

## 5 Working With Measurements

### Measurement Overview

Measurements accompanying ultrasound images supplement other clinical procedures available to the attending physician. Accuracy of the measurements is determined by the Terason Ultrasound software and by proper use of medical protocols.

When you freeze a scan, the Terason software changes the set of available softkey controls and enables the Caliper key. Pressing the Caliper key enables the measurement controls. Repeatedly pressing the Caliper key cycles through the Distance, Trace, and Ellipse measurement options.

When you save an image, all measurements are saved with the image.

You can create measurements on the currently acquired image (with frames stored temporarily).

To make measurements on scanned images, you must understand:

- [Measurement Results Display Location](#) on page 89
- [Measurement Sets](#); see page 89
- [Measuring in the 2D Window](#); see page 89
- [Measuring in the M-Mode Window](#); see page 94
- [Measuring in Spectral Doppler Modes](#); see page 95
- [Measuring Cardiac Exams](#)[Measuring Cardiac Exams](#); see page 96
- [Deleting Measurements](#); see page 100
- [Restoring All Measurement Groups to Defaults](#); see page 100

You can also make measurements on both screens when using Split Screen mode. See [Split-Screen Measurements](#) on page 93.

To obtain a complete set of measurements, you often have to acquire multiple scans. You can make as many scans and measurements as required for the study without losing any measurements. Measurements remain on the Imaging window until you:

- Select a different exam
- Select a different scan mode
- Load a different patient
- Press the Delete softkey
- Press the Clear All softkey

## Measurement Results Display Location

The default location for the display of measurement results is the top left of the image. To move the results to the bottom of the image, press the Results softkey (enabled when a measuring tool is active). You can also change the default location to the bottom of the image using the Result Display Location radio buttons on the Setup/Measurements window.

## Measurement Sets

When you choose an exam preset, the Terason software makes a default set of measurements available. The default set may vary from one supported probe to another. You can also add custom measurements to the available lists. See:

- [Default Measurement Sets](#) on page 89
- [Setting Measurement Defaults](#) on page 159

## Default Measurement Sets

The system loads a set of measurements tailored for the preset you've selected. The measurements are selected using the Calcs key.

**To select a measurement type**, press the Calcs key, and click the desired measurement.

## Measuring in the 2D Window

When you freeze a 2D scan, the Terason software displays softkeys and a Gain Knob menu for measuring, printing, and playing loops in 2D mode.



2D Mode Measure Softkeys (When Scan is Frozen)

The Measure function in the 2D window allows:

- [Measuring Distances](#); see page 90
- [Measuring Elliptical Circumference and Area](#); see page 91
- [Tracing Areas on the Image](#); see page 92
- [Split-Screen Measurements](#); see page 93

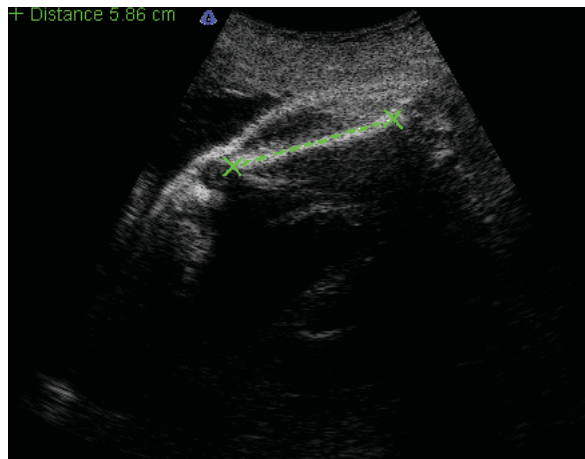
In general, select what you want to measure from the menu of Measurements. If you select a specific measurement, such as Area, only the softkeys that work with that measurement are available.

## Measuring Distances

**To measure a distance** in the 2D window, complete the following steps:

1. If the image is live, press the **Freeze** key.  
The image freezes and the softkey controls change.
2. Press the **Caliper** key.
3. To measure a detailed area with precision, use the **Zoom** function (see [Enlarging an Area of the Image](#) on page 51) to enlarge an area of the 2D scan.
4. Press the **Caliper** key.
5. Click where you want to **start** measuring, move the target cursor, and click where you want to **finish** measuring.

The Terason software displays the results in the top left corner of the 2D window.



**Distance Measurement on an Image**

If you do not see the measurement value, press the Setup key, then select **General > Measurement Value**.

**To make more than one measurement of the same type** on an image, press the appropriate softkey again, then make the additional measurement.

**When making a series of 2D measurements using the Caliper key**, you can keep the caliper active by checking the Keep caliper active box on the Setup/Measurements window. When the box is checked, a new caliper cursor appears when you set the end point of a caliper measurement. When you finish making measurements, save the image, then press the Freeze key to turn off caliper measuring.

## Measuring Elliptical Circumference and Area

You can use either the Ellipse softkey or the Trace softkey to measure a circumference on the image. To measure an oval area, use the Ellipse softkey. To measure the area of an irregular shape, use the Trace softkey. See [Tracing Areas on the Image](#) on page 92 for instructions on using the trace tool.

To measure a small area, use the Zoom function before you measure.

**To use the ellipse tool to measure an elliptical area**, complete the following steps:

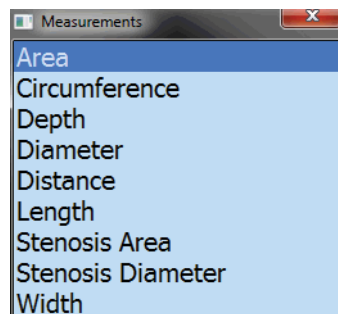
1. If the image is live, press the **Freeze** key.

The image freezes and the softkey controls change.

2. Press the **Caliper** key.

3. Press the **Calcs** key.

The Measurements menu opens.



### Measurements Menu

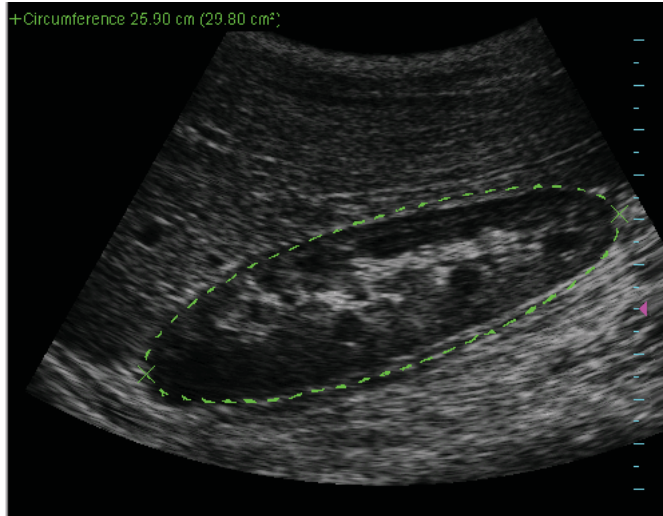
4. Select the **measurement type** by clicking it in the Measurements menu.

If you select Circumference from the Measurement menu, the Ellipse tool is automatically activated.

5. Position the target cursor at **one end** of the area that you want to measure and click.

6. Move the target cursor to the **other end** of the desired area, and click.

The Terason software displays a green line and shows the circumference or area values at the top of the image.



### Ellipse Measurement on an Image

If the measurement value does not show on your computer, select **Setup > General > Measurement Value**.

7. To adjust the other axis of an ellipse, press the **Select key** so that **Axis** is highlighted (above the softkey display), then use the trackball to adjust the width of the ellipse.
8. When the measurement is correct, press the **Left Enter key** to lock it in.

You cannot change a measurement after locking it in. You can now make another measurement without deleting the measurements you've locked in.

9. To save the measurements, press the **Store Key**.

The image is saved with all measurements.

### Tracing Areas on the Image

The Terason software lets you measure an area by tracing the contour of any shape on an image. You can also use the Ellipse tool to measure an area (see [Measuring Elliptical Circumference and Area](#) on page 91 for instructions.)

You can use the trace tool to:

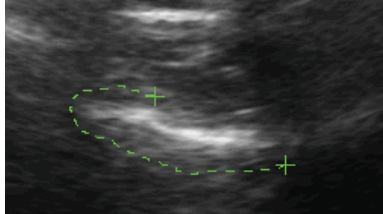
- Trace an irregular shape by sketching the outline
- Draw a polygon by clicking on corners of the shape

You can also combine these methods to trace an area on the image.

**To trace an area on an image**, complete the following steps:

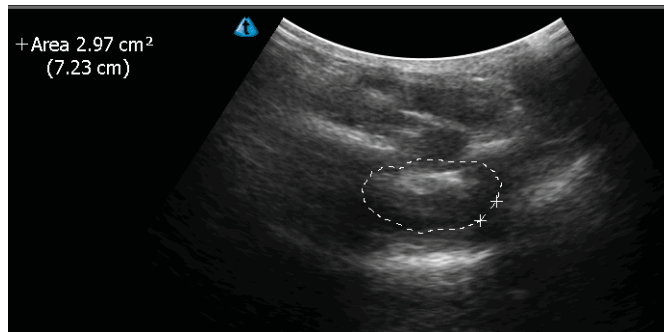
1. If the image is live, press the **Freeze key**.  
The image freezes and the softkey controls change.
2. Press the **Caliper key**.
3. Use one of the following methods to select **the trace tool**:

- Press the **Caliper key** until Trace displays on the softkeys.
  - Select **Area** from the Measurement menu.
4. To **trace an outline**:
    - a. Click where you want to **start** measuring.
    - b. Use the **trackball** to drag the tracing cursor around the object you want to trace.



Tracing an Outline

- c. When your trace is nearly complete, press the **Left Enter key**, and the software completes the loop by drawing a straight line from the current cursor position to the starting point.



Trace Measurement on an Image

When you press the Left Enter key, the trace turns white, and can no longer be edited. Before you click the Left Enter key, you can reverse the track of the cursor to delete parts of the trace.

5. To **edit the uncompleted trace**:
  - a. Press the **Select key**, so that Erase is highlighted above the Softkey display.
  - b. Use the **trackball** to erase the unwanted part of the trace, from most recent back toward the beginning.
  - c. When all the unwanted parts of the trace are erased, press the **Select key** again, so that Draw is highlighted above the Softkey display.
  - d. Use the **trackball** to finish the trace.
  - e. Press the **Left Enter key** to complete the trace.

## Split-Screen Measurements

When measuring in Split Screen mode (see [Working With Split Screen Mode](#) on page 53), all measurements are displayed in a single list, even if both screens contain measurements.

You can make a measurement on either screen or across both screens.

**To make alternating measurements on split screens,** you must Disable Return to live imaging:

1. Press the **Setup key**.
2. Click the **Display tab**.
3. Click **Return to live imaging on toggle active screen**, so that the box is not checked.
4. Click **OK**.

This allows you to make a measurement on one screen, switch to the other screen and make a measurement there, then return to the first screen and make additional measurements. If the box in the Setup/Display window is checked, returning to the first screen makes it live and erases all measurements on it.

**To make a measurement across both screens:**

1. Disable Return to live imaging, as described above.
2. **Freeze a scan** on one screen.
3. Press the **Toggle Screen** softkey.
4. **Freeze a scan** on the other screen.
5. Press the **Caliper key** repeatedly until the tool you need displays.
6. Click the **start point** of the measurement.
7. Click the **end point** of the measurement.
8. Press the **Left Enter key**.

## Measuring in the M-Mode Window

When you freeze an M-mode scan, the Terason software displays softkeys and a Gain Knob menu for measuring, printing, and playing loops in M-mode.



M-Mode Measure Softkeys (When Scan is Frozen)

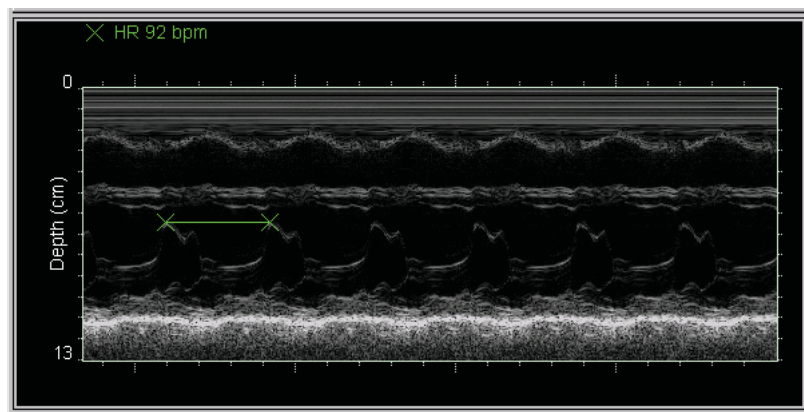
## Making M-Mode Measurements

In the Time Series window of an M-Mode scan, you can measure:

- Heart rate (HR)
- Distance (includes time over distance [TD] and Slope values)

**To measure in the M-Mode Time Series window**, complete the following steps:

1. Press the **Freeze** key.
2. Press the **Caliper** key until the measurement type you need displays.
3. Click the target cursor where you want to **start** measuring.
4. Move the target cursor and click at the desired **end** location. The measurement displays at the top left of the Time Series window.

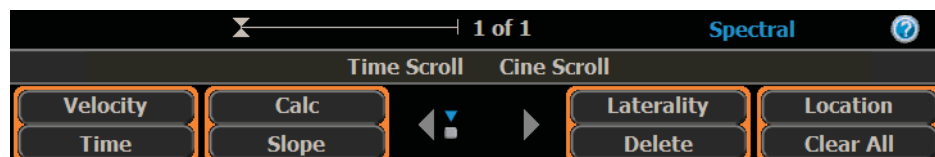


**M-Mode Measurement**

5. **Print and save** the image, if required.

## Measuring in Spectral Doppler Modes

When you freeze a Pulsed-Wave Doppler or Triplex scan, the Terason software changes the softkeys to allow measurement, printing, and other functions.



**PWD Measurement Softkeys**

The Measurement section of the panel controls the following measurement operations:

- Velocity
- Time
- Slope
- Calc

You can use the CA (correction angle) softkey and the 0/+60 softkey to adjust the angle on the frozen scan. This function works the same as the Correction Angle on the PWD tab as described in [Adjusting the Correction Angle](#) on page 77.

If you have added 2D measurements to the Spectral measurement set, you can perform 2D measurements in Spectral Doppler imaging screens.

**To make 2D measurements on Spectral Doppler imaging screens**, press the Calcs key. Any 2D measurements you have added to the Spectral measurement set appear in a Measurements menu at the top right corner of the imaging screen. See [Measuring in the 2D Window](#) on page 89 for instructions in making 2D measurements.

## Measuring Cardiac Exams

You can make any of a number of cardiac measurements and then generate a report. The Terason software provides Cardiac measurements for the 2D Image Display window, the M-Mode Time Series window, and the PWD/CW Time Series window.

When you make a measurement in the 2D Image Display window, the value of the measurement displays at the top left of the window.

### Intima Media Thickness (IMT)

IMT measurements are useful for diagnosing atherosclerosis, by measuring the thickness of an arterial inner wall.

#### To measure the carotid artery inner wall:

1. Connect a **linear probe** to the system.
2. In 2D mode, select the **Carotid preset**.
3. Scan the **carotid artery**.
4. **Freeze** the scan.
5. Press the **Calcs key**.  
The Measurements menu appears.
6. From the menu, select **IMT**.  
A green square displays on the image.
7. Use the trackball to move the **green square** so that it covers both walls of the artery.



**Note:** For correct measurements, the green box must include both walls of the artery. It need not be closely sized, so long as both wall are included.

If necessary, press the Select key to allow resizing the box using the trackball. Pressing the Select key once allows horizontal resizing; pressing twice allows vertical resizing. The width of the box displays at the top left of the Imaging window.

If the display does not trace the inner walls of the artery correctly, press the Edit softkey, then click the proper location of the wall on the image.

8. Press the **Wall softkey** to select the anterior wall, the posterior wall, or both.

The measurements display at the top left of the Imaging window.

## Cardiac Measurement Groups

The Terason software includes default groups of commonly-used measurements that are available in the Measurements menu when an image is frozen. You can add or remove measurements from groups, and create or delete groups.

## Available Cardiac Measurements

The following tables list the measurements that are available for the various scan modes.

### Cardiac Measurements in the 2D Image Display Window

Measurement Group	Measurement	Definition	Tool Used
LV Volume	LVd Ap4C	Left ventricle area, apical 4 chamber in end-diastole	MOD Trace
	LVs Ap4C	Left ventricle area, apical 4 chamber in end-systolic	MOD Trace
	LVd Ap2C	Left ventricle area, apical 2 chamber in end-diastole	MOD Trace
	LVs Ap2C	Left ventricle area, apical 2 chamber in end-systolic	MOD Trace
LV Mass	LVAAd SAX Epi	Left ventricle short-axis epicardial, in end-diastole	Trace
	LVAAd SAX Endo	Left ventricle short-axis endocardial, in end-diastole	Trace
	LVAAs SAX Endo	Left ventricle short-axis endocardial, in end-diastole	Trace
	LVLd	Left ventricle length in end-diastole	Caliper
Ventricle Dimensions	RVAWd	Right ventricle anterior wall thickness in end-diastole	Caliper
	RVIDd	Right ventricle internal dimension in end-diastole	Caliper
	IVSd	Interventricular septal thickness in end-diastole	Caliper
	LVIDd	Left ventricle internal dimension in end-diastole	Caliper
	RVAWs	Right ventricle anterior wall thickness in end-systolic	Caliper
	RVIDs	Right ventricle internal dimension in end-systolic	Caliper
	IVSs	Interventricular septal thickness in end-systolic	Caliper
	LVIDs	Left ventricle internal dimension in end-systolic	Caliper
	LVPWs	Left ventricle posterior wall thickness in end-systolic	Caliper

**Cardiac Measurements in the 2D Image Display Window (Continued)**

Measurement Group	Measurement	Definition	Tool Used
Valves and Atria	LVOT diam	Left ventricle outflow tract diameter	Caliper
	Ao Root diam	Aortic root diameter	Caliper
	RVOT diam	Right ventricle outflow tract diameter	Caliper
	PA diam	Pulmonary artery diameter	Caliper
	AV diam	Aortic valve diameter	Caliper
	AV area	Aortic valve area	Trace
	MV diam	Mitral valve diameter	Caliper
	MV area	Mitral valve area	Trace
	PV diam	Pulmonic valve diameter	Caliper
	TV diam	Tricuspid valve diameter	Caliper
	LA diam	Left atrium diameter	Caliper
	RA diam	Right atrium diameter	Caliper
	Shunts	ASD Qp diam	Atrial septal defect pulmonic diameter
ASD Qs diam		Atrial septal defect systemic diameter	Caliper
VSD Qp diam		Ventricular septal defect pulmonic diameter	Caliper
VSD Qs diam		Ventricular septal defect systemic diameter	Caliper
Gen Qp diam		Pulmonic diameter	Caliper
Gen Qs diam		Systemic diameter	Caliper

**Cardiac Measurements in the M-Mode Time Series Window**

Measurement Group	Measurement	Definition	Tool Used
Ventricle Dimensions	RVAWd	Right ventricle anterior wall thickness in end-diastole	Depth Caliper
	RVAWs	Right ventricle anterior wall thickness in end-systole	Depth Caliper
	RVIDd	Right ventricle internal dimension in end-diastole	Depth Caliper
	RVIDs	Right ventricle inside diameter in end-systole	Depth Caliper
	LVPWd	Left ventricle posterior wall thickness in end-diastole	Depth Caliper
	LVPWs	Left ventricle posterior wall thickness in end-systole	Depth Caliper
	LVIDs	Left ventricle internal dimension in end-systole	Depth Caliper
	LVIDd	Left ventricle internal dimension in end-diastole	Depth Caliper
	IVSd	Interventricular septal thickness in end-diastole	Depth Caliper
	IVSs	Interventricular septal thickness in end-systole	Depth Caliper
Ao / LA	Ao Root Diameter	Aortic root diameter	Depth Caliper
	LA Diameter	Left atrium diameter	Depth Caliper
	MM R-R interval	M-Mode R-wave-to-R-wave interval	Time Caliper

**Cardiac Measurements in the M-Mode Time Series Window**

Measurement Group	Measurement	Definition	Tool Used
Valves	AV R-R interval	Aortic valve R-wave-to-R-wave interval	Time Caliper
	AV Cusp	Aortic valve cusp separation	Depth Caliper
	MV D-E	Mitral valve D-to-E	Depth Caliper
	TV D-E	Tricuspid valve D-to-E	Depth Caliper
	MV E-F slope	Mitral valve E-to-F slope	Slope Caliper
	MV EPSS	Mitral valve E point septal separation	Depth Caliper
	MV excursion	Mitral valve excursion	Depth Caliper

**Cardiac Measurements for PWD/CW Time Series Window**

Measurement Group	Measurement	Definition	Tool Used
AV	AV Mean	Aortic valve mean velocity	Velocity Trace
	AV Peak	Aortic valve peak velocity	Velocity Point
	AV PHT	Aortic valve pressure half-time	Slope Caliper
	AV HR	Aortic valve heart rate	Heart Rate
	AI Peak	Aortic insufficiency peak velocity	Velocity Point
	LVOT Velocity	Left ventricle outflow tract mean velocity	Velocity Trace
	LVOT Peak	Left ventricle outflow tract peak velocity	
	MV	MV Mean	Mitral valve mean velocity
MV E Peak		Mitral valve E peak velocity	Velocity Point
MV A Peak		Mitral valve A peak velocity	Velocity Point
MV PHT		Mitral valve pressure half-time	Slope Caliper
MV IVRT		Mitral valve isovolumetric relaxation time	Time Caliper
MV HR		Mitral valve heart rate	Heart Rate
MR Peak		Mitral regurgitation peak velocity	Velocity Point
LVOT Mean		Left ventricle outflow tract mean velocity	Velocity Trace
LV dp/dt <sup>a</sup>		Left ventricular contractility	Velocity Point
PA Mean		Pulmonary artery mean velocity	Velocity Trace
PV		PV Mean	Pulmonic valve mean velocity
	PV Peak	Pulmonic valve peak velocity	Velocity Point
	PV HR	Pulmonic valve heart rate	Heart Rate
	PI Peak	Pulmonic insufficiency peak velocity	Velocity Point
TV	TV Mean	Tricuspid valve mean velocity	Velocity Trace
	TV E Peak	Tricuspid valve E peak velocity	Velocity Point
	TV A Peak	Tricuspid valve A peak velocity	Velocity Point
	TV PHT	Tricuspid valve pressure half-time	Slope Caliper
	TV HR	Tricuspid valve heart rate	Heart Rate
	TR Peak	Tricuspid regurgitation peak velocity	Velocity Point
	RV dp/dt <sup>b</sup>	Right ventricular contractility	Velocity Point
	RVSP	TR Peak	Tricuspid regurgitation peak velocity
RA Pressure		Right atrium pressure	Entry
VSD Peak		Ventricular septal defect peak velocity	Velocity Point
Sys BP		Systolic blood pressure	Entry
ASD Shunt	ASD Qp TVI	Atrial septal defect pulmonic time-velocity integral	Velocity Trace
	ASD Qp HR	Atrial septal defect pulmonary heart rate	Heart Rate
	ASD Qs TVI	Atrial septal defect systemic time-velocity integral	Velocity Trace
	ASD Qs HR	Atrial septal defect systemic heart rate	Heart Rate

**Cardiac Measurements for PWD/CW Time Series Window (Continued)**

Measurement Group	Measurement	Definition	Tool Used
VSD Shunt	VSD Qp TVI	Ventricular septal defect pulmonary time-velocity integral	Velocity Trace
	VSD Qp HR	Ventricular septal defect pulmonary heart rate	Heart Rate
	VSD Qs TVI	Ventricular septal defect systemic time-velocity integral	Velocity Trace
	VSD Qs HR	Ventricular septal defect systemic heart rate	Heart Rate
General Shunt	Gen Qp TVI	Pulmonic time-velocity integral	Velocity Trace
	Gen Qp HR	Pulmonary heart rate	Heart Rate
	Gen Qs TVI	Systemic time-velocity integral	Velocity Trace
	Gen Qs HR	Systemic heart rate	Heart Rate

- a. This calculation is available in CW mode. The Time-Series window must display a velocity range that includes -300 cm/s. Use the Scale softkey to achieve this.
- b. This calculation is available in CW mode. The Time-Series window must display a velocity range that includes -200 cm/s. Use the Scale softkey to achieve this.

## Deleting Measurements

You can delete the most-recent measurement, or you can delete all measurements on the current image.

**To delete the most recent measurement**, press the Delete softkey.

**To delete all measurements**, press the Clear All softkey.

## Restoring All Measurement Groups to Defaults

**To restore all measurement groups to the defaults:**

1. Press the **Setup** key.
2. Click the **Measurements** tab.
3. Click the **Configure Measurements...** button.
4. Click the **Restore** button.
5. Click **OK**.