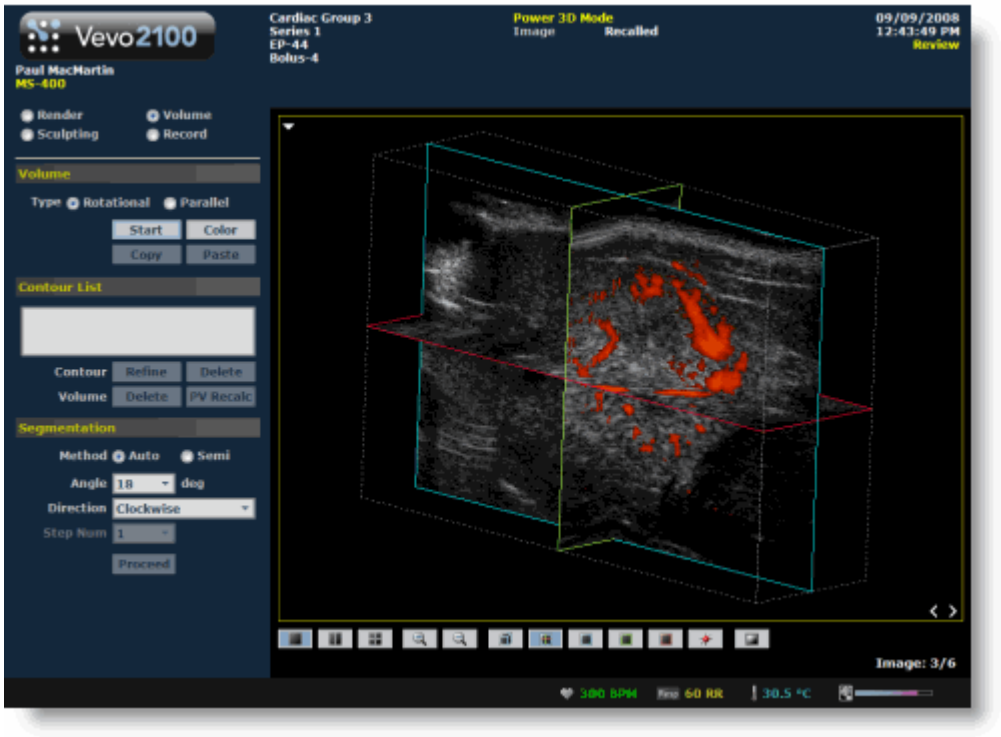
Typical Power 3D-Mode image acquisition session

Power 3D-Mode adds Power Doppler Mode data during a 3D-Mode scan so you can reconstruct a volume that integrates the Power Doppler Mode color data with the surrounding B-Mode 3D volume.

To acquire a Power 3D-Mode image:

1. Set up for a 3D-Mode image acquisition session (page 282).
2. Follow the typical steps for a Power Doppler Mode image acquisition (page 321).
3. When you are satisfied with your Power Doppler Mode image, press 3D.
4. Follow the typical steps for a 3D-Mode image acquisition (page 275).

The system acquires the Power 3D-Mode image slices and then displays the data in the 3D-Mode workspace.

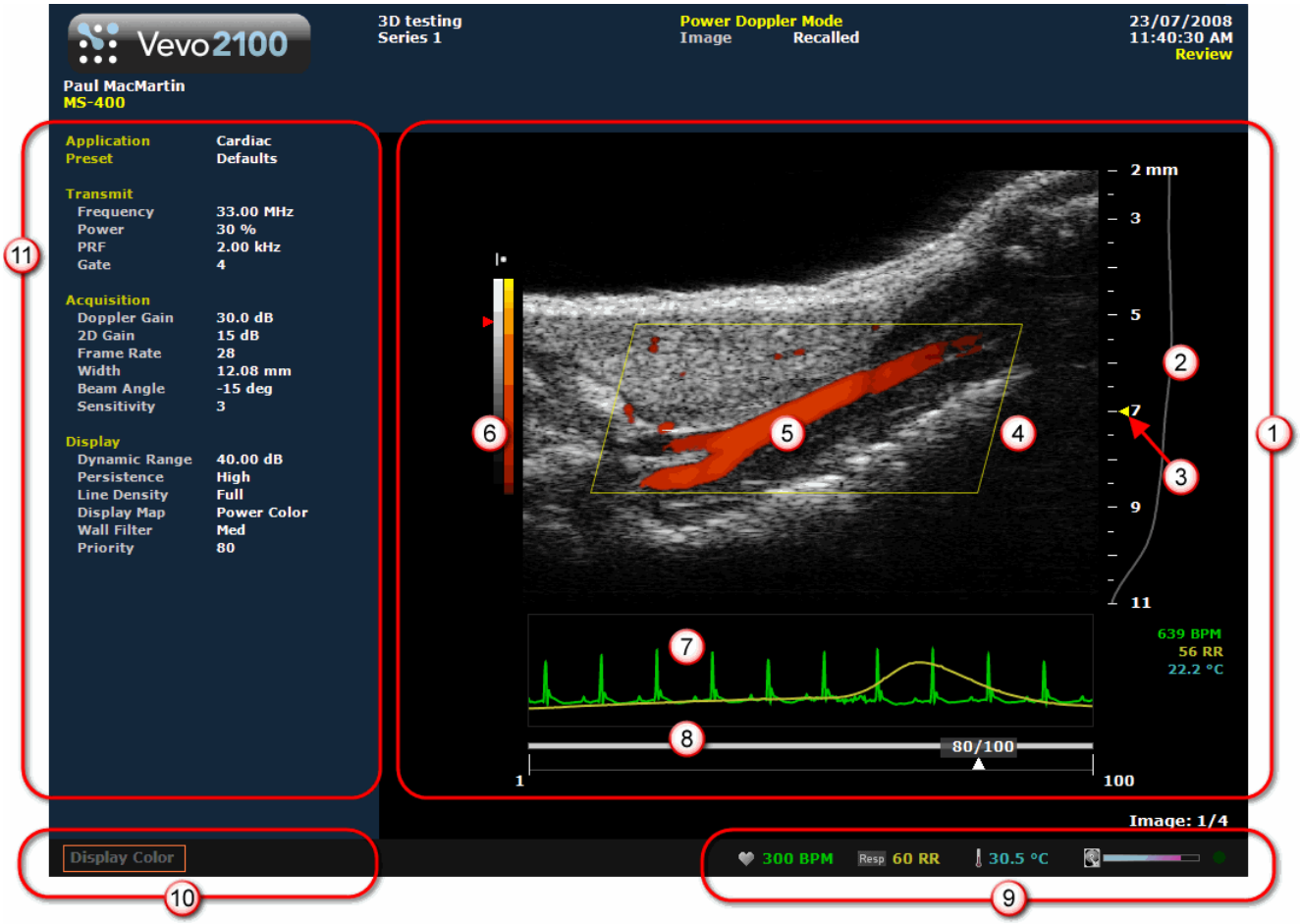


Related information

- *3D-Mode visualization tools* (page 288)
- *Typical 3D-Mode image acquisition session* (page 275)
- *Typical Contrast 3D-Mode image acquisition session* (page 341)

Power Doppler Mode window workspace

The Power Doppler Mode window is the workspace you use whenever you view image data in Power Doppler Mode. The following illustration and table describes the information and features in the Power Doppler Mode window.



Area	Description
1	**Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**Image scale**. Indicates in mm the distance from the face of the transducer.
3	**Focus depth**. Indicates the distance from the face of the transducer where the system maximizes image resolutions. When you reposition the ROI power box, the system automatically resets the focal depth to the vertical center of the box.

Area	Description
4	**Micro-ultrasound image**. Displays the B-Mode data that the transducer acquires. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.
5	**Power box overlay**. The system applies the Power Doppler Mode based colors only to the image data within this region-of-interest box.
6	**Gray scale and power scale**. The right column of the scale is the power scale. The darker colors indicate lower frequency signals. The lighter colors indicate higher frequency signals. The left column of the scale is the gray scale for the B-Mode background image.
7	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station.
8	**Cine loop range control**. Displays the length of the cine loop range. The triangular white marker identifies the individual frame number within the cine loop. You can drag the left and right vertical markers to display only the image frames in that range.
9	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
10	**Screen keys display** ▪ Displays the updated parameter and system information when you make adjustments on the control panel. ▪ Displays control options in the mode that you apply during image acquisition when you press the Screen Keys dial.
11	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).

Control panel controls for Power Doppler Mode

When you are acquiring Power Doppler Mode image data, these are the controls you use to optimize the image you see on the screen.

1

Frequency

Adjusts the transmit frequency of the transducer between the higher and lower frequency levels that are supported by the specific transducer. When you increase the frequency you can improve detail at the focus depth but the system tends to lose detail at deeper tissues.

Push forward to increase the frequency. Pull back to decrease the frequency.

2

Display Map

Cycles you through a predefined set of optimization maps that you can apply either while you are acquiring or reviewing image data.

Push up or pull down to cycle through the available maps for the active imaging mode.

3

Transmit Power

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

4

Line Density

Adjusts the resolution of your image by adjusting how many lines of image data the transducer acquires over your image area. Push up to increase the line density. Pull down to decrease.

The higher you set your line density, the lower the system sets the acquisition frame rate. Because of this trade off, you might find that higher line density is most useful for examining features in tissues that don't move very much such as liver, spleen, pancreas, and prostrate.

For cardiology applications, you will tend to keep the line density lower so you can increase the frame rate to measure more tissue movements over the time span of a complete cardiac cycle.

5

Persist

Applies a pixel averaging algorithm to the most recently acquired frames to produce a more uniform view of the faster moving areas in the image data.

To use this rocker switch control:

Push up or down to cycle through the persistence levels. In the bottom-left corner of the screen the status bar briefly displays the name of the persistence label as you select.

6

Dynamic Range

Adjusts the input signal strength that is mapped into the spectral display. Range: 5-100dB.

- Push up to increase the range by 5dB and lower contrast. Higher dynamic ranges are often used in cardiac imaging.
- Pull down to decrease the range by 5dB and increase contrast. Lower dynamic ranges are often used in abdominal imaging.

7

Doppler Gain

Adjusts the frequency shift in increments of 1.0 dB. Turn clockwise to add gain and brighten the Doppler data. Turn counterclockwise to reduce gain and darken the data.

Active during: PW Doppler Mode, PW Tissue Doppler Mode, Color Doppler Mode, Power Doppler Mode image acquisition sessions.

8

Power

Activates Power Doppler Mode acquisition and begins displaying the power box overlay over the B-Mode background image.

9

Velocity

Adjusts the PRF (pulse repetition frequency).

10

SV/Gate

Push up to increase. Pull back to decrease. **In Power Doppler Mode**: Adjusts the size of the *gate,* indexed in a range from 1-6.

- Set your gate to 1 for the best axial resolution.
- Set your gate to 6 for the best sensitivity.

11

Wall Filter

Filters out signals that correspond to low velocity axial motion. Typically these include vessel wall movement, cardiac wall movement and tissue movement caused by respiration. Push up to filter out more. Pull down to filter out less.

12

Beam Angle

Helps you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam.

This control applies a graduated series of transmission and reception delays to the ultrasound sound signals of each crystal in the transducer. These carefully calibrated sequences can effectively *steer* the ultrasound beam in order to detect minute frequency shifts.

In PW Doppler Mode and PW Tissue Doppler Mode, the current beam angle setting is displayed in the top-left corner of the B-Mode scout image.

In Power Doppler Mode and Color Doppler Mode, this changes the color box.

Active during Color Doppler Mode, Power Doppler Mode, PW Doppler Mode, PW Tissue Doppler Mode imaging sessions.

To use this rocker switch control:

Push up or pull down the control depending on the orientation of your transducer to steer the beam angle.

13

Priority

Determines the threshold point on the gray scale above which the system does not apply color data. The red marker along the left side of the gray scale indicates the threshold point.

Push up to assign more priority to the color data. Pull down to assign less priority to the color data and more priority to the threshold on the B-Mode grayscale bar.

Useful when you suspect, for example, that color data is covering over the actual contour of a vessel wall. In this case you would lower the priority until the overlay data matches the actual tissue contour and properties.

14

Sensitivity

Adjusts the signal-to-noise ratio so that you can:

- Better identify weak-signal targets in the near field that are difficult to distinguish because they are very small
- Better identify large targets in the far field that are difficult to distinguish because the signal is so attenuated at depth.

The higher you set the sensitivity level, the lower the system sets the frame rate. Push up to increase sensitivity. Pull down to decrease.

Power Doppler Mode acquisition settings

To view the Power Doppler Mode acquisition settings:

Press Mode Settings.

The Power Doppler Mode acquisition settings panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.
PRF	The pulse repetition frequency (PRF) of the transmitted PW Doppler signal, measured in kiloHertz. This parameter defines the maximum observable PW Doppler frequency shift and flow velocity. Adjust with the Velocity control.
Gate	Number of transmit cycles in the ultrasound pulse. Adjust the value with the Sensitivity control. The range of values depends on the transducer. Higher gate values deliver more detail sensitivity, but lower image resolution.

Acquisition

Parameter	Description
Doppler Gain	The strength of the ultrasound signal in *dB* increments when it returns to the face of the transducer. Adjust with the Doppler Gain control.
2D Gain	The strength of the ultrasound signal when it returns to the face of the transducer. Range values vary by transducer. Adjust with the 2D Gain control.
Frame Rate	The number of image frames per second that the system is acquiring.
Width	The width of the acquired image area, measured in *mm*. Adjust with the Image Width control.
Beam Angle	The number of degrees of steer to the ultrasound beam so you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam. Adjust with the Beam Angle control.
Sensitivity	The signal resolution level. Adjust with the Sensitivity control.

Display

Parameter	Description
Dynamic Range	The contrast of your image, measured in dB. Adjust with the Dynamic Range control.
Persistence	The state of the Persistence feature: Off, Low, Med, High, Max. Adjust with the Persist control.
Line Density	The line density level. One of four settings: Quarter, Third, Half, Full. Adjust with the Line Density control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.
Wall Filter	The level of low velocity signals, measured in Hz, filtered out of the spectral display. Adjust with the Wall Filter control.
Priority	The threshold level on the B-Mode gray scale, displayed as a percentage, above which the system does not apply color data. Adjust with the Priority control.

Chapter 46

Analyzing Power Doppler Mode images

This chapter shows you how to analyze Power Doppler Mode images that are saved to a study.

In this chapter

Adding generic Power Doppler Mode measurements

Power Doppler Mode provides seven generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

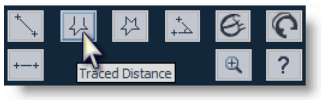
Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for Power Doppler Mode:

- If you are acquiring Power Doppler Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.



  Hover over a tool to see the description label.

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button. The system highlights the button until you complete your measurement.

2. In the physiology data trace window below the image mode data, click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Linear distance measurement

Linear distance is measured in *mm*.

To place a linear distance measurement:

1. Click the linear distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Traced distance measurement

Traced distance is measured in *mm*.

To place a traced distance measurement:

1. Click the traced distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place the final caliper of your trace. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

2D Area measurement

2D Area is measured in *mm²*.

To place a 2D area measurement:

1. Click the 2D area measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place your last caliper.

   If the position of the trackball cursor is within five pixels of the previous caliper when the right-click occurs, the system sets the previously placed caliper as the last caliper and auto-closes the measurement. This feature applies to 2D area measurements in B-Mode, 3D-Mode, and Contrast Mode as well as for 3D-Mode volume contours.
4. The system adds the final line segment to connect your last caliper with your first. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Angle measurement

Angles report interior angle values and are therefore always less than 180 degrees Angles are measured in *deg*.

To place an angle measurement:

1. Click the angle measurement button  .
2. Click on your image to place the initial caliper. This is the outside end of the first ray of your angle.
3. Trackball to where you want to position the vertex of your angle and then click to place the caliper. This completes the first ray.

4. Trackball to the position where you want to end the second ray and then click to place the final caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Section 14

Contrast Mode imaging and analysis

Contrast Mode imaging provides tools to detect and quantify vascular structures and dynamics at the molecular level.

This mode is useful in cancer, vascular and cardiology research for the following real-time in vivo applications:

- Targeted molecular imaging for visualizing and quantifying the expression of intravascular molecular markers — for example: angiogenesis and inflammation
- Tumor perfusion and relative quantification of vascular volume and structure
- Assessment of myocardial perfusion and area of infarction

In This Section

Chapter 47

Acquiring Contrast Mode images

This chapter shows you how to acquire Contrast Mode images.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated.

In this chapter

Typical Contrast Mode image acquisition session

Before you begin

If you want to add physiological data to your image:

- Set up your system for physiological data acquisition (page 109).
- Prepare your animal on the animal platform. For detailed information refer to the operator manual for your Vevo Imaging Station.
- For blood pressure setup, see *Blood Pressure section* (page 113).

Inject the contrast agent. Refer to the appropriate VisualSonics Application Protocol document for more information.

To manually create a typical Contrast Mode bolus injection cine loop:

1. Press Contrast and begin acquiring image data.
2. Position the transducer and locate your region of interest.

3. Acquire 100 to 200 frames of data and then save and label the cine loop as `Baseline`.
4. Press Pre Trigger and inject the contrast agent. If you selected **Auto SAVE on Scan Completion** for **Contrast Mode** in the **General** tab of the **Preferences** window the system saves the cine loop when the acquisition ends.

You have created a cine loop of the bolus injection.

To automatically create a contrast agent destruction cine loop:

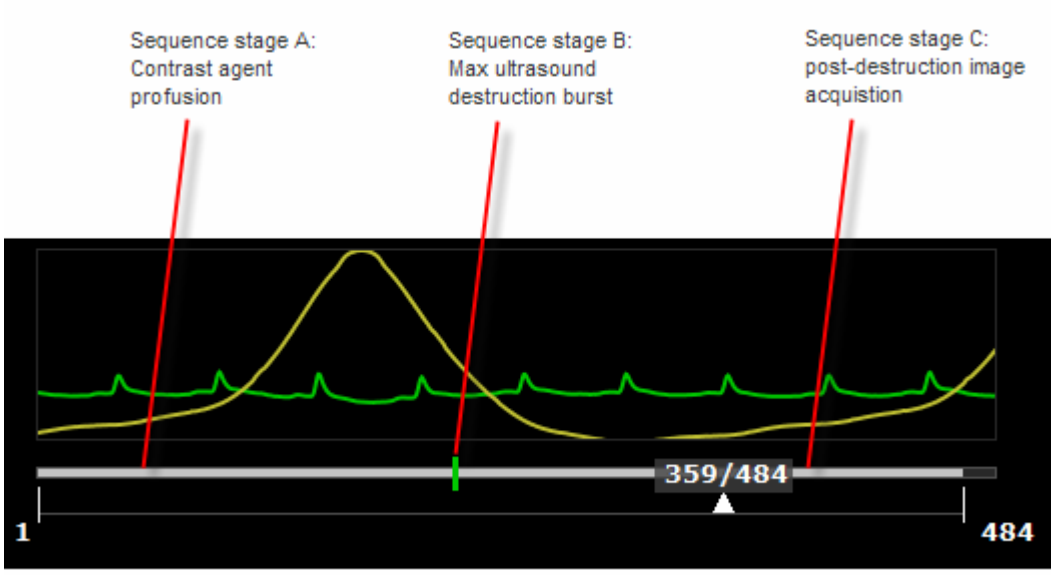
1. Press Contrast and begin acquiring image data.
2. Position the transducer and locate your region of interest.
3. Inject the contrast agent according to your protocol and then press Image Sequence.

   The system completes an automated sequence of actions based on the configuration you define in the **Contrast Mode** (page 74) section in the General tab of the Preferences window:

   a. The system acquires data for a set portion of the default cine loop length as you inject the contrast agent.

   b. The transducer transmits a single ultrasound pulse at maximum setting for a short specified period. This destroys the contrast agent in the region of interest.

   c. The system acquires data for the remainder of the cine loop.



4. Press Cine Store.

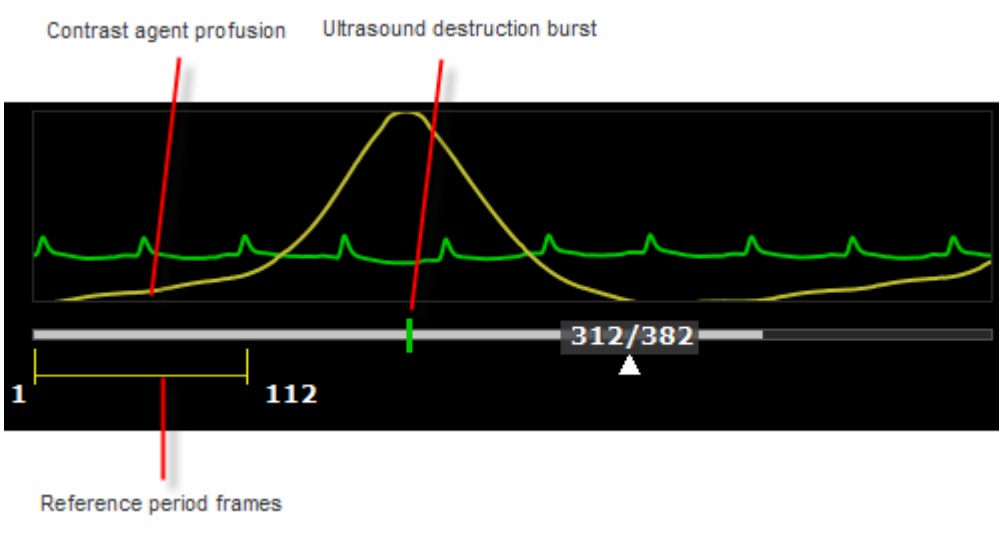
You have successfully acquired the contrast data that the system can work with to isolate the contrast agent ultrasound signal data from the tissue ultrasound signal data.

The contrast overlay data is created by comparing the baseline data acquired before the injection of the contrast agent with the data acquired after the injection. This, in theory, isolates only the signal from the contrast agent.

To create the reference set:

1. If the cine loop is playing, press Cine Loop Review to stop the playback.
2. Use the cine loop range controls under the cine loop bar to bracket a reference period in the cine loop before the burst destruction event.

> **Note:** The reference can be no longer than 500 frames.



3. In the left panel click **Create Reference**.

   A progress bar appears as the system creates the reference data set.
4. Load the cine loop to be processed.
5. Click **Process Cine**.

   A progress bar appears as the system compares the reference set to the full cine loop to calculate the intensity markers that represent contrast agent.

To manually create a contrast agent destruction cine loop:

1. Press Contrast and begin acquiring image data.
2. Position the transducer and locate your region of interest.
3. Inject the contrast agent according to your protocol and then press Burst.

The transducer transmits a single ultrasound pulse burst at maximum setting for the period defined in the Contrast Mode preferences.

4. Press Cine Store.

Next steps

- *Displaying contrast agents as an overlay* (page 348)
- *Adjusting the contrast overlay display* (page 350)

Related information:

- *Typical B-Mode image acquisition session* (page 190)

Typical Contrast 3D-Mode image acquisition

Contrast 3D-Mode adds Contrast Mode scan data during a 3D-Mode scan so you can reconstruct a volume that integrates the Contrast Mode data with the surrounding B-Mode 3D volume.

To acquire a Contrast 3D-Mode image:

1. Set up for a 3D-Mode image acquisition session (page 282).
2. Press Contrast.
3. Complete the 3D motor stage initialization process and 3D acquisition setup process as detailed in *Typical 3D-Mode image acquisition session* (page 275) and click **Scan**.

   The system acquires image slices across the motor stage track and combines them into a cine loop. Unlike a typical cine loop which contains slices along the same image plane over time, this cine loop contains a series of individual slices at different locations as the motor stage moves along its track.
4. Inject the microbubbles according to the specified protocol and then press 3D.
5. Press Cine Store to save the Contrast 3D-Mode image data.
6. Press 3D.

   The system acquires image slices at exactly the same step positions.
7. Click **Destroy 3D**.

   The system stops acquiring data and runs the destruction level ultrasound burst at each step along the the motor stage track and then returns the motor stage to the initial position.
8. Press 3D to acquire post-destruction image data.

9. Press Cine Store.
10. Click **Create Reference**.
11. Press Study Management and then open the first Contrast Mode cine loop you acquired before you ran the destruction sequence.
12. Click **Process Cine**.

    The system generates the green contrast overlay data.
13. Click **Load into 3D**.

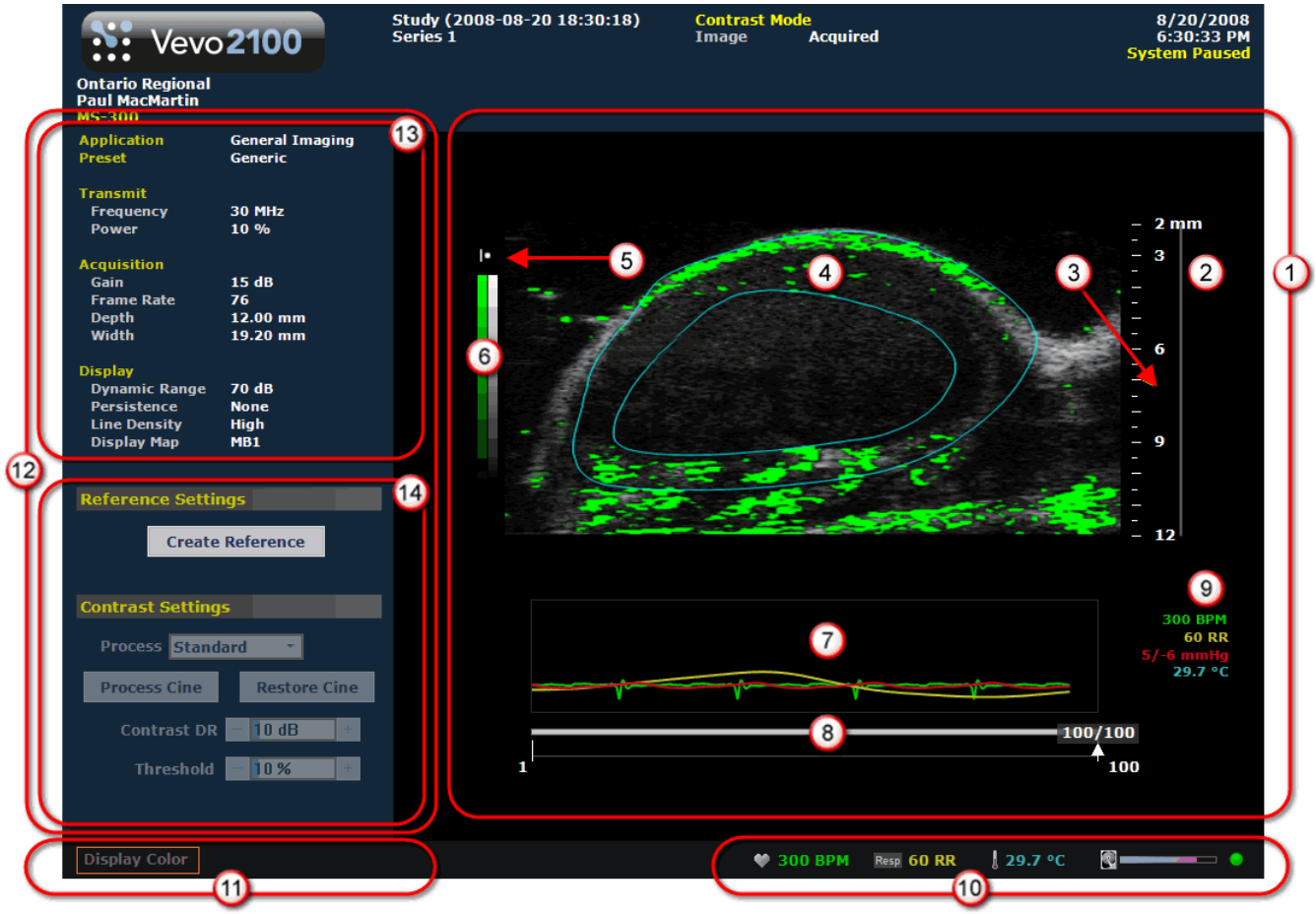
    The system generates the Contrast 3D-Mode data and opens the image in the four-pane **Contrast 3D-Mode** window.
14. Review and manipulate the Contrast 3D Mode image data using the standard 3D-Mode image analysis tools (page 288).

Related information

- *3D-Mode visualization tools* (page 288)
- *Typical Contrast Mode image acquisition session* (page 338)
- *Typical 3D-Mode image acquisition session* (page 275)
- *Typical Power 3D-Mode image acquisition session* (page 323)

Contrast Mode window workspace

The Contrast Mode window is the workspace you use whenever you view image data in Contrast Mode. The following illustration and table describes the information and features in the Contrast Mode window.



Area	Description
1	**Image area export zone**. When you export a stored image and configure your export to send only the **Image Area**, this is the area of the window that the system exports, along with header information.
2	**Image scale**. Indicates in mm the distance from the face of the transducer.
3	**Focus depth**. Indicates the distance from the face of the transducer where the system maximizes image resolutions.
4	**Micro-ultrasound image**. Displays the B-Mode data that the transducer acquires. When you review an image, this is the workspace where you use the image measurement tools to apply your measurements.

Area	Description
5	**Orientation icon**. Indicates the position of the orientation ridge of your transducer in relation to your image. If the image orientation looks backward to you, click this icon to flip the image view left/right.
6	**Green scale and gray scale.** The left column of the scale is the green scale. It indicates the dynamic range of the contrast intensity. The right column of the scale is the gray scale for the B-Mode background image.
7	**Physiological data trace window**. Displays your animal's heart rate, temperature, respiration rate and blood pressure data. During data acquisition this information comes from the Advanced Physiological Monitoring Unit connected to the Vevo Imaging Station.
8	**Cine loop range control**. Displays the length of the cine loop range. The triangular white marker identifies the individual frame number within the cine loop. You can drag the left and right vertical markers to display only the image frames in that range.
9	**Live physiological data values**. Displays the recorded numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature.
10	**Live physiological display**. If the animal is connected to the physiology controller, data appears here in real time during image acquisition and can display the numeric values of the animal's heart rate, respiration rate, blood pressure and body temperature. This area also displays the **image data storage capacity progress bar** so you can see when you should start to back up your image data to free up space on the system. Live physiological data is only active when you enable the inputs in the General tab of the Preferences window.
11	**Screen keys display** ▪ Displays the updated parameter and system information when you make adjustments on the control panel. ▪ Displays control options in the mode that you apply during image acquisition when you press the Screen Keys dial.
12	**Left panel**. Displays a unique set of controls and information sections depending on the control key you press: ▪ Press Mode Settings to set the panel to display the Mode settings. This is the default panel when you open a Mode window. ▪ Press Measure to set the panel to display the measurement tools. These tools are not available when you are acquiring or reviewing images. ▪ Press Physio Settings to set the panel to display the options for a) viewing and manipulating physiological data input from the Advanced Physiological Monitoring Unit and b) manipulating the Respiration Gating and ECG Trigger controls. For complete information on how each panel works, see *Left panel workspace* (page 47).
13	**Mode settings**. Read-only.

Area	Description
14	**Contrast acquisition tools**.

Tool	Description
Create Reference	Processes the data reference set that is defined by the length of the cine range.
Contrast DR	Displays the intensity level of the green overlay.
Threshold	Eliminates overlay data that is not relevant to your contrast agent by specifying the level at which the system displays no contrast image data.
Process Cine	Creates the contrast overlay.

Control panel controls for Contrast Mode

Contrast Mode imaging is based on B-Mode data.

- Use the control panel controls for B-Mode (page 194) to optimize the B-Mode image while you work with the contrast agent.
- Use the highlighted controls in the following control panel diagram when you are completing a typical Contrast Mode imaging session (page 338).

1

Burst

Transmits an ultrasound pulse at maximum setting. This destroys the contrast agent in the region of interest. In the cine loop the system displays a vertical green bar to mark the destruction event.

2

Pre Trigger

In Contrast Mode, starts an analysis based on the number of frames defined in the General tab of the Preferences window.

Stores cine loop data for a predefined number of image frames acquired *after* you press the control, as compared to **Cine Store** which stores data acquired *before* you press the control. To ensure that the system stores your cine loop, select the **Auto SAVE at Scan Completion** option in the General tab of the Preferences window.

3

Image Sequence

In Contrast Mode this control starts a sequence of configurable events. When you press the control:

1. The system begins to store image data for the predefined number of frames in the cine loop, as configured in the **Contrast Mode** preferences (page 74) section of the **General** tab in the **Preferences** window.
2. The destruction burst event (page 407) runs automatically:
   - Using a) the transducer that you connect to the front panel of the Vevo 2100 Imaging System, or using b) the *external* Vevo SoniGene transducer that you connect to the **Parallel** port on the rear panel of the cart
   - At a predefined percentage point of the entire pretrigger cine loop length
   - For a predefined period in tenths of seconds between 0.1 and 1.0 seconds (defaults to 0.5)
3. The system continues to acquire image data for the remainder of the predefined cine loop size, but the image is not automatically stored when the loop is completed unless you select **Auto SAVE on Scan Completion** for **Contrast Mode** in the **General** tab of the **Preferences** window.

To configure the control for Contrast Mode:

- In the **Cine Loop Size** section (page 71) of the **General** tab in the **Preferences** window configure the size of the cine loop.
- In the Contrast Mode preferences section (page 74) of the **General** tab in the **Preferences** window configure the parameters for the destruction sequence.

Contrast Mode acquisition settings

To view the Contrast Mode acquisition settings:

Press Mode Settings.

The Contrast Mode acquisition settings panel displays the following parameters, in addition to labeling the current transducer application and preset:

Transmit

Parameter	Description
Frequency	The ultrasound frequency, measured in *MHz*. Adjust with the Frequency control.
Power	The transmission power level of the ultrasound signal, displayed as a percentage of the maximum power. Adjust with the Transmit Power control.

Acquisition

Parameter	Description
Gain	The strength of the ultrasound signal in *dB* increments when it returns to the face of the transducer. Adjust with the 2D Gain control.
Frame Rate	The number of image frames per second that the system is acquiring.
Depth	The distance, measured in mm, from the face of the transducer. Adjust with the Image Depth control.
Width	The width of the acquired image area, measured in *mm*. Adjust with the Image Width control.

Display

Parameter	Description
Dynamic Range	The contrast of your image, measured in dB. Adjust with the Dynamic Range control.
Persistence	The state of the Persistence feature: Off, Low, Med, High, Max. Adjust with the Persist control.
Line Density	The line density level. One of four settings: Quarter, Third, Half, Full. Adjust with the Line Density control.
Display Map	The selected predefined display map from the predefined set of maps. Adjust with the Display Map control.

Contrast agent technology

Contrast Mode imaging requires the use of contrast agents. Contrast agents are gas-filled microbubbles that produce a strong echogenic signal when excited with an ultrasound pulse.

VisualSonics provides a family of contrast agent kits for targeted and non-targeted applications.

Non-targeted contrast agents

Non-targeted contrast agents are injected into the vascular system either via a small bolus or a continuous infusion using a syringe pump.

The contrast agents are free flowing in the vascular system for a period of time until they are either destroyed with a high-powered ultrasound sequence or are cleared through the system via the kidney or the liver.

Targeted contrast agents

Targeted contrast agents are microbubbles similar to those used in untargeted applications, but are conjugated with a ligand that will bind to specific molecular markers.

A targeted contrast agent flows freely through the vascular system until it finds the specific receptor. At this time it binds to the molecular marker on the endothelial surface of the vessel and will no longer flow freely.

An ultrasound image of a region with bound contrast agents displays the strong echogenic signal provided by the contrast agent.

Displaying contrast agents as an overlay

Before you begin

Acquire your contrast data:

- *Typical Contrast Mode image acquisition session* (page 338)
- *Typical Contrast 3D-Mode image acquisition session* (page 341)

To display the contrast data as an overlay using the control panel:

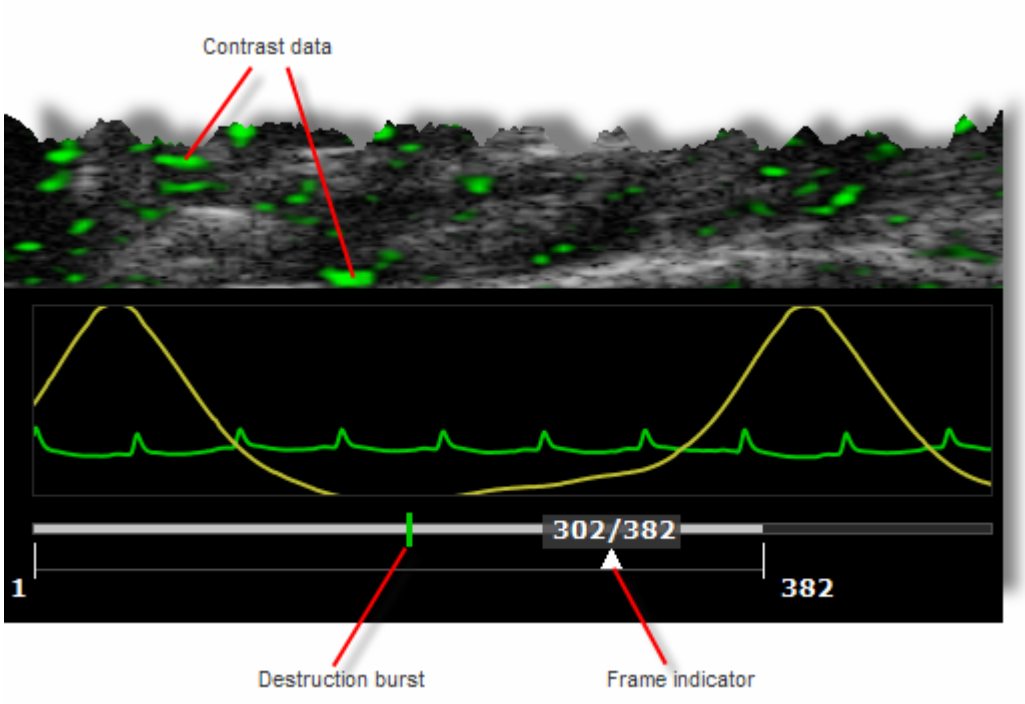
1. In a cine loop acquired by using the Image Sequence process, drag the right side range control bracket to the end of the cine loop.

2. Drag the frame indicator into the range of frames after the vertical green bar which identifies the destruction burst event.
3. Turn Screen Keys until **Display Color** appears in the control panel feedback display.

4. Press Screen Keys to cycle through the following display options:
   - Contrast overlay only
   - B-Mode image only
   - Contrast overlay and B-Mode image

To display the contrast data as an overlay using the workstation:

1. In a cine loop acquired by using the Image Sequence process, drag the right side range control bracket to the end of the cine loop.
2. Drag the frame indicator into the range of frames after the vertical green bar which identifies the destruction burst event.



3. Click the  icon and cycle through the following display options:
   - Contrast overlay only

- B-Mode image only
- Contrast overlay and B-Mode image

Related information

- *Adjusting the contrast overlay display* (page 350)
- *Image Sequence* (page 412)

Adjusting the contrast overlay display

You can modify the amount and intensity of the contrast green overlay data in three ways:

- Adjust the process persistence filter
- Adjust the contrast overlay dynamic range
- Adjust the contrast overlay data threshold

Adjusting the contrast processing filter

Process filtering adjusts the amount of contrast data the system acquires when you *process* the cine loop that includes your reference set.

To modify the process persistence setting:

1. In the **Process** box, select one of the following four options:

Setting	Description
Standard	Default. No additional filters are applied.
Smooth	Applies frame-to-frame averaging. Helpful when you want to remove transient bubble data from the image.
MIP	Applies a maximum intensity persistence to the images. Helpful when you want to trace bubble paths in vessel structures.
Cardiac	Applies a stronger filter. Helpful when you want to study fast moving cardiac structures.

2. Click **Process Cine**. The system applies the selected Process filter as it processes the contrast data in the cine loop.
3. Ensure the cine loop range control extends the full length of the cine loop and then review the post-destruction burst frames to see the result.

Adjusting the contrast dynamic range

Contrast DR is a dynamic range control that modifies the intensity of the contrast data overlay. You can set the value from 5dB-50dB. The lower you set the dynamic range, the more intense the contrast data appears.

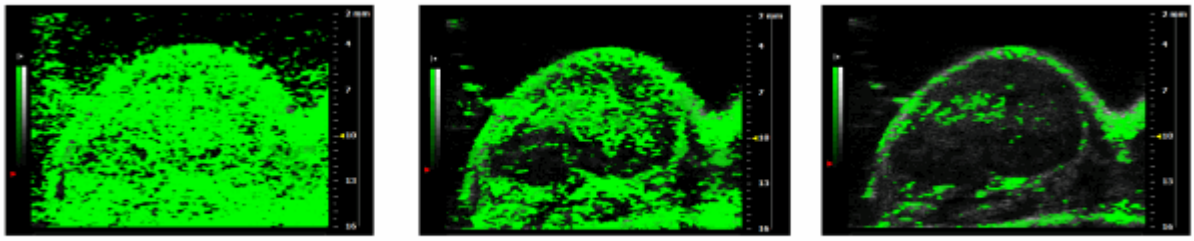
To adjust the contrast overlay dynamic range:

1. In the **Contrast DR** slider control, drag or click in the range bar to coarsely set your contrast.
2. Click the **–** or **+** controls to fine tune the parameter by increments of 1dB.

Adjusting the threshold

The **Threshold** control sets the threshold at which the system displays no contrast image data. You can set the threshold in a range between 1% and 100%.

As shown in the following example, the lower you set the threshold, the more contrast image data you display.



To adjust the contrast overlay data threshold:

1. In the **Threshold** slider control, drag or click in the range bar to coarsely set your threshold.
2. Click the **–** or **+** controls to fine tune the parameter by increments of 1%.

Related information

- *Typical Contrast Mode image acquisition session* (page 338)

Chapter 48

Analyzing Contrast Mode images

This chapter shows you how to analyze Contrast Mode images that are saved to a study.

In this chapter

Adding generic Contrast Mode measurements

Contrast Mode provides seven generic measurement tools. Use these tools when you want to add measurements that aren't part of a measurement protocol.

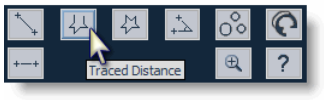
Before you begin

If you want to display the measurement labels and values that you add, select the **Show Values and Labels** option in the Measurement tab of the Preferences window.

To access the generic measurement tools for Contrast Mode:

- If you are acquiring Contrast Mode image data, press Scan/Freeze and then press Measure.
- If you are in the Study Browser, open an image and then press Measure.

  The system displays the measurement tools at the top of the left panel.



  Hover over a tool to see the description label.

Time Interval measurement

Time interval is measured in *ms*.

To place a time interval measurement:

1. Click the time interval measurement button. The system highlights the button until you complete your measurement.

2. In the physiology data trace window below the image mode data, click to place the initial caliper.
3. Trackball to the location where you want to place your end caliper and then click to place the caliper.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Traced distance measurement

Traced distance is measured in *mm*.

To place a traced distance measurement:

1. Click the traced distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place the final caliper of your trace. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Linear distance measurement

Linear distance is measured in *mm*.

To place a linear distance measurement:

1. Click the linear distance measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball to the location where you want to end your measurement and then click to place the end caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

2D Area measurement

2D Area is measured in mm^2.

To place a 2D area measurement:

1. Click the 2D area measurement button  .
2. Click on your image to place the initial caliper.
3. Trackball along the contour of your target tissue and then right-click to place your last caliper.

   If the position of the trackball cursor is within five pixels of the previous caliper when the right-click occurs, the system sets the previously placed caliper as the last caliper and auto-closes the measurement. This feature applies to 2D area measurements in B-Mode, 3D-Mode, and Contrast Mode as well as for 3D-Mode volume contours.
4. The system adds the final line segment to connect your last caliper with your first. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

Mean and standard deviations

For Contrast Mode images you can:

- Measure the mean and standard deviation of gray levels for area measurements
- View a histogram of a selected Contrast Mode ROI measurement.

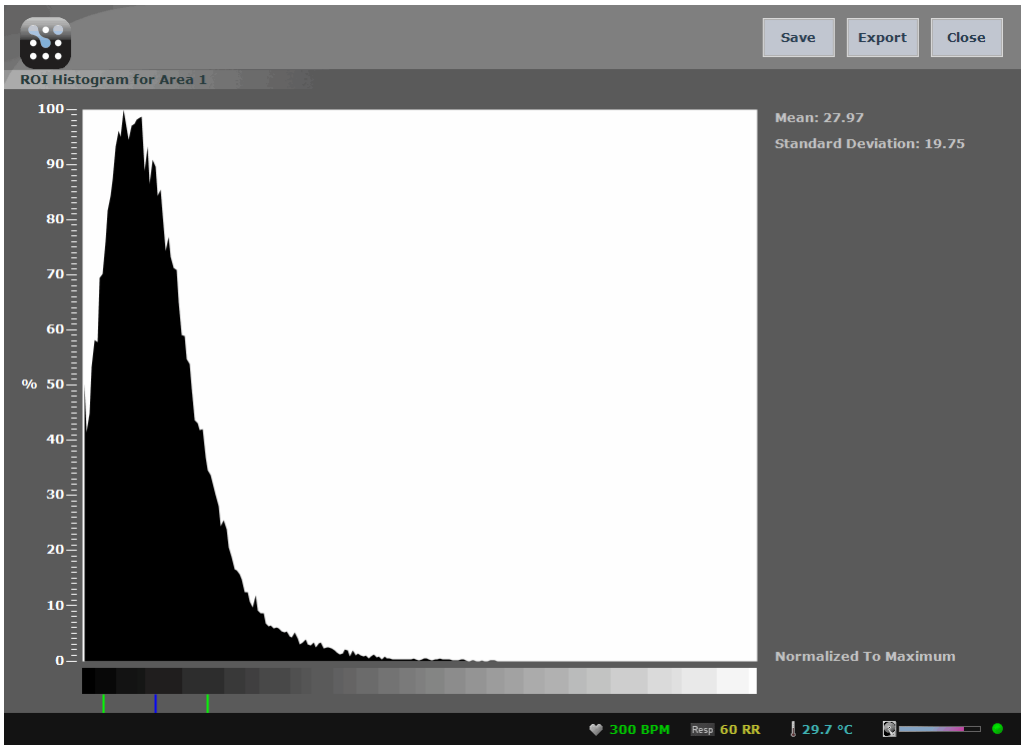
To create the mean and standard deviations ROI histogram:

Right-click the ROI measurement and click **Histogram**.

A pop-up window appears. It displays:

- A plot of the relative distribution of pixels across the gray scale shown on the horizontal axis

- The mean and standard deviation values to the right of the histogram



The blue indicator on the gray scale indicates the mean gray level. The green indicators on the gray scale indicate the standard deviation for the gray level.

To export an image of the histogram plot:

1. Click **Export**.
2. In the **Presets Export** window:
   a. In the browse window, browse to the directory location where you want to export the file and select that directory.
   b. In the **Options** area, select the file type.
   c. In the **Save As** box, if you want to create a unique file name, type the name.
3. Click **OK**.

Angle measurement

Angles report interior angle values and are therefore always less than 180 degrees Angles are measured in *deg*.

To place an angle measurement:

1. Click the angle measurement button .

2. Click on your image to place the initial caliper. This is the outside end of the first ray of your angle.
3. Trackball to where you want to position the vertex of your angle and then click to place the caliper. This completes the first ray.
4. Trackball to the position where you want to end the second ray and then click to place the final caliper. If you selected the **Show Values and Labels** option in the Measurements tab of the Preferences window, the system displays the measurement value and editable label for the measurement.
5. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

Related information

- *Complete procedure for adding a measurement* (page 166)

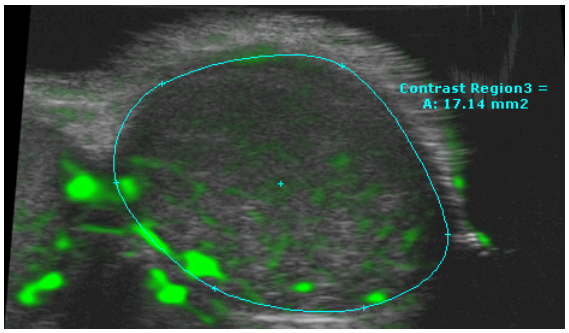
Contrast region measurement

The contrast region measurement traces a region of interest in a Contrast Mode frame. The system then measures the total area of the defined contrast region.

To place a contrast region measurement:

1. Click the contrast region measurement button .
2. Click on your image to place the initial caliper.
3. Click to place individual points around the region to create the contour of your target tissue and then right-click to place your last caliper.

   The system adds the final line segment to connect your last caliper with your first.



4. If you need to move the entire measurement, click on a measurement line and then drag and drop it.
5. Modify the points on your contour (page 171), or modify the contour (page 172) as required.

Copying and pasting a contrast region

To copy and paste a region:

1. Right-click the contour and select **Copy Region**.
2. Right-click in another cine loop and click **Paste Region**.

   The copied region replaces the existing region.
3. On a cine loop that does not contain a contour, right click anywhere on the image and select **Paste Contrast Region**.

   The copied region is added to the loop, with its original coordinates.

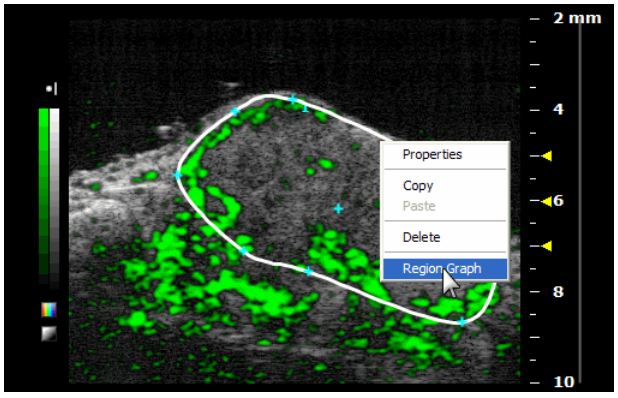
> **Note:** You can also paste a copied contrast region to the same image and then move it to a different location.

Creating a contrast region analysis chart

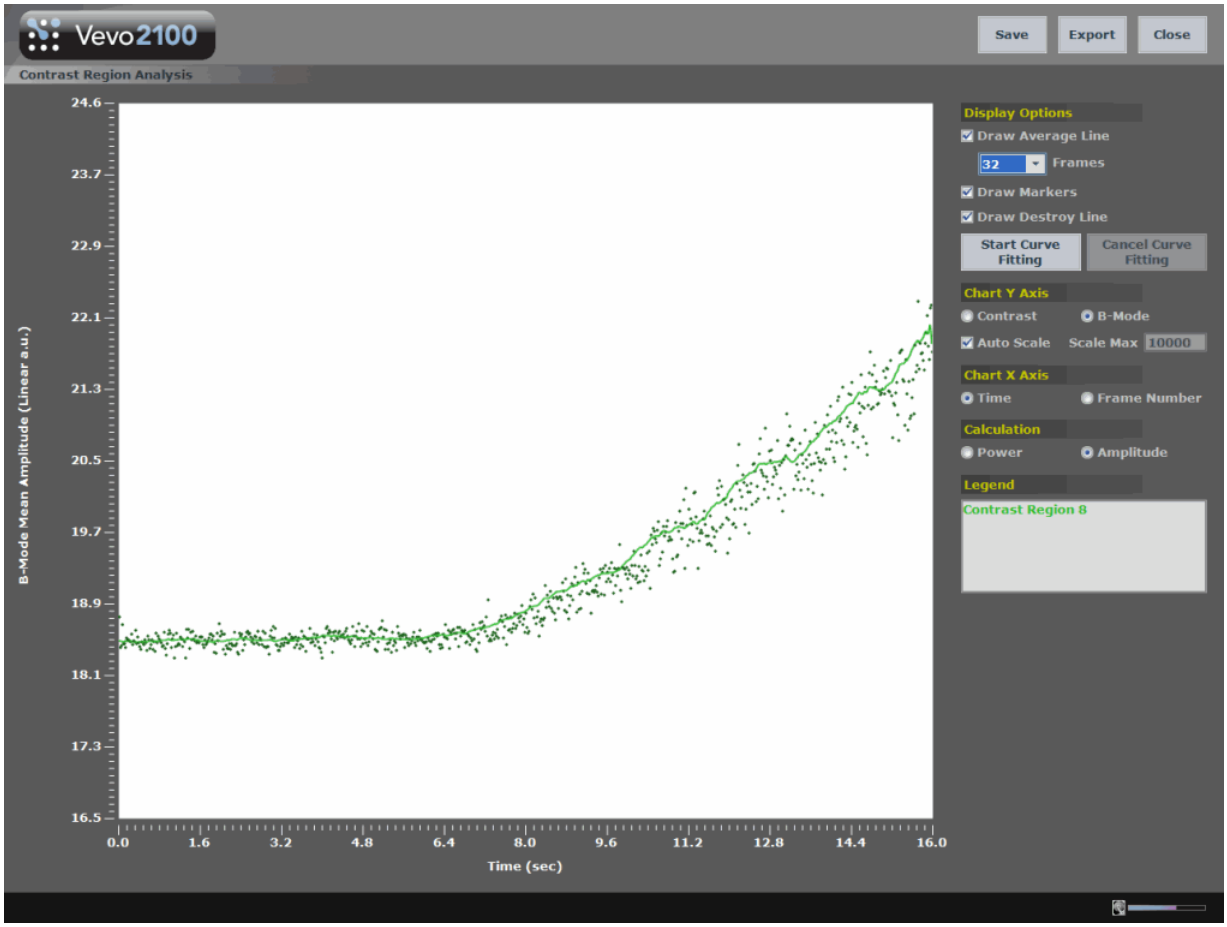
The contrast region analysis graph plots the contrast intensity data of a contrast region over the course of a complete cine loop.

To chart the contrast region data:

1. On the Contrast Mode image, right-click the contour or the image label and select **Region Graph**.



2. The system calculates the contrast intensity within the boundaries of the region curve and displays the data in the **Contrast Region Analysis** window.



To export the contrast region analysis:

1. Click **Export**.

   The **Export Contrast Region** window appears.

2. In the folder browser, browse to the location where you want to export your data and select the folder.
3. In the **Options** section, select the file type(s) you want to export (CSV, BMP, TIFF) and in the **Save As** box, type the name of your report.
4. Click **OK**.
5. The system exports the analysis report for the image you are viewing.

Working with data in the contrast region analysis chart

The contrast region analysis chart provides four sets of controls located to the right of the cart:

- Display Options

- Chart Y Axis
- Chart X Axis
- Calculation

Use these controls to achieve different views of the contrast intensity data.

Display Options

Setting	Description
Draw Average Line	Draws a moving average line through the data points.
Frames	Sets the number of frames over which to complete the average. Select from 2, 4, 8, 16, 32
Draw Markers	Draws markers on the actual data points.
Draw Destroy Line	Displays a vertical red line at the frame number at which the destruction event occurred, if the event did occur.

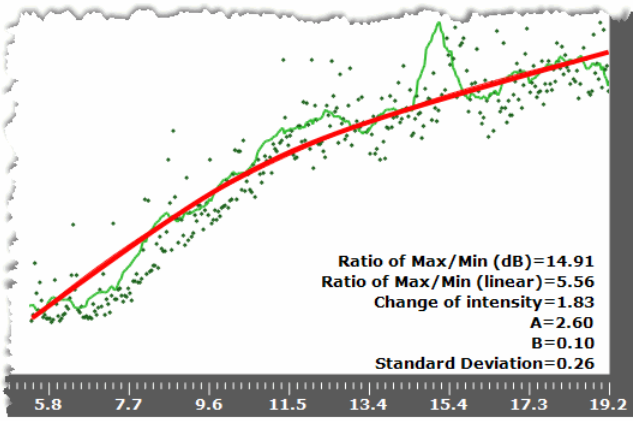
Setting	Description
Curve Fitting	Calculates and plots a perfusion curve based on the following formula*: $y = C + A\left(1 - e^{-B(t - t_0)}\right)$, where: y = Contrast signal (pixel intensity) A = Peak of curve B = Slope of the curve C = Contrast signal offset t = Time t_0 = Time offset **To create the curve:** 1. Click **Start Curve Fitting** and select a data point on the graph at the transition from the base line to the perfusion period. 2. Click a data point where the data begins to plateau and then click **Finish Curve Fitting**. The system calculates and plots the red perfusion curve.  3. Click **Export** and export the data as an image or as a CSV file for further analysis. * Wei, 1998, *Quantification of Myocardial Blood Flow With Ultrasound-Induced Destruction of Microbubbles Administered as a Constant Venous Infusion*.

Chart Y Axis

Setting	Description
Contrast	Select to plot the contrast intensity information from the contrast data, and to make the Percent Area controls and the Calculation controls available.
B-Mode	Select to plot the grayscale intensity data from the B-Mode image.
Auto Scale	Select to view a system-calculated best-fit scale value.
Scale Max	Type a scale value between 0-100,000.

Chart X Axis

Setting	Description
Time	Select to scale the length of the cine loop in second increments.
Frame Number	Select to scale the length of the cine loop in single frame increments.

Calculation

Setting	Description
Power	Sets the Y axis to B-Mode mean power (linear a.u.)
Amplitude	Sets the Y axis to B-Mode mean amplitude (linear a.u.)

Exporting Contrast Mode data

To export contrast region data:

1. From the Contrast Region or Cardiac Region chart window, click Export.
2. In the export dialog box, select the destination directory, name the file, select the file type, and click Save.

The data can be saved as one of the following file types:

- **CSV** Comma separated values, for import into a database or spreadsheet.
- **TIFF** Vector based graphic.
- **BMP** Bitmap graphic.

Cardiac region measurement

The Cardiac Region measurement traces a region of interest in a Contrast Mode frame, consisting of two separate traces. The system then measures the difference in area between the outer trace and the inner trace.

To place a single cardiac region measurement:

1. Click the cardiac region button  .
2. Click along the boundary of the outer wall of the myocardium to add caliper points.
3. After you add three caliper points, the system creates a simple contour that connects the points. You can add caliper points by clicking anywhere along the contour. You don't need to add these points in a particular direction, the way you should when you add the first three points.
4. Right-click to complete the outer wall contour.

5. Click on the boundary of the inner wall of the myocardium, add caliper points using the same procedure you used to create the outer wall contour, and then right-click to complete the inner wall contour.

   The system adds the measurement label on the image and adds the measurement to the **Measured Values** section at the bottom of the left panel.

6. If you need to move the entire measurement, click on a measurement line and then drag and drop it.

To automatically apply cardiac region contours to sequential frames in a cine loop:

1. On the cine loop, move to a frame that displays the maximum point of diastole and create the outer and inner contours for a single cardiac region measurement as described above.

   IMPORTANT: To ensure the best results with the sequential refinement process, add your first three caliper points for every contour in the same direction. For example if you start out adding your first three points for the outer wall in a clockwise direction, add your points for the inner wall in a clockwise direction also.

2. In your cine loop, move forward or backward to a frame that displays the next point of maximum systole and create a second cardiac region measurement.

   IMPORTANT: Add your first three caliper points for these contours in the same direction you added the contours for the first cardiac region.

3. Right-click the contour and then select **Replicate Forward 1 Cycle** or **Replicate Reverse 1 Cycle**.

   The system:

   a. Calculates and creates cardiac region contours for the half-cardiac cycle frames between the maximum diastole and systole points you measured.

   b. Plays the cine loop forward or reverse and applies the calculated contours to each individual frame.

Direction	Description
Replicate Forward 1 Cycle	Starts from the end of your half cardiac cycle and applies the system-calculated contours to the next cardiac cycle.
Replicate Reverse 1 Cycle	Starts from the start of your half cardiac cycle and applies the system-calculated contours to the previous cardiac cycle.

4. If you want to modify a contour in the sequence, you can add, delete or move points and then right-click **Refine Forward** or **Refine Reverse** on your contour to view the results.

Creating a cardiac region analysis chart

The contrast region line graph plots the contrast intensity data of a contrast region over the course of a complete cine loop.

To chart the cardiac region data:

1. On the Contrast Mode image, right-click the contour or the image label and select **Region Graph**.
2. The system calculates the contrast intensity within the boundaries of the region curve and displays the data in the **Cardiac Region Analysis** window.

Working with data in the cardiac region analysis chart

The cardiac region analysis chart provides four analysis features located to the right of the cart:

- Display Options
- Chart Y Axis
- Calculation
- Radius Guide

Use these controls to analyze the views of the contrast intensity data.

Display Options

Setting	Description
Draw Average	Draws a moving average line through the data points.
Plot Frame	Specify the frame to draw if the Draw Average check box is cleared.

Chart Y Axis

Setting	Description
Contrast	Plots the contrast intensity information from the contrast data.
B-Mode	Plots the grayscale intensity data from the B-Mode image.
Auto Scale	View a system-calculated best-fit scale value.
Scale Max	Type a volume value to redraw the graph such that the scale is drawn from 0 to the value you typed in.

Calculation

Setting	Description
Power	Sets the Y axis to B-Mode mean power (linear a.u.)
Amplitude	Sets the Y axis to B-Mode mean amplitude (linear a.u.)

Radius Guide

The X axis **Angle (deg)** on the chart represents a flattened ellipse that surrounds the short axis view. The radius guide helps you orient the plotted values by illustrating how they correspond to sites within this short axis view.

For example, a point on the graph at the 225 mark on the x-axis corresponds to a site along the 225 degree radius inside the guide.

Section 15

Appendixes

This section includes the following reference content.

In This Section

Appendix A

Measurement package protocols

This appendix details the measurement and calculation definitions for each measurement package that is available with the Vevo 2100 Imaging System.

In this appendix

Abdominal Measurement Package

This section provides the measurements and calculations information for the protocols in the Abdominal measurement package.

Liver protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Liver Sagg	Sagittal length	mm	Linear	B-Mode
Liver Trans	Transverse length	mm	Linear	B-Mode
Hepatic Vel	Hepatic vein velocity	mm/s	Velocity	PW Doppler
Hepatic Diam	Hepatic vein diameter	mm	Linear	B-Mode
Hepatic Diam	Hepatic vein diameter	mm	Depth	M-Mode
RHV Vel	Right hepatic vein velocity	mm/s	Velocity	PW Doppler
RHV Diam	Right hepatic vein diameter	mm	Linear	B-Mode
RHV Diam	Right hepatic vein diameter	mm	Depth	M-Mode
LHV Vel	Left hepatic vein velocity	mm/s	Velocity	PW Doppler
LHV Diam	Left hepatic vein diameter	mm	Linear	B-Mode
LHV Diam	Left hepatic vein diameter	mm	Depth	M-Mode
CHA Vel	Common hepatic artery velocity	mm/s	Velocity	PW Doppler

CHA Diam	Common hepatic artery diameter	mm	Linear	B-Mode
CHA Diam	Common hepatic artery diameter	mm	Depth	M-Mode
RHA Vel	Right hepatic artery velocity	mm/s	Velocity	PW Doppler
RHA Diam	Right hepatic artery diameter	mm	Linear	B-Mode
RHA Diam	Right hepatic artery diameter	mm	Depth	M-Mode
LHA Vel	Left hepatic artery velocity	mm/s	Velocity	PW Doppler
LHA Diam	Left hepatic artery diameter	mm	Linear	B-Mode
LHA Diam	Left hepatic artery diameter	mm	Depth	M-Mode
MPV Vel	Main portal vein velocity	mm/s	Velocity	PW Doppler
MPV Diam	Main portal vein diameter	mm	Linear	B-Mode
MPV Diam	Main portal vein diameter	mm	Depth	M-Mode
RPV Vel	Right portal vein velocity	mm/s	Velocity	PW Doppler
RPV Diam	Right portal vein diameter	mm	Linear	B-Mode
RPV Diam	Right portal vein diameter	mm	Linear	M-Mode
LPV Vel	Left portal vein velocity	mm/s	Velocity	PW Doppler
LPV Diam	Left portal vein diameter	mm	Linear	B-Mode
LPV Diam	Left portal vein diameter	mm	Depth	M-Mode
Gast Vel	Gastroduodenal artery velocity	mm/s	Velocity	PW Doppler
Gast Diam	Gastroduodenal artery diameter	mm	Linear	B-Mode
Gast Diam	Gastroduodenal artery diameter	mm	Depth	M-Mode

Spleen protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Spleen Sagg	Sagittal length	mm	Linear	B-Mode
Spleen Transverse	Transverse length	mm	Linear	B-Mode
Splenic Artery Vel	Splenic artery velocity	mm/s	Velocity	PW Doppler
Splenic Artery Diam	Splenic artery diameter	mm	Linear	B-Mode
Splenic Artery Diam	Splenic artery diameter	mm	Depth	M-Mode

Gallbladder protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
GB Sag	Gallbladder sagittal length	mm	Linear	B-Mode
GB Trans	Gallbladder transverse length	mm	Linear	B-Mode
GB Wall Thickness	Gallbladder wall thickness	mm	Linear	B-Mode
CBD	Common bile duct diameter	mm	Linear	B-Mode

Kidney protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
R Kidney Sag	Right kidney sagittal length	mm	Linear	B-Mode
R Kidney Trans	Right kidney transverse length	mm	Linear	B-Mode
RRA PSV	Right kidney renal artery peak systolic velocity	mm/s	Velocity	PW Doppler
RRA DV	Right kidney renal artery diastolic velocity	mm/s	Velocity	PW Doppler
RRA Diam	Right kidney renal artery diameter	mm	Linear	B-Mode
RRA Diam	Right kidney renal artery diameter	mm	Depth	M-Mode
RRV PSV	Right kidney renal vein peak systolic velocity	mm/s	Velocity	PW Doppler
RRV DV	Right kidney renal vein diastolic velocity	mm/s	Velocity	PW Doppler
RRV Diam	Right kidney renal vein diameter	mm	Linear	B-Mode
RRV Diam	Right kidney renal vein diameter	mm	Depth	M-Mode
L Kidney Sag	Left kidney sagittal length	mm	Linear	B-Mode
L Kidney Trans	Left kidney transverse length	mm	Linear	B-Mode
LRA PSV	Left kidney renal artery peak systolic velocity	mm/s	Velocity	PW Doppler
LRA DV	Left kidney renal artery diastolic velocity	mm/s	Velocity	PW Doppler
LRA Diam	Left kidney renal artery diameter	mm	Linear	B-Mode
LRA Diam	Left kidney renal artery diameter	mm	Depth	M-Mode
LRV PSV	Left kidney renal vein peak systolic velocity	mm/s	Velocity	PW Doppler
LRV DV	Left kidney renal vein diastolic velocity	mm/s	Velocity	PW Doppler
LRV Diam	Left kidney renal vein diameter	mm	Linear	B-Mode
LRV Diam	Left kidney renal vein diameter	mm	Depth	M-Mode
Ao PSV	Aorta peak systolic velocity	mm/s	Velocity	PW Doppler

ICA PSV	ICA peak systolic velocity	mm/s	Velocity	PW Doppler
CCA PSV	CCA peak systolic velocity	mm/s	Velocity	PW Doppler

Calculation definitions

Name	Description	Units	Formula
RRA-A RI	Right renal artery to aorta resistive index	none	(RRA PSV – Ao PSV) / RRA PSV
LRA-A RI	Left renal artery to aorta resistive index	none	(LRA PSV – Ao PSV) / LRA PSV
ICA-CCA RI	ICA to CCA resistive index	none	(ICA PSV – CCA PSV) / ICA PSV
RRA RI	Right renal artery resistive index	none	(RRA PSV – RRA DV) / RRA PSV
LRA RI	Left renal artery resistive index	none	(LRA PSV – LRA DV) / LRA PSV

Adrenal Glands protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
RAG Sag	Right adrenal glands sagittal length	mm	Linear	B-Mode
RAG Trans	Right adrenal glands transverse length	mm	Linear	B-Mode
RAA Vel	Right adrenal artery velocity	mm/s	Velocity	PW Doppler
RAA Diam	Right adrenal artery diameter	mm	Linear	B-Mode
RAA Diam	Right adrenal artery diameter	mm	Depth	M-Mode
RAV Vel	Right adrenal artery velocity	mm/s	Velocity	PW Doppler
RAV Diam	Right adrenal artery diameter	mm	Linear	B-Mode
RAV Diam	Right adrenal artery diameter	mm	Depth	M-Mode
LAG Sag	Left adrenal glands Sagittal length	mm	Linear	B-Mode
LAG Trans	Left adrenal glands transverse length	mm	Linear	B-Mode
LAA Vel	Left Adrenal artery velocity	mm/s	Velocity	PW Doppler
LAA Diam	Left Adrenal artery diameter	mm	Linear	B-Mode
LAA Diam	Left Adrenal artery diameter	mm	Depth	M-Mode
LAV Vel	Left Adrenal vein velocity	mm/s	Velocity	PW Doppler
LAV Diam	Left Adrenal vein diameter	mm	Linear	B-Mode
LAV Diam	Left Adrenal vein diameter	mm	Depth	M-Mode

Pancreas protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Pancreas Sag	Pancreas sagittal length	mm	Linear	B-Mode
Pancreas Trans	Pancreas transverse length	mm	Linear	B-Mode
Duct	Pancreatic duct diameter	mm	Linear	B-Mode

Female Reproductive protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Uterus Sag	Uterus sagittal length	mm	Linear	B-Mode
Uterus Trans	Uterus transverse length	mm	Linear	B-Mode
UA Vel	Uterine artery velocity	mm/s	Velocity	PW Doppler
UA Diam	Uterine artery diameter	mm	Linear	B-Mode
UA Diam	Uterine artery diameter	mm	Depth	M-Mode
UV Vel	Uterine vein velocity	mm/s	Velocity	PW Doppler
UV Diam	Uterine vein diameter	mm	Linear	B-Mode
UV Diam	Uterine vein diameter	mm	Depth	M-Mode
ROv Sag	Right ovary sagittal	mm	Linear	B-Mode
ROv Trans	Right ovary transverse	mm	Linear	B-Mode
ROv Art Vel	Right ovarian artery velocity	mm/s	Velocity	PW Doppler
ROv Art Diam	Right ovarian artery diameter	mm	Linear	B-Mode
ROv Art Diam	Right ovarian artery diameter	mm	Depth	M-Mode
ROv Vein Vel	Right ovarian vein velocity	mm/s	Velocity	PW Doppler
ROv Vein Diam	Right ovarian vein diameter	mm	Linear	B-Mode
ROv Vein Diam	Right ovarian vein diameter	mm	Depth	M-Mode
LO Sag	Left ovary sagittal	mm	Linear	B-Mode
LO Trans	Left ovary transverse	mm	Linear	B-Mode
LO Art Vel	Left ovarian artery velocity	mm/s	Velocity	PW Doppler
LO Art Diam	Left ovarian artery diameter	mm	Linear	B-Mode
LO Art Diam	Left ovarian artery diameter	mm	Depth	M-Mode
LO Vein Vel	Left ovarian vein velocity	mm/s	Velocity	PW Doppler
LO Vein Diam	Left ovarian vein diameter	mm	Linear	B-Mode

LO Vein Diam	Left ovarian vein diameter	mm	Depth	M-Mode

Mammary Gland protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Cervical Diam	Mammary glands	mm	Linear	B-Mode
Thoracic Diam	Thoracic diameter	mm	Linear	B-Mode
Abdominal Diam	Abdominal diameter	mm	Linear	B-Mode
Inguinal Diam	Inguinal diameter	mm	Linear	B-Mode
Papilla Mammae Diam	Papilla mammae diameter	mm	Linear	B-Mode

Male Reproductive protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Prostate Sag	Prostate sagittal	mm	Linear	B-Mode
Prostate Trans	Prostate transverse	mm	Linear	B-Mode
RVG Sag	Right vesicular glands sagittal	mm	Linear	B-Mode
RVG Trans	Right vesicular glands transverse	mm	Linear	B-Mode
RVA Vel	Right vesicular artery velocity	mm/s	Velocity	PW Doppler
RVA Diam	Right vesicular artery diameter	mm	Linear	B-Mode
RVA Diam	Right vesicular artery diameter	mm	Depth	M-Mode
RVV Vel	Right vesicular vein velocity	mm/s	Velocity	PW Doppler
RVV Diam	Right vesicular vein diameter	mm	Linear	B-Mode
RVV Diam	Right vesicular vein diameter	mm	Depth	M-Mode
LVG Sag	Left vesicular glands sagittal	mm	Linear	B-Mode
LVG Trans	Left vesicular glands transverse	mm	Linear	B-Mode
LVA Vel	Left vesicular artery velocity	mm/s	Velocity	PW Doppler
LVA Diam	Left vesicular artery diameter	mm	Linear	B-Mode
LVA Diam	Left vesicular artery diameter	mm	Depth	M-Mode
LVV Vel	Left vesicular vein velocity	mm/s	Velocity	PW Doppler
LVV Diam	Left vesicular vein diameter	mm	Linear	B-Mode
LVV Diam	Left vesicular vein diameter	mm	Depth	M-Mode
R Test Sag	Right testicle sagittal	mm	Linear	B-Mode

R Test Trans	Right testicle transverse	mm	Linear	B-Mode
RTA Vel	Right testicular artery velocity	mm/s	Velocity	PW Doppler
RTA Diam	Right testicular artery diameter	mm	Linear	B-Mode
RTA Diam	Right testicular artery diameter	mm	Depth	M-Mode
RTV Vel	Right testicular vein velocity	mm/s	Velocity	PW Doppler
RTV Diam	Right testicular vein diameter	mm	Linear	B-Mode
RTV Diam	Right testicular vein diameter	mm	Depth	M-Mode
L Test Sag	Left testicle sagittal	mm	Linear	B-Mode
L Test Trans	Left testicle transverse	mm	Linear	B-Mode
LTA Vel	Left testicular artery velocity	mm/s	Velocity	PW Doppler
LTA Diam	Left testicular artery diameter	mm	Linear	B-Mode
LTA Diam	Left testicular artery diameter	mm	Depth	M-Mode
LTV Vel	Left testicular vein velocity	mm/s	Velocity	PW Doppler
LTV Diam	Left testicular vein diameter	mm	Linear	B-Mode
LTV Diam	Left testicular vein diameter	mm	Depth	M-Mode
Epid Head	Epididymis head length	mm	Linear	B-Mode
Epid Head	Epididymis head depth	mm	Depth	M-Mode
Epid Tail	Epididymis tail length	mm	Linear	B-Mode
Epid Tail	Epididymis tail depth	mm	Depth	M-Mode

Cardiac Measurement Package

This section provides the measurements and calculations information for the protocols in the Cardiac measurement package.

PSLAX protocol

Measurement definitions

Label	Description	Units	Generic type	Mode	Chain
Trace	LV trace – long axis area	mm^2	MLVArea	B-Mode	
A	LV trace area	mm^2	MLVArea	B-Mode	
A;s	Systolic area	mm^2	MLVArea	B-Mode	
A;d	Diastolic area	mm^2	MLVArea	B-Mode	
V;s	Systolic volume	µL	MLVArea	B-Mode	
V;d	Diastolic volume	µL	MLVArea	B-Mode	
SV	Stroke volume	µL	MLVArea	B-Mode	

EF	Ejection fraction	%	MLVArea	B-Mode	
FS	Fractional shortening	%	MLVArea	B-Mode	
CO	Cardiac output	ml/min	MLVArea	B-Mode	
V	LV trace – long axis volume	µL	MLVArea	B-Mode	
RVID;d	Right ventricular internal diameter (diastole)	mm	Depth	M-Mode	IVS;d
IVS;d	Inter ventricular septum (diastole)	mm	Depth	M-Mode	LVID;d
IVS;d	Inter ventricular septum (diastole)	mm	Length	B-Mode	LVID;d
LVAW;d	Left ventricular anterior wall (diastole)	mm	Depth	M-Mode	LVID;d
LVID;d	Left ventricular internal diameter (diastole)	mm	Depth	M-Mode	LVPW;d
LVID;d	Left ventricular internal diameter (diastole	mm	Length	B-Mode	LVPW;d
LVPW;d	Left ventricular posterior wall (diastole)	mm	Depth	M-Mode	
LVPW;d	Left ventricular posterior wall (diastole)	mm	Length	B-Mode	
IVS;s	Inter ventricular septum (systole)	mm	Depth	M-Mode	LVID;s
IVS;s	Inter ventricular septum (systole)	mm	Length	B-Mode	LVID;s
LVAW;s	Left ventricular anterior wall (systole)	mm	Depth	M-Mode	LVID;s
LVID;s	Left ventricular internal diameter (systole)	mm	Depth	M-Mode	LVPW;s
LVID;s	Left ventricular internal diameter (systole)	mm	Length	B-Mode	LVPW;s
LVPW;s	Left ventricular posterior wall (systole)	mm	Depth	M-Mode	
LVPW;s	Left ventricular posterior wall (systole)	mm	Length	B-Mode	
LVET	Left ventricular ejection time (systole)	ms	Time	M-Mode	
LA	Left atrium	mm	Depth	M-Mode	
LA	Left atrium	mm	Length	B-Mode	
Ao Root	Aortic root	mm	Depth	M-Mode	
Ao Sinus	Aortic sinus	mm	Length	B-Mode	

Calculation definitions

Name	Description	Units	Formula
LV Vol;d (M-Mode)	Left ventricle volume diastole	µL	((7.0 / (2.4 + LVID;d)) * LVID;d^3)
LV Vol;d (B-Mode)	Left ventricle volume diastole	µL	((7.0 / (2.4 + LVID;d)) * LVID;d^3)
LV Vol;s (M-Mode)	Left ventricle volume systole	µL	((7.0 / (2.4 + LVID;s)) * LVID;s^3)
LV Vol;s (B-Mode)	Left ventricle volume systole	µl	((7.0 / (2.4 + LVID;s)) * LVID;s^3)
%EF (M-Mode)	LV ejection fraction	%	100 * ((LV Vol;d – LV Vol;s) / LV Vol;d)
%EF (B-Mode)	LV ejection fraction	%	100 * ((LV Vol;d – LV Vol;s) / LV Vol;d)
%FS (M-Mode)	LV fractional shortening	%	100 * ((LVID;d – LVID;s) / LVID;d)
%FS (B-Mode)	LV fractional shortening	%	100 * ((LVID;d – LVID;s) / LVID;d)
LV Mass (M-Mode)	LV mass uncorrected	mg	1.053 * ((LVID;d + LVPW;d + IVS;d)^3 – LVID;d^3)
LV Mass (B-Mode)	LV mass uncorrected	mg	1.053 * ((LVID;d + LVPW;d + IVS;d)^3 – LVID;d^3)

LV Mass Cor (M-Mode)	LV mass corrected	mg	LV Mass (M-Mode) * 0.8
LV Mass Cor (B-Mode)	LV mass corrected	mg	LV Mass (B-Mode)* 0.8
LV Mass AW (M-Mode)	LV Mass AW Uncorrected	mg	1.053 * ((LVID;d + LVPW;d + LVAW;d)3 – LVID;d3)
LV Mass AW Cor (M-Mode)	LV Mass AW corrected	mg	LV Mass AW (M-Mode) * 0.8

SAX protocol

Measurement definitions

Label	Description	Units	Generic type	Mode	Chain
Trace	LV trace - short axis area	mm^2	MLVArea	B-Mode	
A	LV trace area	mm^2	MLVArea	B-Mode	
A;s	Systolic area	mm^2	MLVArea	B-Mode	
A;d	Diastolic area	mm^2	MLVArea	B-Mode	
FAC	Fractional area change	%	MLVArea	B-Mode	
IVS;d	Inter ventricular septum (diastole)	mm	Depth	M-Mode	LVID;d
IVS;d	Inter ventricular septum (diastole)	mm	Length	B-Mode	LVID;d
LVID;d	Left ventricular internal diameter (diastole)	mm	Depth	M-Mode	LVPW;d
LVID;d	Left ventricular internal diameter (diastole)	mm	Length	B-Mode	LVPW;d
LVPW;d	Left ventricular posterior wall (diastole)	mm	Depth	M-Mode	
LVPW;d	Left ventricular posterior wall (diastole)	mm	Length	B-Mode	
IVS;s	Inter ventricular septum	mm	Depth	M-Mode	LVID;s
IVS;s	Inter ventricular septum	mm	Length	B-Mode	LVID;s
LVID;s	Left ventricular internal diameter (systole)	mm	Depth	M-Mode	LVPW;s
LVID;s	Left ventricular internal diameter (systole)	mm	Length	B-Mode	LVPW;s
LVPW;s	Left ventricular posterior wall (systole)	mm	Depth	M-Mode	
LVPW;s	Left ventricular posterior wall (systole)	mm	Length	B-Mode	

Calculation definitions

Name	Description	Units	Formula
LV Vol;d (M-Mode)	Left ventricle volume diastole	µl	((7.0 / (2.4 + LVID;d)) * $LVID;d^3$
LV Vol;d (B-Mode)	Left ventricle volume diastole	µl	((7.0 / (2.4 + LVID;d)) * $LVID;d^3$
LV Vol;s (M-Mode)	Left ventricle volume systole	µl	((7.0 / (2.4 + LVID;s)) * $LVID;s^3$
LV Vol;s (B-Mode)	Left ventricle volume systole	µl	((7.0 / (2.4 + LVID;s)) * $LVID;s^3$
%EF (M-Mode)	LV ejection fraction	%	100 * ((LV Vol;d – LV Vol;s) / LV Vol;d)

%EF (B-Mode)	LV ejection fraction	%	100 * ((LV Vol;d – LV Vol;s) / LV Vol;d)
%FS (M-Mode)	LV fractional shortening	%	100 * ((LVID;d – LVID;s) / LVID;d)
%FS (B-Mode)	LV fractional shortening	%	100 * ((LVID;d – LVID;s) / LVID;d)
LV Mass (M-Mode)	LV mass uncorrected	mg	$1.053 * ((LVID;d + LVPW;d + IVS;d)^3 – LVID;d^3)$
LV Mass (B-Mode)	LV mass uncorrected	mg	$1.053 * ((LVID;d + LVPW;d + IVS;d)^3 – LVID;d^3)$
LV Mass Cor (M-Mode)	LV mass corrected	mg	LV Mass (M-Mode) * 0.8
LV Mass Cor (B-Mode)	LV mass corrected	mg	LV Mass (B-Mode)* 0.8

LV MASS protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LV Trace	Four wall trace of the LV systolic diameter	mm	MLVArea	M-Mode
D;d	Diastolic diameter	mm	MLVArea	M-Mode
D;s	Systolic diameter	mm	MLVArea	M-Mode
V;s	Systolic volume	µL	MLVArea	M-Mode
V;d	Diastolic volume	µL	MLVArea	M-Mode
SV	Stroke volume	mm	MLVArea	M-Mode
EF	Ejection fraction	%	MLVArea	M-Mode
FS	Fractional shortening	%	MLVArea	M-Mode
CO	Cardiac output	ml/min	MLVArea	M-Mode
LV Mass	LV mass uncorrected	mg	MLVArea	M-Mode
LV Mass Cor	LV mass corrected	mg	MLVArea	M-Mode
Endocardial Area; d	Endocardial area in diastole	mm^2	Area	B-Mode
Endocardial Major; d	Endocardial major in diastole	mm	Length	B-Mode
Endocardial Area; s	Endocardial area in systole	mm^2	Area	B-Mode
Endocardial Major; s	Endocardial major in systole	mm	Length	B-Mode
Epicardial Area; d	Epicardial area in diastole	mm^2	Area	B-Mode
Epicardial Major; d	Epicardial major in diastole	mm	Length	B-Mode
Epicardial Area; s	Epicardial area in systole	mm^2	Area	B-Mode
Epicardial Major; s	Epicardial major in systole	mm	Length	B-Mode

Calculation definitions

Name	Description	Units	Formula
Endocardial Volume; d	Endocardial volume in diastole	µl	$\frac{4\pi}{3} \times \frac{End\ Major;\ d}{2} \times \left(\frac{End\ Area;\ d}{\pi\left(\frac{End\ Major;\ d}{2}\right)} \right)^2$
Endocardial Volume; s	Endocardial volume in systole	µl	$\frac{4\pi}{3} \times \frac{End\ Major;\ s}{2} \times \left(\frac{End\ Area;\ s}{\pi\left(\frac{End\ Major;\ s}{2}\right)} \right)^2$
Endocardial Stroke Volume	Stroke volume	µl	Endocardial Volume; d - Endocardial Volume; s
Endocardial %EF	Percent ejection fraction	%	$\frac{Endocardial\ SV}{Endocardial\ Vol;\ d} \times 100$
Endocardial %FAC	Percent fractional area change	%	$\frac{Endocardial\ Area;\ d - Endocardial\ Area;\ s}{Endocardial\ Area;\ d} \times 100$
Endocardial Area Change	Area change	mm^2	$Endocardial\ Area;\ d - Endocardial\ Area;\ s$
Endocardial Fractional Shortening	Fractional shortening	%	(Endocardial Major; d - Endocardial Major; s) / Endocardial Major; d
Endocardial CO	Cardiac output	ml/min	$\frac{Endocardial\ SV}{2} \times Heart\ Rate$ **Note:** Heart rate is additional parameter for Endocardial Major; d measurement
a; d	Average LV epicardial radius in diastole	mm	$\sqrt{\frac{LVEpicardialArea;d}{\pi}}$
b; d	Average LV endocardial radius in diastole	mm	$\sqrt{\frac{Endocardial\ Area;d}{\pi}}_s$
T; d	Average wall thickness	mm	a - b
LV Mass; d	LV Mass	mg	$1.05 * \left(\frac{5}{6} * Epicardial\ Area;d * (Epicardial\ Major;d + T;d)\right) - \left(\frac{5}{6} * Endocardial\ Area;d * Endocardial\ Major;d\right)$

ARCH protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Asc Ao	Ascending aorta length	mm	Length	B-Mode
Trans Arch	Transverse aortic arch diameter	mm	Length	B-Mode
Desc Ao	Descending aorta diameter	mm	Length	B-Mode

Simpson's protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Simp Area Dist; d	Simpson's area distal, diastole	mm^2	Area	B-Mode
Simp Area Mid; d	Simpson's area mid, diastole	mm^2	Area	B-Mode
Simp Area Prox; d	Simpson's area proximal, diastole	mm^2	Area	B-Mode
Simp Length; d	Simpson's length, diastole	mm	Length	B-Mode
HR	Heart rate	BPM		
Simp Area Dist; s	Simpson's area distal, systole	mm^2	Area	B-Mode
Simp Area Mid; s	Simpson's area mid, systole	mm^2	Area	B-Mode
Simp Area Prox; s	Simpson's area proximal, systole	mm^2	Area	B-Mode
Simp Length; s	Simpson's length, systole	mm	Length	B-Mode

Calculation definitions

Name	Description	Units	Formula
Simp Volume; d	Simpson's volume calculation in diastole	µl	$(AreaProx;d + AreaMid;d) \times h + AreaDist;d \times \frac{h}{2} + \frac{\pi}{6} \times h^3$ Where: h = Simpson Length in diastole
Simp Volume; s	Simpson's volume calculation in systole	µl	$(AreaaProx;s + AreaMid;s) \times h + AreaaDist;s \times \frac{h}{2} + \frac{\pi}{6} \times h^3$ Where: h = Simpson Length in systole
Simp SV	Stroke Volume	µL	Simp Volume; d - Simp Volume; s
Simp FAC	Fraction area change	%	100 * (Simp Area Mid;d- Simp Area Mid;s)/Simp Area Mid; d
Simp %EF	Ejection fraction	%	100 * Simp Sv / Simp Volume; d
Simp %FS	Fractional shortening	%	100*(Simp Length; d - Simp Length; s) / (Simp Length; d)
Simp CO	Cardiac output	ml/min	Simp SV * Heart Rate

Volume/Flow protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LVOT	Left ventricular outflow tract length	mm	Length	B-Mode
LVOT VTI	LVOT velocity time integral	cm	VTI	PW Doppler
Mean Vel	LVOT mean velocity	mm/s	VTI	PW Doppler
Mean Grad	LVOT mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	LVOT peak velocity	mm/s	VTI	PW Doppler
Peak Grad	LVOT peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	LVOT cycles	(none)	VTI	PW Doppler
RVOT	Right ventricular outflow tract length	mm	Length	B-Mode
RVOT VTI	RVOT velocity time integral	cm	VTI	PW Doppler
Mean Vel	RVOT mean velocity	mm/s	VTI	PW Doppler
Mean Grad	RVOT mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	RVOT peak velocity	mm/s	VTI	PW Doppler
Peak Grad	RVOT peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	RVOT cycles	(none)	VTI	PW Doppler
MV VTI (ann)	Mitral valve VTI (annulus)	cm	VTI	PW Doppler
Mean Vel	Mitral valve mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Mitral valve mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Mitral valve peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Mitral valve peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Mitral valve cycles	(none)	VTI	PW Doppler
MV Ann	Mitral valve annulus diameter	mm	Linear	B-Mode
TV VTI	Tricuspid valve VTI (annulus)	cm	VTI	PW Doppler
Mean Vel	Tricuspid valve mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Tricuspid valve mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Tricuspid valve peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Tricuspid valve peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Tricuspid valve cycles	(none)	VTI	PW Doppler
TV Ann	Tricuspid valve annulus diameter	mm	Linear	B-Mode
AoV VTI	Aorta velocity time integral	cm	VTI	PW Doppler
Mean Vel	Aorta mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Aorta mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Aorta peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Aorta peak pressure gradient	mmHg	VTI	PW Doppler

Cycles	Aorta cycles	(none)	VTI	PW Doppler
PV VTI	Pulmonary velocity time integral	cm	VTI	PW Doppler
Mean Vel	Pulmonary mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Pulmonary mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Pulmonary peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Pulmonary peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	RVOT cycles	(none)	VTI	PW Doppler
AV Peak V	Aortic valve peak velocity	mm/s	Vertical Velocity	PW Doppler

Calculation definitions

Name	Description	Units	Formula
AoV SV	Aortic valve stroke volume	µL	7.85 *LVOT^2* AoV VTI
AoV CO	Aortic valve cardiac output	ml/min	(AoV SV * HR(from LVOT)) / 1000
PV SV	Pulmonary valve stroke volume	µL	7.85 * RVOT^2 * PV VTI
PV CO	Pulmonary valve cardiac output	ml/min	(PV SV * HR(from RVOT)) / 1000
MV SV	Mitral valve stroke volume	µL	7.85 * MV Ann2 * MV VTI
MV CO	Mitral valve cardiac output	ml/mim	(MV SV * HR(from MV Ann)) / 1000
TV SV	Tricuspid valve stroke volume	µL	7.85 * TV Ann^2 * TV VTI
TV CO	Tricuspid valve cardiac output	ml/mim	(TV SV * HR(from TV Ann)) / 1000
AVA	Aortic valve area	mm^2	$\frac{((LVOT/2)^2 \times \pi \times LVOT\ VTI, peakvel)}{AV\ PeakV}$
AV Mean V	Aortic Valve mean velocity	mm/s	AoV VTI, Mean Velocity
AV Peak Press	Aortic valve peak pressure	mmHg	4 * (AV Peak V)^2 / 1000
PVA	Pulmonic valve area	mm^2	$\frac{((RVOT/2)^2 \times \pi \times RVOT\ VTI, peakvel)}{PV\ VTI, peakvel}$

AoV Flow protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LVOT	Left ventricular outflow tract length	mm	Length	B-Mode
LVOT VTI	LVOT velocity time integral	cm	VTI	PW Doppler
Mean Vel	LVOT mean velocity	mm/s	VTI	PW Doppler
Mean Grad	LVOT mean pressure gradient	mmHg	VTI	PW Doppler

Peak Vel	LVOT peak velocity	mm/s	VTI	PW Doppler
Peak Grad	LVOT peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	LVOT cycles	(none)	VTI	PW Doppler
AV Peak V	Aortic valve peak velocity	mm/s	Vertical Velocity	PW Doppler
AoV VTI	Aorta velocity time integral	cm	VTI	PW Doppler
Mean Vel	Aorta mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Aorta mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Aorta peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Aorta peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Aorta cycles	(none)	VTI	PW Doppler
Desc Ao V	Descending aorta peak velocity	mm/s	Vertical Velocity	PW Doppler
AI PHT	Aortic insufficiency deceleration	mm/s^2	Acceleration	PW Doppler
T	Aortic insufficiency half time	ms	Time	PW Doppler
Desc Ao Vp	Descending aorta velocity time integral, proximal	cm	VTI	PW Doppler
Mean Vel	Descending aorta mean velocity, proximal	mm/s	VTI	PW Doppler
Mean Grad	Descending aorta mean pressure gradient, proximal	mmHg	VTI	PW Doppler
Peak Vel	Descending aorta peak velocity, proximal	mm/s	VTI	PW Doppler
Peak Grad	Descending aorta peak pressure gradient, proximal	mmHg	VTI	PW Doppler
Cycles	Descending aorta cycles, proximal	(none)	VTI	PW Doppler
Desc Ao Vd	Descending aorta Velocity time integral, distal	cm	VTI	PW Doppler
Mean Vel	Descending aorta mean velocity, distal	mm/s	VTI	PW Doppler
Mean Grad	Descending aorta mean pressure gradient, distal	mmHg	VTI	PW Doppler
Peak Vel	Descending aorta peak velocity, distal	mm/s	VTI	PW Doppler
Peak Grad	Descending aorta peak pressure gradient, distal	mmHg	VTI	PW Doppler
Cycles	Descending aorta cycles, distal	(none)	VTI	PW Doppler
AAT	Aortic acceleration time	ms	Time	PW Doppler
AET	Aortic ejection time	ms	Time	PW Doppler

Calculation definitions

Name	Description	Units	Formula
AV Peak Press	Aortic valve peak pressure gradient	mmHg	$(4 * (\text{AV Peak V})^2)/1000$
AV Mean V	Aortic valve mean velocity	mm/s	AoV VTI, Mean Velocity
AoV SV	Stroke volume	µl	$7.85 * \text{LVOT}^2 * \text{AoV VTI}$
AoV CO	Cardiac output	ml/min	(AoV SV * HR(from LVOT)) / 1000
AVA	Aortic valve area	mm^2	$\frac{((LVOT/2)^2 \times \pi \times LVOT\ VTI, peakvel)}{AV\ PeakV}$

MV Flow protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
MV VTI	Mitral valve velocity time integral	cm	VTI	PW Doppler
Mean Vel	Mitral valve mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Mitral valve mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Mitral valve peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Mitral valve peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Mitral valve cycles	(none)	VTI	PW Doppler
MV E	Mitral valve E velocity	mm/s	Vertical Velocity	PW Doppler
MV A	Mitral valve A velocity	mm/s	Vertical Velocity	PW Doppler
MV PHT	Mitral valve pressure half time	mm/s2	Acceleration	PW Doppler
T	Mitral valve pressure half time	ms	Time	PW Doppler

Calculation definitions

Name	Description	Units	Formula
MV E/A	Mitral valve E to A ratio	N/A	MV E / MV A
MV Area	MV area	mm^2	220 / (MV PHT, time)

LV Diastolic Function protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
MV VTI	Mitral valve velocity time integral	cm	VTI	PW Doppler
Mean Vel	Mitral valve mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Mitral valve mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Mitral valve peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Mitral valve peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Mitral valve cycles	(none)	VTI	PW Doppler
MV E	Mitral valve E velocity	mm/s	Vertical Velocity	PW Doppler

MV A	Mitral valve A velocity	mm/s	Vertical Velocity	PW Doppler
MV Decel	E wave deceleration time	mm/s^2	Acceleration	PW Doppler
T	E wave deceleration time	ms	Time	PW Doppler
IVRT	Isovolumic relaxation time	ms	Time	PW Doppler
IVCT	Isovolumic contraction time	ms	Time	PW Doppler
MV ET	Mitral valve ejection time	ms	Time	PW Doppler
NFT	Non-filling time	ms	Time	PW Doppler
AET	Aortic ejection Time	ms	Time	PW Doppler

Calculation definitions

Name	Description	Units	Formula
MV E/A	Ratio of Mitral valve E to A	N/A	MV E/ MV A
LV MPI	LV Myocardial performance index	N/A	(NFT - AET) / AET

TV Flow protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
TV VTI	Tricuspid velocity time integral	cm	VTI	PW Doppler
Mean Vel	Tricuspid mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Tricuspid mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Tricuspid peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Tricuspid aorta peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Tricuspid aorta cycles	(none)	VTI	PW Doppler
TV E	Tricuspid valve E wave velocity	mm/s	Vertical Velocity	PW Doppler
TV A	Tricuspid valve A wave velocity	mm/s	Vertical Velocity	PW Doppler
TR Peak V	Tricuspid regurgitation peak velocity	mm/s	Vertical Velocity	PW Doppler

Calculation definitions

Name	Description	Units	Formula
RVSP	Right ventricular systolic pressure	mmHg	$(4 * (\text{TR Peak Velocity})^2) / 1000$
TV E/A	Ratio of tricuspid valve E to A	N/A	TV E/ TV A

PV Flow protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
PV VTI	Pulmonary velocity time integral	cm	VTI	PW Doppler
Mean Vel	Pulmonary mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Pulmonary mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Pulmonary peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Pulmonary aorta peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Pulmonary aorta cycles	(none)	VTI	PW Doppler
PV Peak V	Pulmonary valve peak velocity	mm/s	Velocity	PW Doppler
PR Peak V	Pulmonary regurgitation peak velocity	mm/s	Velocity	PW Doppler
PAT	Pulmonary acceleration time	ms	Time	PW Doppler
PET	Pulmonary ejection time	ms	Time	PW Doppler
RVOT	Right ventricular outflow tract length	mm	Length	B-Mode
RVOT VTI	RVOT velocity time integral	cm	VTI	PW Doppler
Mean Vel	RVOT mean velocity	mm/s	VTI	PW Doppler
Mean Grad	RVOT mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	RVOT peak velocity	mm/s	VTI	PW Doppler
Peak Grad	RVOT peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	RVOT cycles	(none)	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
Peak Gradient	Pulmonary valve peak gradient	mmHg	(4 * (Pulmonary valve peak velocity)^2) / 1000
PVA	Pulmonic valve area	mm^2	$\frac{\left((RVOT/2)^2 \times \pi \times RVOT\ VTI,\ peakvel\right)}{PV\ VTI,\ peakvel}$

Tissue Doppler protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
MV E	Mitral valve velocity at E	mm/s	Velocity	PW Doppler
E'	Velocity at E'	mm/s	Velocity	Tissue Doppler
A'	Velocity at A'	mm/s	Velocity	Tissue Doppler
IVRT	Isovolumic relaxation time	ms	Time	Tissue Doppler
IVCT	Isovolumic contraction time	ms	Time	Tissue Doppler
ET	Ejection time	ms	Time	Tissue Doppler
TV LW E'	Tricuspid valve velocity at E'	mm/s	Velocity	Tissue Doppler
TV LW A'	Tricuspid valve velocity at A'	mm/s	Velocity	Tissue Doppler
MV LW E'	Mitral valve velocity at E'	mm/s	Velocity	Tissue Doppler
MV LW A'	Mitral valve velocity at A'	mm/s	Velocity	Tissue Doppler
MV IVS E'	Mitral valve IVS velocity at E'	mm/s	Velocity	Tissue Doppler
MV IVS A'	Mitral valve IVS velocity at A'	mm/s	Velocity	Tissue Doppler

Calculation definitions

Name	Description	Units	Formula
E'/A'	Ratio of E' velocity to A' velocity	none	E' / A'
A'/E'	Ratio of A' velocity to E' velocity	none	A' / E'
MV E/E'	Ratio of MV E velocity to E' velocity	none	MV E / E'
TV LW E'/A'	Ratio of E' velocity to A' velocity	none	TV LW E' / TV LW A'
TV LW A'/E'	Ratio of A' velocity to E' velocity	none	TV LW A' / TV LW E'
MV LW E'/A'	Ratio of E' velocity to A' velocity	none	MV LW E' / MV LW A'
MV LW A'/E'	Ratio of A' velocity to E' velocity	none	MV LW A' / MV LW E'
MV IVS E'/A'	Ratio of E' velocity to A' velocity	none	MV IVS E' / MV IVS A'
MV IVS A'/E'	Ratio of A' velocity to E' velocity	none	MV IVS A' / MV IVS E'

RV Diastolic Function protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
TV VTI	Tricuspid velocity time integral	cm	VTI	PW Doppler
Mean Vel	Tricuspid mean velocity	mm/s	VTI	PW Doppler
Mean Grad	Tricuspid mean pressure gradient	mmHg	VTI	PW Doppler
Peak Vel	Tricuspid peak velocity	mm/s	VTI	PW Doppler
Peak Grad	Peak pressure gradient	mmHg	VTI	PW Doppler
Cycles	Tricuspid cycles	(none)	VTI	PW Doppler
TV E	Tricuspid valve E wave velocity	mm/s	Vertical Velocity	PW Doppler
TV A	Tricuspid valve A wave velocity	mm/s	Vertical Velocity	PW Doppler
TV Decel	Tricuspid E wave deceleration time	mm/s^2	Acceleration	PW Doppler
T	Tricuspid E wave deceleration time	ms	Time	PW Doppler
IVRTr	Right ventricle relaxation time	ms	Time	PW Doppler
IVCTr	Right ventricle contraction time	ms	Time	PW Doppler
TV ET	Tricuspid valve ejection time	ms	Time	PW Doppler
NFTr	Right ventricle non-filling time	ms	Time	PW Doppler
PET	Pulmonary ejection Time	ms	Time	PW Doppler

Calculation definitions

Name	Description	Units	Formula
TV E/A	Ratio of tricuspid valve E to A	N/A	TV E/ TV A
RV MPI	RV myocardial performance index	N/A	(NFTr - PET) / PET

Embryology Measurement Package

This section provides the measurements and calculations information for the protocols in the Embryology measurement package.

Uterine Horn protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
UA Vel	Umbilical artery velocity	mm/ms	Velocity	PW Doppler
UA Diam	Umbilical artery diameter	mm	Linear	B-Mode

UA Diam	Umbilical artery diameter	mm	Depth	M-Mode
UV Vel	Umbilical vein velocity	mm/ms	Velocity	PW Doppler
UV Diam	Umbilical vein diameter	mm	Linear	B-Mode
UV Diam	Umbilical vein diameter	mm	Linear	M-Mode
VA Vel	Vitelline artery velocity	mm/ms	Velocity	PW Doppler
VA Diam	Vitelline artery diameter	mm	Linear	B-Mode
VA Diam	Vitelline artery diameter	mm	Depth	M-Mode
VV Vel	Vitelline vein velocity	mm/ms	Velocity	PW Doppler
VV Diam	Vitelline vein diameter	mm	Linear	B-Mode
VV Diam	Vitelline vein diameter	mm	Depth	M-Mode

Placenta protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Placenta Sag	Sagittal length	mm	Linear	B-Mode
Placenta Trans	Transverse length	mm	Linear	B-Mode

Ophthalmology Measurement Package

This section provides the measurements and calculations information for the protocols in the Ophthalmology measurement package.

Ophthalmology protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
Lens Length	Lens length	mm	Linear	B-Mode
Lens Area	Lens area	mm^2	Polygon	B-Mode
Lens Curvature	Lens curvature	mm	Linear	B-Mode
Lens Radius	Lens radius	mm	Radius	B-Mode
Anterior Chamber Area	Anterior chamber area	mm^2	Polygon	B-Mode
Cornea Length	Cornea length	mm	Linear	B-Mode

Choroid Thickness	Choroid thickness	mm	Linear	B-Mode
Sclera Thickness	Sclera thickness	mm	Linear	B-Mode
Retina Thickness	Retina thickness	mm	Linear	B-Mode
Retinal Artery Velocity	Retinal artery velocity	mm/s	Velocity	PW Doppler
Retinal Vein Velocity	Retinal vein velocity	mm/s	Velocity	PW Doppler

Vascular Measurement Package

This section provides the measurements and calculations information for the protocols in the Vascular measurement package.

Abdominal Aorta and Inferior Vena Cava protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
AA Vel	Abdominal aorta peak velocity	mm/s	Velocity	PW Doppler
AA Diam	Abdominal aorta diameter	mm	Linear	B-Mode
AA Diam	Abdominal aorta diameter	mm	Depth	M-Mode
AA VTI	Abdominal aorta velocity time integral	cm	VTI	PW Doppler
Peak Vel	Abdominal aorta peak velocity	cm	VTI	PW Doppler
Mean Vel	Abdominal aorta mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Abdominal aorta peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Abdominal aorta mean gradient	mmHg	VTI	PW Doppler
IVC Vel	Inferior vena cava peak velocity	mm/s	Velocity	PW Doppler
IVC Diam	Inferior vena cava diameter	mm	Linear	B-Mode
IVC Diam	Inferior vena cava diameter	mm	Depth	M-Mode

Mesenteric Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
SMA PSV	Superior mesenteric artery peak systolic velocity	mm/s	Velocity	PW Doppler
SMA EDV	Superior mesenteric artery end diastolic velocity	mm/s	Velocity	PW Doppler

SMA Diam;s	Superior mesenteric artery diameter	mm	Linear	B-Mode
SMA Diam;d	Superior mesenteric artery diameter	mm	Linear	B-Mode
SMA Diam;s	Superior mesenteric artery diameter, systole	mm	Depth	M-Mode
SMA Diam;d	Superior mesenteric artery diameter, diastole	mm	Depth	M-Mode
SMA VTI	Superior mesenteric artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Superior mesenteric artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Superior mesenteric artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Superior mesenteric artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Superior mesenteric artery mean gradient	mmHg	VTI	PW Doppler
IMA PSV	Inferior mesenteric artery peak systolic velocity	mm/s	Velocity	PW Doppler
IMA EDV	Inferior mesenteric artery end diastolic velocity	mm/s	Velocity	PW Doppler
IMA Diam;s	Inferior mesenteric artery diameter, systole	mm	Linear	B-Mode
IMA Diam;d	Inferior mesenteric artery diameter, diastole	mm	Linear	B-Mode
IMA Diam;s	Inferior mesenteric artery diameter, systole	mm	Depth	M-Mode
IMA Diam;d	Inferior mesenteric artery diameter, diastole	mm	Depth	M-Mode
IMA VTI	Inferior mesenteric artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Inferior mesenteric artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Inferior mesenteric artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Inferior mesenteric artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Inferior mesenteric artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
SMA RI	Superior mesenteric artery resistive index	none	(Superior Mesenteric Artery PSV - Superior Mesenteric Artery EDV)/ Superior Mesenteric Artery PSV
SMA PI	Superior mesenteric artery pulsatility index	none	(Superior Mesenteric Artery PSV - Superior Mesenteric Artery EDV)/ Superior Mesenteric Artery VTI,Mean Velocity
IMA RI	Inferior mesenteric artery resistive index	none	(Inferior Mesenteric Artery PSV - Inferior Mesenteric Artery EDV)/ Inferior Mesenteric Artery PSV
IMA PI	Inferior mesenteric artery pulsatility index	none	(Inferior Mesenteric Artery PSV - Inferior Mesenteric Artery EDV)/ Inferior Mesenteric Artery VTI,Mean Velocity

Carotid Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LCCA PSV	Left common carotid peak systolic velocity	mm/s	Velocity	PW Doppler
LCCA EDV	Left common carotid end diastolic velocity	mm/s	Velocity	PW Doppler
LCCA Diam;s	Left common carotid diameter, systole	mm	Linear	B-Mode
LCCA Diam;d	Left common carotid diameter, diastole	mm	Linear	B-Mode
LCCA Diam;s	Left common carotid diameter, systole	mm	Depth	M-Mode
LCCA Diam;d	Left common carotid diameter, diastole	mm	Depth	M-Mode
LCCA VTI	Left common carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left common carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left common carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left common carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left common carotid mean gradient	mmHg	VTI	PW Doppler
RCCA PSV	Right common carotid peak systolic velocity	mm/s	Velocity	PW Doppler
RCCA EDV	Right common carotid end diastolic velocity	mm/s	Velocity	PW Doppler
RCCA Diam;s	Right common carotid diameter, systole	mm	Linear	Mode
RCCA Diam;d	Right common carotid diameter, diastole	mm	Linear	B-Mode
RCCADiam;s	Right common carotid diameter, systole	mm	Depth	M-Mode
RCCADiam;d	Right common carotid diameter, diastole	mm	Depth	M-Mode
RCCAVTI	Right common carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right common carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right common carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right common carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right common carotid mean gradient	mmHg	VTI	PW Doppler
LICA PSV	Left internal carotid peak systolic velocity	mm/s	Velocity	PW Doppler
LICA EDV	Left internal carotid end diastolic velocity	mm/s	Velocity	PW Doppler
LICA Diam;s	Left internal carotid diameter, systole	mm	Linear	B-Mode
LICA Diam;d	Left internal carotid diameter, diastole	mm	Linear	B-Mode
LICA Diam;s	Left internal carotid diameter, systole	mm	Depth	M-Mode
LICA Diam;d	Left internal carotid diameter, diastole	mm	Depth	M-Mode
LICA VTI	Left internal carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left internal carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left internal carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left internal carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left internal carotid mean gradient	mmHg	VTI	PW Doppler

LECA PSV	Left external carotid peak systolic velocity	mm/s	Velocity	PW Doppler
LECA EDV	Left external carotid end diastolic velocity	mm/s	Velocity	PW Doppler
LECA Diam;s	Left external carotid diameter, systole	mm	Linear	B-Mode
LECA Diam;d	Left external carotid diameter, diastole	mm	Linear	B-Mode
LECA Diam;s	Left external carotid diameter, systole	mm	Depth	M-Mode
LECA Diam;d	Left external carotid diameter, diastole	mm	Depth	M-Mode
LECA VTI	Left external carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left external carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left external carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left external carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left external carotid mean gradient	mmHg	VTI	PW Doppler
RICA PSV	Right internal carotid peak systolic velocity	mm/s	Velocity	PW Doppler
RICA EDV	Right internal carotid end diastolic velocity	mm/s	Velocity	PW Doppler
RICA Diam;s	Right internal carotid diameter, systole	mm	Linear	B-Mode
RICA Diam;d	Right internal carotid diameter, diastole	mm	Linear	B-Mode
RICA Diam;s	Right internal carotid diameter, systole	mm	Depth	M-Mode
RICA Diam;d	Right internal carotid diameter, diastole	mm	Depth	M-Mode
RICA VTI	Right internal carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right internal carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right internal carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right internal carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right internal carotid mean gradient	mmHg	VTI	PW Doppler
RECA PSV	Right external carotid peak systolic velocity	mm/s	Velocity	PW Doppler
RECA EDV	Right external carotid end diastolic velocity	mm/s	Velocity	PW Doppler
RECA Diam;s	Right external carotid diameter, systole	mm	Linear	B-Mode
RECA Diam;d	Right external carotid diameter, diastole	mm	Linear	B-Mode
RECA Diam;s	Right external carotid diameter, systole	mm	Depth	M-Mode
RECA Diam;d	Right external carotid diameter, diastole	mm	Depth	M-Mode
RECA VTI	Right external carotid velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right external carotid peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right external carotid mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right external carotid peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right external carotid mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
LCCA RI	Left common carotid resistive index	none	(Left Common Carotid PSV - Left Common Carotid EDV)/ Left Common Carotid PSV

LCCA PI	Left common carotid pulsatility index	none	((Left Common Carotid PSV - (Left Common Carotid EDV)/ (Left Common Carotid VTI,Mean Velocity
RCCA RI	Right common carotid resistive index	none	(Right Common Carotid PSV - Right Common Carotid EDV)/ Right Common Carotid PSV
RCCA PI	Right common carotid pulsatility index	none	(Right Common Carotid PSV - Right Common Carotid EDV)/ Right Common Carotid VTI,Mean Velocity
LICA RI	Left internal carotid resistive index	none	(Left Internal Carotid PSV - Left Internal Carotid EDV)/ Left Internal Carotid PSV
LICA PI	Left internal carotid pulsatility index	none	(Left Internal Carotid PSV - Left Internal Carotid EDV)/ Left Internal Carotid VTI,Mean Velocity
LECA RI	Left external carotid resistive index	none	(Left External Carotid PSV - Left External Carotid EDV)/ Left External Carotid PSV
LECA PI	Left external carotid pulsatility index	none	(Left External Carotid PSV - Left External Carotid EDV)/ Left External Carotid VTI,Mean Velocity
RICA RI	Right internal carotid resistive index	none	(Right Internal Carotid PSV - Right Internal Carotid EDV)/ Right Internal Carotid PSV
RICA PI	Right internal carotid pulsatility index	none	(Right Internal Carotid PSV - Right Internal Carotid EDV)/ Right Internal Carotid VTI,Mean Velocity
RECA RI	Right external carotid resistive index	none	(Right External Carotid PSV - Right External Carotid EDV)/ Right External Carotid PSV
RECA PI	Right external carotid pulsatility index	none	(Right External Carotid PSV - Right External Carotid EDV)/ Right External Carotid VTI,Mean Velocity

Innominant and Subclavian Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
IA PSV	Innominant artery peak systolic velocity	mm/s	Velocity	PW Doppler
IA EDV	Innominant artery end diastolic velocity	mm/s	Velocity	PW Doppler
IA Diam;s	Innominant artery diameter, systole	mm	Linear	B-Mode
IA Diam;d	Innominant artery diameter, diastole	mm	Linear	B-Mode
IA Diam;s	Innominant artery diameter, systole	mm	Depth	M-Mode
IA Diam;d	Innominant artery diameter, diastole	mm	Depth	M-Mode
IA VTI	Innominant artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Innominant artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Innominant artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Innominant artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Innominant artery mean gradient	mmHg	VTI	PW Doppler
LSA PSV	Left Subclavian artery peak systolic velocity	mm/s	Velocity	PW Doppler
LSA EDV	Left Subclavian artery end diastolic velocity	mm/s	Velocity	PW Doppler
LSA Diam;s	Left Subclavian artery diameter, systole	mm	Linear	B-Mode

LSA Diam;d	Left Subclavian artery diameter, diastole	mm	Linear	B-Mode
LSA Diam;s	Left Subclavian artery diameter, systole	mm	Depth	M-Mode
LSA Diam;d	Left Subclavian artery diameter, diastole	mm	Depth	M-Mode
LSA VTI	Left Subclavian artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left Subclavian artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left Subclavian artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left Subclavian artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left Subclavian artery mean gradient	mmHg	VTI	PW Doppler
RSA PSV	Right Subclavian artery peak systolic velocity	mm/s	Velocity	PW Doppler
RSA EDV	Right Subclavian artery end diastolic velo	mm/s	Velocity	PW Doppler
RSA Diam;s	Right Subclavian artery diameter, systolecity	mm	Linear	B-Mode
RSA Diam;d	Right Subclavian artery diameter, diastole	mm	Linear	B-Mode
RSA Diam;s	Right Subclavian artery diameter, systole	mm	Depth	M-Mode
RSA Diam;d	Right Subclavian artery diameter, diastole	mm	Depth	M-Mode
RSA VTI	Right Subclavian artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right Subclavian artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right Subclavian artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right Subclavian artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
IA RI	Innominant artery resistive index	none	(Innominant Artery PSV - Innominant Artery EDV)/ Innominant Artery PSV
IA PI	Innominant artery pulsatility index	none	(Innominant Artery PSV - Innominant Artery EDV)/ Innominant Artery VTI, Mean Velocity
LSA RI	Left subclavian artery resistive index	none	(Left Subclavian Artery PSV - Left Subclavian Artery EDV)/ Left Subclavian Artery PSV
LSA PI	Left subclavian artery pulsatility index	none	(Left Subclavian Artery PSV - Left Subclavian Artery EDV)/ Left Subclavian Artery VTI, Mean Velocity
RSA RI	Right subclavian artery resistive index	none	(Right Subclavian Artery PSV - Right Subclavian Artery EDV)/ Right Subclavian Artery PSV
RSA PI	Right subclavian artery pulsatility index	none	(Right Subclavian Artery PSV - Right Subclavian Artery EDV)/ Right Subclavian Artery VTI, Mean Velocity

Iliac Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
CLI PSV	Common left iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
CLI EDV	Common left iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
CLI Diam;s	Common left iliac artery diameter, systole r	mm	Linear	B-Mode
CLI Diam;d	Common left iliac artery diameter, diastole	mm	Linear	B-Mode
CLI Diam;s	Common left iliac artery diameter, systole	mm	Depth	M-Mode
CLI Diam;d	Common left iliac artery diameter, diastole	mm	Depth	M-Mode
CLI VTI	Common left iliac artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Common left iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Common left iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Common left iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Common left iliac artery mean gradient	mmHg	VTI	PW Doppler
CRI PSV	Common right iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
CRI EDV	Common right iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
CRI Diam;s	Common right iliac artery diameter, systole	mm	Linear	B-Mode
CRI Diam;d	Common right iliac artery diameter, diastole	mm	Linear	B-Mode
CRI Diam;s	Common right iliac artery diameter, systole	mm	Depth	M-Mode
CRI Diam;d	Common right iliac artery diameter, diastole	mm	Depth	M-Mode
CRI VTI	Common right iliac artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Common right iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Common right iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Common right iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Common right iliac artery mean gradient	mmHg	VTI	PW Doppler
LII PSV	Left internal iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
LII EDV	Left internal iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
LII Diam;s	Left internal iliac artery diameter, systole	mm	Linear	B-Mode
LII Diam;d	Left internal iliac artery diameter, diastole	mm	Linear	B-Mode
LII Diam;s	Left internal iliac artery diameter, systole	mm	Depth	M-Mode
LII Diam;d	Left internal iliac artery diameter, diastole	mm	Depth	M-Mode
LII VTI	Left internal iliac artery velocity time Integral	cm	VTI	PW Doppler
Peak Vel	Left internal iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left internal iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left internal iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left internal iliac artery mean gradient	mmHg	VTI	PW Doppler

LEI PSV	Left external iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
LEI EDV	Left external iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
LEI Diam;s	Left external iliac artery diameter, systole	mm	Linear	B-Mode
LEI Diam;d	Left external iliac artery Diameter, diastole	mm	Linear	B-Mode
LEI Diam;s	Left external iliac artery Diameter, systole	mm	Depth	M-Mode
LEI Diam;d	Left external iliac artery Diameter, diastole	mm	Depth	M-Mode
LEI VTI	Left external iliac artery Velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left external iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left external iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left external iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left external iliac artery mean gradient	mmHg	VTI	PW Doppler
RII PSV	Right internal iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
RII EDV	Right internal iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
RII Diam;s	Right internal iliac artery diameter, systole	mm	Linear	B-Mode
RII Diam;d	Right internal iliac artery diameter, diastole	mm	Linear	B-Mode
RII Diam;s	Right internal iliac artery diameter, systole	mm	Depth	M-Mode
RII Diam;d	Right internal iliac artery diameter, diastole	mm	Depth	M-Mode
RII VTI	Right internal iliac artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right internal iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right internal iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right internal iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right internal iliac artery mean gradient	mmHg	VTI	PW Doppler
REI PSV	Right external iliac artery peak systolic velocity	mm/s	Velocity	PW Doppler
REI EDV	Right external iliac artery end diastolic velocity	mm/s	Velocity	PW Doppler
REI Diam;s	Right external iliac artery diameter, systole	mm	Linear	B-Mode
REI Diam;d	Right external iliac artery diameter, diastole	mm	Linear	B-Mode
REI Diam;s	Right external iliac artery diameter, systole	mm	Depth	M-Mode
REI Diam;d	Right external iliac artery diameter, diastole	mm	Depth	M-Mode
REI VTI	Right external iliac artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right external iliac artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right external iliac artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right external iliac artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right external iliac artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
CLI RI	Common left iliac artery resistive index	none	(Common Left Iliac Artery PSV - Common Left Iliac Artery EDV)/ Common Left Iliac Artery PSV

CLI PI	Common left iliac artery pulsatility index	none	(Common Left Iliac Artery PSV - Common Left Iliac Artery EDV)/ Common Left Iliac Artery VTI, Mean Velocity
CRI RI	Common right iliac artery resistive index	none	(Common Right Iliac Artery PSV - Common Right Iliac Artery EDV)/ Common Right Iliac Artery PSV
CRI PI	Common right iliac artery pulsatility index	none	(Common Right Iliac Artery PSV - Common Right Iliac Artery EDV)/ Common Right Iliac Artery VTI, Mean Velocity
LII RI	Left internal iliac artery resistive index	none	(Left Internal Iliac Artery PSV - Left Internal Iliac Artery EDV)/ Left Internal Iliac Artery PSV
LII PI	Left internal iliac artery pulsatility index	none	(Left Internal Iliac Artery PSV - Left Internal Iliac Artery EDV)/ Left Internal Iliac Artery VTI, Mean Velocity
LEI RI	Left external iliac artery resistive index	none	(Left External Iliac Artery PSV - Left External Iliac Artery EDV)/ Left External Iliac Artery PSV
LEI PI	Left external iliac artery pulsatility index	none	(Left External Iliac Artery PSV - Left External Iliac Artery EDV)/ Left External Iliac Artery VTI, Mean Velocity
RII RI	Right internal iliac artery resistive index	none	(Right Internal Iliac Artery PSV - Right Internal Iliac Artery EDV)/ Right Internal Iliac Artery PSV
RII PI	Right internal iliac artery pulsatility index	none	(Right Internal Iliac Artery PSV - Right Internal Iliac Artery EDV)/ Right Internal Iliac Artery VTI, Mean Velocity
REI RI	Right external iliac artery resistive index	none	(Right External Iliac Artery PSV - Right External Iliac Artery EDV) / Right External Iliac Artery PSV
REI PI	Right external iliac artery pulsatility index	none	(Right External Iliac Artery PSV - Right External Iliac Artery EDV) / Right External Iliac Artery VTI, Mean Velocity

Femoral Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LFA PSV	Left femoral artery peak systolic velocity	mm/s	Velocity	PW Doppler
LFA EDV	Left femoral artery end diastolic velocity	mm/s	Velocity	PW Doppler
LFA Diam;s	Left femoral artery diameter, systole	mm	Linear	B-Mode
LFA Diam;d	Left femoral artery diameter, diastole	mm	Linear	B-Mode
LFA Diam;s	Left femoral artery diameter, systole	mm	Depth	M-Mode
LFA Diam;d	Left femoral artery diameter, diastole	mm	Depth	M-Mode
LFA VTI	Left femoral artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left femoral artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left femoral artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left femoral artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left femoral artery mean gradient	mmHg	VTI	PW Doppler
RFA PSV	Right femoral artery peak systolic velocity	mm/s	Velocity	PW Doppler
RFA EDV	Right femoral artery end diastolic velocity	mm/s	Velocity	PW Doppler
RFA Diam;s	Right femoral artery diameter, systole	mm	Linear	B-Mode

RFA Diam;d	Right femoral artery diameter, diastole	mm	Linear	B-Mode
RFA Diam;s	Right femoral artery diameter, systole	mm	Depth	M-Mode
RFA Diam;d	Right femoral artery diameter, diastole	mm	Depth	M-Mode
RFA VTI	Right femoral artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right femoral artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right femoral artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right femoral artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right femoral artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
LFA RI	Left femoral artery resistive index	none	(Left Femoral Artery PSV - Left Femoral Artery EDV)/ Left Femoral Artery PSV
LFA PI	Left femoral artery pulsatility index	none	(Left Femoral Artery PSV - Left Femoral Artery EDV)/ Left Femoral Artery VTI, Mean Velocity
RFA RI	Right femoral artery resistive index	none	(Right Femoral Artery PSV - Right Femoral Artery EDV)/ Right Femoral Artery PSV
RFA PI	Right femoral artery pulsatility index	none	(Right Femoral Artery PSV - Right Femoral Artery EDV)/ Right Femoral Artery VTI, Mean Velocity

Saphenous Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LSaA PSV	Left saphenous artery peak systolic velocity	mm/s	Velocity	PW Doppler
LSaA EDV	Left saphenous artery end diastolic velocity	mm/s	Velocity	PW Doppler
LSaA Diam;s	Left saphenous artery diameter, systole	mm	Linear	B-Mode
LSaA Diam;d	Left saphenous artery diameter, diastole	mm	Linear	B-Mode
LSaA Diam;s	Left saphenous artery diameter, systole	mm	Depth	M-Mode
LSaA Diam;d	Left saphenous artery diameter, diastole	mm	Depth	M-Mode
LSaA VTI	Left saphenous artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left saphenous artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left saphenous artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left saphenous artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Left saphenous artery mean gradient	mmHg	VTI	PW Doppler
RSaA PSV	Right saphenous artery peak systolic velocity	mm/s	Velocity	PW Doppler

RSaA EDV	Right saphenous artery end diastolic velocity	mm/s	Velocity	PW Doppler
RSaA Diam;s	Right saphenous artery diameter, systole	mm	Linear	B-Mode
RSaA Diam;d	Right saphenous artery diameter, diastole	mm	Linear	B-Mode
RSaA Diam;s	Right saphenous artery diameter, systole	mm	Depth	M-Mode
RSaA Diam;d	Right saphenous artery diameter, diastole	mm	Depth	M-Mode
RSaA VTI	Right saphenous artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right saphenous artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right saphenous artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right saphenous artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right saphenous artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
LSaA RI	Left saphenous artery resistive index	none	(Left Saphenous Artery PSV – Left Saphenous Artery EDV)/ Left Saphenous Artery PSV
LSaA PI	Left saphenous artery pulsatility index	none	(Left Saphenous Artery PSV - Left Saphenous Artery EDV)/ Left Saphenous Artery VTI, Mean Velocity
RSaA RI	Right saphenous artery resistive index	none	(Right Saphenous Artery PSV – Right Saphenous Artery EDV)/ Right Saphenous Artery PSV
RSaA PI	Right saphenous artery pulsatility index	none	(Right Saphenous Artery PSV - Right Saphenous Artery EDV)/ Right Saphenous Artery VTI, Mean Velocity

Renal Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
LRA PSV	Left renal artery peak systolic velocity	mm/s	Velocity	PW Doppler
LRA EDV	Left renal artery end diastolic velocity	mm/s	Velocity	PW Doppler
LRA Diam;s	Left renal artery diameter, systole	mm	Linear	B-Mode
LRA Diam;d	Left renal artery diameter, diastole	mm	Linear	B-Mode
LRA Diam;s	Left renal artery diameter, systole	mm	Depth	M-Mode
LRA Diam;d	Left renal artery diameter, diastole	mm	Depth	M-Mode
LRA VTI	Left renal artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Left renal artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Left renal artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Left renal artery peak gradient	mmHg	VTI	PW Doppler

Mean Grad	Left renal artery mean gradient	mmHg	VTI	PW Doppler
RRA PSV	Right renal artery peak systolic velocity	mm/s	Velocity	PW Doppler
RRA EDV	Right renal artery end diastolic velocity	mm/s	Velocity	PW Doppler
RRA Diam;s	Right renal artery diameter, systole	mm	Linear	B-Mode
RRA Diam;d	Right renal artery diameter, diastole	mm	Linear	B-Mode
RRA Diam;s	Right renal artery diameter, systole	mm	Depth	M-Mode
RRA Diam;d	Right renal artery diameter, diastole	mm	Depth	M-Mode
RRA VTI	Right renal artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Right renal artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Right renal artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Right renal artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Right renal artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
LRA RI	Left renal artery resistive index	none	(Left Renal Artery PSV – Left Renal Artery EDV)/ Left Renal Artery PSV
LRA PI	Left renal artery pulsatility index	none	(Left Renal Artery PSV - Left Renal Artery EDV)/ Left Renal Artery VTI, Mean Velocity
RRA RI	Right renal artery resistive index	none	(Right Renal Artery PSV – Right Renal Artery EDV)/ Right Renal Artery PSV
RRA PI	Right renal artery pulsatility index	none	(Right Renal Artery PSV - Right Renal Artery EDV)/ Right Renal Artery VTI, Mean Velocity

Other Artery measurements

Measurement definitions

Label	Description	Units	Generic type	Mode
OA PSV	Other artery peak systolic velocity	mm/s	Velocity	PW Doppler
OA EDV	Other artery end diastolic velocity	mm/s	Velocity	PW Doppler
OA Diam;s	Other artery diameter, systole	mm	Linear	B-Mode
OA Diam;d	Other artery diameter, diastole	mm	Linear	B-Mode
OA Diam;s	Other artery diameter, systole	mm	Depth	M-Mode
OA Diam;d	Other artery diameter, diastole	mm	Depth	M-Mode
OA VTI	Other artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Other artery peak velocity	mm/s	VTI	PW Doppler

Mean Vel	Other artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Other artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Other artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

OA RI	Other artery resistive index	none	(Other Artery PSV - Other Artery EDV)/ Other Artery PSV
OA PI	Other artery pulsatility index	none	(Other Artery PSV - Other Artery EDV)/ Other Artery VTI, Mean Velocity

Umbilical Arteries protocol

Measurement definitions

Label	Description	Units	Generic type	Mode
UT PSV	Uterine artery peak systolic velocity	mm/s	Velocity	PW Doppler
UT EDV	Uterine artery end diastolic velocity	mm/s	Velocity	PW Doppler
UT VTI	Uterine artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Uterine artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Uterine artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Uterine artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Uterine artery mean gradient	mmHg	VTI	PW Doppler
UM PSV	Umbilical artery peak systolic velocity	mm/s	Velocity	PW Doppler
UM EDV	Umbilical artery end diastolic velocity	mm/s	Velocity	PW Doppler
UM VTI	Umbilical artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Umbilical artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Umbilical artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Umbilical artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Umbilical artery mean gradient	mmHg	VTI	PW Doppler
VIT PSV	Vitelline artery peak systolic velocity	mm/s	Velocity	PW Doppler
VIT EDV	Vitelline artery end diastolic velocity	mm/s	Velocity	PW Doppler
VIT VTI	Vitelline artery velocity time integral	cm	VTI	PW Doppler
Peak Vel	Vitelline artery peak velocity	mm/s	VTI	PW Doppler
Mean Vel	Vitelline artery mean velocity	mm/s	VTI	PW Doppler
Peak Grad	Vitelline artery peak gradient	mmHg	VTI	PW Doppler
Mean Grad	Vitelline artery mean gradient	mmHg	VTI	PW Doppler

Calculation definitions

Name	Description	Units	Formula
UT RI	Uterine artery resistive index	none	(Uterine Artery PSV - Uterine Artery EDV)/ Uterine Artery PSV
UM RI	Umbilical artery resistive index	none	(Umbilical Artery PSV - Umbilical Artery EDV)/ Umbilical Artery PSV
VIT RI	Uterine artery resistive index	none	(Vitelline Artery PSV - Vitelline Artery EDV)/ Vitelline Artery PSV

Appendix B

Troubleshooting

If a problem is encountered when using the Vevo 2100 Imaging System, try the solutions described in this appendix. If none of the solutions solves the problem, contact a VisualSonics Technical Support representative (support@visualsonics.com).

System panel controls

Problem	Solution
System does not power up	▪ Ensure that the main power cable for the system is properly connected to the Vevo 2100 Imaging System. ▪ Ensure that the system is plugged into a grounded/earthed wall outlet. Turn the main power switch On. ▪ Turn the computer standby switch On.
No audio	▪ Adjust the Volume dial ▪ Adjust any PW Doppler settings (such as the PW Doppler angle, the Doppler Gain, the Sample Volume Position) to increase the strength of the PW Doppler signal.

Study Browser

Problem	Solution
Unable to create new studies	Ensure that an transducer is connected to the front panel of the Vevo 2100 Imaging System, and ensure that it has been initialized.
Unable to commit a study session	Ensure that an operator has been specified.
The system tells you that your study is corrupted	**Cause:** You are still in an active image acquisition session working on an active series. The system cannot open the Study Info window until you close the series. This prevents you from accidentally leaving and closing the series before you have added all the required images to your series. **Solution:** Click Close Series now or complete all the images you need to acquire for your series and then return to the Study Browser and click Close Series. Then press Study Info.

B-Mode

Problem	Solution
Lack of penetration or sensitivity	▪ Ensure that there is adequate coupling medium (for example, ultrasound gel) between the transducer and the animal. ▪ Adjust the position of the TGC sliders. ▪ Increase the Transmit Power. ▪ Ensure the appropriate transducer is being used.

Related information

- *Transducer options* (page 20)

M-Mode

Problem	Solution
Lack of penetration or sensitivity	▪ Ensure that there is adequate coupling medium (for example, ultrasound gel) between the transducer and the animal. ▪ Adjust the position of the TGC sliders. ▪ Increase the Transmit Power. ▪ Ensure the appropriate transducer is being used.

PW Doppler Mode

Problem	Solution
Aliasing in the PW Doppler Mode acquisition	▪ Increase the Frequency. ▪ Decrease the Doppler Angle. ▪ Adjust the Baseline setting.
The PW Doppler signal is very small when the viewed flow is slow	▪ Decrease the Frequency setting.
Signal appears to be low intensity	▪ Adjust the Doppler Gain setting.
Signal exhibits saturation	▪ Lower the Doppler Gain setting.

Problem	Solution
Low frequency noise level in PW Doppler acquisition is high	▪ Increase the Wall Filter setting.
Noise appears in the image	▪ Adjust the Sample Volume size and position such that it includes tissue only.

3D-Mode

Problem	Solution
Can't initialize the motor	▪ Ensure that the cable for the 3D motor stage is connected to the rear panel. ▪ Ensure that the motor is positioned such that there are no objects obstructing the path of the transducer during initialization.
Expected data is not acquired	▪ Ensure the transducer is oriented correctly, with the transducer arm of the transducer moving perpendicular to the direction of travel of the 3D motor stage. ▪ Ensure that the Range and Step Size settings are adequate for acquiring the desired amount of data. ▪ If two transducers are connected, ensure that the active transducer is the one connected to the 3D motor stage. ▪ Ensure that the transducer is tightly connected to the port on the front of the cart.

Power Doppler Mode

Problem	Solution
Color bands in the image	▪ Enable Respiration Gating. ▪ Adjust Wall Filter setting. ▪ Adjust Scan Speed setting. ▪ Adjust the Priority settings.
Respiration artifacts in the image	▪ Enable Respiration Gating. ▪ Adjust Wall Filter setting. ▪ Adjust Sweep Speed setting.
Lack of sensitivity	▪ Ensure the anatomy being studied is in the focal zone for the transducer.

Problem	Solution
Lack of penetration or sensitivity	▪ Increase the Transmit Power. ▪ Ensure that there is adequate coupling medium (for example, ultrasound gel) between the transducer and the animal. ▪ Adjust the position of the TGC sliders. ▪ Ensure the appropriate transducer is being used.

Contrast Mode

Problem	Solution
Contrast Mode functions are not available	▪ Ensure that Contrast Mode is the active mode.
The green in the contrast overlay is not displayed where expected	▪ The reference data set should be one that doesn't have bubbles (created either before the contrast agent is injected or after a destroy function). The reference data set must be the darker data set (in other words, it should be the data with the least amount of material in the blood stream.)
The amount of green in the contrast overlay is too much or too little	▪ Ensure that the Contrast setting is appropriate before creating the reference loop. To do this, create a temporary reference loop, and process it against itself (i.e., against the same reference loop). There should be no green in the processed image. If there is, adjust the Contrast setting and repeat.

Physiological data

Problem	Solution
No ECG signal is displayed	▪ Ensure the ECG cable is connected to the physiological monitoring and control system, and the keyed end of the cable is connected to the front panel of the Vevo cart.
ECG signal appears flatlined	▪ Ensure that the ECG monitor is producing a strong, consistent signal.
ECG signal is poor	▪ Ensure that all of the animal’s limbs are secured to the ECG pads on animal platform. ▪ Ensure that no gel has leaked onto any of the contacts on the animal platform. ▪ Ensure that there is no 50/60 Hz noise source near the animal platform (for example a lamp or a power cable).

Problem	Solution
Blood pressure signal is not accurate	▪ Calibrate the blood pressure signal. ▪ Check hardware gain and blood pressure check box in Operator Preferences. ▪ Check positioning and operation of blood pressure catheter.

Measurements, annotations and calculations

Problem	Solution
Measurement tools are not available	▪ Ensure that the system is not acquiring data or playing a cine loop. ▪ Ensure that data is displayed in the mode window.
A calculated value is not displayed in the Value column for calculations	▪ Not all the measurements from which the calculation is derived have been made. Make the additional measurements so that the software may compute the calculation.
PV Loop calculations are not available	▪ The system might not have recorded a blood pressure signal. Ensure that a blood pressure source is connected to the animal.

Appendix C

Descriptions of control panel controls

This appendix lists all available controls in alphabetical order and describes the function of each control.

2D Gain

Adjusts the strength of the ultrasound signal when it returns to the face of the transducer. Range values for the control are specific to each individual transducer.

Turn clockwise to add gain and brighten your entire image. Turn counterclockwise to reduce gain and darken your image.

In M-Mode: Applies to the images in both the M-Mode window as well as the B-Mode scout window.

Active during: B-Mode, M-Mode, Contrast Mode, Color Doppler Mode and Power Doppler Mode.

3D

Activates 3D-Mode acquisition and opens the dialog box you use to set up the 3D motor stage and the transducer settings for the image slices that will create the 3D data.

Annotate

Opens the text annotation tool if the cursor is not enabled.

Back

Will remove or undo the last measurement point before you commit your measurement.

o+↑

Press and hold FN while you tap this Up arrow key to increase the keyboard backlighting brightness between the Off setting and a series of seven brightness levels.

o + ↓

Press and hold FN while you tap this Down arrow key to decrease the keyboard backlighting brightness between the the series of seven brightness levels and the Off setting.

Baseline

Adjusts the vertical position of the horizontal zero frequency line (the *baseline*) that divides the image data coming toward the transducer face from the image data moving away from the transducer face. Push up to raise the line. Pull down to lower the line.

Beam Angle

Helps you generate flow direction information when the orientation of your target vessel is perpendicular or almost perpendicular to your ultrasound beam.

This control applies a graduated series of transmission and reception delays to the ultrasound sound signals of each crystal in the transducer. These carefully calibrated sequences can effectively *steer* the ultrasound beam in order to detect minute frequency shifts.

In PW Doppler Mode and PW Tissue Doppler Mode, the current beam angle setting is displayed in the top-left corner of the B-Mode scout image.

In Power Doppler Mode and Color Doppler Mode, this changes the color box.

Active during Color Doppler Mode, Power Doppler Mode, PW Doppler Mode, PW Tissue Doppler Mode imaging sessions.

To use this rocker switch control:

Push up or pull down the control depending on the orientation of your transducer to steer the beam angle.

B-Mode

Activates B-Mode acquisition and begins displaying the acquired B-Mode data in the B-Mode window.

Burst

Transmits an ultrasound pulse at maximum setting. This destroys the contrast agent in the region of interest. In the cine loop the system displays a vertical green bar to mark the destruction event.

Cine Loop Review

Push-button dial.

- Press to toggle cine loop playback on/off.

- Turn to adjust playback speed or move from frame to frame when in pause mode.
- When you review M-Mode, PW Doppler Mode and PW Tissue Doppler Mode data, turn to increase or decrease the sweep speed of the Doppler data.

Cine Store

In B-Mode, **M-Mode, Contrast Mode, Color Doppler Mode and Power Doppler Mode**: Stores a set of sequential frames.

In PW Doppler Mode, PW Tissue Doppler Mode and M-Mode: Stores image data acquired over time.

In 3D-Mode: Stores 3D image data.

Close

Closes the active study or series.

Color

Activates Color Doppler Mode acquisition and begins displaying the color box overlay over the B-Mode background image.

Copy From

Copies studies from an external storage location into the Study Browser.

Copy To

Copies studies to an external storage location.

Cursor

Toggles the trackball function from the cine loop frame control to a standard cursor. When the cursor is toggled off, you can position an overlay. When the cursor on, the cursor is displayed but you cannot use the trackball. When you stop scanning in PW Doppler Mode or M-Mode and the cursor is off, you can move the trackball and scroll through the cine loop.

DEL

Deletes the selected item.

Depth Offset

Available during all acquisition sessions for all modes that are based on B-Mode or include a B-Mode scout window. Adjusts, in 1mm increments, the distance

from the face of the transducer at which the system begins to display the ultrasound image.

To use this rocker switch control:

- Pull down to remove a 1mm strip of image data from the top. For example, if your transducer is set to acquire data from 2mm to 12mm, when you pull the control down once, the display will only show the data between 3mm and 12mm. The minimum depth varies by transducer.
- Push up to add a 1mm strip of image data to the top.

Display Map

Cycles you through a predefined set of optimization maps that you can apply either while you are acquiring or reviewing image data.

Push up or pull down to cycle through the available maps for the active imaging mode.

Doppler Angle

Adjusts the angle correction in 5-degree increments between the vertical line of the ultrasound pulse from the face of the transducer and the direction of vascular flow in the sample volume in a PW Doppler Mode image acquisition session. The dashed yellow line indicates the direction of flow.

When the system receives the return signal, it applies an algorithm to the signal data to correct for the delta. This produces usable PW Doppler Mode data.

To use this dial control:

1. Turn the dial to align the dashed yellow line with the direction of the vascular flow in your sample volume region.

   The system always displays the value of the resulting angle as a positive value between 0 degrees and 80 degrees, regardless of which side of the vertical line you align the dashed line.

   For angles between 60 degrees and 80 degrees, the system applies the color blue to the dashed line. This indicates that the angle is too great to correct.

2. Reposition your transducer and/or the animal to bring the angle of the vessel as parallel as you can to the vertical yellow line that represents the transducer beam.

Doppler Gain

Adjusts the frequency shift in increments of 1.0 dB. Turn clockwise to add gain and brighten the Doppler data. Turn counterclockwise to reduce gain and darken the data.

Active during: PW Doppler Mode, PW Tissue Doppler Mode, Color Doppler Mode, Power Doppler Mode image acquisition sessions.

Dynamic Range

Adjusts the input signal strength that is mapped into the spectral display. Range: 5-100dB.

- Push up to increase the range by 5dB and lower contrast. Higher dynamic ranges are often used in cardiac imaging.
- Pull down to decrease the range by 5dB and increase contrast. Lower dynamic ranges are often used in abdominal imaging.

Active during: M-Mode, PW Doppler Mode, PW Tissue Doppler Mode, Power Doppler Mode image acquisition sessions.

ESC

Click to cancel an individual measurement, or store the measurements you have made during a measurement chain.

Export

Exports image frames, cine loops, DICOM images, reports and tables. Opens the Export window.

Focal Zones

This control adjusts the number and configuration of focal zones on your B-Mode based image.

Focal zones enhance the resolution across your image, while slightly reducing the acquisition frame rate. The system always displays at least one focal zone, and you can apply a maximum of two additional zones depending on the transducer. When you add focal zones the system maximizes the resolution for a larger area of your image, and reduces the acquisition frame rate.

To use this rocker switch control:

1. Push the rocker switch forward to cycle through the following focal zone application sequence:
   - Single zone
   - Two zones, narrow
   - Two zone, wide
   - Three zones, narrow
   - Three zones, wide

2. Pull the rocker switch back to cycle back through the focal zone options in reverse.

Focus Depth

Adjusts the depth of the B-Mode focal zone or focal zones on your image. When you have more than one focal zone this control moves the depth of all the focal zones as a group. Push up to decrease the depth. Pull down to increase.

Frame Rate

Adjusts the acquisition frame rate. Turn clockwise to increase the frame rate. Turn counterclockwise to lower the frame rate.

- In Contrast Mode you can select Low, Medium, High, Max
- In PW Doppler Mode and PW Tissue Doppler Mode at high pulse rate frequencies in the dual mode window view, use the control to increase or decrease the refresh rate for the B-Mode scout window

Active during: Contrast Mode, PW Doppler Mode and PW Tissue Doppler Mode image acquisition sessions.

Frame Store

Stores a snapshot of all the content in the visible frame in the ultrasound image area.

In M-Mode, PW Doppler Mode and PW Tissue Doppler Mode, stores the complete cine loop.

Frequency

Adjusts the transmit frequency of the transducer between the higher and lower frequency levels that are supported by the specific transducer. When you increase the frequency you can improve detail at the focus depth but the system tends to lose detail at deeper tissues.

Push forward to increase the frequency. Pull back to decrease the frequency.

Help

Opens the Help system for the Vevo 2100 Imaging System.

Image Depth

Adjusts how deep in *mm* you want to display the ultrasound signal. Pull down to increase the depth. Push up to decrease the depth. The available depth is transducer dependent.

Image Label

In the Study Browser: Adds a name to the image that is currently selected in the list.

In a Mode window: Stores the current image and adds the name that you type in the box if the **Auto SAVE on Image Label** option is selected in the General tab of the Preferences window.

Image Process

Provides additional pre- and post-processing options for the active imaging Mode. **Note:** Not supported in the current release.

Image Sequence

Image Sequence

In Contrast Mode this control starts a sequence of configurable events. When you press the control:

1. The system begins to store image data for the predefined number of frames in the cine loop, as configured in the **Contrast Mode** preferences (page 74) section of the **General** tab in the **Preferences** window.
2. The destruction burst event (page 407) runs automatically:
   - Using a) the transducer that you connect to the front panel of the Vevo 2100 Imaging System, or using b) the *external* Vevo SoniGene transducer that you connect to the **Parallel** port on the rear panel of the cart
   - At a predefined percentage point of the entire pretrigger cine loop length
   - For a predefined period in tenths of seconds between 0.1 and 1.0 seconds (defaults to 0.5)
3. The system continues to acquire image data for the remainder of the predefined cine loop size, but the image is not automatically stored when the loop is completed unless you select **Auto SAVE on Scan Completion** for **Contrast Mode** in the **General** tab of the **Preferences** window.

To configure the control for Contrast Mode:

- In the **Cine Loop Size** section (page 71) of the **General** tab in the **Preferences** window configure the size of the cine loop.
- In the Contrast Mode preferences section (page 74) of the **General** tab in the **Preferences** window configure the parameters for the destruction sequence.

Image Width

Adjusts the physical width of the area the transducer is imaging. Push up to increase the width. Pull down to decrease the width.

Tip: The closer you can reasonably narrow the width of your image around your target structure, the higher the system sets the acquisition frame rate. This is especially helpful when you are studying cardiac tissue movement.

Invert

Flips the image.

- **In B-Mode**: Press to flip the image left/right.
- **In M-Mode**: In the dual window view, press to flip the B-Mode scout image left/right.
- **In PW Doppler Mode** and **PW Tissue Doppler Mode in the dual window view**: Press to flip the spectrum window vertically.
- **In Color Doppler Mode**: Press to flip the image left/right.
- **In Power Doppler Mode**: Press to flip the image left/right.
- **In Contrast Mode**: Press to flip the image left/right.

Active during: Image acquisition and review sessions in all imaging Modes except 3D-Mode.

L/R Screen

Toggles focus from left to right screen when in split screen mode.

Line Density

Adjusts the resolution of your image by adjusting how many lines of image data the transducer acquires over your image area. Push up to increase the line density. Pull down to decrease.

The higher you set your line density, the lower the system sets the acquisition frame rate. Because of this trade off, you might find that higher line density is most useful for examining features in tissues that don't move very much such as liver, spleen, pancreas, and prostrate.

For cardiology applications, you will tend to keep the line density lower so you can increase the frame rate to measure more tissue movements over the time span of a complete cardiac cycle.

Measure

When in a Mode window, activates the measurement panel.

M-Mode

Activates M-Mode image acquisition.

To use this key control:

1. Press to begin displaying the M-Mode sample volume overlay on the full-window B-Mode acquisition data.
2. Press M-Mode again (or press Update) to display the live M-Mode data in the lower window and the live B-Mode data with the sample volume overlay data in the scout window.

Mode Settings

When in a Mode window, activates the mode settings panel.

New

When you are in the Study Browser, opens the New dialog box so you can create a new study or a new series.

Persist

Applies a pixel averaging algorithm to the most recently acquired frames to produce a more uniform view of the faster moving areas in the image data.

To use this rocker switch control:

Push up or down to cycle through the persistence levels. In the bottom-left corner of the screen the status bar briefly displays the name of the persistence label as you select.

Active during: All image acquisition sessions except 3D-Mode.

In B-Mode: Reduces distracting artifacting such as shimmering effects. Levels: Off, Low, Med, High. This is most useful when you are imaging uniform tissues such as the liver, kidney and prostate.

In M-Mode: In the dual window view, applies only to the M-Mode image data window. It does not apply persistence to the B-Mode scout window. To change the persistence on your B-Mode image, press Update to view the full B-Mode image, apply the appropriate persistence level, and then press Update again to return to M-Mode. The updated persistence applies to the image in your B-Mode scout window.

In Color Doppler Mode and Power Doppler Mode: Applies to the color signal data only. It does not apply to the B-Mode background data. Levels: Off, Low, Med, High, Max. Helpful when you are studying abdominal organ tissue such as liver, kidney and pancreas.

In Contrast Mode: Sets the process persistence filter level. Levels: None, MIP.

Physio Settings

When in a Mode window, activates the physiological settings panel.

Power

Activates Power Doppler Mode acquisition and begins displaying the power box overlay over the B-Mode background image.

Pre Trigger

In Contrast Mode, starts an analysis based on the number of frames defined in the General tab of the Preferences window.

Stores cine loop data for a predefined number of image frames acquired *after* you press the control, as compared to Cine Store which stores data acquired *before* you press the control. To ensure that the system stores your cine loop, select the **Auto SAVE at Scan Completion** option in the General tab of the Preferences window.

In B-Mode, Color Mode, Power Doppler Mode, Contrast Mode: You define the pretrigger's cine loop size in the **Cine Loop Size** section (page 71) of the **General** tab in the **Preferences** window.

Presets

Active during image acquisition in all modes except 3D-Mode. This rocker switch cycles you through all the preset groups of acquisition parameters for the active imaging Mode. The list of presets include the transducer-specific presets as well as any custom presets that other operators added to the system.

All presets are both mode dependent, transducer dependent and application dependent.

Priority

Determines the threshold point on the gray scale above which the system does not apply color data. The red marker along the left side of the gray scale indicates the threshold point.

Push up to assign more priority to the color data. Pull down to assign less priority to the color data and more priority to the threshold on the B-Mode grayscale bar.

Useful when you suspect, for example, that color data is covering over the actual contour of a vessel wall. In this case you would lower the priority until the overlay data matches the actual tissue contour and properties.

PW

Activates PW Doppler Mode acquisition. Press to begin displaying the yellow PW Doppler Mode sample volume, press Update to display the live PW Doppler Mode spectral data in the lower window and the live B-Mode data in the scout window, then press Simul.

Report

Displays the Measurement/Analysis report page for the selected studies or series.

Save Preset

Opens the Save Preset Settings dialog box so you can label and save the current image acquisition parameters as a single preset in the current imaging mode.

Scan/Freeze

During image acquisition, toggles between acquiring image data and freezing the acquisition. When you freeze the acquisition the system stores cine loop data if you select **Auto SAVE on Image Label** in the General tab of the Preferences window.

During image analysis, starts and stops data playback.

Screen Keys

Push dial control to cycle through options for the current imaging mode.

In B-Mode: Toggles the needle guide display on and off during an injection imaging session.

In Color Doppler Mode, Power Doppler Mode, Contrast Mode: Cycles through three image states: Overlay + B-Mode, B-Mode only, overlay only.

Select

This control is the equivalent of the left button on a computer mouse. When a procedure in this documentation directs you to *click*, press this control.

> **Note:** When the manual directs you to right-click, press Update.

Sensitivity

Adjusts the signal-to-noise ratio so that you can:

- Better identify weak-signal targets in the near field that are difficult to distinguish because they are very small
- Better identify large targets in the far field that are difficult to distinguish because the signal is so attenuated at depth.

The higher you set the sensitivity level, the lower the system sets the frame rate. Push up to increase sensitivity. Pull down to decrease.

Simul

This toggle control sets the system to acquire live data simultaneously in both the B-Mode scout window as well as the PW Doppler image window.

In the dual window view, use this feature when you want to adjust your sample volume in the B-Mode scout window while you view the waveform data in the PW Doppler Mode window.

To use this toggle control:

1. Press to activate the simultaneous state.

   A black vertical strip scans across the spectrum from left to right.

2. To eliminate this striping, press the toggle again to freeze the scout window and return to PW Doppler image data only.

Active during: M-Mode, PW Doppler Mode and PW Tissue Doppler Mode image acquisition sessions.

Split Screen

During analysis in a Mode window, toggles between full screen and vertical split screen. In split-screen display, you can acquire data in one of the two screens.

Study Info

In the Study Browser: Opens the Study Info window for the selected study.

In a Mode window: Opens the Study Info window for the displayed image.

Study Management

Opens the Study Browser window.

SV/Gate

Push up to increase. Pull back to decrease.

In M-Mode: This control adjusts the size of the sample *gate*, measured in *mm*. The control adjusts the distance of the vertical line between the two yellow calipers.

In the dual window view, the system displays the M-Mode sample gate image data. Current data is on the right side, trailing data extends to the left.

In PW Doppler Mode: This control adjusts the distance in *mm* of the vertical line between the two yellow calipers of the *sample volume*.

In the dual window view, the system displays the spectral data that the system acquires along this line. Current data is on the right side, trailing data extends to the left.

In Power Doppler Mode and Color Doppler Mode: Adjusts the size of the gate, indexed in a range from 1-6.

- Set your gate to 1 for the best axial resolution. This is optimal for identifying very small vessels.
- Set your gate to 6 for the best sensitivity. This is optimal for studying deep vessels such as an abdominal aorta.

Active during: Color Doppler Mode and Power Doppler Mode image acquisition sessions. In M-Mode and PW Doppler Mode, the control is active in the full-screen B-Mode window after you select the Mode.

Sweep Speed

Adjusts the cine loop playback speed parameter so that you can stretch out or compress the cine loop data in the review window. Push up to increase the speed and compress the cine loop image. Pull down to decrease the speed and expand the cine loop image.

When you are reviewing the cine loop you can also use the Cine Loop Review control to adjust the sweep speed.

In M-Mode: Set the sweep speed parameter in a range from 200 Hz to 4000 Hz in increments of 100 Hz. The system displays the updated values in the status bar in the lower left area of the screen.

In cardiac applications you might want to decrease the M-Mode sweep speed so you can view more wall movements over more cardiac cycles in the window, or increase the speed so you can view more wall detail over one cycle.

In PW Doppler Mode and **PW Tissue Doppler Mode**: Set the sweep speed parameter in a range from 0.25 seconds at 4000 Hz to 5.1 seconds at 200 Hz. In

some cases, if your imaging window is large and the Velocity is set high, the minimum speed may be greater. The system displays the updated values in the status bar in the lower left area of the screen.

Active during: M-Mode, PW Doppler Mode and PW Tissue Doppler Mode image acquisition and review sessions.

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Time gain compensation controls. During image acquisition in any B-Mode based imaging mode, each slider adjusts the ultrasound signal to compensate for minor attenuation as it returns through deeper situated tissue. Each slider adjusts the return signal across a specific depth band. The top slider adjusts the return signal across the area closest to the probe face. The bottom slider adjusts the return signal across the area furthest from the probe face. Push the slider to the right to boost the signal and brighten the image data in that horizontal band, and left to attenuate the signal and darken that band.

Tissue

During a PW Doppler Mode image acquisition, activates PW Tissue Doppler Mode image acquisition.

Transmit Power

Adjusts the power of the ultrasound signal transmission.

Turn clockwise to increase power. Turn counterclockwise to decrease power. Between 1% and 10% power the control adjusts power in increments of 1%. Between 10% to 100% power the control adjusts in increments of 10%.

Update

Function 1: display control

Alternates the display from the dual view (B-Mode scout window on top, Mode image window on the bottom) to the B-Mode image plus overlay so you can position your sample gate (in M-Mode) or sample volume (in PW Doppler Mode) more precisely.

To use this toggle control:

1. Press to view the dual view.
2. Press again to display the B-Mode window and overlay.

Function 2: right-click button

When the manual directs you to right-click, press Update.

Velocity

Adjusts the PRF (pulse repetition frequency). The higher you set the PRF, the lower the signal resolution.

In PW Doppler Mode: Adjust the range of the scale of the Y axis on the Power Doppler Mode image window by adjusting the pulse rate frequency of the ultrasound signal. Use this control when the spectral waveform is either too compressed or too expanded for your purposes.

> **Note:** In the General tab of the Preferences window you can set the **PW Doppler Scale** (Y axis) to display either velocity or frequency.

Turn the dial clockwise to compress the waveform by increasing the range of the scale. Turn counterclockwise to expand the waveform by decreasing the range of the scale.

Volume

Adjusts the speaker volume for the PW Doppler Mode and PW Tissue Doppler Mode audio data that the system acquires along with the spectral data.

To use this dial control:

- Turn clockwise to increase the volume.
- Turn counterclockwise to decrease the volume.

Active during: PW Doppler Mode and PW Tissue Doppler Mode image acquisition and review sessions.

Wall Filter

Filters out signals that correspond to low velocity axial motion. Typically these include vessel wall movement, cardiac wall movement and tissue movement caused by respiration. Push up to filter out more. Pull down to filter out less.

In PW Doppler Mode: Use this control to filter out the display of low velocity signal artifacting that appears as a horizontal black band along either side of the white baseline. Push up to reduce the lower velocity signals and bring the waveform of the spectral data closer to the baseline. Pull down to display more low velocity signals.

In Color Doppler Mode and Power Doppler Mode: Set as low as you can so that you don't lose any flow, but higher than any motion that creates low frequency artifacting.

Zoom

Activates a customizable blue zoom box overlay and magnifies the image data inside that box.

To use this three-stage toggle control:

1. Press Zoom to activate the control and display the blue zoom box overlay.
2. Modify the proportion of the zoom box.
   a. Press Update. The system changes the box to a dashed-line box.
   b. Trackball left/right and up/down to change the width and height of the zoom box.
   c. Press Update to reapply the box.
3. Trackball to position the zoom box.
4. Press Zoom when you are satisfied with the proportion and position of your zoom box.

   The system crops out all data outside the zoom box and applies a 2x magnification to the data inside the box.
5. Press Zoom to zoom out to the original image area.

Active during: B-Mode, Color Doppler Mode, Power Doppler Mode image acquisition sessions. Available in M-Mode, PW Doppler Mode, PW Tissue Doppler Mode only when you are only displaying the B-Mode image and sample volume or gate overlay.

Appendix D

Options and accessories

This appendix lists the available options and accessories for the Vevo 2100 Imaging System.

MicroScan transducers

Item	Part number
MS-200: 15MHz MicroScan transducer ▪ Broadband Frequency: 9 MHz - 18 MHz ▪ Applications: Rabbit, general and abdominal imaging	VS-11956
MS-250: 20 MHz MicroScan transducer ▪ Broadband Frequency: 13 MHz - 24 MHz ▪ Applications: Rat cardiology and abdominal imaging	VS-11957
MS-400: 30 MHz MicroScan transducer ▪ Broadband Frequency: 18 MHz - 38 MHz ▪ Applications: Optimized for Mouse Cardiovascular imaging with frame rates greater than 300 frames per second	VS-11959
MS-550D: 40 MHz MicroScan transducer ▪ Broadband Frequency: 22 MHz - 55 MHz ▪ Applications: Mouse cancer and abdominal imaging	VS-11960
MS-550S: 45 MHz MicroScan transducer ▪ Broadband Frequency: 32 MHz - 56 MHz ▪ Applications: Optimized for mouse embryology imaging and injection	VS-11961

Imaging and analysis software options

Item	Part number
ECG-Triggered - Respiration Gated Analysis	VS-11954
M-Mode	VS-11948
PW Doppler Mode	VS-11949
PW Tissue Doppler Mode	VS-11950
Color Doppler Mode	VS-11951
Power Doppler Mode	VS-11952
3D Mode	VS-11484
Contrast Imaging Functionality	VS-11953
LV Analysis	VS-11955
VevoStrain™ Analysis	VS-11846

Vevo 2100 Workstation Software	VS-11962
Vevo 2100 Workstation System	VS-11963

MicroMarker™ contrast agent and cannulation kits

Item	Part number
Vevo MicroMarker™ Non-Targeted Contrast Agent Kit	VS-11694
Vevo MicroMarker™ Target-Ready Contrast Agent Kit	VS-11675
Vevo MicroMarker™ DEPO™ Contrast Agent Kit	VS-11676
MicroMarker™ VA (Vascular Access) Cannulation Kit (1-pack)	VS -11720
MicroMarker™ VA (Vascular Access) Cannulation Kit (3-pack)	VS -11721
MicroMarker™ TVA (Tail Vein Access) Cannulation Kit	VS-11848
Tail Vein Catheters	VS-11912

Imaging stations and image-guided injection components

Item	Part number
Vevo 2100 Imaging Station 1	SA-11982
Vevo 2100 Imaging Station 2	SA-11983
Mouse Handling Table	SA-11436
Rat Handling Table	SA-11550
Advanced Physiological Monitoring Unit (TMH 150)	SA-11426
Imaging Station Extension with Injection Mount	SA-11934
Vevo Embryo Injection Expansion Set	SA-11852
Vevo SoniGene™ System	SA-11820
Vevo Replacement Injection Unit	SA-11315
Vevo Ball Joint Unit -Short	SA-11179
Vevo Ball Joint - Tall and Quick-Lift Unit	SA-11278
Universal Rotating RMV Clamp for Rail System	SA-11801
Universal Power Supply Kit (120V)	SA-11208
Universal Power Supply Kit (230V)	SA-11209
Replacement Rectal Temperature Probe	SA-11271
Vevo 2100 Imaging Starter Kit	SA-10907
Image-Guided Injection Starter Kit	SA-11059
10-Pack Glass Pulled Capillaries	SA-11052
Glass Capillary Tubes (3.5” long, unfinished)	SA-11454
10-Pack High Wall Petri Dish	SA-11213
10-Pack Low Wall Petri Dish	SA-11620
Membranes (1pk = 50 pcs)	SA-11054
Membrane tape (1 pk = 50 pcs)	SA-11053
Thermasonic Gel Warmer (110V)	SA-10749

Thermasonic Gel Warmer (230V)	SA-10750
Low Viscosity Ecogel (1 pk = 6 x 250mL)	SA-11621
High Viscosity Aquasonic Gel (1 pk = 6 x 250mL)	SA-11622
ECG Sigma Gel - Electrode gel (60g)	SA-10740
Nair Hair Remover Cream	SA-10747
Aquagel Lubricant	SA-10738
T-Spray	SA-10748

Power cords and plugs

Item	Part number
Mains AC Power Cord – North America	SA-11233
Mains AC Power Cord - Australia/New Zealand	SA-11234
Mains AC Power Cord - Japan	SA-11235
Mains AC Power Cord - Israel	SA-11236
Mains AC Power Cord - Continental Europe	SA-11237
Mains AC Power Cord - Italy	SA-11238
Mains AC Power Cord - UK/Ireland	SA-11239
Mains AC Power Cord - Switzerland	SA-11240
Mains AC Power Cord - Denmark	SA-11241
Mains AC Power Cord - China	SA-11242
Mains AC Power Cord - Argentina	SA-11243
Mains AC Power Cord - India/South Africa	SA-11244
Plug - Australia/New Zealand	SA-10759
Plug - Japan	SA-10760
Plug - Israel	SA-10761
Plug - Italy	SA-10763
Plug - UK/Ireland	SA-10764
Plug - Switzerland	SA-10765
Plug - Denmark	SA-10766
Plug - China	SA-10767
Plug - France/Belgium	SA-10768
Plug - Argentina	SA-10769
Plug - India/South Africa	SA-10770

Vevo anesthesia systems and accessories - oxygen and Medical Air

Item	Part number
Vevo Compact Dual Anesthesia System (Tabletop Version)	SA-12055
New orders must be shipped with 2 regulators of O2 and MA types	

Vevo Compact Dual Anesthesia System (Mobile Version) New orders must be shipped with 2 regulators of O2 and MA types	SA-12056
Vevo Compact Medical Air Anesthesia System Conversion Kit (Tabletop Version)	SA-11829
Vevo Compact Medical Air Anesthesia System Conversion Kit (Mobile Version)	SA-11922
“H” Type Regulator	SA-10414
“E” Type Regulator	SA-10415
“H” Type Medical Air Regulator	SA-11830
“E” Type Medical Air Regulator	SA-11831
Single Yoke Assembly/Regulator	SA-11408
Single Yoke Medical Air Assembly/Regulator	SA-11921
Dual Procedure Anesthesia Circuit	SA-11508
9 mm Bain Circuit (for Mouse Anesthesia)	SA-11486
12.5 mm Bain Circuit (for Rat Anesthesia)	SA-11301
14 mm Bain Circuit (for Rat Anesthesia)	SA-11302
10’ (3m) Oxygen Hose D.I.S.S. x D.I.S.S. - Green (NA) (931530)	SA-11795
10’ (3m) Oxygen ISO D.I.S.S. Female –Male Hose Assembly (Japanese)	SA-11303
10’ (3m) Oxygen ISO D.I.S.S. Female –Female Hose Assembly (Australian)	SA-11304
10’ (3m) Oxygen ISO D.I.S.S. Female –Male Hose Assembly (German)	SA-11305
10’ (3m) Oxygen ISO D.I.S.S. Female – D.I.S.S Female Hose Assembly	SA-11306
10’ (3m) Oxygen ISO D.I.S.S. Female – N.I.S.T Female Hose Assembly	SA-11307
10’ (3m) Oxygen ISO D.I.S.S. Female – Male Hose Assembly (British)	SA-11308
10’ (3m) Oxygen ISO D.I.S.S. Female – Drager Din	SA-11309
10’ (3m) Oxygen ISO D.I.S.S. Female – Afnor Male Hose Assembly (French)	SA-11310
10’ (3m) Hose Assembly ISO Air DF – Afnor Male Hose Assembly (French)	SA-11923
10’ (3m) Hose Assembly ISO Air DF –Male Hose Assembly (German)	SA-11924
10’ (3m) Hose Assembly ISO Air DF –Female Hose Assembly (Scandinavian)	SA-11925
10’ (3m) Hose Assembly ISO Air DF – Male Hose Assembly (British)	SA-11926
10’ (3m) Hose Assembly ISO Air DF –Male Hose Assembly (Japanese/Korean)	SA-11927
10’ (3m) Hose Assembly ISO Air DF – N.I.S.T Female Hose Assembly (European)	SA-11928
10’ (3m) Hose Assembly ISO Air DF –Female Hose Assembly (Australian)	SA-11929
10’ (3m) Hose Assembly ISO Air DF – Drager Din (Italy)	SA-11930

User training

Item	**Part number**
Introductory 2-Day On-Site User Training	VS-INTUSRTRAIN
On-Site 1-Day User Training	VS-ADDUSRTRAIN

2-Day On-Site MicroMarker™ Training	VS-2D-MMTRAIN
1-Day On-Site MicroMarker™ Training	VS-1D-MMTRAIN
Additional 1-Day of On-Site User Training	VS-ADD-1DTRAIN
Customized 2-Day In Vivo User Training (Toronto)	VS-INVIVOTRAIN
2-Day In Vivo Workshop (Toronto)	VS-2D-WSHOP
1-Day In Vivo Workshop (Toronto)	VS-1D-WSHOP
2-Day In Vivo Imaging Workshop (Amsterdam)	VS-2D-WSHOP-EU
1-Day In Vivo Imaging Workshop (Amsterdam)	VS-1D-WSHOP-EU

Supplier

VisualSonics Inc. is the supplier for all the items that are listed in this appendix.

VisualSonics Inc.
3080 Yonge Street, Suite 6100, Box 66
Toronto, Ontario CANADA M4N 3N1

Tel: +1 (416) 484-5000
Toll Free: 1-866-416-4636 (North America)
Fax: +1 (416) 484-5001

www.visualsonics.com

Appendix E

Product safety testing and electrical testing

VisualSonics products tested

Vevo 2100 Imaging System

VisualSonics MicroScan transducers: MS-200, MS-250, MS-400, MS-550D, MS-550S

Tested to the following standards

CISPR 11:1997/EN 55011:1998, CLASS A, GROUP 1 - Limits and methods of measurements of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment.

EN 61326:1997 + A1:1998 + A2:2001 (IEC 61326:2002) - Electrical equipment for measurement, control and laboratory use - electromagnetic compatibility.

CAN/CSA C22.2 No. 61010-1-04; µL Std No. 61010-1; EN 61010-1:2001

Test laboratories

Global Advantage International Inc.

180 Brodie Drive, Unit 2

Richmond Hill, Ontario, Canada, L4B 3K8

Send any questions to

Product Safety and Testing

Quality Assurance and Regulatory Affairs

VisualSonics Inc.

3080 Yonge Street, Suite 6100, Box 66

Toronto, Ontario, Canada, M4N 3N1

Tel: +1 (416) 484-5000

Toll-Free: 1-866-416-4636 (North America)

Fax: +1 (416) 484-5001

E-mail: productsafety@visualsonics.com

Authorized representative

Europe

Atlantic Bridge Limited

Zenith House 11 the Street Chirton Devizes Wiltshire SN10 3QS UK

Tel: +44(0) 1380.848170

Contact: Mr. David Baker

E-mail: david.baker@atlanticbridge.co.uk

Appendix F

Safety

Please read the safety information before using the Vevo 2100 Imaging System. The following information applies to the Vevo 2100 Imaging System and supporting equipment.

The use of this equipment is intended for qualified research scientists.

Read all warnings and cautionary notes carefully before you use this equipment.

IMPORTANT: If you operate the Vevo 2100 Imaging System products in a manner not specified in this operator manual you void the terms of the product warranty.

Warnings

WARNING: THIS EQUIPMENT IS NOT APPROVED FOR USE ON HUMANS.

The Vevo 2100 Imaging System has been designed and tested for use on laboratory research animals. This equipment must not be used on any living human being.

WARNING: Where available, always use the lowest power settings necessary to obtain diagnostically acceptable images.

High levels of transmitted ultrasound energy can damage tissue. Never tamper with or alter the Vevo 2100 Imaging System in any way such that the acoustic power level is increased.

WARNING: Use ONLY VisualSonics transducers with the Vevo 2100 Imaging System. The use of other transducers may affect safety and system performance.

Electric shock hazards

WARNING: Before connecting the Vevo 2100 to the mains, verify that the specified voltage on the rear panel matches the power source voltage.

An incorrect power source voltage could cause an electrical hazard and could cause serious damage to the equipment.

WARNING: Before connecting the Vevo 2100 to the mains, always check that the mains cable is undamaged.

WARNING: Do not remove any panels from the Vevo 2100 Imaging System. Do not remove the outer transducer housing.

Service to the system is to be performed by qualified personnel only, with the exception of servicing the air filters. No operator-serviceable parts are located inside the system.

Any internal adjustments, replacements or modifications to the Vevo 2100 Imaging System electronics or to the transducers should be made only by qualified VisualSonics Technical Support Representatives.

WARNING: If the system is not properly grounded or earthed, it becomes a possible electrical shock hazard. Protection against electrical shock has been provided through an isolation transformer and chassis grounding via a plug to an appropriate power source.

DO NOT remove the ground wires from any part of the Vevo 2100 Imaging System for any reason.

WARNING: Ensure that all power sources, whether a UPC or a wall outlet, are properly grounded or earthed.

WARNING: Disconnect the system from the power source before cleaning the system or performing any maintenance operations.

WARNING: Connection of devices not authorized by VisualSonics to the Vevo 2100 Imaging System isolation transformer could result in an electrical hazard.

WARNING: If any part of the Vevo 2100 Imaging System is in contact with hazardous chemicals or biological materials, appropriate precautions must be taken by all who come into contact with the Vevo 2100 Imaging System until the device is declared completely free of harmful contamination.

WARNING: The Vevo 2100 Imaging System is both delicate and heavy.

Careless moving and rough handling can damage the system and cause injury to others (e.g., rolling over feet, colliding with people or walls). Never use the system if there is damage to the cart, cables or accessories.

WARNING: Do not immerse the transducer in coupling medium beyond the lowest ring on the transducer housing.

The housing of the transducer is not watertight. If the transducer is immersed beyond the lowest ring on the transducer housing, the electrical safety features may be compromised.

WARNING: DO NOT spray or drip any liquid into the system or onto the keyboard, as this could affect reliable operation and electrical safety.

Electromagnetic interference

WARNING: The Vevo 2100 Imaging System should never be used where patient safety could be affected by the malfunction of medical devices.

The Vevo 2100 Imaging System is designed for use in preclinical laboratories and is not cleared for use with or in the vicinity of active medical devices. High levels of electromagnetic energy may interfere with the operation of the Vevo 2100 Imaging System. Furthermore, the Vevo 2100 Imaging System could affect the safe operation of sensitive medical devices.

Cautionary notes

This operator manual includes a broad range of cautionary notes.

Safety symbols used in this manual

The following table lists the safety symbols used in this manual.

Symbol	Publication	Description
	IEC 60417 - 5031	Alternating current
	IEC 60417 - 5017	Earth (ground) terminal
	IEC 60417 - 5019	Protective earth (ground)
	IEC 60417 - 5007	On (supply)
	IEC 60417 - 5008	Off (supply)
	ISO 7000 - 0434	Attention, consult accompanying documents

Physical hazards

CAUTION: Watch out for strained and twisted cables.

Some of the optional accessories have long cables. Take care when working around the cables.

CAUTION: VisualSonics recommends that the Vevo 2100 Imaging System be pushed by one person from behind and guided by another person in front, using the grab bars. Please use caution when going up or down ramps. Keep the system upright during transport.

Ensure that the castors are locked when the Vevo 2100 Imaging System is not being transported.

Never lift the system using the grab bars.

Magnetic field sensitivity

CAUTION: DO NOT station the Vevo 2100 Imaging System close to large clinical magnets as the magnetic fields may affect the performance of the Vevo system and cause distortion in the acquired image.

Labeling and verification

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference; and
- This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the operator will be required to correct the interference at his own expense.

WARNING: Changes or modifications not expressly approved by VisualSonics could void the operator's authority to operate the equipment.

Appendix G

Specifications

Environmental specifications

The Vevo 2100 Imaging System operating environment should be free of fumes, dirt, and electrical interference.

Specification	Value
Temperature	10º to 40º C (50º to 104º F)
Relative humidity	15% to 80% non-condensing
Altitude	Up to 2000m

System dimensions

Dimension	Value
Height (without monitor)	112 cm (44 in.)
Height (with monitor)	155 cm (61 in.)
Width	71 cm (28 in.)
Depth	101 cm (39.5 in.)
Weight	170kg (375 lb.)

Ensure that sufficient clearance is available around the system for adequate airflow and cooling. Do not block the air vents or air filters.

Electrical specifications

VisualSonics manufactures systems that operate with AC line voltages of 100V, 120V, and 240V. The electrical configuration of the system is noted on the system nameplate.

- 100V~, 50/60Hz, 5A
- 120V~, 50/60Hz, 5A
- 240V~, 50/60Hz, 2.5A

For optimal system performance, use a dedicated, interference-free, isolated, grounded/earthed wall outlet.

WARNING: Before having the system installed, ensure that the electrical service in the facility is adequate.

Do not modify the attachment plug or use an adapter. Doing so may cause an electrical hazard.

Appendix H

Technical support and user maintenance

This appendix details the technical support and user maintenance information.

Service provided by VisualSonics

If problems arise with the Vevo 2100 Imaging System, VisualSonics will ensure that the system remains operational, with minimal downtime.

When such problems occur, please contact the VisualSonics Technical Support department so that a Technical Support representative can assess and resolve the problem:

In North America

- Phone: 1-416-484-5000
- Fax: 1-416-484-5001
- Toll-Free: 1-866-416-4636
- E-mail: support@visualsonics.com

In Europe

- Phone: +31 (0) 20 751 2020
- Fax: +31 (0) 20 751 2021
- Toll-Free: +800 0751 2020
- E-mail: support@visualsonics.com

For minor problems, the Technical Support representative can help you troubleshoot the situation by phone or by e-mail. For more complex problems, VisualSonics may:

- Send a Technical Support representative to the location to evaluate the problem
- Request that the equipment be transported to the VisualSonics Service department

Maintaining the Vevo 2100 Imaging System

The Vevo 2100 Imaging System requires proper care and cleaning. Improper system care voids the warranty or the service contract.

Move the system carefully. Be especially alert when you move the system along inclined passages.

Moving the system

Use the following precautions when you move the system:

- Turn the system off and disconnect the power cord and any other cords. Secure loose cables using the cable holder beneath the keyboard shelf.
- Disconnect the transducers and store them in the provided cases.
- Unlock the castors.
- Use the grab bars to move the system.
- Do not use the grab bars to lift the system.
- Do not allow the system to strike walls or door frames.
- Use care when moving the system off ramps or elevators.
- Lock the castors when the system is to remain stationary.

CAUTION: Care should also be taken when handling heavy items, as it is easy to crush limbs when lifting or moving them.

Cleaning the system

To clean the Vevo 2100 Imaging System:

1. Turn the system off and unplug it from the power outlet.
2. Clean the system cart, the integrated keyboard/trackball, and the monitor with a damp cloth soaked in mild soap and water.

CAUTION: DO NOT spray or drip any liquid into the system or onto the keyboard.

To clean the trackball if it rolls roughly:

1. With the tip of a pen turn the trackball housing ring counterclockwise.
2. Remove the ring, remove the ball, and then wipe it with a damp cloth.

3. Replace the ball and the housing ring.

To disinfect the system:

Use Sporicidin wipes.

Maintaining the MicroScan transducer

The MicroScan transducer is the most delicate component of the Vevo 2100 Imaging System. Use care when handling the transducer. Proper handling maintains the high quality performance of the transducer in addition to extending the working lifetime of the transducer and the transducer.

WARNING: High levels of ultrasound energy can damage tissue. Do not touch the transducer when acoustic power could be generated. Always switch off the Vevo 2100 before attempting any cleaning or replacing the transducer.

Cleaning the transducer

After every imaging session, gently wipe down the transducer with a soft cloth and isopropyl alcohol or use Sporacidin wipes.

Storing the transducer

The transducer may be stored in the holder attached to the sides of the Vevo 2100 Imaging System.

Place the transducer into one of the holders with the nose pointing upward. Always ensure that the cable is not twisted when storing the transducer.

Always use the provided case to transport the transducer from one site to another.

Follow these guidelines when you store the transducer in the provided case:

- Make sure that the transducer is clean and dry before you place it in the case.
- Place the transducer in the case carefully to prevent kinking of the cable.
- Avoid storing the transducer in areas of extreme temperatures or in direct sunlight.
- Store the transducer separately from other instruments to avoid inadvertent damage.

Disposal

The equipment owner is required to ensure that environmental and health and safety regulations are met when disposing of this equipment.

Because the Vevo 2100 Imaging System includes components that may contain substances that could be harmful, particular care should be taken to meet the current regulations for the disposal of hazardous substances.

The following substances within the Vevo 2100 Imaging System are potential health hazards:

Substance	Location in Vevo 2100 Imaging System	Indication of Quantity
Lead (Pb)	Soldered joints	Very small quantities
Lithium Ion	Back-up battery in computer	Very small quantities
Mercury	LCD monitor	Very small quantities

These substances are only capable of being released when the component or the whole assembly is being disposed of.

Should there be any queries about any of the substances within the Vevo 2100 Imaging System, please contact VisualSonics.

Cleaning the air filters

The Vevo 2100 Imaging System includes three air filters. One is situated on the rear panel, the other two are are situated at bottom of the front and back of the cart.

VisualSonics recommends that you clean the air filters every three months. If an air filter has been torn, it should be replaced. Contact a VisualSonics Technical Support Representative (support@visualsonics.com).

Cleaning the rear panel air filter

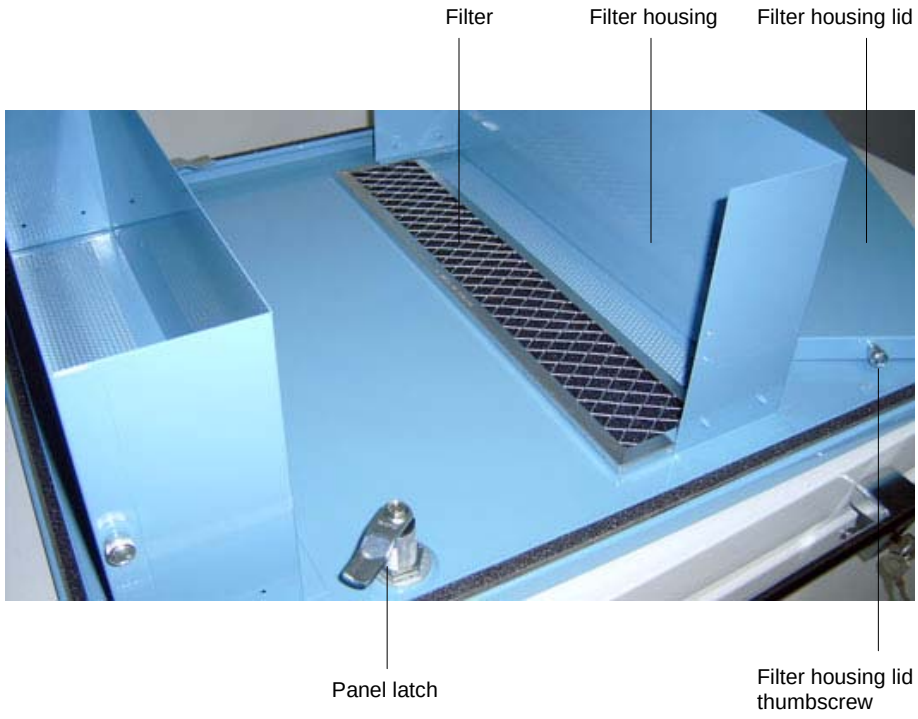
You will need a flathead screwdriver to complete this procedure.

To clean the air filter:

1. With a flat-head screwdriver turn the panel latch screw counter-clockwise until you loosen the panel from the frame.

2. Firmly but carefully lift the panel until the white tongues are out of the frame slots.

3. Carefully pull the panel straight back.
4. Twist off the filter housing lid thumbscrews and remove the filter housing lid.



5. Slide the filter from the filter housing.
6. Wash the filter with water or vacuum it to remove dust.

To replace the air filter:

1. Slide the filter back into the filter housing.
2. Replace the filter housing lid and twist on the filter housing lid thumbscrews.
3. Carefully slide the panel tongues into the frame slots and then screw the pane latch screw back in until it is tight.

Cleaning the frame base air filters

Your system includes one air filter at the front of the frame base and an identical one at the rear.

To clean either frame base air filter:

1. Loosen the thumbscrews that secure the filter housing to the base of the cart frame.
2. Slide the filter housing away from the cart to release it.
3. Remove the four wing-nuts.
4. Remove the filter from the filter housing.
5. Wash the filter with water, or vacuum it to remove dust.

To replace the air filter:

1. Place the filter in the filter housing.
2. Secure the filter using four wing-nuts.
3. Slide the filter housing back into the cart.
4. Tighten the thumbscrews to secure the filter housing to the base of the cart frame.

Appendix I

Declaration of Conformity

VISUALSONICS

3080 yonge street suite 6100
box 66 toronto canada M4N 3N1
T +1.416.484.5000
F +1.416.484.5001
TF +1.866.416.4636
www.visualsonics.com

INSIGHT THROUGH *IN VIVO* IMAGING™

E C DECLARATION OF CONFORMITY FOR THE VEVO 2100®

The EC Directives covered by this Declaration

1. Council Directive 2006/95/EEC concerning electrical equipment designed for use within certain voltage limits (the "Low Voltage Directive" and
2. Council Directive 2004/108/EC relating to electromagnetic compatibility - " the EMC Directive"

The Products Covered by this Declaration

Vevo 2100® High Resolution Imaging System

The Basis on which Conformity is Declared

The product identified above complies with the Safety Requirements of the Low Voltage Directive and applicable requirements of the EMC Directive. Compliance has been achieved by reference to the following Harmonised and International Standards:

EN 61010-1: 2001 (IEC 61010:2001)
EN 61326:2006 (IEC 61326:2005)
EN 60950-1 2006
EN 55011:2007 (CISPR 11:2003)

The technical documentation required to demonstrate compliance with the Essential Requirements of the Low Voltage Directive and the Electro-Magnetic Compatibility Directive has been compiled by the signatory below and is available for inspection by the relevant enforcement authorities.

Signed:..... Date: Oct. 28/2008.
Name: Randy AuCoin **Position: VP, QA & Regulatory Affairs**

Authorised Representative in Europe

Signed:..... Date: 30 October 2008
Name: D H G Baker **Position: Director Atlantic Bridge Limited**
Address: Zenith House, 11 The Street, Chirton, Devizes, Wiltshire. England. SN10 3QS
The attention of the specifier, purchaser, assembler or user is drawn to the special precautions and limitations which are included in the Technical and User Manuals for the product and which are also available from the Company on request.

Glossary of Terms

3D-Mode
3D-Mode provides a three-dimensional view of an area of interest. The system acquires the 3D data by creating a rapid series of B-Mode slices, then combining these slices into a whole image.

You can then use the analysis tools to manipulate the three-dimensional renderings and make volumetric measurements of the structures you are interested in.

Annotation
A text label you can add to any ultrasound image.

AVI
Audio Video Interleave (AVI) is a standard file format developed by Microsoft that includes both live video and sound.

B-Mode
B-Mode is an ultrasonic imaging mode that produces a two-dimensional image to represent a cross-section of an object through the scanning plane.

Typically, B-Mode is the most commonly used imaging mode in the system because it is the most effective mode for scanning to locate anatomical structures that you might then want to examine using one of the other imaging modes.

BMP
BMP is a Bitmap file extension of a static image file format. Each bit of the saved BMP file represents a piece or pixel of the image.

Caliper
An operator-defined point for a measurement.

CD-R
Recordable CD format.

CD-ROM
Read only CD format.

CD-RW
Re-writeable CD format.

Cine loop
A multiple frame animation of your image frames.

Color Doppler Mode
Color Doppler uses PW Doppler Mode ultrasound to produce an image of a blood vessel. In addition, the system converts the Doppler sounds into colors that are overlaid on the image of the blood vessel to represent the speed and direction of blood flow through the vessel.

Contrast Mode
Contrast Mode imaging provides tools to detect and quantify vascular structures and dynamics at the molecular level.

This mode is useful in cancer, vascular and cardiology research for real-time in vivo applications such as:

- Targeted molecular imaging for visualizing and quantifying the expression of intravascular molecular markers — for example: angiogenesis and inflammation
- Tumor perfusion and relative quantification of vascular volume and structure
- Assessment of myocardial perfusion and area of infarction

CSV
Comma Separated Value (CSV) is a file format used to represent database fields. Each entry of the file represents one field and is separated from the next field by a comma.

DICOM
Digital Imaging and Communications in Medicine (DICOM) is a comprehensive set of standards for handling, storing and transmitting information in medical imaging. It includes a file format definition and a network communication protocol.

Dongle
A hardware device that serves as copy protection for the software by rendering the software inoperable when the device is not plugged into a USB connector.

Doppler angle
The angle between the ultrasound pulse and the direction of blood flow. This angle is also known as the incident angle to flow or the angle of insonation.

ECG
Electrocardiogram is a electronic representation of a physiological measurement of the electrical potentials of heart tissue. The output is a trace of the heart rhythm.

Focal length
The distance from the active surface of the transducer to the middle of the focal zone.

Focal zone
The portion of a focused ultrasound beam which is the region of optimal resolution. The structure of interest is optimally focused when it is imaged within this region.

Frame rate
The number of acquisition image updates per second in B-Mode. A higher acquisition frame rate is desirable when watching a moving structure such as the heart, or when moving the transducer.

M-Mode
M-Mode is used primarily to measure the movement of structures in the heart such as valves, chambers, and walls.

MIP (Max)
Maximum Intensity Persistence highlights the denser portions of the volume by bringing them forward in the image and making them brighter. This more clearly displays a small bright object in the middle of a dark ultrasound image.

MIP (Min)
Minimum Intensity Persistence highlights the less dense portions of the volume by bringing them forward in the image and making them darker. This more clearly displays a small dark object in the middle of a bright ultrasound image.

Operator
A specified operator of the system with whom study sessions may be associated.

Power Doppler Mode
Power Doppler Mode displays the energy from the returning Doppler signal and assigns a color range to the energy generated by moving blood flow. Power Doppler.

Pressure-volume loop
A graphical method of identifying and evaluating LV pressure-volume relationship changes related to dynamic levels of cardiac stress.

PW Doppler Mode
PW Doppler Mode (Pulsed Wave Doppler) is an ultrasound mode you can use to measure the velocity and direction of flow. The Vevo software presents the detected PW Doppler signal as both a spectral image in the display window as well as an audio output through the system speakers.

Rocker switch
A rocker switch is a spring-return key that provides the operator with dynamic and incremental control of a parameter value. To increase the parameter value, press the switch forward; to decrease the value, press the switch backward.

Sample volume
The region of interest being imaged during PW Doppler Mode, PW Tissue Doppler Mode or M-Mode acquisition. Sample volume size is defined by the length of the pulse and the width of the ultrasound beam.

Scout window
A small B-Mode window that renders the region of interest for M-Mode, PW Doppler Mode or PW Tissue Doppler Mode acquisition.

Session
A period of time that an operator spends adding information (acquiring data or making measurements and/or annotations on acquired data) to a study.

TIFF
Tagged Image File Format (TIFF) is a standard still image file format that includes tagged fields with the image that can be read by the opening application.

WAV
WAV is the file extension for a Waveform file format developed by Microsoft that includes sound. This file format is used exclusively in Windows.

Workstation
VisualSonics offers an optional Vevo 2100 Workstation Software package which includes all the software tools and features that you will find on the Vevo 2100 Imaging System

excluding the image acquisition tools features.

Index

Q

R

S

VISUALSONICS

3080 yonge street suite 6100
box 66 toronto canada M4N 3N1
T > +1.416.484.5000
F > +1.416.484.5001
E > info@visualsonics.com
W > www.visualsonics.com