4 Working With Scan Modes

Scan Modes Overview

All of the information in this chapter pertains to live imaging. Many of the controls and functions change when you freeze the scan. For information on using functions when the scan is frozen, see Working with Annotations on page 54. and Chapter 5 - Working With Measurements.

Follow these general guidelines to choose which scan mode to use for an exam:

- Select 2D Mode to view a two-dimensional display of the anatomy. 2D controls adjust the depth, focus, overall image gain, brightness, and exam type. See Using 2D Image Controls on page 65.
- Select M-Mode (Motion Mode) to evaluate motion over time. See Using M-Mode Image Controls on page 72.
- Select Pulsed-Wave Doppler (PWD) mode when you want obtain frequency or velocity information from a specific point along the ultrasound cursor. See Using Spectral Doppler Image Controls on page 73.
- Select Color Doppler (CD) when you must view the mean velocity within an assigned region of interest. See Using Color Image Controls on page 80
- Use Triplex to combine Pulsed-Wave Doppler scanning with Color Doppler scanning. See Scanning in Triplex Mode on page 85.

Using the Softkeys and Console Controls

A set of softkey controls below the Imaging window display the currently available imaging controls (for example, see 2D Softkeys on page 65). The softkeys are operated by the keys on the console (see The uSmart3300 Console on page 27.) When you select a scan mode, the software configures the softkeys for that mode. The controls displayed vary depending on which probe is connected, and on other selections. Pressing the left and right arrow keys at the left side of the console changes the display to other controls available in the selected mode.

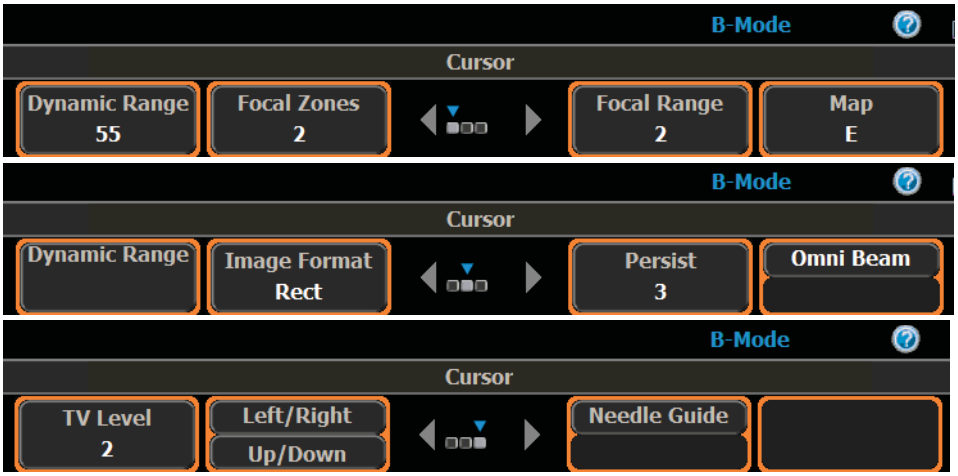
To change a setting, use the toggle keys on the console. Each toggle key controls the setting in one of the softkeys at the bottom of the Imaging window. The position of the key set corresponds to the position of the onscreen button – the leftmost key controls the setting in the leftmost softkey, and so on.

See Console Controls on page 27 for more information on using the console.

See Scan Properties Display on page 25 for a description of the display that lists current imaging settings.

Using 2D Image Controls

The figure 2D Softkeys shows an example of available 2D image controls. You can only adjust these image controls during live scanning. When you freeze a scan, the Terason software replaces the softkeys with a different set, for printing and making annotations and measurements on the scan image. (See Working with Annotations on page 54 and Chapter 5 - Working With Measurements.)



2D Softkeys

Note: The softkey display depends on the probe that is connected, the selected scan mode, and the selected exam. The display you see may differ from the illustrations in this guide.

You can adjust the following 2D image controls during live scanning:

- Frequency
- Scan Depth
- Focus depth
- Gain
- Time Gain Compensation (TGC)
- Image Format
- Omni Beam
- Left/Right and Up/Down invert
- Colorization
- Persistence
- Image map
- Needle guide
- Dynamic range
- TeraVision

Adjusting the Frequency

When you select an exam, the Terason software sets an appropriate frequency for that exam. You can select an alternate frequency to better suit specific circumstances. In general, a higher transmit frequency yields better 2D resolution, while a lower frequency gives the best penetration.

To select high, medium, or low frequency, use the Frequency softkey. The exact frequencies vary, depending on the connected probe. Each frequency has a number of other parameters associated with it, which depend on the type of exam. The selected frequency shows as H, M, or L in a character string in the information to the right of the Imaging window. In the example below, medium frequency is selected.

Selected Frequency Display

Adjusting the Scan Depth

The Depth key adjusts the field of view. You can increase the depth to see larger or deeper structures. You can decrease the depth to enlarge the display of structures near the skin line, or to not display unnecessary areas at the bottom of the window.

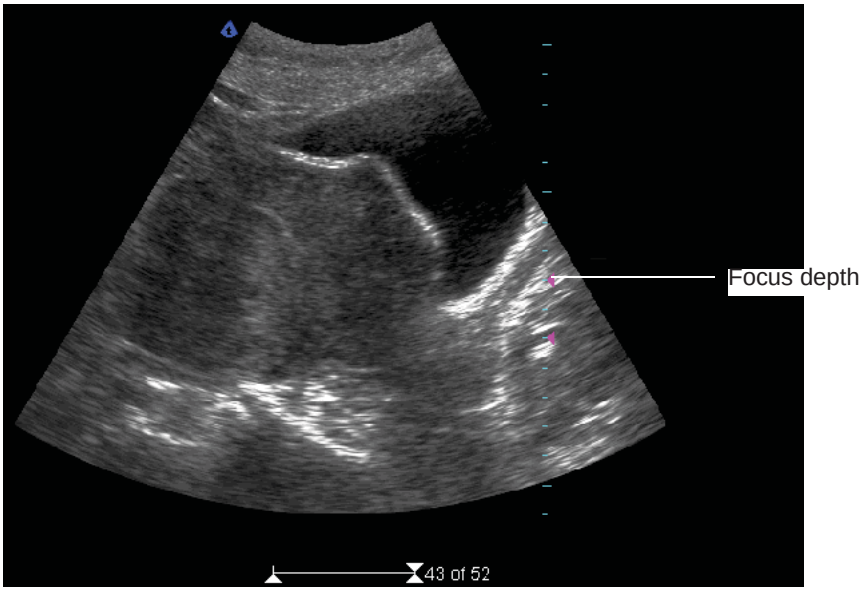
When you select an exam type, the Terason software enters a preset depth value for the specific exam type and probe.

To set the scan depth, use the Depth key. After adjusting the depth, you may want to adjust the gain, time gain compensation (TGC) curve, and focus control settings.

You can view a depth ruler on the image by selecting Depth Ruler on the General tab of the Setup window.

Adjusting the Focus Depth

Focus optimizes the image by increasing the resolution for a specific area. The figure below shows the depth ruler along the right side of the image.



Example Depth Ruler

A pink triangle on the depth ruler indicates the focus depth. This indicator is only visible if you show the depth ruler. The depth is also displayed as text in the scan information area (See Scan Properties Display on page 25).

When you select an exam type, the software updates the focus value to a preset value for the specific exam type, probe, and frequency.

In 2D mode, you can set up to four focus depths, using the Focal Zones softkey. In all the other modes, you can set only one focus depth. When you use more than one focus depth, you can choose the distribution of the focus depths.

To set the focus depth, use the Focus key.

To **set multiple focus depths** in 2D, complete these steps:

1. Use the Focal Zones softkey to select the desired number of focus zones.
2. Use the Focal Range softkey to select a distribution for the focus zones.

   The distribution is shown by the spacing of the depth indicators on the depth ruler. The actual spacing of the focus depths depends on the number of points selected and on the depth

Note: Increasing the number of focal zones decreases the frame rate.

Adjusting the Gain

2D gain allows you to increase or decrease amplification of the returning echoes, which increases or decreases the amount of echo information displayed in an image.

Adjusting gain may brighten or darken the image if sufficient echo information is generated. When you adjust the gain, the Terason software increases or decreases the overall gain while maintaining the shape of the TGC curve. See Adjusting Time Gain Compensation on page 68 for more information on TGC settings.

When you select a preset, the Terason software sets the gain to a preset value for the specific preset and probe.

To increase or decrease the gain, turn the Gain knob to the right or left.

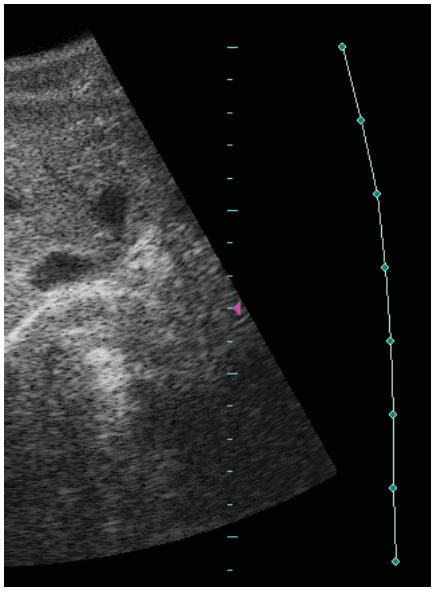
Adjusting Time Gain Compensation

Scanning tissues at greater depths causes attenuation of the returned signal. The TGC sliders adjust amplification of returning signals to correct for the attenuation. TGC balances the image to equalize the brightness of echoes from near field to far field.

The Terason software rescales the TGC settings when you do any of the following:

- Change the depth
- Load a new exam type
- Select a different frequency
- Adjust the gain setting

The TGC slider bar spacing is proportional to the depth. The TGC curve on the image display represents the TGC settings, and appears when you move one of the sliders.



Example TGC Curve on an Image

Each slider controls one dot on the curve. You can adjust the TGC sliders individually as needed. Drag a slider to the left to decrease the gain, or drag it to the right to increase the gain.

To show or hide the TGC curve, press the Setup key, then click the General tab, and select Show, Hide, or Time Out in the TGC box.

Select Show to always show the curve, or select Hide to always hide the curve. If you select Time Out (the default setting), the curve displays briefly when you start the application or adjust an individual TGC slider.

Adjusting the Image Format

When using a linear probe, the Image Format softkey lets you choose an image format of rectangular (Rect) or trapezoidal (Trap).

To select the shape of the sectors, press the Image Format softkey. It toggles between Rect and Trap.

See Setting Display Defaults on page 157 for information on choosing defaults associated with sector width and image format.

Omni Beam

Omni permits electronic steering of the ultrasound beam to acquire scans of an ROI from several directions. Omni works with linear and curved-linear array probes.

When Omni is on, the code OM shows in the scan information display, and the focus markers on the depth ruler change to this: 

Omni Beam Code in Information String

To turn Omni Beam on or off, press the Omni Beam softkey.

Inverting Images

The Left/Right and Up/Down softkeys control the orientation of the scanned image.

The following figure shows the effect of using the invert softkeys.

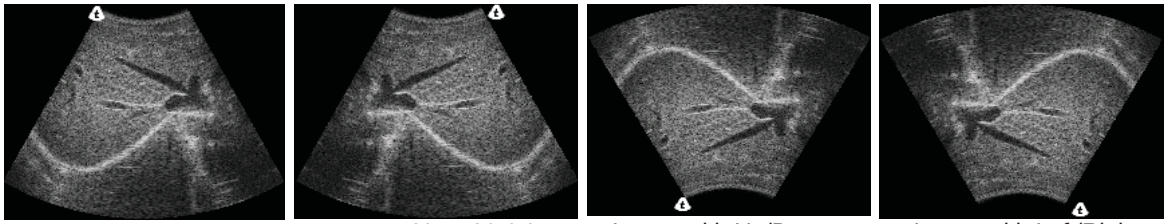


Image with no Invert | Image with Left/Right Invert | Image with Up/Down Invert | Image with Left/Right and Up/Down Invert

Effect of Inverting an Image

To invert the scanned image, click the Left/Right or Up/Down softkey.

Adjusting Persistence

Persistence refers to image frame averaging of real-time images or loops. When the persistence rate is high, the image appears less speckled and smoother. However, increasing the persistence rate may produce a blurred image if the tissue is moving when you freeze the image. When the persistence is low, the opposite is true.

To change the amount of frame averaging, press the Persist softkey to select a value from 0 to 7. The 0 setting represents 0% and 7 represents 100% persistence.

The persistence setting displays onscreen as a character in the information text string, as shown in the following figure.

Persistence Setting in Information String

Adjusting the Image Map

The Map control lets you choose how grayscale is distributed across the image. Each map emphasizes certain regions of the signal amplitude range. This feature is useful for close viewing of certain anatomical features and for detecting subtle pathologies.

To change the number of gray levels, press the Map softkey. You can choose any of nine maps, labeled from A to I.

Note: The change in image quality from one map to the next is not a linear sequence. Observe the reference bar to see the effect of the various maps. (See Image Map Reference Bar, below.)

The current map setting displays on the Map softkey. The information text string on the Imaging window also includes a code for the selected map setting. In the example below, the second item (D) is the map setting.

Map Setting (D) in Information String

Image Map Reference Bar

The effect of your map choice is represented by a reference bar to the left of the depth scale on the image.

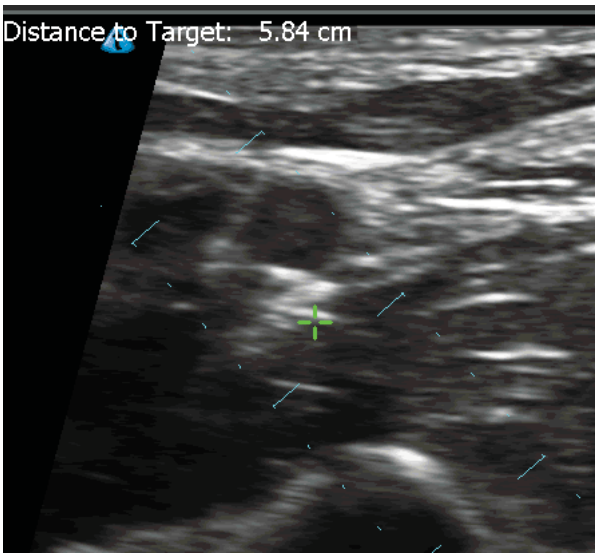
Selecting a Needle Guide

The needle guide softkey is active only when a probe that supports biopsies or other medical procedures is connected. To display a needle guide, use the softkeys to turn on the needle guide and to select the correct needle guide, if more than one guide is available.

Depending on the connected probe, you may only see one needle guide option. If the bracket for that probe supports more than one angle or depth, options for each supported angle or depth are displayed.

To toggle the needle guide on or off, press the Needle Guide softkey. If more than one guide is available, press the Guide Type softkey to select a different guide.

See Performing a Biopsy on page 127 for more information on using needle guides.



Needle Guides and Target for a Biopsy

On the 2D image, the cyan dashed lines are the guide lines, and the green is the needle guide target indicator.

To toggle the target indicator on and off, press the Target softkey. Use the trackball to set the target depth.

The distance from the probe to the target displays in the upper left corner of the Imaging window.

Adjusting Dynamic Range

The Dynamic Range softkey controls the range of acoustic levels displayed in the image, which affects the contrast of the image. A number on the softkey indicates the amount of compression, from 0 to 100.

To adjust dynamic range, use the Dynamic Range softkey. The 0 setting gives greatest contrast, and 100 gives the least contrast.

TeraVision

TeraVision is an image-enhancement option. See Enhancing the Image Using TeraVision™ Optimization on page 53.

To enable or disable TeraVision, use the TV Level softkey. Using the softkey, you can set TeraVision levels of Off, 1, 2, or 3.

Using Tissue Doppler Imaging

Selecting tissue Doppler imaging (TDI) optimizes the image controls for imaging tissue motion. The control settings vary with the selected scan mode. The control values can be adjusted and preset independently of non-TDI settings. TDI is disabled when the image is frozen. TDI works only with the 4V2A probe.

To apply tissue Doppler imaging, press the TDI softkey while in 2D mode.

Using M-Mode Image Controls

When you select M-Mode, the Terason software applies a group of preset image settings and changes the available softkey controls. When you freeze a scan, the Terason software replaces the imaging softkey controls with controls for measuring features of the M-mode image and for examining frames and playing loops. (See Measuring in the M-Mode Window on page 94.)

M-Mode Softkeys

For information on the M-Mode image controls, see:

- Using the Gain Knob in M-Mode on page 72
- Adjusting the Sweep Speed on page 72
- Adjusting the Ultrasound Cursor Position on page 73

When M-mode is chosen, the Terason software automatically selects the ultrasound cursor, and moving the trackball controls the cursor position. Pressing the Left Enter key deselects the cursor and locks it in place. Pressing the Cursor key selects the ultrasound cursor.

Using the Gain Knob in M-Mode

The Active button in the center of the Gain knob controls which set of imaging controls for the active modes displays. In M-Mode, those are controls for 2D and M-Modes. The currently-selected control set name displays in blue above the softkeys. To select a different control set, press the Active button.

In M- mode, the available Gain Knob controls are:

- 2D Gain

See Console Controls on page 27 for more information on using the console.

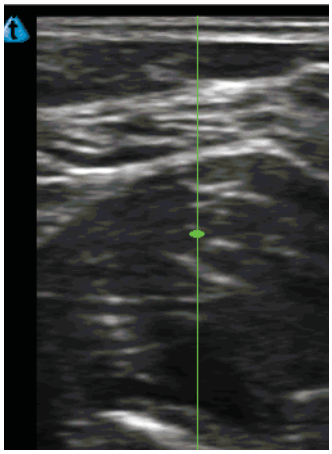
Adjusting the Sweep Speed

The Sweep Speed softkey sets how fast the timeline is scanned across the Time Series window.

To set the sweep speed, press the Sweep Speed softkey to select Slow, Medium, or Fast. The tick marks in the Time Series window are closer or farther apart depending on the speed. Each large tick mark represents one second.

Adjusting the Ultrasound Cursor Position

The following figure shows the ultrasound cursor:



Ultrasound Cursor

To move the ultrasound cursor, press the Cursor key to select the ultrasound cursor, then use the trackball to move it to a new location. When the cursor is where you want it, press the Left Enter key.

When the ultrasound cursor is selected, it turns green. When locked in position, it returns to its normal color.

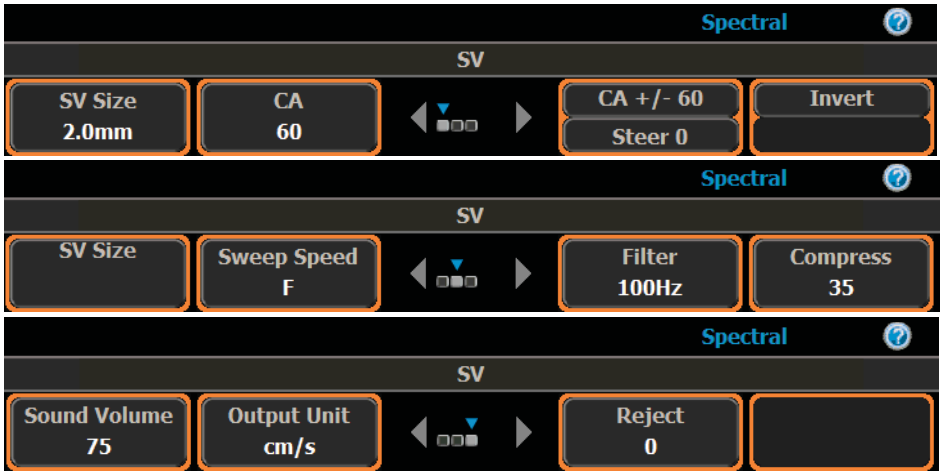
Anatomical M-Mode

Enabling Anatomical M-Mode with the Anatomic softkey allows you to rotate and move the scan line vertically.

Using Spectral Doppler Image Controls

When you select Pulsed-Wave Doppler, the Terason software applies a group of preset image settings and changes the available softkey controls. When you freeze a Pulsed-

Wave scan, the Terason software replaces the imaging softkey controls with controls for measuring features of the PWD image and for examining frames and playing loops.



PWD Mode Softkeys

For information on spectral Doppler image controls, see:

- Using the Gain Knob in PWD Mode on page 74
- Adjusting the Sweep Speed on page 75
- Adjusting Scale on page 75
- Adjusting the Wall Filter on page 76
- Adjusting the Steering Angle on page 76
- Adjusting the Correction Angle on page 77
- Inverting the Waveform on page 77
- Adjusting the Ultrasound Cursor Position on page 78
- Adjusting the Sample Volume (SV) Size and Depth on page 78
- Setting the PWD Gate Position on page 78
- Adjusting Spectral Gain on page 78
- Adjusting Noise Rejection on page 79
- Adjusting the Baseline on page 79
- Adjusting the Sound Volume on page 79
- Updating the Displays on page 79

Using the Gain Knob in PWD Mode

The Active button in the center of the Gain knob controls which set of imaging controls for the active modes displays. In PWD mode, those are controls for 2D and Spectral modes. The currently-selected control set is displayed in blue above the softkeys. To select a different control set, press the Active button. Special Trackball Responses to PWD Mode

When Pulsed-Wave Doppler mode is chosen, the Terason software automatically selects the ultrasound cursor and the Sample Volume Gate (SVG), and moving the trackball controls the ultrasound cursor and SVG position. Pressing the Left Enter key sets the ultrasound cursor and SVG in position. Pressing the Cursor key selects the ultrasound cursor and the SVG when in PWD mode

Adjusting the Sweep Speed

The Terason software lets you choose the sweep speed for Spectral Doppler modes. A slow speed shows more waveforms over time but less detail. A medium speed is suitable for normal use. Fast speed shows fewer waveforms over time but with more detail.

The spacing of the ticks along the top of the Time Series window indicates the sweep speed. Each large tick represents one second. When an image is frozen, you cannot change the setting.

The Sweep Speed softkey sets how fast the timeline is scanned across the Time Series window.

To set the sweep speed, press the Sweep Speed softkey to select Slow, Medium, or Fast.

Setting the Velocity Display Units

The Time Series window shows the velocity of flow in cm/s or kHz. You can change the units at any time, so long as the cursor angle is 70° or less.

To change the velocity display units, press the Output Unit softkey. Pressing the softkey toggles between cm/s and kHz.

Adjusting Scale

Pulse Repetition Frequency defines the velocity range of the display, which manifests as scale. The maximum value (in Hz) for the PRF depends on the specific probe and the location of the sample volume.

The PRF should be set high enough to prevent aliasing, and low enough to provide adequate detection of slow blood flow. It may be necessary to vary the PRF during an exam, depending on the speed of the blood flow, or when pathology is present.

Aliasing occurs when the frequency of what you are observing exceeds one half of the sample rate. If the blood is moving faster than the pulse repetition rate, then the waveform on the display will alias, or wrap around, the baseline.

You can only change this setting when viewing a live image, not when an image is frozen. The Terason software may automatically change the PRF value when you move the region of interest, to ensure that the maximum PRF value does not exceed its limit.

To adjust the PRF value, use the Scale key. The Velocity (cm/s) scale to the left of the Time Series window changes in response to the Scale setting, and the PRF value shows in the Scan Properties display.

The increment value for each click depends on the current range. For example, if the Scale setting is 4000, each time you press the up or down softkey, the Terason software adds or subtracts 500 Hz from that value, until the selected value falls into a lower or higher range.

Increasing the PRF also increases the Thermal Index (TI) value (refer to “General Description of Indices” in Volume 2 of the *User Guide* for more information about thermal indices).

Note: In Triplex scanning only, the PRF value is tied to the setting in 2D mode (Color Doppler). If you change the PRF value on one mode, the Terason software also changes the PRF value on the other mode. This depends on whether you are scanning in simultaneous or non-simultaneous mode, which is controlled by the Update key.

Adjusting the Wall Filter

Doppler systems use a wall filter (high pass frequency filter) to eliminate unwanted low-frequency high-intensity signals (known as clutter) from the display. Clutter can be caused by tissue motion or by rapid movement of the probe.

Increasing the wall filter setting reduces the display of low velocity tissue motion. Decreasing the wall filter setting displays more information, but more wall tissue motion.

Use a wall filter setting that is high enough to remove clutter but low enough to display information near the baseline.

To adjust the wall filter value, use the Filter softkey.

The wall filter range is from 1% to 25% of the PRF, so changing the PRF with the Scale key also changes the range of the wall filter and the increments by which the Filter softkey changes its setting. The increment value for each click depends on the current range. For example, if the wall filter range is 1000Hz, each time you click the Filter softkey, the Terason software adds or subtracts 100 Hz from the filter value.

Adjusting the Steering Angle

When using Spectral Doppler, be aware of the Doppler angle-to-flow (the angle between the axis of the ultrasound beam and the plane that the blood flows in). When the ultrasound beam is perpendicular to the flow (90º angle-to-flow), an absent or confusing color pattern displays, even when the flow is normal. An adequate Doppler angle-to-flow is required to obtain useful Spectral Doppler information. In most instances, the more nearly parallel to the flow the Doppler beam is (the lower the angle-to-flow), the better the received signal. Angles less than 60º provide the best quality Spectral Doppler.

Electronic steering is useful when the flow is at a poor angle to the Doppler beam. However, it is often also necessary to press on one end of the probe or the other to improve the Doppler angle-to-flow.

Electronic steering is only available with flat linear-array probes (the 4V2A and 15L4). This option does not display with any other probes. Curved linear probes are not capable of electronic steering, and depending on the clinical situation, may require that you press down on one corner of the probe to obtain an adequate angle to flow.

The steering angle does not directly affect the calibration of the velocity scale.

To select a different steering angle, press the Steer key to get the desired angle.

You can only use this control when viewing a live image. When an image is frozen, you cannot change the setting.

Adjusting the Correction Angle

To obtain accurate velocities, you must maintain Doppler angles of 60º or less. It is often necessary to press on one end of the probe or the other to improve the Doppler angle-to-flow.

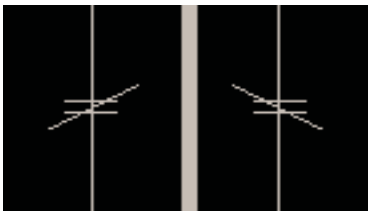
In the Terason Ultrasound System, the velocity display in centimeters per second is shown only in the correction angle range between +70º and –70º. At angles greater than 70º, the error in the velocity calculation is too large, and the velocity scale is converted to frequency (in kHz), independent of the correction angle. The flow-direction indicator still shows on the window, for reference.

To adjust the correction angle, press the CA softkeys to increase or decrease the angle. The angle setting displays in the image information section of the Imaging window, to the right of the depth scale.

To set the correction angle to 0 or 60º, press the CA+/– 60 softkey or the Steer 0 softkey. The CA+/– 60 softkey toggles the correction angle between –60º and +60º and the Steer 0 softkey sets the angle to 0º.

The correction angle controls are active on live images only.

The following figure shows adjustments made to the correction angle and sample volume:



60 Angle, 4.5 mm (Left) and 45 Angle (Right)

Inverting the Waveform

You can invert the Pulsed Doppler waveform. The Doppler scale is separated by a zero baseline across the width of the spectral display. (See Adjusting the Baseline on page 79.) The data above the baseline is classified as forward flow. The data below the baseline is classified as reverse flow.

When the waveform is inverted, reverse flow displays above the baseline and forward flow is below the baseline.

To invert the waveform, press the Invert softkey.

You can only use this control when viewing a live image. When an image is frozen, you cannot change this setting.

Adjusting the Ultrasound Cursor Position

To adjust the ultrasound cursor in the 2D image display, press the Cursor key**,** use the trackball to move the cursor, and press the Left Enter key to lock the cursor in position.

Adjusting the Sample Volume (SV) Size and Depth

The sample volume size control adjusts the size of the Doppler region being examined. The lower the value, the narrower the sample size used in the calculation of flow velocity. The sample volume displays along the ultrasound cursor as two parallel lines. The distance between the two parallel lines is the size of the sample volume in millimeters.

To adjust the sample volume (SV) size, press the SV Size softkeys. The SV Size displays on the softkey and in the image information area to the right of the depth scale on the Imaging window. You can set a value from 0.5 to 20 mm (in 0.5 mm increments).

To adjust the position of the sample volume, select it using the Cursor key**,** then the use the trackball or the touch pad to move it to the desired location. Press the Left Enter key to anchor it.

You can only use this control when viewing a live image. When an image is frozen, you cannot adjust the sample volume.

Modifying the depth location of the sample volume affects the Thermal Index (TI) value (refer to “General Description of Indices” in Volume 2 of the *User Guide* for more information about thermal indices).

Setting the PWD Gate Position

The sample volume indicator allows you to start a scan in a 2D scan mode, set the sample volume location, and switch to Spectral Doppler mode. The sample volume locks in position. When scanning in CD mode, this procedure switches to Triplex mode (if enabled by your license).

To locate the sample volume, in the 2D window, press the Cursor key, then use the trackball to set the gate position.

Adjusting Spectral Gain

The PW gain setting (not the 2D gain setting) increases or decreases the amplification of the returning signal (live or playback) for the Time Series display. The gain should be adjusted so that the spectral waveform is bright, but not so high that the systolic window fills in, or other artifacts are created.

To adjust the PWD gain, use the Gain knob. Make sure Spectral shows above the softkeys display.

You can adjust gain for live images or saved loops being played. You cannot adjust the gain for frozen images or paused loops.

Adjusting Noise Rejection

Noise Rejection controls rejection of low-level returned signals. Increasing rejection darkens the image background. A number on the softkey indicates the level of noise rejection.

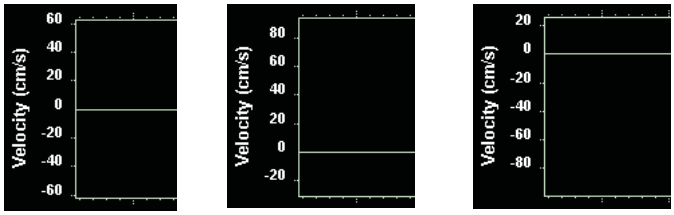
To adjust noise rejection, use the Reject softkey. A number on the softkey indicates the level of noise rejection.

Adjusting the Baseline

The baseline refers to the zero baseline in the Time Series Display window. Adjusting this control moves the zero baseline up or down. When you adjust the baseline, you can display more forward or reverse flow, taking advantage of the full scale available at that particular PRF value.

To adjust the baseline, press the Baseline key.

The figure below shows a centered baseline (the default), and adjusted baselines.



Centered Baseline (default) | Lowered Baseline | Raised Baseline

Effects of Altering the Baseline

You can adjust baseline for live images, but not for frozen images or paused loops.

Adjusting the Sound Volume

The Sound Volume control lets you define the volume of the Doppler signal.

Adjust the sound volume of the signal to a comfortable level. If it is too high, system noise may interfere with the sound produced by the blood flow.

To adjust the volume, use the Sound Volume softkey. A number on the softkey indicates the sound volume level, from 0 to 100.

The computer speaker should be turned on and its volume set to the mid-range. You can also use a high quality headphone or external speaker.

Updating the Displays

The **Update** key lets you choose whether or not to continue scanning the anatomy (displayed in the 2D window) while acquiring Spectral Doppler scan data (displayed in the Time Series window). When Update is selected, the key lights up blue, and the Terason software continuously updates the 2D scan while acquiring Spectral Doppler data. When not selected, the key lights up white and the Terason software freezes the 2D data while acquiring Spectral Doppler data.

The default setting for this key in most exams is *selected* (continuous scanning of the 2D and Spectral Doppler data).

When you de-select the Update key (but do not freeze the scan), you cannot adjust some of the 2D image controls. The following table lists the image controls that can and cannot be adjusted when Update is not selected.

Availability of 2D Image Controls When Update Disabled

Available	Not Available	
Exam	Depth	TGC curve
Frequency	Focus	Sector width
Noise Rejection	Gain	Map
	Left/Right invert	Colorization
	Up/Down invert	Persistence

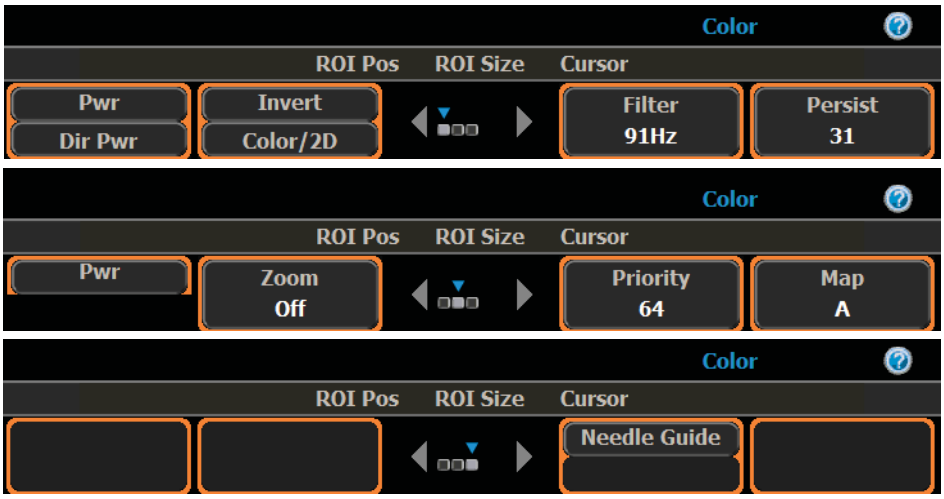
To toggle the 2D window between live and frozen, press the Update key.

Using Color Image Controls

When you select Color mode, the Terason software displays softkeys and a Gain Knob menu for Color mode.

To use Color mode image controls, see the following topics:

- Using the Gain Knob in Color Mode on page 81
- Special Trackball Responses to Color Mode on page 81
- Adjusting the Scan Area on page 81
- Adjusting Scale on page 82
- Inverting the Doppler Display (Color Invert) on page 83
- Adjusting the Color Gain on page 84
- Adjusting the Color Priority on page 84
- Adjusting the Color Persistence on page 84
- Adjusting the Color Baseline on page 85
- Choosing a Color Map on page 85



Color Mode Softkeys

Note: Softkey displays shown in this manual are examples. The displays on your system may be different.

Using the Gain Knob in Color Mode

The Active button in the center of the Gain knob controls which set of imaging controls displays. In Color mode, those are controls for 2D and Color modes. The currently-selected control set is displayed in blue above the softkeys. To select a different control set, press the Active button.

Special Trackball Responses to Color Mode

When Color mode is chosen, the Terason software automatically selects the ROI Position (ROI Pos), and moving the trackball changes the position. A click of the Select key above the trackball changes control to the ROI Size; and rolling the trackball shrinks or expands the ROI. When the ROI is in the correct position and is the correct size, click the Left Enter key to set the ROI. Pressing the Cursor key selects the ultrasound cursor, and the trackball controls the cursor position.

See Console Controls on page 27 for more information on using the console.

Adjusting the Scan Area

The size of the scan area (also referred to as the region of interest, or ROI) is one of the major controls that affect the frame rate. The smaller the scan area, the faster the frame rate. The larger the scan area, the slower the frame rate.

You can move the scan area by pressing the Select key, moving the ROI to a new position, and pressing the Left Enter key to anchor it. Pressing the Select key twice selects the ROI Size, and lets you resize and reshape it using the trackball.

You cannot move or resize the ROI when the image is frozen.

To move the region of interest, complete the following steps:

1. Press the **Select key** to select the ROI.

   The cursor disappears, and ROI Pos displays in blue above the softkeys.

2. Use the **trackball** to move the ROI.

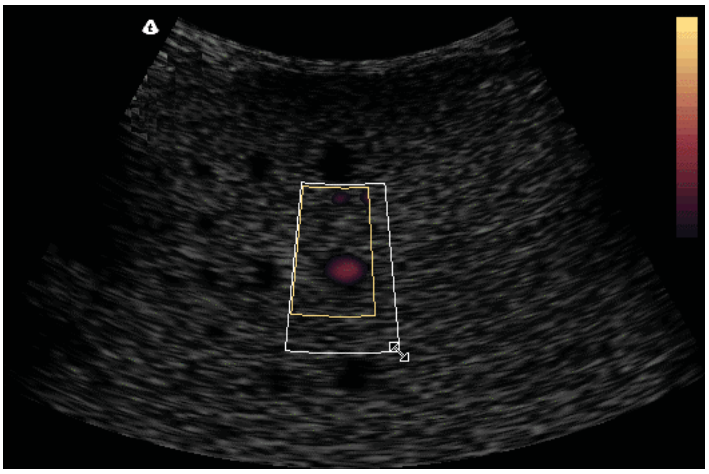
3. Press the **Left Enter key**.

To adjust the size of the region of interest, complete the following steps:

1. Press the **Select key twice** to select the ROI.

   The cursor disappears, the ROI outline becomes a dotted line, and ROI Size displays in blue above the softkeys.

2. Use the **trackball** to resize the ROI.



Resizing the Scan Area

3. Press the **Left Enter key**.

The Terason application may automatically adjust the PRF value when you move the region of interest to ensure that the maximum PRF is not exceeded for the new depth.

Adjusting Scale

Pulse Repetition Frequency defines the velocity range of the display, which manifests as scale. The maximum value (in kHz) for the PRF depends on the specific probe, and the location of the region of interest.

The PRF should be set high enough to prevent aliasing, and low enough to provide adequate detection of low flow. It may be necessary to vary the PRF during an exam, depending on the speed of the blood flow, or if pathology is present.

Aliasing occurs when the frequency of what you are observing exceeds one half of the sample rate. If the blood is moving faster than the pulse repetition rate, then the Doppler display will alias, or wrap-around, the baseline.

If the PRF is set too high, low-frequency shifts caused by low-velocity flow may not show.

As PRF increases, the maximum Doppler shift that can display without aliasing also increases.

You can only use this control when viewing a live image. When an image is frozen, you cannot change PRF.

To adjust the PRF value, use the Scale key.

The increment value for each click depends on the current range. For example, if the PRF setting is 4.0 kHz, each time you click the right or left arrow, the Terason software adds or subtracts 500 Hz from that value, until the selected value falls into a lower or higher range.

Increasing the PRF also increases the Thermal Index (TI) value (refer to "General Description of Indices" in Volume 2 of the *User Guide* for more information about thermal indices).

Inverting the Doppler Display (Color Invert)

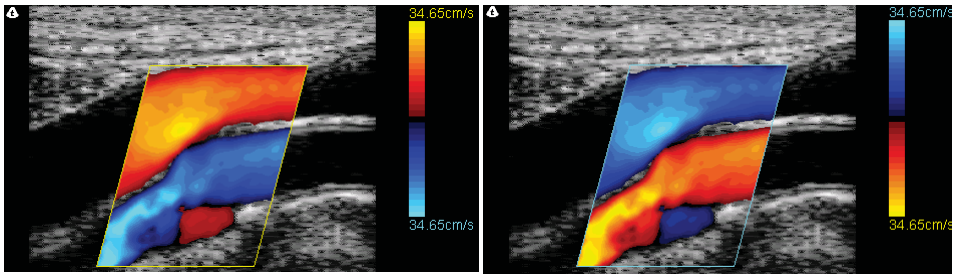
In Color Doppler, you can invert the color scale.

Normally, the color red is assigned to positive frequency shifts (flow toward the probe), and blue is assigned to negative frequency shifts (flow away from the probe). This color assignment can be reversed by pressing the Invert softkey. Flow toward the probe is always assigned the colors of the top half of the color bar, and flow away from the probe is assigned the colors of the bottom half of the color bar.

When you press the Invert softkey, the Color Doppler reference bar and the color of the scan data within the Region of Interest are both inverted.

Invert may be used when scanning the internal carotid artery (ICA), for example. In general, flow in this vessel goes away from the probe. If Invert is enabled, the ICA flow displays in shades of red. The color bar displays shades of blue on the top half, and shades of red on the bottom.

To invert the Doppler colors, press the Invert softkey:



Color Invert Not Selected Color Invert Selected

Effects of the Color Invert Softkey

Notice that the colors on the reference bar are also inverted.

The figure above should be viewed in color; when printed in black and white, the effect may be obscured.

Adjusting the Wall Filter

Doppler systems use a wall filter (high pass frequency filter) to eliminate unwanted low-frequency, high-intensity signals (also known as clutter) from the display. Clutter can be caused by tissue motion or by rapid movement of the probe.

Raising the wall filter setting reduces the display of low velocity tissue motion. Lowering the wall filter setting displays more information. However, more wall tissue motion is also displayed.

The wall filter setting should be set high enough to ensure that Color Doppler flash artifacts from tissue or wall motion are not displayed, but low enough to display slow flow. If the wall filter is set too high, slower flow may be not seen.

Set the wall filter setting higher for applications where there is significant tissue motion, or in instances where the probe is moved rapidly while scanning in Color Doppler mode. Set the wall filter setting lower for small parts or instances where flow is slow but there is not much tissue motion.

Use a wall filter setting that is high enough to remove clutter but low enough to display Doppler information near the baseline.

To adjust the wall filter value, use the Filter softkey. The current value displays on the softkey and on the Image Information area of the Imaging window (as a number following "WF").

The wall filter range is from 1% to 50% of the Scale value.

Adjusting the Color Gain

Color gain can be increased to correct an inadequate fill of color within a vessel, and decreased to correct an unacceptable amount of color outside of a vessel.

You can adjust the color gain to increase or decrease the amplification of the returning signal being played or displayed. There is no indicator in the scan properties list for Color gain like that for 2D gain.

To change the color gain, turn the Gain knob to the left (decrease) or right (increase).

Adjusting the Color Priority

The color priority of the image defines the amount of color displayed over bright echoes, and helps confine color within the vessel walls. Color priority affects the level at which color information overwrites the 2D information. If you must see more flow in an area of some significant 2D brightness, increase the color priority. To better contain the display of flow within the vessels, decrease the color priority. If the color priority is set to zero, no color is displayed.

To change the color priority, use the Priority softkey. The current Color Priority setting shows on the softkey display.

Adjusting the Color Persistence

The color persistence setting determines the amount to be averaged between frames. Increasing the persistence causes the display of flow to persist on the 2D image. Decreasing the persistence allows better detection of short duration jets, and provides a basis for better flow/no flow evaluations. Adjusting color persistence also produces better vessel contour depiction.

To change the color persistence, use the Persist softkey. The current Color Persistence setting shows on the softkey display.

Adjusting the Color Baseline

Color baseline adjustments are usually unnecessary. The baseline refers to the zero baseline within the Color Doppler image. To adjust it, move the baseline down to display more positive flow (forward) and move the baseline up to display more negative flow (reverse). This adjustment can be used to prevent aliasing in either direction.

To move the color baseline, use the Baseline key. The current setting of the baseline shows on the Color Doppler reference bar.

You can see the effect of your change on the color reference bar. If the bar is not visible, select **Setup** > **General** > **Reference Bar** to add it to the image display.

Choosing a Color Map

The Map softkey chooses one of five color maps to show Color Doppler data. You can configure the color map independently for each exam by selecting an exam, then a color map. When you select a different exam, the Terason software loads the color map for the selected exam.

The color maps are designated A through E. Some maps use more colors than others, and some display in a smoother gradient than others.

To select a color map, use the Map softkey. The current map letter shows in the softkey display.

Scanning in Triplex Mode

Triplex scan mode combines Pulsed-Wave Doppler scanning with Color Doppler scanning.

To activate Triplex scanning, select Color Doppler mode, then press the PW key on the console.

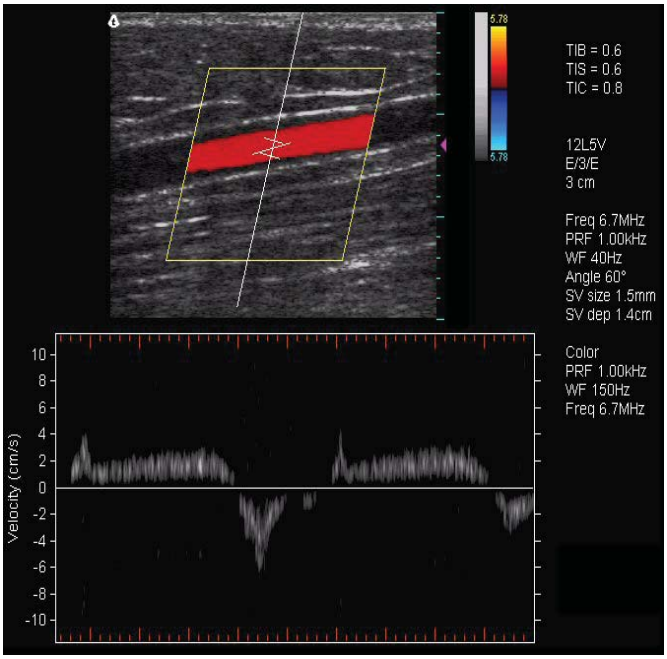
Note: In Triplex scanning only, the PRF value is tied to the setting on the 2D mode (Color Doppler). If you change the PRF value in one mode, the Terason software also changes the PRF value in the other mode. This depends on whether you are scanning in simultaneous or non-simultaneous mode, which is controlled by the Update console key. See Updating the Displays on page 79.

To adjust image controls for Triplex scanning, first adjust the image controls for the 2D scan mode, then go to the Color Doppler window and press the Cursor key to select the PWD ultrasound cursor and Sample Volume location.

Some of the 2D image controls cannot be adjusted when scanning in Triplex, so you must adjust the image controls in 2D mode (described in Using 2D Image Controls on page 65). You can only adjust these image controls during live scanning. When you freeze a scan,

the Terason software replaces the softkeys with a different set, for printing and making annotations and measurements on the scan image. (See Working with Annotations on page 54 and Chapter 5, Working With Measurements, on page 88).

The application adds the Time Series window for PWD to the 2D image.



Live Triplex Scan

Adjusting the ROI and Range Gate

When scanning in Triplex mode, you can move the region of interest, adjust its size, or move the range gate.

To move the region of interest, complete the following steps:

1. Press the **Select key** to select the ROI.
2. Use the **trackball** to move the ROI.
3. Press the **Left Enter key**.

To adjust the size of the region of interest, complete the following steps:

1. Press the **Select key twice** to select the ROI.
2. Use the **trackball** to resize the ROI.
3. Press the **Left Enter key**.

To move the range gate, complete the following steps:

1. Press the **Cursor key**.
2. Use the **trackball** to set the range gate.
3. Press the **Left Enter key**.

Using Image Controls in Triplex

When Triplex scanning, the PW softkeys are available.

The Image Information display shows two PRF values in Triplex mode. The Terason software sets the Color PRF to an integral fraction (1/2, 1/3, 1/4, etc.) of the PWD PRF. If you change the PRF value in one mode, the Terason software changes the other PRF setting as well.

You can independently set the Wall Filter for the 2D and PWD scans.

Using the Gain Knob in Triplex Mode

The Active button in the center of the Gain knob controls which set of imaging controls for the active modes displays. In Triplex mode, those are controls for 2D, Spectral, and Color modes. The currently-selected control set is displayed in blue above the softkeys. To select a different control set, press the Active button.