1 About the Terason Ultrasound System

Overview

The Terason Ultrasound System is an easy-to-use, portable ultrasound system that produces high resolution images.

The microminiaturized ultrasound system runs under the standard Windows interface for easy navigation. You can also connect the system to a printer for image output.

This section of the Terason User's Guide includes the following topics:

Caution: Some actions can expose the Ultrasound System computer to attack by viruses. These actions include: installing non-Terason software, connecting a USB drive, and connecting the system to a network. If you intend to perform any of those actions, or any other action that might expose the computer to a virus, Terason strongly recommends that you install an effective anti-virus software package. Terason has found that Norton AntiVirus v.9 or above and Microsoft Security Essentials are compatible with the Terason Ultrasound System.

Caution: Terason tests the installed version of Windows for safety, stability, and compatibility with the imaging software. The Windows Update function is disabled to prevent changes that might affect that stability and compatibility. Do not enable Windows automatic updates without first contacting Terason.

Indications For Use

The Terason Ultrasound System is a general-purpose imaging system intended for use by qualified physicians for analysis by ultrasound imaging or fluid-flow of the human body. Specific clinical applications and exam types include: Fetal, Abdominal, Intra-Operative (abdominal, organs and vascular), Pediatrics, Small Organ (Thyroid, Breast, Testes); Neonatal and Adult Cephalic; Trans-rectal, Trans-vaginal, Musculoskeletal (Conventional and Superficial); Cardiac (Adult & Pediatric); Peripheral Vascular.

For Diagnostic Ultrasound Indications for Use forms for the probes offered with the Terason ultrasound system, see Volume 2 of the *User Guide*.

Caution: The Terason uSmart3300 is for prescription use only.

Caution: Federal law restricts this device to sale by or on the order of a physician. The Terason system should only be used in a medical facility under the supervision of a trained physician.

Caution: Do not use the Terason Ultrasound System during an MRI exam or when using a defibrillator.

Warning: To avoid injury, make sure the Ocular preset is selected before beginning any scan of the eye. The FDA has established lower acoustic energy limits for ophthalmic use (see Indications For Use on page 15), and if the Ocular preset is selected, the system will not exceed those limits.

About Ultrasound Modes

Ultrasound is primarily an operator-dependent imaging technology. The quality of images and the ability to make a correct diagnosis based on scans depend on precise image adjustments and adequate control settings applied during the exam. The Terason software provides tools to optimize the image quality during a patient scan for all image modes.

The Terason Ultrasound System can be licensed with different levels of features. The following table lists which scan modes come with each version.

Terason Scan Mode Availability

Mode	Basic	Standard	Advanced	Optional
2D Mode	X	X	X	
M-Mode (Motion Mode)	X	X	X	

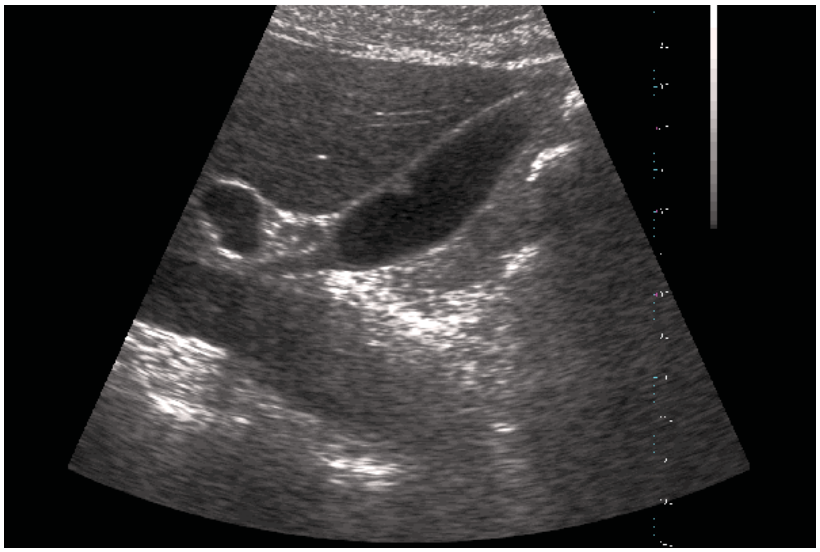
Terason Scan Mode Availability

Mode	Basic	Standard	Advanced	Optional
Triplex		X	X	
Color Doppler			X	
Pulsed-Wave Doppler			X	
Continuous-Wave Doppler		X		X
Omni Beam				X
DICOM Image Transfer				X

2D Mode

The Terason Ultrasound System delivers 2-dimensional digital imaging using 256 digital beam-forming channels. This imaging mode delivers excellent image uniformity, tissue contrast resolution, and steering flexibility in frequencies from 2 MHz to 12 MHz. The high channel count supports true phased array and high-element count imaging probes.

The 2D scan data displays in the 2D Imaging window. The figure below shows a sample 2D obstetrical scan.



Example 2D Scan

To use 2D, see:

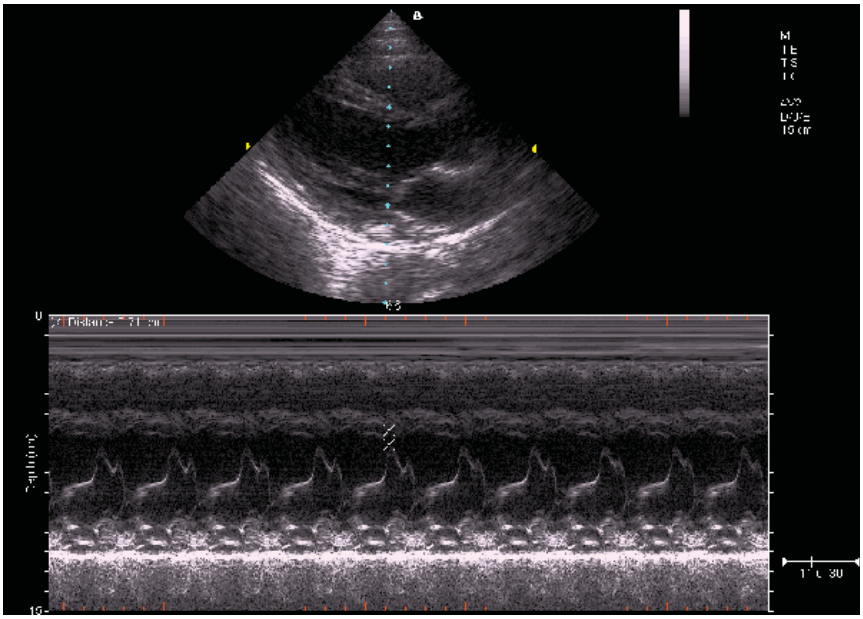
- Acquiring Images on page 43
- Using 2D Image Controls on page 65
- Measuring in the 2D Window on page 89

M-Mode (Motion Mode)

The Terason Ultrasound System provides simultaneous 2-dimensional (2D mode) and M-Mode imaging. This combination is valuable for the efficient assessment of moving structures.

Use M-Mode to determine patterns of motion for objects within the ultrasound beam. Typically, this mode is used for viewing motion patterns of the heart.

M-Mode displays scan data of the anatomy in the 2D Imaging window, and the motion scan in the Time Series window. The following figure shows a sample M-Mode scan.



Example M-Mode Scan

For more information on using M-mode, see:

- Acquiring Images on page 43
- Using M-Mode Image Controls on page 72
- Measuring in the M-Mode Window on page 94

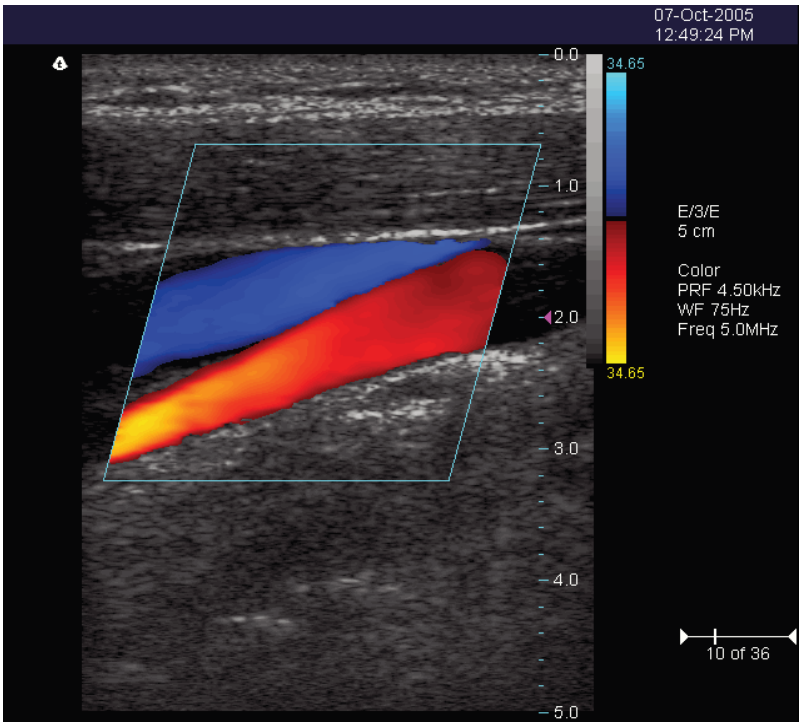
Color Doppler

Color Doppler mode is used to detect the presence, direction, and relative velocity of blood flow by assigning color-coded information to these parameters. The color is depicted in a region of interest (ROI) that is overlaid on the 2D image. Non-inverted flow towards the probe is assigned shades of red, and flow away from the probe displays in shades of blue. The mean Doppler shift is then displayed against a grayscale scan of the structures.

All forms of ultrasound-based imaging of red blood cells are derived from the received echo of the transmitted signal. The primary characteristics of this echo signal are its frequency and its amplitude (or power). The frequency shift is determined by the movement of the red blood cells relative to the probe – flow towards the probe produces a higher-frequency signal than flow away from the probe. Amplitude depends on the amount of moving blood within the volume sampled by the ultrasound beam. You can also apply a high frame rate or high resolution to control the quality of the scan.

Higher frequencies generated by rapid flow are displayed in lighter colors, and lower frequencies in darker colors. For example, the proximal carotid artery is normally displayed in bright red and orange, because the flow is toward the probe, and the frequency (velocity) of flow in this artery is relatively high. By comparison, the flow in the jugular vein displays as blue because it flows away from the probe.

The Color Doppler scan data displays in the 2D Imaging window. The following figure shows a sample Color Doppler scan.



Example Color Doppler Scan

For more information on using Color Doppler, see:

- Acquiring Images on page 43
- Using Color Image Controls on page 80

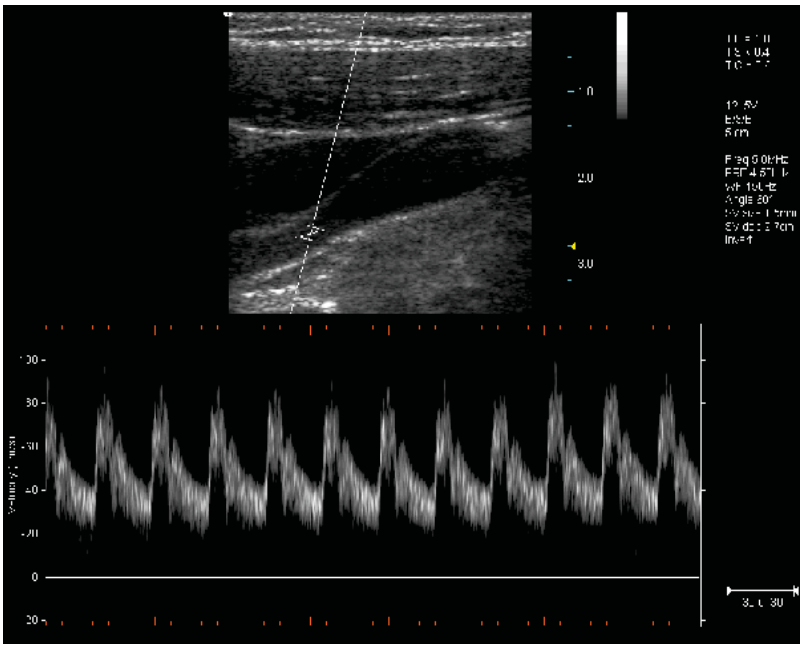
Pulsed-Wave Doppler

A Pulsed-Wave Doppler (PWD) scan produces a series of pulses used to study the motion of blood flow in a small region along a desired scan vector, called the sample volume or sample gate.

The X-axis of the graph represents time, and the Y-axis represents Doppler frequency shift. The shift in frequency between successive ultrasound pulses, caused mainly by moving red blood cells, can be converted into velocity and flow if an appropriate angle between the insonating beam and blood flow is known.

Shades of gray in the spectral display represent the strength of the signal. The thickness of the spectral signal is indicative of laminar or turbulent flow (laminar flow typically shows a narrow band of blood flow information).

In the Terason Ultrasound System, Pulsed-Wave Doppler and 2D are shown together in a mixed-mode display. This combination lets you monitor the exact location of the sample volume on the 2D image in the 2D Imaging window, while acquiring Pulsed-Wave Doppler data in the Time Series window.



Example Pulsed-Wave Doppler Scan

In the 2D scan, the long line lets you adjust the ultrasound cursor position, the two parallel lines (that look like =) let you adjust the sample volume (SV) size and depth, and the line that crosses them lets you adjust the correction angle.

For more information on using Pulsed Wave Spectral Doppler, see:

- Acquiring Images on page 43
- Using Spectral Doppler Image Controls on page 73
- Measuring in Spectral Doppler Modes on page 95

Continuous-Wave Doppler

Continuous-Wave Doppler scans display all velocities present over the entire length of the ultrasound cursor. This is useful for imaging very high velocities such as those resulting from a leaking heart valve.

As with Pulsed-Wave Doppler scans, the X-axis of the graph represents time, and the Y-axis represents Doppler frequency shift.

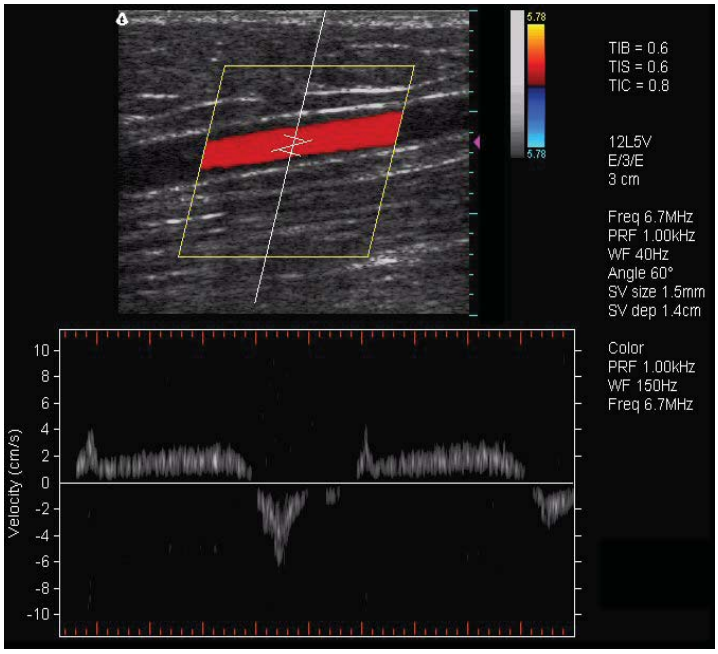
For more information on using Continuous-Wave Spectral Doppler, see:

- Acquiring Images on page 43
- Using Spectral Doppler Image Controls on page 73
- Measuring in Spectral Doppler Modes on page 95

Triplex

Triplex scan mode is available only with the Advanced version of the Terason software. Triplex scan mode combines simultaneous or non-simultaneous Doppler imaging (Color Doppler) with Pulsed-Wave Doppler imaging to view arterial or venous velocity and flow data. Triplex allows you to perform range-gated assessment of flow.

Triplex applications include vascular studies, phlebology, perinatal, and radiology. The following triplex image example shows the greater saphenous vein.



Example Triplex Scan

For more information on using Triplex mode, see:

- Acquiring Images on page 43
- Scanning in Triplex Mode on page 85

TeraVision

TeraVision is an optional image-optimization package that sharpens images produced by the Terason Ultrasound system.

See Enhancing the Image Using TeraVision™ Optimization on page 53

DICOM Image Transfer

To understand using DICOM image transfer, see Using Studies with a DICOM Server on page 138.

Support for Medical Procedures

The Terason Ultrasound System can be configured with needle guides used for tissue biopsy, fluid aspriation, amniocentesis, and catheter placement. The system can also be incorporated into cryoablation (or targeted ablation) and brachytherapy products from other vendors. The Terason Ultrasound System scans the anatomy or vessel for size, location, and patency, and provides guide lines between which the needle will appear.

For biopsy and vascular puncture applications, a needle guide kit directs needles to the proper location for percutaneous vascular punctures and nerve blocks. The needle guide allows you to direct the needle into the center of a vessel or tissue mass, helping to avoid adjacent vital tissue. You can see the anatomy in real time before, during, and after the procedure, and can save images and Cine loops for future reference.

For cryoablation or brachytherapy applications, the system may include an insertion template and a stepper or stabilizer. The procedure for these applications is defined by the company that provides those systems. The Terason software displays the insertion grid and needles on the scan to show the progress of the procedure.

You can use the needle guides in the following modes:

- 2D Mode, see page 16
- Color Doppler, see page 17
- M-Mode (Motion Mode), see page 16

See Performing Medical Procedures on page 127 for information on using the Terason Ultrasound System to perform biopsies.

Terason Probes

The Terason Ultrasound System consists of the probe, electronics envelope, and the Terason software. All of the Terason probes can be used with all scan modes.

For a list and specifications of Terason probes, see “System Specifications” and “Indications For Use” in Volume 2 of the *User Guide.*

Using the Terason Cart

Terason offers a special cart to support the uSmart3300 ultrasound system. To use the cart, the system must be properly mounted to it

Mounting the System On the Cart

To secure the uSmart3300 to the cart:

1. Fold up the **two feet** on the bottom of the system.
2. Place the system on the inclined shelf, with the **two feet resting in the two depressions** in the shelf.
3. Secure the **lock** to the system and the cart.

To mount the power supply on the cart:

1. Place the **power supply** in the open space under the cart shelf.
2. Pass the **DC cable** from the open side of the power supply space to the system, and the **AC cable** from the other open side of the power supply space to the AC power outlet.
3. Push all excess length of the **DC and AC cables** into the space under the shelf.

Warning: To prevent injury and equipment damage, do not overload the cart. No more than 25 Lbs (11.4 Kg) of equipment and other material should be placed on the cart. Do not lean on the cart.

Moving the Cart

Before moving the cart, all parts of the system and any accessories must be securely attached to the cart so that they cannot slide off or drag on the floor.

To prepare the cart for moving:

1. Make sure the **system and power supply** are properly secured, as described in Mounting the System On the Cart on page 21.
2. Disconnect the **AC cable** from the power mains, and coil the cable on the hook at the rear of the cart so that it cannot drag on the ground.
3. Firmly seat **probes** in the holders at the rear of the cart. Coil their cables on the hooks at the sides of the cart so that they cannot drag on the ground.
4. Firmly seat **gel bottles** in the holders at the sides of the cart shelf.
5. Remove all **loose items** from the shelf and place them in the bin below it.
6. Grasp the handle at the front of the cart and release the **wheel brakes**.

Warning: To prevent injury and equipment damage, always grasp the ultrasound cart firmly when moving it. Do not park the cart on an incline, and when you do park it, set the wheel brakes.

When transporting the cart, the cart top must be in its lowest position. When transporting the cart over irregular surfaces, such as thresholds, the cart should be grasped firmly by the handle and pulled over these irregular surfaces.

Always secure the system, power supply, probes, and any accessories to the cart before moving the cart.

Using the Probe Multiplex Option

If you purchased the cart with the probe multiplex option, you can have up to three probes connected at the same time.

To connect the multiplex unit to the system:

1. Make sure the system is **shut down**.
2. Connect the **multiplex jumper cord** to the system probe port, just as you would a probe cord.
3. Power up the **system**.
4. Connect a probe or probes to the multiplex unit **probe ports**.

   You do not have to power down the system when connecting or disconnecting probes to the multiplex unit.

   The system automatically detects probes connected to the multiplex unit. When more than one probe is connected, a Probe button appears on the scanning window.
5. Tap the Probe button on the screen to cycle between connected probes.

   The selected probe name displays at the top right of the scanning window.

Imaging, Patient, Report, and Review Windows

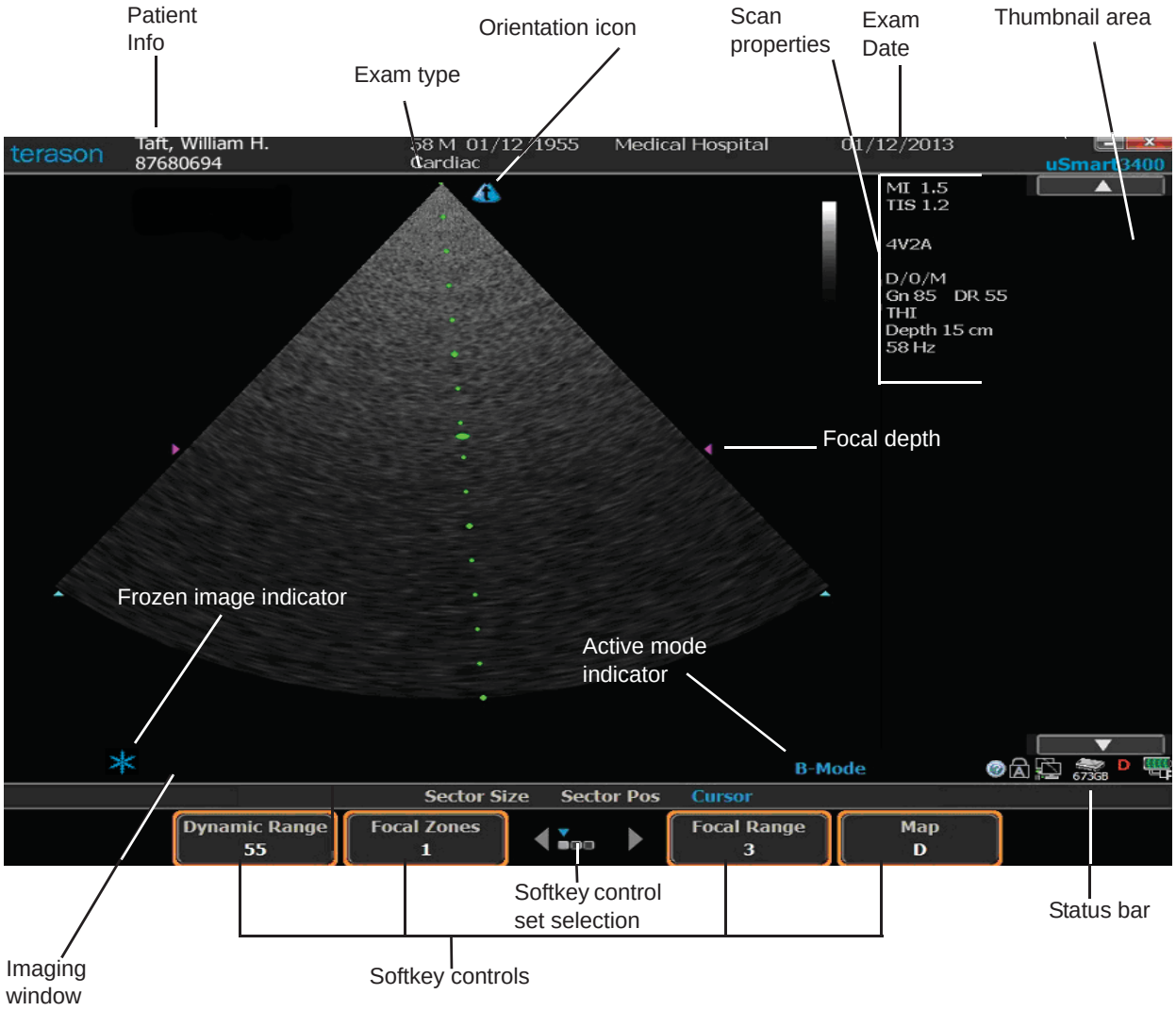
These windows use the same space on the computer screen. Press the appropriate key to open that window.

To use these windows, see:

- Imaging Window on page 23
- Status Bar on page 24
- Working With Scan Modes on page 64
- Setting Up Patient Information on page 32
- Reviewing Patient Studies on page 115

Imaging Window

When you start the Terason software, the Imaging window displays.



Terason Imaging Window

The Imaging window consists of the 2D window above the Time Series window (if the selected scan mode generates a Time Series window). The 2D window displays in all scan modes; the Time Series window displays only when scanning in M-Mode, PWD mode, CWD mode, or Triplex mode.

If a control, button, key, or menu shows in gray, it usually means that the function is not available for the current circumstances.

For details of the imaging information display, see Status Bar on page 24 and Scan Properties Display on page 25.

Status Bar

The Imaging screen includes a status bar at the lower right corner.

Status Bar

The status bar displays the following indicators, from left to right:

Help button - click this to open the Help file.

Caps lock - shows if the Caps key is depressed. If the Caps key is not depressed, this space is empty.

Network connection - shows if the computer is connected to a network. If there is no connection, a red X shows on the indicator.

Disk free space - shows how much free space is left on the computer hard drive.

DICOM status - shows whether the connection to a DICOM server is active, and whether sending of any studies to the DICOM server has failed. See DICOM Status Indicator on page 139 for a full explanation of this indicator.

System power - shows the remaining charge of the system battery, and whether the AC power supply is connected. In the illustration, the battery is fully charged, and the system is connected to an AC power source. As the battery discharges, the green bands disappear, from right to left. When the battery is almost fully discharged, a single red band shows at the left end of the indicator. When the battery is partly discharged and the AC power supply is connected, a yellow lightning bolt shows on the battery icon. When the battery is full charged and the AC power supply is connected, a power plug icon displays below the battery icon.

Minimize and Exit Buttons

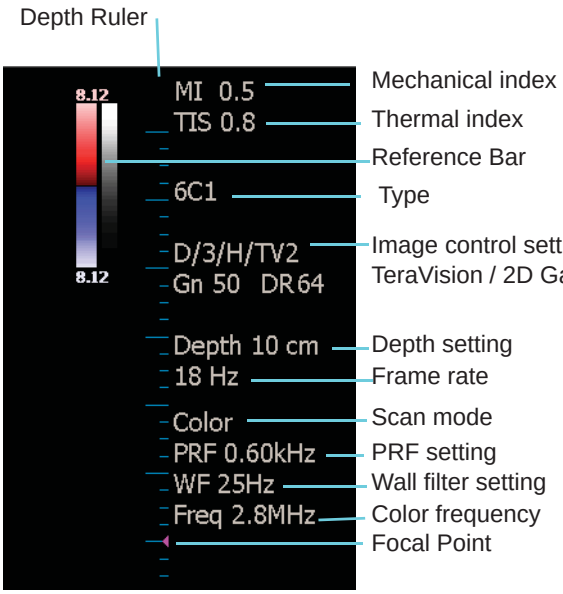
Two buttons at the top right corner of the screen let you hide or close the Terason ultrasound window.

Minimize button - click this to hide the Terason Ultrasound screen and view the Windows desktop. To return to the Terason Ultrasound screen, press alt-tab on the computer keyboard.

Exit button - click this to exit the Terason Ultrasound program. To restart the Terason Ultrasound program, double-click the ultrasound icon on the Windows desktop.

Scan Properties Display

The Imaging window includes a text display that shows information about the current scan. The image control settings displayed vary, depending on the scan mode and other factors.



Scan Properties Display (*Example*)

* The 2D gain display is initially 50. This is not an absolute value; the actual gain changes with different presets, but always displays as 50 initially. When you change the gain using the Gain knob, the displayed value goes up or down.

When the Cardiac exam type is selected, the depth ruler and focal depth indicator are on the ultrasound cursor, as shown in the figure Terason Imaging Window on page 24.

See Chapter 4, Working With Scan Modes, on page 64 for explanations of how to change settings.

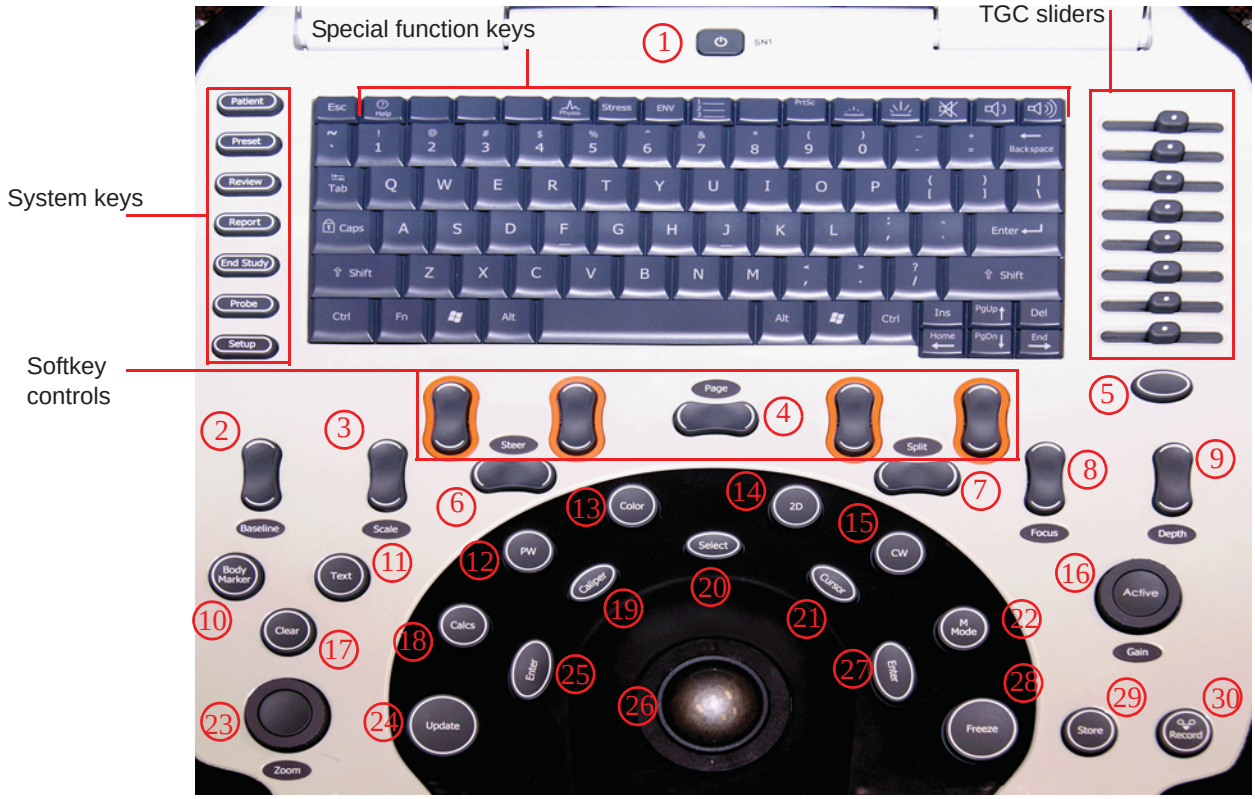
Review Window

You can view a saved study in the Review window. While reviewing a saved study, you can add annotations and measurements in the same way as on the Imaging window. See Working with Annotations on page 54 and Working With Measurements on page 88.

Note: The text home position set in the Imaging window does not apply to the Review window. The text home position set in the Review window does not apply to the Imaging window.

The uSmart3300 Console

A console houses controls that configure and operate the Terason Ultrasound system.



1: Power button
2: Baseline key
3: Scale key
4: Page key
5: Unassigned
6: Steer key
7: Split key
8: Focus key
9: Depth key
10: Body Marker key
11: Text key
12: PW mode key
13: Color mode key
14: 2D mode key
15: CW mode key
16: Gain/Active control
17: Clear key
18: Calcs key
19: Caliper key
20: Select key
21: Cursor key
22: M-Mode key
23: Zoom control
24: Update key
25: Left Enter key
26: Trackball
27: Right Enter key
28: Freeze key
29: Store key
30: Record key

Terason Console

Console Controls

The console includes an alphanumeric keyboard, a group of system keys, TGC sliders, softkey controls, and numerous controls for ultrasound imaging functions.

Ultrasound Imaging Controls

The numbered controls in the illustration Terason Console perform the functions listed below:

1. **Power**: Starts the system and shuts it down.

2. **Baseline**: Changes the Doppler baseline in PW, CW and Color Doppler modes. Pressing the top of the key moves the baseline up, and pressing the bottom of the key moves it down.
3. **Scale**: Changes the velocity scale (by changing the PRF) in PW, CW and Color Doppler modes. Pressing the top of the key increases the PRF, and pressing the bottom of the key decreases it.
4. **Page**: Changes which set of active softkeys are displayed.
5. This key is currently unassigned.
6. **Steer**: In 2D, Color Doppler or PWD modes, this key steers the ultrasound signal. Pressing the left end of the key steers left, and pressing the right end steers right.
7. **Split**: Pressing the left end of the key opens split-screen with the left screen active, or when split screen is already on, makes the left screen active. Pressing the right end of the key opens split-screen with the right screen active or makes the right screen active. Pressing the end of the key that corresponds to the active screen exits split-screen.
8. **Focus**: Changes the depth of the signal focus. Pressing the top of the key moves the focus up, and pressing the bottom of the key moves it down.
9. **Depth**: Changes the total image depth. Pressing the top of the key moves the image depth up, and pressing the bottom of the key moves it down.
10. **Body Marker**: Inserts body markers in the scan.
11. **Text**: Enables text entry and annotation on the scan.
12. **PW**: Enters and exits Pulsed-wave Doppler mode.
13. **Color**: Enters and exits Color Doppler mode.
14. **2D**: Enters 2D mode.
15. **CW**: Enters and exits Continuous-wave Doppler mode.
16. **Gain/Active**: Turning the knob changes the gain. Pushing the Active button toggles between the active scanning modes and the softkeys associated with those modes.
17. **Clear**: Erases the currently selected annotation or measurement.
18. **Calcs**: Opens the Calculations menu.
19. **Caliper**: Starts a generic measurement. Pressing the key repeatedly cycles through available calculations.
20. **Select**: Chooses a trackball function. The selected function is highlighted in blue above the softkey display.
21. **Cursor**: Selects and displays or deselects and hides the ultrasound cursor.
22. **M-Mode**: Enters and exits M-Mode.
23. **Zoom**: Push to enter ROI box Zoom, or exit Zoom mode. Turn for Quick Zoom
24. **Update**: Turns updating of the 2D image on and off in PWD and CW modes.
25. **Left Enter**: Selects and deselects items. When the Windows screen is active, the Left Enter key acts like the left button on a mouse.

26. **Trackball**: Controls movement of the cursor, the ROI, and other features.
27. **Right Enter**: Opens context menus.When the Windows screen is active, the Right Enter key acts like the right button on a mouse.
28. **Freeze**: Freezes and unfreezes the scan.
29. **Store**: Stores a single-frame image.
30. **Record**: Stores a loop.

System Keys

At the top left of the console is a group of system keys that control what the windows are active. They are:

- **Patient** – Opens the Patient window
- **Preset** – Opens the Preset menu
- **Review** – Opens the Review window
- **Report** – Opens the Report window
- **End Study** – Closes the current study
- **Probe** – Opens the Imaging window
- **Setup** – Opens the Setup window

Special Function Keys

At the top center of the console is a keyboard that includes the standard set of computer keys, except for the Function keys. A special set of function keys comprises the top row of the keyboard. These special keys are:

- **Help** – Opens the online Help file
- **PrtScr** – Copies the screen to the Windows clipboard
- Reduces screen brightness
- Increases screen brightness
- Mutes sound volume
- Decreases sound volume
- Increases sound volume

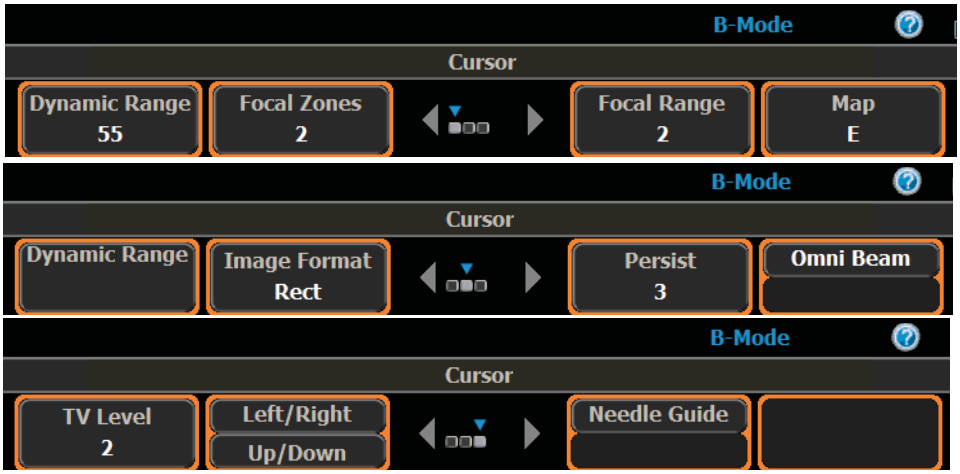
Softkeys

The keys just below the keyboard control the functions of the softkeys displayed across the bottom of the Imaging window. The softkey functions are dependent on what probe is connected, which scanning mode is chosen, and whether the scan is live or frozen.

The illustrations below show examples of the softkeys when the image is live and frozen.

Note: The softkeys the system displays depend 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.**

Example Softkeys



Example Live Image Softkeys

Example Frozen Image Softkeys

Beep Codes

The Terason Ultrasound system produces beeps when certain events occur. The following list explains the meaning of the different beep codes.

- **Two short beeps**: Produced when a probe is connected or disconnected, or when the system is started with a probe already connected.
  This is only a notification; it is safe to use the system.
- **Eight beeps**: Produced when communication between the computer and the ultrasound engine is lost.
  If the imaging function resumes, it is safe to use the system. If the imaging function does not resume, restart the ultrasound software. If the error persists, stop using the system and contact Terason Technical Support.
- **Two-tone beeps**: Indicates that the system detected and corrected an internal transmitter timing error.

It is safe to continue using the system. Freezing or unfreezing the scan turns the beeping off. If this occurs frequently, contact Terason Technical Support.

- **Continuous short beeps**: Produced when the system reaches an internal temperature of 72° C. The beeping stops when the internal temperature falls to less than 72° C.
  It is safe to continue using the system, but if the internal temperature rises to 80° C, the system shuts down.

Note: If the system continues to emit continuous short beeps even after it has cooled down, disconnect the power-supply cord from the computer. Wait a few minutes, then reconnect the power-supply cord.

Equipment List

The Terason Ultrasound System may include the following hardware:

- Terason uSmart3300 Ultrasound System.
- Online *Terason Ultrasound System User Guide* (this document)
- CD-ROMs containing the operating system and Terason ultrasound imaging software
- One (1) power cord
- Medical grade AC/DC power adapter (Protek PMP120-13-2.)
- ECG module
- ECG lead set - 10 sets of electrodes
- Cart
- Footswitch (Kinessis FS20A-USB-UL)
- Printer (the only approved printer is the Sony UPD-897 medical-grade printer.)
- One or more probes:

Warning: Using accessories, probes, or cables other than those specified, with the exception of those sold by the manufacturer as replacement parts for internal components, may result in increased electromagnetic emissions or decreased EMI immunity of the Terason Ultrasound System.

System Warranty

The warranty period for the Terason Ultrasound System is twelve (12) months, but you can purchase an extended warranty. To obtain warranty service, U.S. customers call Terason at 1-866-TERASON (1-866-837-2766); International customers call 781-270-4143.

The warranty on the Terason Ultrasound System is voided if unauthorized personnel perform service or maintenance on the ultrasound system, except for those service or maintenance actions specifically designated for local service technicians. To ensure correct system performance and to protect your warranty, contact Terason for service.