

**Vetus 5/Vetus 5S/Vetus 5T/Vetus 5Pro/Vetus
5Exp/Velite 5/Velite 5S/Velite 5T/Velite 5Pro/Velite
5Exp**

Veterinary Diagnostic Ultrasound System

Operator's Manual

[Advanced Volume]

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2. The contents of this manual are subject to change without prior notice and without our legal obligation.

Preface

This manual details the procedures for operating the Veterinary Diagnostic Ultrasound System. Carefully read and understand the manual before using the system to ensure its safe and correct operation.

NOTE: When operating the system, refer to the following manual: Operator's Manual (Basic Volume)
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Depending on the software version, the preset settings and optional configuration, the actual interfaces may appear differently from those shown in this manual.

NOTE: The functions described in this manual are not provided for all systems sold in all regions. The functions available depend on the specific system purchased.

All the menus and screens in this manual take the system in full configuration as an example.

Safety Precautions

1. Meanings of Signal Words

In this manual, the signal words  **Danger**,  **WARNING**,  **CAUTION** and **NOTE** are used regarding safety and other important instructions. The signal words and their meanings are defined as follows. Please understand their meanings clearly before reading this manual.

Signal word	Meaning
 Danger	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
 WARNING	Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.
 CAUTION	Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.
NOTE	Indicates a potentially hazardous situation that, if not avoided, may result in property damage.

2. Meaning of Safety Symbols

Symbol	Description
	General warning, caution, risk of danger.

3. Safety Precautions

Please observe the following precautions to ensure animal and operator safety when using this system.

 CAUTION:	1. Select the proper animal image and measurement tools. Only qualified professionals can decide the appropriate measurements and results. 2. Confine measurement calipers to the actual Region of Interest (ROI). Measurements that extend beyond the ROI will be incorrect. 3. Before examining a new animal, it is necessary to press the <End Exam> key to end the current scan and delete the animal information and data. Failure to do so will result in new animal data being combined with the previous animal's data. 4. When the system is turned OFF or the <End Exam> key is pressed, all unsaved data are lost. 5. Changing modes during a measurement will delete the General Measurement data. 6. Pressing the <Freeze> key to unfreeze the image during a measurement will clear the General Measurement data. 7. Pressing the <Measure> key during a measurement will clear the General Measurement data.
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8. Pressing the <Clear> key will clear the measurement caliper and all data in the result window, such as comments and body marks.
9. In dual-B imaging mode, the measurement results of the merged image can be inaccurate. Therefore, the results are provided for reference only, not for confirming diagnoses.
10. The quality of the extended image constructed in iScape (panoramic imaging) is dependent on the skill of the operator. Extra attention should be paid during the iScape measurement since the results could be inaccurate.
11. Ensure that measurement data correctly corresponds to the fetus during the Reproduction Measurement.
12. Fully understand the functionality of this system by referring to the *Operator's Manual - Basic Volume*.
13. When the result of auto trace does not match the image exactly, perform the measurement manually.

1 Overview

1.1 Basic Operations and Buttons

Tip: The following descriptions for buttons and keys are used in this manual:

- < >: Denotes a key/button on the control panel or keyboard. E.g. <Set>.
- []: Denotes a button/item on the screen menu or touch screen. E.g. [OK].

Click/Select [item/button]: to move the cursor over the item/button and press <Set>.

Basic Measurement Procedures

1. Press <End Exam> to end the last exam.
2. Press <Patient> and enter the animal information.

This includes animal ID, name, height, weight, etc. Enter manually for a new animal or load an existing animal from iStation or Worklist.

The animal information entered is used for measurement data storage, analysis and exam report. For more details, see “Exam Preparation → Animal Information” in the Operator's Manual [Basic Volume].
3. Press <Probe> and select a proper exam mode.

For more details, see “Select Exam Mode and Probe” chapter in the Operator's Manual [Basic Volume].
4. Measurement preset.

To preset measurement parameters, and general/application measurement packages, etc., see “2 Measurement Preset” for details.
5. Press <Measure> or <Caliper> to start measurement.
6. Select an item from the measurement menu or touch screen to start.

For general and application measurement items (tools), see chapter “3 General Measurement” of the specified application measurements for details.
7. Press <Report> to view the exam report.

For report editing and browsing, see “1.7 Report”.

Button Functions

Keys	Basic Operations
Measure	To enter/exit the application measurement. Press <Esc> to exit measurement status.
Caliper	To enter/exit the general measurement. Press <Esc> to exit measurement status.
Left/right Set key	To select an item in the measurement menu and press <Set> to activate it. Press <Set> to confirm and end the current operation during measurement.
Update	To switch between the fixed end and active end of the caliper during a measurement. In iWorks status, press to enter a measurement according to the prompt.

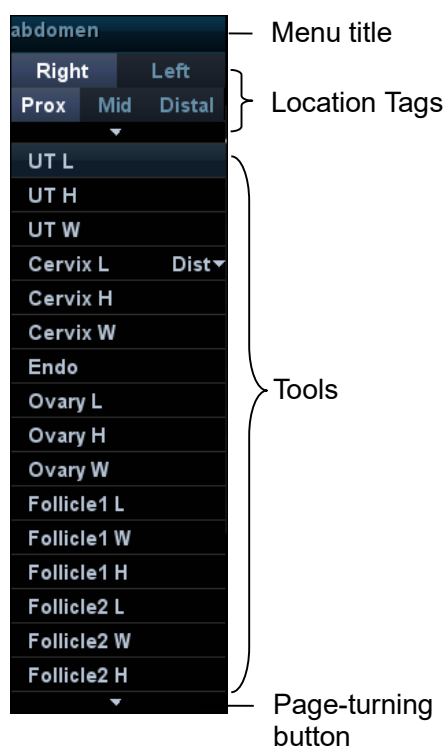
Keys	Basic Operations
Clear	Short press: to return to the previous measurement step or delete the caliper backwards. Long press: to clear all measurement calipers on the screen and data in the results window.
Report	To enter/exit the report page.
Cursor	To show/hide the cursor.
Trackball	To move the cursor.

For details on key functions, see “System Overview” chapter in the Operator's Manual [Basic Volume].

1.2 Measurement Menu

The General and Application measurement menus are different. For more information on the measurement menu, see “3 General Measurement” and the specified application measurement chapter.

- The measurement menu is as follows:



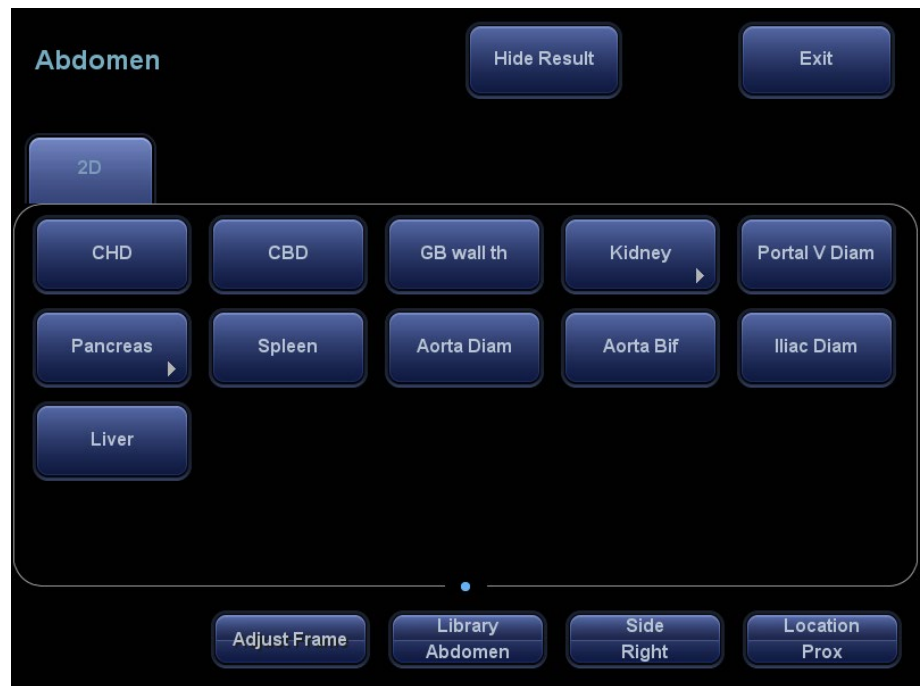
■ Touch screen display:

Measurement package

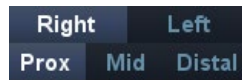
Mode

Tools

Knob-adjusting area



1.2.1 Measurement Location



The location widgets are used to select the measurement locations.

- Side (Left/Right): belongs to items (e.g., kidney) that contain measurements of left/right side parameters respectively.
- Location (Prox./Mid./Dist.): belongs to items (e.g., vascular) that contain measurements of Proximal, Middle or Distal parameters.
- Location (Far/near): belongs to items (e.g., carotid) that contain measurements of anterior or posterior parameters.
- Pole (U/M/L): belongs to items (e.g., some abdomen vessels) that contain measurements of upper, middle or lower parameters.

■ To Select the Measurement Location

- a) Move the cursor to the location widgets (e.g., Side).
- b) Press <Set> to select the Measurement location.

Or you can rotate the knob under the touch screen to adjust those controls, as shown in the following figure.



Tip: The location widgets are applicable only in the application measurements.

1.2.2 Measurement Tool

There are two kinds of measurement tools.

- General tools: basic measurement tools in General Measurement, such as the “distance” and “Area.”
- Application tools: the measurement tools in Application Measurement. These items are classified and combined in clinical application packages such as Abdomen, Reproduction, etc.

Tip:

1. Most application tools use the general measurement method while measuring. Only the application measurement results are recorded in the report.
2. For the definitions of measurement, calculation and study, see “1.3 Measurement, Calculation and Study.”

To Activate the Measurement Tool

The procedure is as follows:

1. Select the tool:
 - Move the cursor onto the tool on the measurement menu and press <Set>.
 - Or, touch the item on the touch screen to select the tool.
2. Perform the measurement according to the actual situation and hints on the bottom of the screen.
3. After finishing the measurement, perform the necessary operations.

Select Measurement Method Online

Some measurement tools have multiple methods to select.

1. Select item in the menu or the touch screen.
2. Click “” on the right side of the item on the menu to select the method, as shown in the following figure. (or select directly from the touch screen)

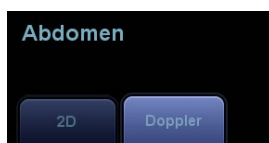


Other Features

Features	Descriptions
Current measurement tool/item	Highlighted.
Measured item	A performed application item/tool is marked with a “√.” (If one or some items in a submenu (extended menu) of a study are already performed, this study will be marked as measured.)
Page up/down	Use directional buttons to turn the pages.
Results window	Show/hide the results window by setting [Result] to “Hide” or “Show” on the touch screen.

1.2.3 Mode Switching

Touch the mode tab to switch to other measurement menus available for other modes.



1.2.4 Measurement Library Switching

- During application measurement, rotate the knob under [Library] on the touch screen to select from the available measurement libraries under the current probe of the current exam mode.
- Click menu title in the top-left corner of the screen to switch, as shown below:



Available measurement libraries can be preset. See “2.3.2.2 Measurement Package Preset” chapter for details.

1.3 Measurement, Calculation and Study

There are three kinds of measurement items.

Measurement

Results of measurements are directly obtained via the measurement tools, which are indicated by “” in the preset screen ([Setup]->[Measure]).

For example, “Distance” in the 2D general measurement or “Liver” in the Abdomen measurement.

Calculation

Results of calculations are automatically derived by the system using other measured or calculated values as parameters, they are indicated by “” in the preset screen ([Setup]->[Measure]).

For example, “Renal Vol” in the Abdomen measurement.

If all measurements related to a calculation tool are completed, the system will automatically calculate the result. If some measurement tools are performed again, the system will automatically update the calculation result using the latest measurement results.

Study

A group of measurements and/or calculations for a specific clinical application, which are indicated by “” in the preset screen ([Setup]->[Measure]).

For example, “Kidney” in the Abdomen measurement.

Fold/unfold the study to hide/show the measurement or calculation items included.

1.4 Measurement Caliper

A measurement caliper is a graphic consisting of several points and a straight line or curve drawn on the ultrasound image.

Fixed/Active End

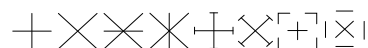
The ends of calipers can be active or fixed. The active end is called a Cursor.

Caliper Color

An active caliper appears green, while a fixed one appears white in the system default preset.

Caliper End Symbols

8 symbols are used as caliper ends, as shown in the figure below.



These symbols display in calipers as well as in the results window to identify different measurements.

NOTE: You can preset the cursor type in [Setup]->[System Preset] → [Application], see “2.2 Measurement Parameters Preset” for more information.

1.5 Results Window

The measurement window displays the conducted measurement's result and the engaging measurement in real time.

1.5.1 Results Display

Select [Result] to be “Show” on the touch screen and the latest results display in the results window in time sequence.

When viewing the results:

- If the results window is full, the oldest value will be replaced according to the “first in, first out” rule.
A maximum of 8 results can display in the results window and a maximum of two graphical results windows can display in the screen.
- To identify the measurement results, symbols or numbers are used in the numerical results window (B-histogram, B-profile) while “No:1” or “No:2” is used in the graphical results window.

The results can display as follows:

- No result displays when a measurement item/tool is activated but without the start point fixed.
- The result displays as digits when the value obtained is within the clinical range.
- The result displays as “?” when it is out of the ultrasonic range.

1.5.2 Moving the Results Window

To move the results window,

1. Place the cursor on the results window title and press <Set>.
2. Rotate the trackball to place the results window in the desired position.
3. Press <Set> to fix the results window.

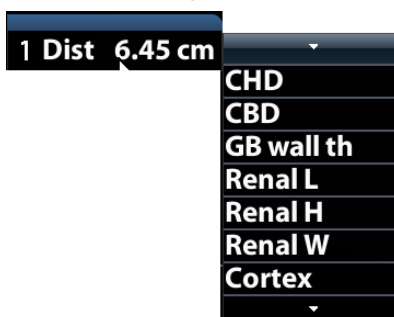
1.5.3 Results Window Assignment

An application measurement result can be assigned to a general measurement item from the results window. The application item can be an existing item in the system or a new user-defined one.

Assigning an Existing Application Item

The procedure is as follows:

1. Move the cursor to a general measurement value in the results window. Press <Set> when the item is highlighted in green and the matching list appears as shown below.



Application items that meet the following requirements are displayed:

- Contained in the current application package.
- The item to be assigned and the assigner should use the same general measurement tool for the result.

Application items in the current measurements that use the “Distance” method are listed as shown above.

2. Select an application item from the list, then press <Set>.
3. The assigned value displays in the results window and is saved in the exam report.

Tip:	To perform an assignment directly to the latest general measurement result: 1. Enter the application measurement menu (e.g., Reproduction) when a general measurement (e.g., “Area”) is completed. 2. Click the desired application item (e.g., HC) in the menu (or on the touch screen). The selected application item also has to meet the matching rules in step 1. 3. If the application item(s) is/are included in the current report, the assignment results will be saved in the report.
-------------	---

Assigning a New Application Item

When no (desired) item displays in the matching list, you can create a new application item. The procedure is as follows:

1. Select [new] at the bottom of the matching list.
2. The following dialog box appears.



Type in the new name.

3. Click [OK] to assign the general result to the new item.

NOTE: Re-assignment for the assigned general result is not available.

Exiting Result Assignment

Press <Esc> on the keyboard, or select [Cancel] in the matching list to exit.

Auto-Spectrum Calculation Assignment

Like a general measurement result, you can assign the auto-spectrum calculation results to an application item, using the same steps as described above.

For details about auto-spectrum calculation, see “3.4.5 D Trace.”

NOTE: The application item to assign should be an item using D trace in the current application package.

1.6 Cross-window Measurement

For linear probing, cross-window measurement is available in dual-B mode when the left and right windows are imaging with the same probe, depth and invert mode.

Under Free Xros M mode (option), you can perform cross-window measurement of time and HR.

1.7 Report

The report records measurement results, which are automatically saved by the system after each measurement.

- Press <Report> to enter the report dialog box.
- The default report of the current exam appears.
- After viewing, press <Report>, <Freeze> or <Esc>, or select [Cancel] or [Save] to exit the report page.

1.7.1 Viewing Reports

- Each measurement contains the three latest values and a final value.
- The report only displays results of tools that are displayed in the report template by default and are completed.
- Select [Previous] or [Next] to switch between pages if the report has more than one page.

1.7.2 Editing Reports

Available report editing operations are:

- Editing measurement data
- Entering ultrasound remarks
- Selecting images
- Save/load report
- Analyzing report data

Editing Measurement Data

 **CAUTION:** Input appropriate data when editing the measurement values, otherwise misdiagnosis may occur.

- The three measurement values in the text boxes are editable. Move the cursor to the text box and press <Set>.
- The modified value(s) is/are underlined.
- The final value displays in the [Value] column. Select an option ([Last], [Avg.], [Max.] or [Min.]) from [Method] to determine the method in which the final value is calculated.

NOTE: 1. Only measurement values are editable while calculation values are not.
 2. After a measurement value is modified, the average value of the tool and the corresponding calculation value will be updated automatically.

■ Clearing Data

Tap [Clear All] on the report page to clear all measurement data and click [Save].

Entering Ultrasound Remarks

In the [Comments] box, enter the corresponding information.

You can also save or load the comments.

- Save comment: enter information in the Comments box and then tap [Save Comment] on the touch screen to save current information in the report comment database.
- Load comment: tap [Load Comment] on the touch screen to open the dialogue box to check history saved comment information. You can select related information to add to current report comment or select the location of the comments.

Selecting Images

Images saved for the current exam can be added to the report.

1. Click [Add Picture] on the report page.

Left Column: Available Items, Images saved for the current exam.

Right Column: Selected Items, Images selected to add to the report.

2. Select the image.

- a) Add/Remove the image by pressing:

[>] to add the selected image in the left column to the right column.

[>>] to add all the images in the left column to the right column.

[<] to remove the selected image from the right column.

[<<] to remove all images from the right column.

- b) Adjust the image arrangement.

Select an image in the right column and click [Move Up] or [Move Down] to adjust the sequence in which the images are arranged in the report.

3. Click [OK] to confirm.

■ Export report

1. Under report status, tap [Export] to bring up the dialog box.

Reports can be exported as RTF or PDF documents, which can be viewed and edited on a PC.

2. Select the drive and directory.
3. Enter the filename for the report to export and select the file type.
4. Select the file type.
5. Click [OK] to confirm.

Create, delete or rename the directory by pressing:

[New]: To create a new template.

[Delete]: To delete the selected directory. Make multiple selections using the <Shift> and <Set> keys.

[Rename]: To rename a selected directory.

1.7.3 Viewing History Reports

If more than one exam is performed for an animal, an [Exam] drop-down list appears in the top-left part on the report.

1. Select previous exams from the [Exam] drop-down list.
2. According to the exam mode, select a proper template from the [Report Type].

Make sure the template matches the exam mode, otherwise the measurement result will not display correctly. E.g. An abdomen measurement result will not display in a reproduction report template preset without any abdomen measurement items.

3. View the history report.

NOTE:

1. History reports can be viewed, but cannot be edited.
2. The animal's information can also be viewed in iStation, see "Animal Data Management" in the Operator's Manual [Basic Volume] for details.

1.7.4 Printing Reports

Tap [Print] on the touch screen to print the report.

Or tap [Print View] to preview. On the preview page, you can:

Print report: Click [Print].

Page up/down: Select [Prev. Page] or [Next] to view the previous or next page.

Zoom in/out: Select a zoom ratio from the drop-down list: whole page, 100%, page wide.

Image Layout Select the layout from the drop-down list.

Exit the preview: Click [Close].

2 Measurement Preset

Before measuring, preset the following parameters:

- Measurement Parameters Preset
- General Measurement Preset
- Application Measurement Preset
- Report Preset

2.1 Basic Preset Procedures

The basic measurement preset procedures are as follows:

1. Press <F10 Setup> to enter the Preset:
2. Preset the measurement parameters.
Enter [Setup] → [System Preset] → [Application] to preset the measurement ruler, etc. See “2.2 Measurement Parameters Preset” for details.
3. Measurement preset.
Enter [Setup] → [Measure] → [Caliper], [Measure] and [Report] to preset the measurement menu and items. See “2.3 Measurement Preset” for details.
4. Exit the setup for the settings to take effect.
Select [Save] in the [Setup] menu to exit the setup.

NOTE: The settings are only brought into effect by clicking [Save] to exit the [Setup] menu.

2.2 Measurement Parameters Preset

Basic operation steps are as follows:

1. Press <F10 Setup> to display the [Setup] menu.
2. Select [Setup] → [System Preset] → [Application] to preset the following parameters:
 - Measurement Ruler
 - Left ventricular study
 - Dog BSA Formula
 - Follicle
3. Click [Save] to confirm.

Measurement Ruler



You can preset:

Tools	Descriptions
Cursor Type	Type of cursor displayed on the measurement caliper and results window. Value options: ■ Number: the cursor always displays as “+” while different measurements are marked with numbers. ■ Symbols: the cursor displays sequentially in 8 symbols to identify different measurements.
Cursor Size	The size of the cursor.
Heartbeat	The number of cardiac cycles in the heart rate calculation. (In heart rate measurement, the number of cardiac cycles should match the preset number.)
Clear results while deleting the caliper	Uncheck. The image is unfrozen or the image mode is changed after the measurement is completed. The measurement results are saved if the caliper is cleared.
Unit Setting	Set the units of measurement items for the application selected from the drop-down list “App Region”. Click [Apply] to complete the settings.

Left Ventricle Function Study Tool Setting

Set the tools used in the Cube/Teichholz/Gibson study.

Dog BSA Formula

Set the BSA formula for dog.

Comment

You can preset:

- Whether clear the comments while unfreezing image or changing probe/exam
- Whether clear Bodymark when unfreezing

2.3 Measurement Preset

Basic Procedures:

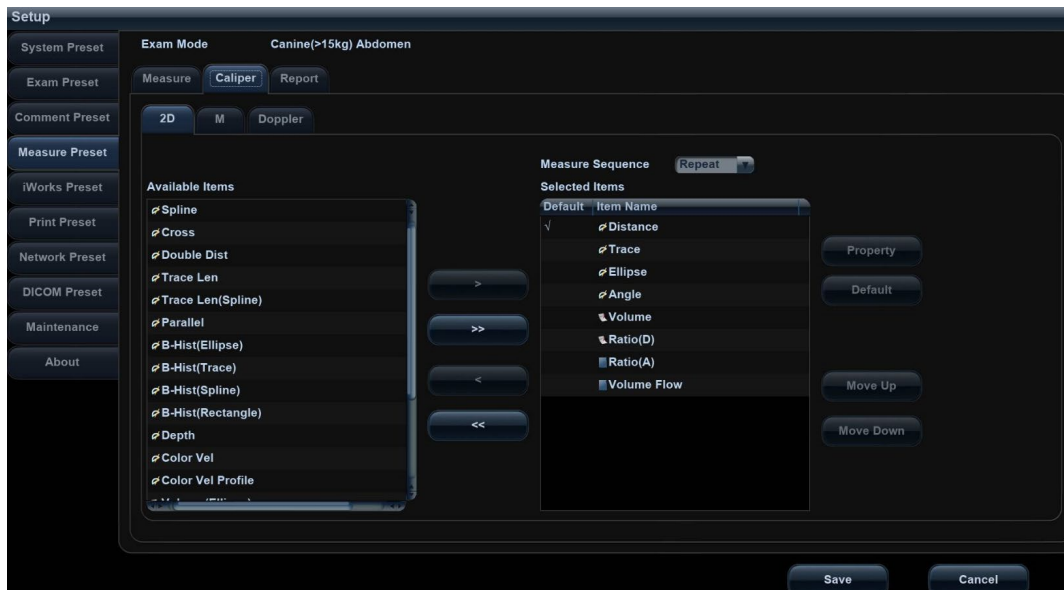
1. Press <F10 Setup> to display the [Setup] menu.
2. Select [Measure] in the [Setup] menu.
3. Preset the general measurement and application measurement.
For details, see “2.3.1 General Measurement Preset” and “2.3.2 Application Measurement Preset.”
4. Click [Save] to confirm.

Note: In [Setup]→[Measure] screen, “exam mode XX” on the upper left side refers to the currently configured exam mode. The configured general/application menus are only related to the current exam mode.

2.3.1 General Measurement Preset

You can preset the General Measurement packages for 2D (B/Color/Power Mode), M Mode, or Doppler (PW/CW) Mode respectively.

1. Select the [Caliper] on the [Measure] page, as shown in the figure below.



2. Select the [2D], [M] or [Doppler] tab to go to the corresponding preset menu.

[Available Items]: general measurement tools configured by the system in the current scanning mode which are available but not assigned yet.

[Selected Items]: displays the tools to be added to the menu.

3. Add/Remove the item.

Add/Remove the general measurement item using the following buttons:

[>] To add the selected tool from the [Available Items] to the [Selected Items].

[>>] To add all tools in the [Available Items] to the [Selected Items].

[<] To remove the selected tool from the [Selected Items] to the [Available Items].

[<<] To remove all tools from the [Selected Items] to the [Available Items]. You do not need to select any items before removing.

4. Set the default item.

Select an item from the [Selected Items], then click [Default]. The item is marked with a √.

The default item is activated automatically when entering this general measurement menu.

5. Adjust the item position.

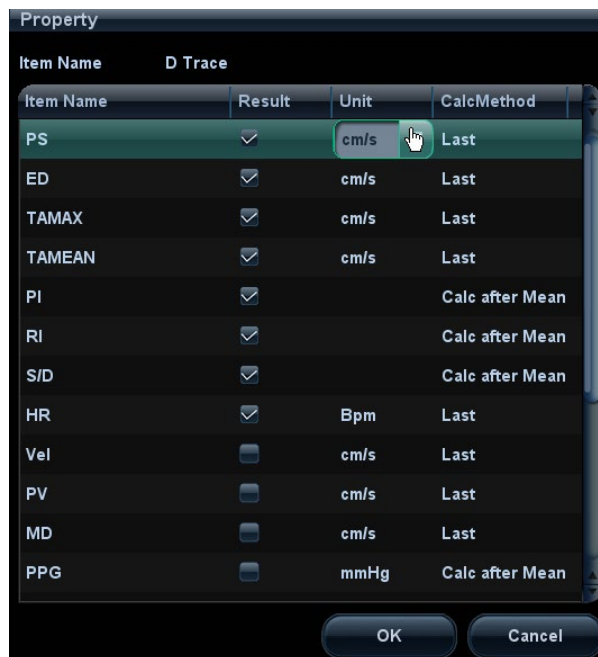
Select an item from the right column and click [Up]/[Down] to adjust the sequence in which the items are arranged in the corresponding general measurement menu (touch screen display).

6. Modify the properties of a measurement item.

The following takes D trace as an example to show how to set the properties of a measurement tool.

(1) Enter the [Measure] → [Caliper] → [Doppler] page.

(2) Select [D Trace] from the [Selected Items] and click [Property] to bring up the following dialog box.



Descriptions of the attributes are shown in the following table.

Attributes	Descriptions
Item Name & Result	Results obtained from D trace are listed. The selected items will be displayed in the results window after measurement. ■ If PV is selected, other results become deselected (except the temporary result “velocity”). ■ Some results, such as PS and ED, can be derived via a simple method (e.g., Velocity), but others, such as TAMAX, can only be derived via complicated methods such as Manual, Spline, Auto, etc. ● Only Vel. is available in [Method] if only PS or ED is selected. ● Methods for obtaining PS and TAMAX simultaneously (trace, spline and auto) should be chosen if both PS and TAMAX are selected (TAMEAN should use auto method).
Unit	Select the measurement unit. Click “Unit” column of each item to select.
Meas. Method	Select the measurement method for the tool. Click “CalcMethod” column of each item to select.

(3) Click [OK] to confirm the setting.

7. Select the measurement sequence.

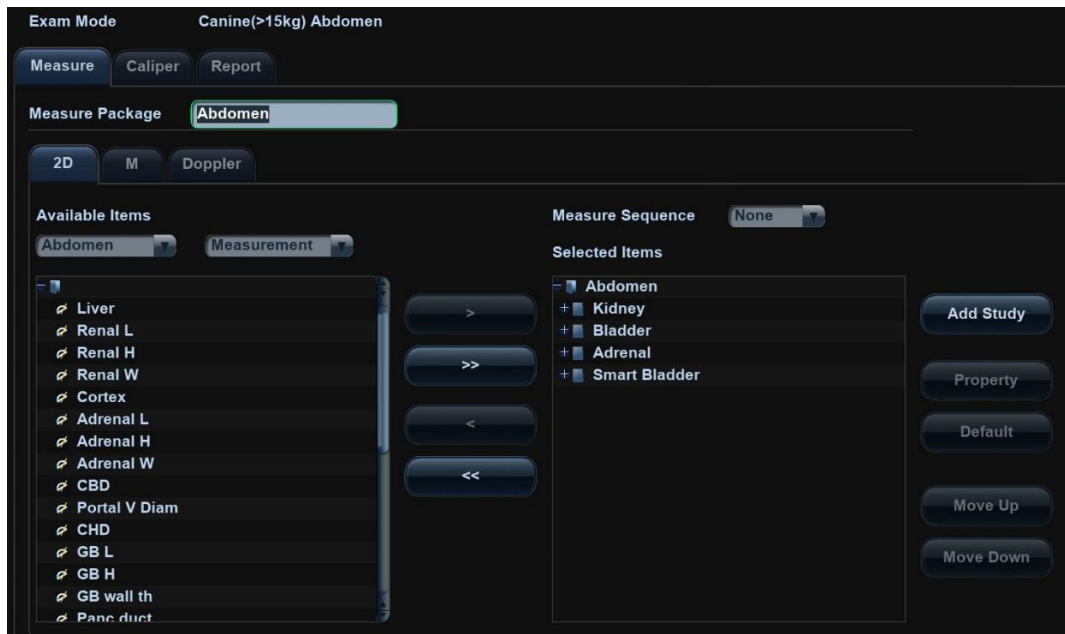
- [Repeat]: after the current measurement is completed, the system automatically activates the current tool again.
- [Next]: after the current measurement is completed, the system automatically activates the next tool in the menu.
- [None]: after the current measurement is completed, the cursor can be moved over the whole screen. And the cursor will automatically return to the menu of the corresponding measurement.

8. Click [Save] to confirm.

2.3.2 Application Measurement Preset

2.3.2.1 Basic Procedures

1. Select [Measure] in the [Measure] page, as shown in the figure below.



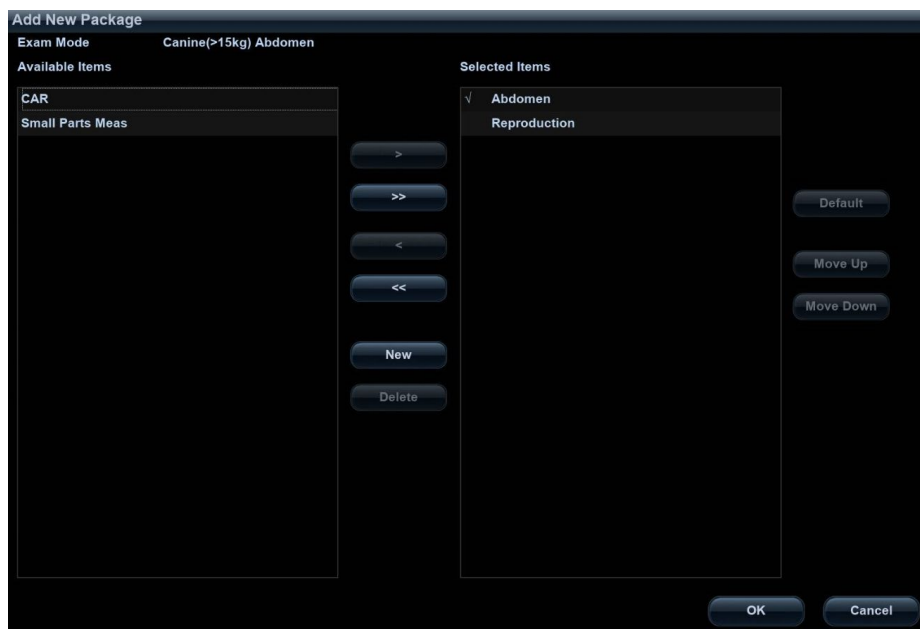
2. Select the 2D, M or Doppler scanning mode.
3. Choose or edit the Measurement Package.
The default package for current exam mode appears in the [Measurement Package].
 - Enter or edit the package name directly in the [Measurement Package] text box, then add items to edit the current package.
 - Or click [Advanced] to add or select a package.For details about creating, deleting and setting the default package, see “2.3.2.2 Measurement Package Preset.”
4. Select an application region from the drop-down list under [Available Items].
5. Select [Measurement], [Calculate], [Study], [User Defined] or [All] from the drop-down list under [Available Items]. The corresponding items appear in the list.
For details about measurement, calculation and study, see “1.3 Measurement, Calculation and Study.”
6. Preset the measurement menu.
For details on adding, creating and setting default items, see “2.3.2.3 Measurement Menu Preset.”
For details on measurement tool property settings, see “2.3.1 General Measurement Preset.”
7. Select the measurement sequence.
 - [Repeat]: after the current measurement is completed, the system automatically activates the current tool again.
 - [Next]: after the current measurement is completed, the system automatically activates the next tool in the menu.
 - [None]: after the current measurement is completed, the cursor can be moved over the whole screen. And the cursor will automatically return to the menu of the corresponding measurement.
8. Click [Save] to confirm.

2.3.2.2 Measurement Package Preset

During measurement, the preset package displays on the touch screen. Items in the package can be preset and may belong to different application regions.

You may configure more than one measurement package for current exam mode. Under actual measurement status, switch the measurement library if necessary (by clicking [Library] on the touch screen or clicking the menu title.)

Click [Advanced] to enter the following page.



Here,

- [Available Items]: shows application packages configured in the system but not yet assigned to the current mode.
- [Selected Items]: shows application packages assigned to the current exam mode. If more than one package is assigned to the current exam mode, you can switch measurement packages using the [Library] selection on the touch screen or clicking menu title in the measuring status.

Package editing includes Creating Packages, Add/Remove Items, Deleting Measurement Packages, Setting Default Packages, Adjusting Package Positions.

Creating Packages

1. Click [New].
2. Enter a name for the new package in the dialog box pop-up.
3. Click [OK] to confirm.

The new package displays in the [Available Items] list.

Adding/Removing Packages

Add/remove the package by pressing:

- [>] To add the package selected from the [Available Items] to the [Selected Items].
- [>>] To add all packages in the [Available Items] to the [Selected Items].
- [<] To remove the package selected from the [Selected Items] to the [Available Items].
- [<<] To remove all packages in the [Selected Items] to the [Available Items].

Deleting Packages

1. Select a package from the [Available Items] list.
2. Click [Delete].

Tip: To delete an item from [Selected Items], you need to move it to the [Available Items] first.

Setting Default Packages

1. Select a package from the [Selected Items] list, then click [Default].
2. The default package is marked with a $\checkmark$.

Tip:

1. The default package displays when entering the [Measure] page.
2. The measurement menu of the default package (corresponding to the exam mode) displays when entering the measuring status.

Adjusting Package Positions

Select a package from the [Selected Items] and click [Move Up]/[Move Down] to adjust the sequence that the packages in the menu are arranged in.

2.3.2.3 Measurement Menu Preset

The following operations are available.

- Adding/Removing Items
- Setting Default Items
- Adjusting Item Positions
- User-defined Study Items

Adding/Removing Items

- Adding Items

You can add measurements, calculations or study items in the [Available Items] to the [Selected Items] column, or to the study item in the [Selected Items] column (added items display as sub-items in the study). The selected items display in the menu and on the touch screen.

Add/Remove the general measurement item using the following buttons:

- [>] To add the selected tool from the [Available Items] to the [Selected Items].
- [>>] To add all tools in the [Available Items] to the [Selected Items].
- [<] To remove the selected tool from the [Selected Items] to the [Available Items].
- [<<] To remove all tools from the [Selected Items] to the [Available Items]. You do not need to select any items before removing.

- Setting Default Items

You can set a measurement, calculation or study in the [Selected Items] as the default item. The default item will be activated automatically when entering the measurement menu containing it.

1. Select an item from the [Selected Items] list.
2. Click [Default]. The defaulted item is marked with a $\checkmark$.

To deselect the default tool, select it and click [Default] or set another item as the default.

Tip: If a particular item is set as the default item, it automatically displays the submenu of the study when entering this measurement menu.

Adjusting Item Positions

You can adjust the position of the measurement, calculation or study in the [Selected Items] list.

1. Select an item from the [Selected Items].
2. Click [Up]/[Down].

The order in the list is also the item position in the menu.

User-defined Study Items

You can add or remove user-defined study items in the [Selected Items] column.

1. Enter the [Measure] → [Measure] page.
2. Click [Add Study] on the right.
3. Enter the study name in the dialog box that appears.
4. Click [OK] and the item will be added to the “Selected Items.”
5. Select a measurement/calculation item from the “Available Items” and click [>] to add the item to the user-defined study.
6. Repeat the last step to add more items if necessary.
7. Move the cursor to click on the study and click [Property] on the right to edit the sequence.

Remove User-defined Items

■ Remove Measurement/Calculation

1. Select “User-defined” in the “Available Items”, and select the desired item.
2. Click [Delete] on the right.

■ Remove Studies

Select a user-defined study, click [<].

NOTE: 1. Adding B-Hist or B-Profile to the study is not supported.
2. Click [Export Custom] in the measurement preset window to export the user-defined measurement.

2.3.3 Report Preset

Basic procedures:

1. Select [Report] on the [Measure] page.
2. Manage the report template. Available operations: Adding new Report Templates.
3. Continue setting other presets, or click [Save] in the [Setup] menu to bring the settings into effect.

Setting Default Templates

1. Enter the [Measure] → [Report] page.
2. Select a report template from the list.
3. Click [Default].
4. Click [Save] to confirm.

3 General Measurement

General Measurement Tools:

- 2D (B/Color/Power/DirPower) Mode
- M General Measurements
- Doppler (PW/CW) Mode

3.1 Basic General Measurement Procedures

1. Start the exam.
2. Select the imaging mode (B/M/Doppler), then scan the image.
3. Press <Caliper> to enter the 2D/M/Doppler general measurement menu.
4. Select an item from the general measurement menu (or the touch screen) to start the measurement. See “1.2.2 Measurement Tool” chapter for details.
 - You can use the trackball and <Set> key to perform general measurement on the main screen (see 2D, M, Doppler general measurement for details);

- | | |
|-------------|--|
| Tip: | <ol style="list-style-type: none">1. The order of the measurement items can be preset. See “2.3.1 General Measurement Preset” for details.2. A measurement tool can be activated by clicking the item either in the measurement menu or on the touch screen. It is described as “Select/Click ... in the measurement menu” in the following procedures.3. Under B+M or B+Doppler mode, touch mode tab on the touch screen to switch to the related measurement menu. |
|-------------|--|

3.2 2D General Measurements

3.2.1 Depth

Function:

- Sectoral surface probe: the depth is the distance from the center of the sector to the cursor.
- Convex array or linear array probe: the depth is the distance from the transducer surface to the measuring cursor in the direction of the ultrasonic wave.

Tip: The real-time depth displays in the results window only before the <Set> key is pressed to fix the starting point. The history value of the depth is not displayed in the results window.

1. Select [Depth] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Use the trackball to move the cursor to the desired point.
3. Press <Set> to set the measurement point and the result displays in the results window.

3.2.2 Distance

Function: Measures the distance between two points on the image.

1. Select [Distance] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the starting point with the trackball.
3. Press <Set> to set the starting point.
4. Move the cursor to the end point with the trackball. Then press <Clear> to cancel setting the starting point. Or press <Update> to switch between the fixed end and the active end of the caliper.
5. Press <Set> to set the end point and the result displays in the results window.

3.2.3 Angle

Function: measures the angle of two crossing planes on the image and the range is: 0°-180°.

1. Select [Angle] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Set two line segments as described in “3.2.2 Distance.”
The angle appears in the results window after setting the line segments.

3.2.4 Area & Circumference

Function: measures the area and circumference of a closed region on the image. Four measurement methods are available:

- Ellipse: fix an ellipse region by two equal-cut perpendicular axes.
- Trace: fix a closed region by free tracing.
- Spline: fix a spline curve by a series of points (12 points at most).
- Cross: fix a closed region with two axes perpendicular to each other. The starting point and the end point of the axes can both be fixed freely.

Tip: These four methods are also applicable to other measurement items and will not be repeated when mentioned below. The operations are as follows:

Ellipse

1. Select [Ellipse] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to set the starting point of the first axis of the ellipse.
4. Move the cursor to position the end point of the first axis of the ellipse. Then press <Update> to switch between the fixed end and the active end of the first axis. Or press <Clear> to cancel the start point of the first axis.
5. Press <Set> to set the end point of the first axis of the ellipse. The second axis appears on the screen.
6. Moving the trackball will increase or decrease the ellipse from the fixed axis. Move the trackball to trace the area of interest as closely as possible.
Or, press the <Update> or <Clear> key to return to the step before setting the first axis.
7. Press <Set> to anchor the ellipse region. The measurement result will be displayed in the results window.

Trace

1. Select [Trace] in the measurement menu or the touch screen. The cursor appears on the screen (and the touch screen).
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target to trace the outline of the target.
To modify the trace line, rotate the <Angle> knob:
 Anticlockwise: to cancel a series of points.
 Clockwise: to resume a series of points. You may also resume the points by rolling trackball back.
5. Press <Set> and the trace line will be closed with a straight line connecting the start and end points. The trace will also be closed when the cursor is very near to the starting point.

Spline

1. Select [Spline] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to set the first reference point of the spline.
4. Move the cursor along the area of interest and press <Set> to anchor the second reference point.
5. Roll the trackball and a spline defined by three points of the first and second reference points and the active cursor appears on the screen.
6. Move the cursor along the edge of the target and set more reference points (12 at most) to make the spline approach the target region as closely as possible.

To correct a previous point, press <Clear>.

7. Press <Set> twice to anchor the last reference point. The spline is fixed and the results display in the results window.

Cross

1. Select [Cross] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point of the first axis.
4. Use the trackball to position the end point of the first axis and then press <Set>. Then press <Update> to switch between the start point and the end point of the first axis. Or press <Clear> to cancel setting the starting point of the first axis.
5. Press <Set> to set the end point of the first axis. The second axis (perpendicular to the first axis) of the cross appears on the screen.
6. Move the trackball and press <Set> to fix the starting point of the second axis.
7. Move the cursor to the end point of the second axis. Then press <Update> to switch between the start point and the end point of the first axis. Or press <Clear> to cancel setting the starting point of the first axis.
8. Press <Set> to set the end point of the second axis and fix the region. The results appear in the result window.

3.2.5 Volume

Function: measures the volume of the target object.

Method:

■ 3 Dist.

For calculating the object's volume with 3 axes of two images scanned in the plane perpendicular to each other in B mode. The calculation formula is as follows:

$$Volume(cm^3) \square \frac{\pi}{6} \times D1(cm) \times D2(cm) \times D3(cm)$$

Where D1, D2 and D3 are the length of three axes of the target object.

■ Ellipse

To calculate the object's volume by its horizontal section area. The calculation formula is as follows:

$$Volume(cm^3) \square \frac{\pi}{6} \times a(cm) \times b^2(cm)$$

Where a is the length of the major axis of the ellipse while b the minor.

■ Ellipse Dist.

To calculate the object's volume by its horizontal and vertical section area. The calculation formula is as follows:

$$Volume(cm^3) \square \frac{\pi}{6} \times a(cm) \times b(cm) \times m(cm)$$

Here a , b and m indicate the length of the major, minor and the third axis of the ellipse respectively.

Operations:

Volume

1. Select [Volume] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Here D1, D2 and D3 are the lengths of three axes of the target object.
See “3.2.2 Distance” for detailed procedures.
Generally D1, D2 and D3 should belong to different scanning planes.

Volume (Ellipse)

1. Select [Volume (Ellipse)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. The procedure is similar to that of Ellipse in the area measurement, see “3.2.4 Area” for details.

Volume (Ellipse Dist.)

1. Select [Volume (E+ Dist.)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Use the Ellipse method to measure the vertical section area.
The procedure is similar to that of Ellipse in the Area measurement, see “3.2.4 Area” for details.
3. Unfreeze the image. Rescan the area of interest perpendicular to the previous image.
4. Measure the length of the third axis with the Distance measurement method, see “3.2.2 Distance” for detailed procedures.

3.2.6 Double Dist.

Function: measures the lengths of line segments A and B perpendicular to each other.

1. Select [Double Dist.] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the measurement starting point.
3. Press <Set> to set the starting point of the first line segment.
4. Use the trackball to position the end point of the first axis and then press <Set>. Then press <Update> to switch between the start point and the end point of the first axis. Or press <Clear> to cancel setting the starting point of the first axis.
5. Press <Set> to set the starting point of the first line segment. The second line segment perpendicular to the fixed line segment appears on the screen.
6. Move the cursor to the starting point of the second line segment.
7. Press <Set> to set the starting point of the second line segment. Or, press <Update> or <Clear> to return to the last step.
8. Move the cursor to the end point of the second line segment. Then press <Update> to switch between the starting point and the end point of the second axis. Or press <Clear> to cancel setting the starting point of the second axis.
9. Press <Set> to confirm the end point of the second line segment.

3.2.7 Parallel

Function: measures the distance between every two line segments of five parallel line segments, namely, four distances in total.

1. Select [Parallel] in the measurement menu or the touch screen. Two lines perpendicular to each other appear on the screen. The intersection is the starting point of the line segment.
2. Rotate the <Angle> knob to change the angle of the lines and press <Set> to confirm.
3. Move the cursor to the starting point of the line segment.
4. Press <Set> to confirm the starting point and the first line.
5. Move the cursor and press <Set> to confirm the other four parallel lines when the last parallel line is set and the end point of the line that is perpendicular to the five parallel lines is confirmed. During the measurement, press <Set> twice to set the last parallel line and complete the measurement.

3.2.8 Curve Length

Function: measures the length of a curve on the image. Measurement methods available include Trace and Spline.

Trace

1. Select [Trace Len] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target to trace the outline of the target.

To modify the trace line, rotate the <Angle> knob:

Anticlockwise: to cancel a series of points.

Clockwise: to resume a series of points. You may also resume the points by rolling trackball back.

5. Press <Set> to anchor the end point of the trace line.

Spline

1. Select [Trace Len (Spline)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the trackball along the target and press <Set> to anchor the second, third, fourth, etc., points. A maximum of 12 points can be anchored.

To correct a previous point, press <Clear>.

5. Press <Set> twice to set the end point of the spline.

3.2.9 Ratio (D)

Function: measures the lengths of two line segments and then calculates their ratio.

1. Select [Ratio (D)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Measure the length of the two line segments, see "3.2.2 Distance" for detailed procedures.
The results display in the results window after the measurement of the second line is completed.

3.2.10 Ratio (A)

Function: measures the area of two closed regions and then calculates their ratio. The methods are Ellipse, Trace, Cross and Spline.

1. Select [Ratio (A)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Measure the area of the two closed regions; you may select different measurement methods for each region. See “3.2.4 Area” for details.

3.2.11 B-Profile

Function: measures the gray distribution of ultrasonic echo signals on a line.

Tip: The following operations are performed on Freeze images by default.

1. Select [B-Profile] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Set a line segment, see “3.2.2 Distance” for detailed procedures.

The result is shown in the figure below:



Where

- No:** The number of the graph. Value: 1 or 2.
The last two results will be displayed on the screen.
- Gmax:** The maximum gray.
- Gmin:** The minimum gray.
- Gmean:** The average gray.
- Gsd:** The variance of gray.

3.2.12 B-Hist

Function: measures and counts the gray distribution of ultrasonic echo signals within a closed region. The methods to set a closed region are Ellipse, Trace, Spline and Rect. (Rectangle).

Tip: The following operations are performed on Freeze images by default.

Rectangle

Rect. sets a rectangle with two points on the cross. The operations are:

1. Select [B-Hist (Rectangle)] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the first vertex of the rectangle, press <Set>.
3. Move the cursor to the second vertex of the rectangle, press <Set>. The result is shown in the following figure:



Where

Horizontal axis: The gray of the image

The vertical axis: The gray distribution percentage.

No: The number of the graph. The last two results will be displayed on the screen.

N: The total pixel number in the area to be measured.

M: $M = \sum D_i / N$;

MAX: MAX = the pixel number in the maximum gray/ $N \times 100\%$

SD: Standard deviation. $SD = (\sum D_i^2 / N - (\sum D_i / N)^2)^{1/2}$

D_i : the gray at each pixel point

$\sum D_i$: the total grays of all pixels.

Ellipse

See "Ellipse" in the "3.2.4 Area" for detailed procedures.

Trace

See "Trace" in the "3.2.4 Area" for detailed procedures.

Spline

See "Spline" in the "3.2.4 Area" for detailed procedures.

3.2.13 Color Vel.

- Tip:**
1. This measurement item is meant for a general estimation, not for accurate measurement.
 2. The following operations are performed on Freeze images by default.

Function: measures the velocity of blood flow on the Color Mode image.

1. Select [Color Vel.] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the point to be measured for blood flow velocity.
3. Press <Set> to fix the point, a floating line is displayed in the direction parallel to the ultrasonic wave beam at that point.

The compensation angle is currently 0°. You can change the angle (0°-80°) by rotating the <Angle> knob to align the floating line in the same direction as the blood flow at the point to be measured.

4. Press <Set> to set the direction of the blood flow. The result displays in the results window.

3.2.14 Volume Flow

Function: measures blood flow through a vascular cross section per unit time.

For details, see "3.4.7 Volume Flow."

3.3 M General Measurements

3.3.1 Distance

Function: measures the distance between two points on the M Mode image.

1. Select [Distance] in the measurement menu or the touch screen. Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the end point. The crossing point can then only be moved in a vertical direction. Then
press <Update> to switch between the fixed end and active end of the caliper. Or
press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

3.3.2 Time

Function: measures the time interval between two points on the M Mode image.

1. Select [Time] in the measurement menu or the touch screen. Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the measurement end point. The crossing point can only be moved in a horizontal direction. Then
press <Update> to switch between the fixed end and active end of the caliper. Or
press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

3.3.3 Slope

Function: measures the distance and time between two points on the M Mode image and calculates the slope between the two points.

1. Select [Slope] in the measurement menu or the touch screen. Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the measurement end point. The crossing point is connected to the starting point by a dashed line. Then
press <Update> to switch between the fixed end and active end of the caliper. Or
press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

3.3.4 Velocity

Function: measures the distance and time between two points on the M Mode image and then calculates the average velocity between the two points.

1. Select [Velocity] in the measurement menu or the touch screen. Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the end point. The crossing point can then only be moved in a vertical direction.
Then press <Update> to switch between the fixed end and active end of the caliper. Or
press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

3.3.5 HR

Function: measures the time interval of n ($n \leq 8$) cardiac cycles on the M Mode image and calculates the heart rate.

The number of cardiac cycles “ n ” can be preset in the [System Preset] → [Application] preset dialog box. See “2.2 Measurement Parameters Preset” for details.



CAUTION:

During the measurement, the number of cardiac cycles between the measurement start and end points must be exactly the same as preset ([Setup]→[System Preset]→[Application]). Otherwise, misdiagnosis may occur.

1. Select [HR] in the measurement menu or the touch screen. Two dotted lines perpendicular to each other appear on the screen.
2. Select n cardiac cycles.

The HR result in the results window displays the measured heart rate value and the preset number of cardiac cycles, as shown in the figure below.

HR 76(2) Bpm

Number of
Cardiac Cycles
Heart Rate

3.4 Doppler General Measurements

3.4.1 Time

Function: measures the time interval between two points on the Doppler image.

The operations are similar to the Time measurement in M Mode. See “3.3.2 Time” for details.

3.4.2 HR

Function: measures the time interval between n ($n \leq 8$) cardiac cycles on the Doppler Mode image and calculates the number of heart beats per minute (BPM).

The operations are similar to the Heart Rate measurement in M Mode. See “3.3.5 HR” for details.

3.4.3 D Vel.

Function: measures the velocity, pressure gradient and correction angle of a certain point on the Doppler spectrum.

Tip:

The real-time velocity displays in the results window only before the <Set> key is pressed to fix the starting point. The history value of the velocity is not displayed in the results window.

1. Select [D Vel.] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the point to be measured for velocity.
3. Press <Set> and the result displays in the results window.

3.4.4 Acceleration

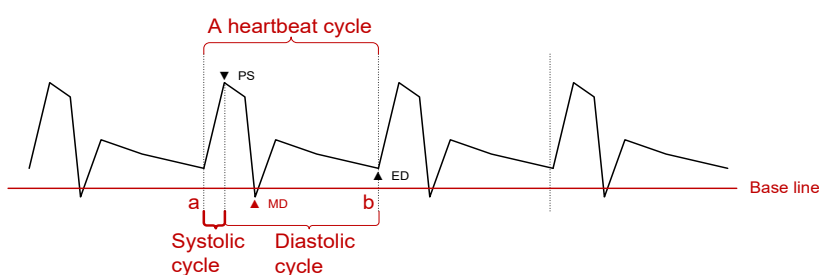
Function: measures the velocities of two points and their time interval on the Doppler image, and calculates the acceleration, pressure gradient, velocity difference and correction angle.

1. Select [Acceleration] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the first point to be measured for velocity.
3. Press <Set> to fix the first point.
4. Move the cursor to the second point to be measured for velocity.
5. Press <Set> to fix the second point. The results display in the results window.

3.4.5 D Trace

Function: measures clinical indices using spectral Doppler tracing. Measurement methods available are Trace, Auto, Spline, Vel. (Velocity) and 2 PT (Two Points).

A sketch of a Doppler spectrum is shown below:



NOTE: When doing D trace, please set systolic starting time as the starting point and diastolic ending time as end point. That is, by tracing the Doppler spectrum from systolic to diastolic to calculate indices.

■ Operations:

1. Select [D Trace] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the starting point to be measured and press the [Set] key to fix the point.
3. Move the cursor around the object.
Move the cursor right: draw a trace line overlapping the spectrum as much as possible.
Move the cursor left to correct the trace line already drawn.
4. Trace the end point to be measured and press <Set> to fix the point.

Result parameters

The results obtained from D trace are:

Parameters	Descriptions	
PS	Peak Systolic Velocity	The highest velocity of the red blood cells crossing the sample volume.
ED	End-Diastolic Velocity	Measures the blood velocity at the end of the cardiac cycle.
MD	Min-Diastolic Velocity	Minimum absolute Velocity in the diastolic cycle.
Vel.	/	Flow velocity

Parameters	Descriptions	
Average velocity	/	The average flow velocity in the whole traced Doppler spectrum. ■ TAMAX (Time Averaged Maximum Velocity): $TAMAX(cm/s) \square \int_{T_a}^{T_b} V(t) dt / (T_b - T_a)$ Where V(t) is the maximum velocity ■ TAMEAN (Time Averaged Mean Velocity): Obtained by auto-spectrum calculation. $TAMEAN(cm/s) \square \int_{T_a}^{T_b} V(t) dt / (T_b - T_a)$ Where V(t) is the mean velocity.
PPG	Peak Pressure Gradient	The corresponding pressure gradient of the peak systolic velocity. PPG (mmHg) = 4 × PS (m/s) ²
Average Pressure Gradient	/	The average pressure gradient in the whole traced Doppler spectrum. ■ MPG: Maximum Pressure Gradient. $MPG(mmHg) = \int_{T_a}^{T_b} 4(V(t))^2 dt / (T_b - T_a)$ Where V(t) is the peak systolic velocity. ■ MMPG: Mean velocity Mean Pressure Gradient. (Obtained during auto-spectrum calculation.) $MMPG(mmHg) = \int_{T_a}^{T_b} 4(V(t))^2 dt / (T_b - T_a)$ ■ Where V(t) is the mean systolic velocity.
VTI	Velocity-Time Integral	Velocity-time integral. The integral of the product of Doppler instantaneous velocity and the total time interval. $VTI(m) \square \int_{T_a}^{T_b} V(t) dt$
AT	Acceleration Time	The time of the blood velocity accelerating from the end of diastole to the systolic peak. This is usually the time interval between the end of the first cardiac cycle and the peak of the next cardiac cycle. Choose the first peak when two peaks exist in the systolic cycle.
DT	Deceleration Time	Deceleration Time.
HR	Heart Rate	Calculates the heart rate per minute by measuring the time interval of one cardiac cycle.
S/D	/	PS/ED. S/D (No unit) = PS (m/s) / ED (m/s)
D/S	/	ED/PS. D/S (No unit) = ED (m/s) / PS (m/s)
PI	Pulsatility Index	Pulsatility index. PI (No unit) = (PS (m/s) – ED (m/s)) / TAMAX (m/s)

Parameters	Descriptions	
RI	Resistive Index	Resistance index. RI (No unit) = (PS (m/s) – ED (m/s)) / PS (m/s)
θ	/	The correction angle is the spectrum angle during measurement, which is a result obtained from a non D trace measurement tool and is usually displayed together with the spectral measurement results.
PV	Peak Velocity	The peak velocity in systolic or diastolic cycles (with no difference), which is the highest velocity of the red blood cells that cross the sample volume. It can be used to examine the venous vessel.

NOTE:

1. In the formulae above, T means time, the unit is s; V means the velocity at each point during T, the unit is cm/s; a is the traced starting point, while b is the traced end point.
2. The above parameters are all the information obtained in D trace, while in application the system only displays part of them according to the operation and preset.

Measurement Method

The measurement method varies according to the result selected.

■ Velocity

Function: measures the velocity, pressure gradient and correction angle of a certain point on the Doppler spectrum.

The operations are similar to the Time measurement in M Mode. See “3.4.3 D Vel.” for details.

■ 2 PT

Function: measures the velocity, pressure gradient and correction angle between two points on the Doppler spectrum.

1. Select items using the [2 PT] method in the measurement menu, the cursor displays as a large “+.”
2. Move the cursor to the starting point to be measured and press <Set> to fix the point.
3. Move the cursor to the end point to be measured and press <Set> to fix the point.

■ Spline

1. Select items using the [Spline] method from the measurement menu.
2. Move the cursor to the starting point to be measured and press <Set> to fix the point.
3. Move the cursor along the edge of the desired region. Continue to fix the second, third, etc., point (50 points at most) of the spectrum.
4. Press <Set> twice to anchor the last reference point. Or
the measurement ends automatically when there are 50 reference points.

■ Auto-Spectrum Calculation

You can also acquire the above results by auto calculation, which calculates the recent cardiac cycles.

- Click [Auto Calc.] in the PW image menu to activate it. The system traces automatically and displays the results in the top-right part of the screen.
- Touch “Auto Calc” tab on the touch screen, and click [Auto Calc. Param.] in the PW image menu. You can select the parameters to be calculated.
- Click [Auto Cardiac Cycle] in the PW image menu. You can select the cycle number to be calculated.

3.4.6 PS/ED

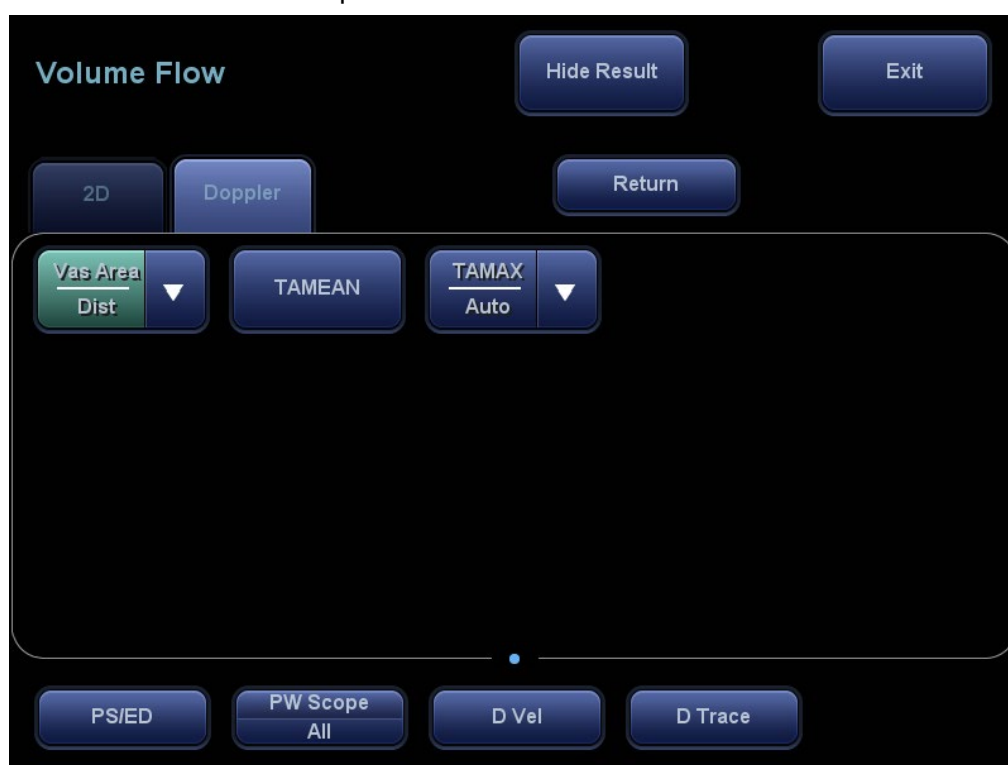
Function: measures the Peak Systolic (PS) velocity and End Diastolic (ED) velocity on the Doppler spectrum, and calculates their resistance index (RI), S/D and correction angle.

1. Select [PS/ED] in the measurement menu or the touch screen. The cursor appears on the screen.
2. Move the cursor to the Systolic Peak and press <Set> to fix the point.
3. Move the cursor to the Diastolic End and press <Set> to fix the point.

3.4.7 Volume Flow

Function: measures blood flow through a vascular cross section per unit time.

1. Select [Volume Flow] in the measurement menu or the touch screen. The submenu displays. Take touch screen as an example.



- Click [Vas. Area] to select the method for calculating the area: dist. or trace.
 - Click [PW Scope] to select the scope to be traced.
2. Measure the vascular area.
 3. Click [TAMEAN] or [TAMAX] to calculate the volume flow.

Item		Description	Method or formula
Vas. Area	Dist.	Obtain the area by measuring the vascular diameter.	$\text{Vas. Area} = \pi \times \text{Vas Diam (cm)}^2 / 4$
	Trace	Obtain the area using the trace method.	Area in 2D General Measurements

Item	Description	Method or formula
TAMEAN	Vol Flow(Area) - TAMEAN	$\text{Vol Flow(A) (ml/min)} = \text{Vas TAMEAN (cm/s)} \times \text{Vas. Area (cm}^2\text{)} \times 60 \text{ (s)}$ Vas. TAMEAN - Time Averaged Mean Velocity, obtained from the Vas. Trace measurement.
TAMAX	Vol Flow(Area) - TAMAX	$\text{Vol Flow(A) (ml/min)} = \text{Vas TAMAX (cm/s)} \times \text{Vas Area (cm}^2\text{)} \times 60 \text{ (s)}$ Vas. TAMAX - Time Averaged Maximum Velocity, obtained from the Vas. Trace measurement.

3.5 References

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4 Abdomen

4.1 Abdomen Exam Preparations

Make the following preparations before measuring:

1. Confirm that the current probe is appropriate.
2. Check that the current system date is correct.
3. Press <Patient> and register the animal information in the [Animal Info] → [ABD] dialog box.
4. Switch to the correct exam mode.

4.2 Basic Abdomen Measurement Procedures

1. Press <Patient> and register the animal information in the [Animal Info] → [ABD] dialog box.
2. Press <Measure> to enter the Application Measurements.
If the current menu is not the one containing the Abdomen Measurement tools, move the cursor to the menu title and select the package with the Abdomen Measurement tools.
3. Select the measurement tool in the menu (or the touch screen) to start the measurement.
See section “4.3 Abdomen Measurement Tools” and steps in “3 General Measurement” for measurement methods.
4. Press <Report> to view the exam report. See “4.5 Abdomen Exam Report” for details.

4.3 Abdomen Measurement Tools

NOTE: The measurement tools mentioned below are configured in the system. The application measurement packages provided in this system are generally different combinations of measurement tools.

Measurement, calculation and study measurement items in 2D and Doppler mode (no M mode measurement items) are listed below:

2D Abdomen Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	Liver	/	Distance in 2D General Measurements
	Renal L	Renal Length	
	Renal H	Renal Height	
	Renal W	Renal Width	
	Cortex	Renal Cortical Thickness	
	Adrenal L	Adrenal Length	
	Adrenal H	Adrenal Height	
	Adrenal W	Adrenal Width	
	CBD	Common bile duct	
	Portal V Diam	Portal Vein Diameter	
	CHD	Common hepatic duct	
	GB L	Gallbladder Length	
	GB H	Gallbladder Height	
	GB wall th.	Gallbladder wall thickness	
	Panc. duct	Pancreatic duct	
	Panc. head	Pancreatic head	
	Panc. body	Pancreatic body	
	Panc. tail	Pancreatic tail	
	Spleen	/	
	Aorta Diam.	Aorta Diameter	
	Aorta Bif.	Aorta Bifurcation	
	Iliac Diam.	Iliac Diameter	
	Pre-BL L	Pre-void Bladder Length	
	Pre-BL H	Pre-void Bladder Height	
	Pre-BL W	Pre-void Bladder Width	
	Post-BL L	Post-void Bladder Length	
	Post-BL H	Post-void Bladder Height	
	Post-BL W	Post-void Bladder Width	

Types	Tools	Descriptions	Methods or formulae
Measurement	Ureter	/	Distance in 2D General Measurements
Calculation	Renal Vol.	Renal Volume	See below
	Pre-BL Vol.	Pre-void Bladder Volume	See below
	Post-BL Vol.	Post-void Bladder Volume	See below
	Mictur. Vol.	Micturated Volume	See below
Study	Kidney	/	See below
	Adrenal	/	See below
	Bladder	/	See below
	Smart Bladder	/	See below

Doppler Abdomen Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	Ren. A Org.	Renal Artery Origin	D trace in General D measurements
	Arcuate A	Arcuate Artery	
	Segment A	Segmental Artery	
	Interlobar A	Interlobar Artery	
	Renal A	Renal Artery	
	M Renal A	Main Renal Artery	
	Renal V	Renal Vein	
	Aorta	/	
	Celiac Axis	/	
	SMA	Superior Mesenteric Artery	
	C Hepatic A	Common Hepatic Artery	
	Hepatic A	Hepatic Artery	
	Splenic A	Splenic Artery	
	IVC	Inferior Vena Cava	
	Portal V	Portal Vein	
	M Portal V	Main Portal Vein	
	Hepatic V	Hepatic Vein	
	Lt Hepatic V	Left Hepatic Vein	
	Rt Hepatic V	Right Hepatic Vein	
	M Hepatic V	Middle Hepatic Vein	
	Splenic V	Splenic Vein	
	SMV	Superior Mesenteric Vein	

Types	Tools	Descriptions	Methods or formulae
Study	/	/	

4.4 Abdomen Measurement Operations

Tip:	1. See the table in “4 Abdomen Measurement Tools” above for measurement tools and methods. 2. For the definitions of measurement, calculation and study, see “1.3 Measurement, Calculation and Study”. 3. The order of the measurement items can be preset. See “2.3.2 Application Measurement Preset” for details. 4. A measurement tool can be activated by clicking the item in the measurement menu or on the touch screen. It is described as “Select/Click ... in the measurement menu” in the following procedures.
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4.4.1 Measurement Tool Operations

1. Select the item/tool in the measurement menu.
2. Perform the measurement referring to the methods in the table above.

4.4.2 Calculation Tool Operations

Renal Vol.

Function: measures the Renal L, Renal H and Renal W, calculates the Renal Vol.

NOTE: needs to be measured on the left and right sides respectively.

1. Select [Renal Vol] in the measurement menu or the touch screen.
2. Use the Distance measurement method in 2D General Measurements to measure the Renal L, Renal H and Renal W. The Renal Vol. is calculated automatically.

Pre-BL Vol.

Function: measures the Pre-BL L, Pre-BL H and Pre-BL W, calculates the Pre-BL Vol.

1. Select [Pre-BL Vol] in the measurement menu or the touch screen.
2. Use the Distance method in 2D General Measurements to measure the Pre-BL L, Pre-BL H and Pre-BL W. The Pre-BL Vol. is calculated automatically. The Mictur.Vol is displayed in the report if the Post-BL Vol is measured.

Post-BL Vol.

Function: measures the Post-BL L, Post-BL H and Post-BL W, calculates the Post-BL Vol.

1. Select [Post-BL Vol] in the measurement menu or the touch screen.
2. Use the Distance method in 2D General Measurements to measure Post-BL L, Post-BL H and Post-BL W. The Post-BL Vol is calculated automatically. The Mictur.Vol is displayed in the report if the Pre-BL Vol is measured.

Mictur. Vol.

Function: measures the Pre-BL Vol and Post-BL Vol, calculates the Mictur.Vol.

1. Select [Mictur.Vol] in the measurement menu or the touch screen.
2. Use the Distance method in 2D General Measurements to measure the Pre-BL L, Pre-BL H and Pre-BL W. The Pre-BL Vol. is calculated automatically and displayed in the report.

3. Use the Distance method in 2D General Measurements to measure Post-BL L, Post-BL H and Post-BL W. The Post-BL Vol. and Mictur.Vol. are calculated automatically, the Post-BL Vol. is displayed in the report.

4.4.3 Study Tool Operations

Kidney

Function: measures the Renal L, Renal H and Renal W, calculates the Renal Vol.

NOTE: needs to be measured on the left and right sides respectively.

1. Select [Kidney] in the measurement menu or the touch screen.
2. Use the Distance measurement method in 2D General Measurements to measure the Renal L, Renal H and Renal W. The Renal Vol. is calculated automatically.
3. Use the method of Distance measurement of 2D General Measurements to measure Cortex.

Adrenal

Function: measures Adrenal L, Adrenal H and Adrenal W.

NOTE: needs to be measured on the left and right sides respectively.

1. Select the [Adrenal] in the measurement menu or the touch screen.
2. Use the method of Distance measurement of 2D General Measurements to measure Adrenal L, Adrenal H and Adrenal W.

Bladder

Function: measures the Pre-BL L, Pre-BL H, Pre-BL W, Post-BL L, Post-BL H and Post-BL W, calculates the Pre-BL Vol., Post-BL Vol and Mictur.Vol.

1. Select [Bladder] in the measurement menu or the touch screen.
2. Use the Distance method in 2D General Measurements to measure the Pre-BL L, Pre-BL H and Pre-BL W. The Pre-BL Vol. is calculated automatically.
3. Use the Distance method in 2D General Measurements to measure Post-BL L, Post-BL H and Post-BL W. The Post-BL Vol. and Mictur.Vol. are calculated automatically.

Smart Bladder

NOTE: Smart Bladder must be used with convex-wide probe.

Function: measure the volume of the urine in the bladder.

1. Scan and obtain the horizontal section image of the bladder.
2. Select the [Smart Bladder] in the measurement menu.
Envelop of the bladder section is traced automatically, and two diameters d1 and d2 (perpendicular to each other by default) are recognized by the system. Here,
You can press <Update> to exchange among the ends of the diameters and modify the length and the position of the end points.
3. Press <Set> to fix the measurement of d1 and d2.
4. Scan and obtain the vertical section of the bladder.
5. Select the [Smart Bladder] in the measurement menu.
Envelop of the bladder section is traced automatically, and diameter d3 is recognized by the system. Here,
You can press <Update> to exchange the ends of the diameter and modify the length and the position of the end points.
6. Press <Set> to fix the measurement of d3.
The Volume is calculated by the system.

4.5 Abdomen Exam Report

During or after a measurement, press <Report> on the Control Panel to browse the report. For details about report browsing, printing and exporting, etc., see “1.7 Report.”

5 Reproduction

5.1 Reproduction Exam Preparations

Make the following preparations before measuring:

1. Confirm that the current probe is appropriate.
2. Check that the current system date is correct.
3. Press <Patient> and register the animal information in the [Animal Info] → [REP] dialog box.
For more details, see “Exam Preparation → Animal Information” in the Operator’s Manual [Basic Volume].
4. Switch to the correct exam mode.

5.2 Basic Measurement Procedures

1. Press <Patient> and register the animal information in the [Animal Info] → [REP] dialog box.
2. Press <Measure> to enter the Application Measurements.
3. Select the measurement tool from the menu or the touch screen to start the measurement.
See the table in “5.4 Reproduction Measurement Tools” below for measurement tools.
See section “5.5 Reproduction Measurement Operations” and steps in “3 General Measurement” for measurement methods.
4. Press <Report> to view the exam report. See “5.7 Reproduction Exam Report” for details.

5.3 GA

The ultrasound GA is calculated according to the parameters obtained in the measurements.

■ GA in reproduction Items

The GA in the reproduction items is calculated from the related GA tables/formulae.

1. The GA and other measurement values display in the results window after a measurement.
If the Diagnostic GA exceeds the threshold, an OOR (out of range) displays in the results window and this result is not recorded in the report.
2. The GA of an reproduction item displays to the right of the item measurements.

5.4 Reproduction Measurement Tools

The system supports the following 2D reproduction measurements.

NOTE: The measurement tools mentioned below are configured in the system. The application measurement packages provided in this system are generally different combinations of measurement tools. For more information about package preset, see “2.3.2.2 Application Measurement Preset.”

2D Reproduction Measurements

Types	Tools	Descriptions	Methods or formulae
Dog obstetric measurements	Dog CRL	Dog Crown Rump Length	Distance in 2D General Measurements
	Dog GS	Dog Gestational Sac Diameter	
	Dog HD	Dog Head Diameter	
	Dog BD	Dog Body Cavity Diameter	
Feline obstetric measurements	Feline BD	Feline Body Cavity Diameter	
	Feline HD	Feline Head Diameter	
Equine obstetric measurements	Equine GS-H	Equine Gestational Sac Diameter Horizontal	
	Equine GS-V	Equine Gestational Sac Diameter Vertical	
Bovine obstetric measurements	Bovine CRL	Bovine Crown Rump Length	
	Bovine TD	Bovine Trunk Diameter	
	Bovine HD	Bovine Head Diameter	
Ovine obstetric measurements	Ovine CRL	Ovine Crown Rump Length	
	Ovine BPD	Ovine Biparietal Diameter	

5.5 Reproduction Measurement Operations

Operations of measurement is described using examples.

Tip: 1. See the table in “5.4 Reproduction Measurement Tools” above for measurement tools and methods.

2. The order of the measurement items can be preset. See “2.3.2 Application Measurement Preset” for details.

5.5.1 Measurement Tool Operations

Take the Dog CRL measurement as an example.

1. Select the [Dog CRL] item/tool in the measurement menu or the touch screen.
See “Select Measurement Method Online” for details on how to select a method online.
2. Measure the area according to the Area method in 2D General Measurements.
The measurement results, and GA calculation display in the results window.

For more details about GA, see “5.3 GA.”

5.6 Multi-Fetus Exam

The system allows multi-fetus examination.

NOTE: Ensure that the fetus displayed in the multi-fetus measurement menu is the one on which you intend to perform the measurements.

In a similar way to the reproduction measurement:

1. Set the number of fetuses in [Gestations] via [Animal Info] → [REP].
If [Gestations] is set to be more than 1, the [Fetus] widget displays in the REP measurement menu (and on the touch screen), as shown in the figure below.



You can switch between [Fetus A], [Fetus B]... via the widget (or the [Fetus] button on the touch screen).

2. Carry out the measurement of the fetus respectively.
The measurement results in the results window are marked with fetus label A, B or C.
3. In the Reproduction report, select [Fetus A] or [Fetus B]... to switch between the results for different fetuses.

5.7 Reproduction Exam Report

During or after a measurement, press <Report> on the Control Panel to browse the report.

See “5.6 Multi-Fetus Exam” for multi-fetus exam reports.

For details about report browsing, printing and exporting, etc., see “1.7 Report.”

5.8 GA Formulae and References

5.8.1 GA Formulae and Reference for Dog

Dog's standard GA is 64 days.

It is recommended to measure Dog CRL and Dog GS when the dog's GA is less than 40 days, and to measure Dog HD and Dog BD when the dog's GA is greater than 40 days.

- Dog CRL: $GA(\text{day}) = 3 \times \text{Dog CRL (cm)} + 27$
- Dog GS: $GA(\text{day}) = 6 \times \text{Dog GS (cm)} + 20$
- Dog HD: $GA(\text{day}) = 15 \times \text{Dog HD (cm)} + 20$
- Dog BD: $GA(\text{day}) = 7 \times \text{Dog BD (cm)} + 29$
- Dog HD&BD: $GA(\text{day}) = 6 \times \text{Dog HD (cm)} + 3 \times \text{Dog BD (cm)} + 30$

Reference: Veterinary Imaging, Xie Fuqiang, Publishing House of Chinese University of Agriculture, first edition, March 3rd, 2004

5.8.2 GA Formulae and Reference for Cat

Cat's standard GA is 58 days.

- Cat BD: $GA(\text{day}) = 11 \times \text{Cat BD (cm)} + 21$
- Cat HD: $GA(\text{day}) = 25 \times \text{Cat HD (cm)} + 3$

Reference: Veterinary Imaging, Xie Fuqiang, Publishing House of Chinese University of Agriculture, first edition, March 3rd, 2004

5.8.3 GA Formulae and Reference for Equine

Equine's standard GA is 330 days.

- Equine GS-H: $GA(\text{day}) = (\text{Equine GS-H (cm)} + 0.55) / 0.15$
- Equine GS-V: $GA(\text{day}) = (\text{Equine GS-V (cm)} + 0.10) / 0.14$

Reference: F.S. Pipers, DVM, PhD; W. Zent, DVM; R. Holder, DVM; A. Asbury, DVM. Ultrasonography as an adjunct to pregnancy assessments in the mare. JAVMA, Vo; 184, No.3, February 1, 1984.

5.8.4 GA Formulae and Reference for Bovine

Bovine's standard GA is 285 days.

It is recommended to measure Bovine CRL when the bovine's GA is less than 50 days, and to measure Bovine TD and Bovine HD when the bovine's GA is greater than 50 days.

- Bovine CRL: $GA(\text{day}) = \ln(\text{Bovine CRL (cm)}) \times 16.73 + 27.5$
- Bovine TD: $GA(\text{day}) = \ln(\text{Bovine TD (cm)}) \times 37.21 + 39.7$
- Bovine HD: $GA(\text{day}) = \ln(\text{Bovine HD (cm)}) \times 45.23 + 37.7$

Reference: PRACTICAL APPLICATION OF ULTRASOUND IN BOVINE EMBRYO TRANSFER. W. E. Beal. Department of Animal and Poultry Sciences. Virginia Tech, Blacksburg, VA 24061.

5.8.5 GA Formulae and Reference for Ovine

Ovine's standard GA is 145 days.

It is recommended to measure Ovine CRL when the ovine's GA is between 20 and 40 days, and to measure Ovine BPD when the ovine's GA is greater than 40 days.

- Ovine CRL: $GA\ (day) = 14.05 + 1.16 \times \text{Ovine CRL (cm)} - 0.012 \times (\text{Ovine CRL (cm)})^2$
- Ovine BPD: $GA\ (day) = 21.4 + 18.5 \times \text{Ovine BPD (cm)}$

Reference: SCHRICK, F. N., INSKEEP, E. K. 1993: Determination of early pregnancy in ewes utilizing transrectal ultrasonography. *Theriogenology* 40: 295-306

6 Cardiology

6.1 Cardiac Exam Preparations

Make the following preparations before measuring:

1. Confirm that the current probe is appropriate.
2. Check that the current system date is correct.
3. Press <Patient> and enter the animal information on the [Animal Info] → [CARD] page.
For more details, see “Exam Preparation → Animal Information” in the Operator’s Manual [Basic Volume].
4. Switch to the correct exam mode.

6.2 Basic Cardiac Measurement Procedures

1. Press <Patient> and enter the animal information on the [Animal Info] → [CARD] page.
2. Press <Measure> to enter the Application Measurement.
3. Select the measurement tool from the menu or the touch screen to start the measurement.
See the table in “6.3 Cardiac Measurement Tools” for measurement tools.
See section “6.3 Cardiac Measurement Tools” and steps in “3 General Measurement” for measurement methods.
4. Press <Report> to view the exam report. See “6.5 Cardiac Exam Report” for details.

6.3 Cardiac Measurement Tools

The system supports the following cardiac measurements:

- NOTE:**
1. The measurement tools mentioned below are configured in the system. The application measurement packages provided in this system are generally different combinations of measurement tools. For more information about package preset, see “2.3.2.2 Application Measurement Preset.”
 2. Some application items in the measurement preset library (and matching list in the results assignment) are displayed different from those in the measurement menu and results window.
In the preset library (and matching list in the results assignment), the item is followed with the word indicating the mode or location.

6.3.1 2D Cardiac Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	LA Diam.	Left Atrium Diameter	Distance in 2D General Measurements
	LA Major	Left Atrium Major Diameter	
	LA Minor	Left Atrium Minor Diameter	

Types	Tools	Descriptions	Methods or formulae
	RA Major	Right Atrium Major Diameter	Distance in 2D General Measurements
	RA Minor	Right Atrium Minor Diameter	
	LV Major	Left Ventricular Major Diameter	
	LV Minor	Left Ventricular Minor Diameter	
	RV Major	Right Ventricular Major Diameter	
	RV Minor	Right Ventricular Minor Diameter	
	LA Area	Left Atrium Area	Area in 2D General Measurements
	RA Area	Right Atrium area	
	LV Area(d)	Left Ventricular area at end-diastole	
	LV Area(s)	Left Ventricular area at end-systole	
	RV Area(d)	Right Ventricular area at end-diastole	
	RV Area(s)	Right Ventricular area at end-systole	
	LVIDd	Left Ventricular Internal Diameter at end-diastole	Distance in 2D General Measurements
	LVIDs	Left Ventricular Internal Diameter at end-systole	
	RVDd	Right Ventricular Diameter at end-diastole	
	RVDs	Right Ventricular Diameter at end-systole	
	LVPWd	Left Ventricular Posterior wall thickness at end-diastole	
	LVPWs	Left Ventricular Posterior wall thickness at end-systole	
	RVAWd	Right Ventricular Anterior wall thickness at end-diastole	
	RVAWs	Right Ventricular Anterior wall thickness at end-systole	
	IVSd	Interventricular Septal Thickness at end-diastole	
	IVSs	Interventricular Septal Thickness at end-systole	
Measurement	Ao. Diam.	Aorta Diameter	
	Ao. Arch Diam.	Aorta Arch Diameter	
	Ao. Asc. Diam.	Ascending Aorta Diameter	
	Ao. Desc. Diam.	Descending Aorta Diameter	
	Ao. Isthmus	Aorta Isthmus Diameter	

Types	Tools	Descriptions	Methods or formulae
	Ao. ST Junct.	Aorta ST Junction Diameter	
	Ao. Sinus Diam.	Aorta Sinus Diameter	
	Duct. Art. Diam.	Ductus Arteriosus Diameter	
	Pre Ductal	Previous Ductal Diameter	
	Post Ductal	Posterior Ductal Diameter	
	ACS	Aortic Valve Cusp Separation	Distance in 2D General Measurements
	LVOT Diam.	Left Ventricular Outflow Tract Diameter	
	AV Diam.	Aorta Valve Diameter	
	AVA	Aortic Valve Area	Area in 2D General Measurements
	PV Diam.	Pulmonary Valve Diameter	Distance in 2D General Measurements
	LPA Diam.	Left Pulmonary Artery Diameter	
	RPA Diam.	Right Pulmonary Artery Diameter	
	MPA Diam.	Main Pulmonary Artery Diameter	
	RVOT Diam.	Right Ventricular Outflow Tract Diameter	
	MV Diam.	Mitral Valve diameter	Area in 2D General Measurements
	MVA	Mitral Valve Area	
	MCS	Mitral Valve Cusp Separation	Distance in 2D General Measurements
	MV EPSS	Distance between point E and Interventricular Septum when mitral valve is fully open	
	TV Diam.	Tricuspid Valve Diameter	
	TVA	Tricuspid Valve Area	Area in 2D General Measurements
	IVC Diam.(Insp.)	Inferior Vena Cava Inspiration Diameter	
	IVC Diam.(Expir.)	Inferior Vena Cava Expiration Diameter	
Measurement	SVC Diam.(Insp.)	Superior Vena Cava Inspiration Diameter	Distance in 2D General Measurements
	SVC Diam.(Expir.)	Superior Vena Cava Expiration Diameter	
	LCA Diam	Left Coronary Artery	
	RCA Diam	Right Coronary Artery	
	VSD Diam.	Ventricular Septal Defect Diameter	Distance in 2D General Measurements
	ASD Diam.	Atrial Septal Defect Diameter	

Types	Tools	Descriptions	Methods or formulae
	PDA Diam.	Patent Ductus Arteriosus Diameter	
	PFO Diam.	Patent Oval Foramen Diameter	
	PEd	Pericardial Effusion at diastole	
	PEs	Pericardial Effusion at systole	
	HR	Heart Rate	Heart Rate in M General Measurements
	Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode
	Systole	End-systolic Left Ventricular Measurement	
	RA Vol(A4C)	Right Atrium Volume (4-chamber)	See "Simpson" study
Calculation	LA/Ao.	Left Atrium Diameter/Aorta Diameter	LA Diam. (cm)/Ao. Diam. (cm)
Study	See below	/	/

6.3.2 M Cardiac Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	LA Diam.	Left Atrium Diameter	Distance in M General Measurements
	LVIDd	Left Ventricular Internal Diameter at end-diastole	
	LVIDs	Left Ventricular Internal Diameter at end-systole	
	RVDd	Right Ventricular Diameter at end-diastole	
	RVDs	Right Ventricular Diameter at end-systole	
	LVPWd	Left Ventricular Posterior wall thickness at end-diastole	
	LVPWs	Left Ventricular Posterior wall thickness at end-systole	
	RVAWd	Right Ventricular Anterior wall thickness at end-diastole	
	RVAWs	Right Ventricular Anterior wall thickness at end-systole	
	IVSd	Interventricular Septal Thickness at end-diastole	
	IVSs	Interventricular Septal Thickness at end-systole	
	Ao. Diam.	Aorta Diameter	
	Ao. Arch Diam.	Aorta Arch Diameter	
	Ao. Asc. Diam.	Ascending Aorta Diameter	
	Ao. Desc. Diam.	Descending Aorta Diameter	
	Ao. Isthmus	Aorta Isthmus Diameter	
	Ao. ST Junct.	Aorta ST Junction Diameter	
	Ao. Sinus Diam.	Aorta Sinus Diameter	
	LVOT Diam.	Left Ventricular Outflow Tract Diameter	
	ACS	Aortic Valve Cusp Separation	
	LPA Diam.	Left Pulmonary Artery Diameter	
	RPA Diam.	Right Pulmonary Artery Diameter	
	MPA Diam.	Main Pulmonary Artery Diameter	
	RVOT Diam.	Right Ventricular Outflow Tract Diameter	
	MV E Amp.	Amplitude of the Mitral Valve E wave	

Types	Tools	Descriptions	Methods or formulae
	MV A Amp.	Amplitude of the Mitral Valve A wave	Slope in M General Measurements
	MV E-F Slope	Mitral Valve E-F slope	
	MV D-E Slope	Mitral Valve D-E slope	
	MV D-E Amp	Amplitude of the Mitral Valve DE wave	Distance in M General Measurements
	MCS	Mitral Valve Cusp Separation	
	MV EPSS	Distance between point E and the interventricular septum	
	PEd	Pericardial Effusion at diastole	
	PEs	Pericardial Effusion at systole	Time in M General Measurements
	LVPEP	Left Ventricular pre-ejection period	
	LVET	Left Ventricular Ejection Time	
	RVPEP	Right Ventricular Pre-Ejection Period	
	RVET	Right Ventricular Ejection Time	
	HR	Heart Rate	Heart Rate in M General Measurements
	Diastole	End-diastolic Left Ventricular Measurement	Parallel method in M mode
	Systole	End-systolic Left Ventricular Measurement	
	TAPSE	Tricuspid Annular Plane Systolic Excursion	Distance in M General Measurements
Calculation	LA/Ao.	Left Atrium Diameter/Aorta Diameter	LA Diam. (cm)/Ao. Diam. (cm)
Study	See below		

6.3.3 Doppler Cardiac Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	MV Vmax	Mitral Valve Maximum Velocity	D Vel. in Doppler General Measurements
	MV E Vel.	Mitral Valve E-wave Velocity	
	MV A Vel.	Mitral Valve A-wave Velocity	
	MV E VTI	Mitral Valve E-wave Velocity-Time Integral	D Trace in Doppler General Measurements
	MV A VTI	Mitral Valve A-wave Velocity-Time Integral	
	MV VTI	Mitral Valve Velocity-Time Integral	

Types	Tools	Descriptions	Methods or formulae
	MV AccT	Mitral Valve Acceleration Time	Acceleration in Doppler General Measurements
	MV DecT	Mitral Valve Deceleration Time	
	IVRT	Mitral Valve Isovolumic Relaxation Time	Time in Doppler General Measurements
	IVCT	Mitral Valve Isovolumic Contraction Time	
	MV E Dur.	Mitral Valve E-wave Duration	
	MV A Dur.	Mitral Valve A-wave Duration	
	LVOT Vmax	Left Ventricular Outflow Tract Maximum Velocity	D Vel. in Doppler General Measurements
	LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General measurements
Measurement	LVOT AccT	Left Ventricular Outflow Tract Acceleration Time	Acceleration in Doppler General Measurements
	AAo Vmax	Ascending Aorta Maximum Velocity	D Vel. in Doppler General Measurements
	DAo Vmax	Descending Aorta Maximum Velocity	
	AV Vmax	Aorta Valve Maximum Velocity	
	AV VTI	Aorta Valve Velocity-Time Integral	D Trace in Doppler General measurements
	LVPEP	Left Ventricular Pre-Ejection Period	Time in Doppler General Measurements
	LVET	Left Ventricular Ejection Time	
	AV AccT	Aorta Valve Acceleration Time	
	AV DecT	Aorta Valve Deceleration Time	
	RVET	Right Ventricular Ejection Time	Time in Doppler General Measurements
	RVPEP	Right Ventricular Pre-Ejection Period	
	TV Vmax	Tricuspid Valve Maximum Velocity	D Vel. in Doppler General Measurements
	TV E Vel.	Tricuspid Valve E-wave Flow Velocity	
	TV A Vel.	Tricuspid Valve A-wave Flow Velocity	
	TV VTI	Tricuspid Valve Velocity-Time Integral	D Trace in Doppler General measurements
	TV AccT	Tricuspid Valve Acceleration Time	Acceleration in Doppler General Measurements
	TV DecT	Tricuspid Valve Deceleration Time	

Types	Tools	Descriptions	Methods or formulae
	TV A Dur.	Tricuspid Valve A-wave Duration	Time in Doppler General Measurements
	RVOT Vmax	Right Ventricular Outflow Tract Maximum Velocity	D Vel. in Doppler General Measurements
	RVOT VTI	Right Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General measurements
	PV Vmax	Pulmonary Valve Maximum Velocity	D Vel. in Doppler General Measurements
	PV VTI	Pulmonary Valve Velocity-Time Integral	D Trace in Doppler General measurements
	PV AccT	Pulmonary Valve Acceleration Time	Acceleration in Doppler General Measurements
	MPA Vmax	Main Pulmonary Artery Maximum Velocity	D Vel. in Doppler General Measurements
	RPA Vmax	Right Pulmonary Artery Maximum Velocity	
	LPA Vmax	Left Pulmonary Artery Maximum Velocity	
	PVein S Vel.	Pulmonary Vein S-wave Flow Velocity	D Vel. in Doppler General Measurements
	PVein D Vel.	Pulmonary Vein D-wave Flow Velocity	
	PVein A Vel.	Pulmonary Vein A-wave Flow Velocity	
	PVein A Dur.	Pulmonary Vein A-wave Duration	Time in Doppler General Measurements
	PVein S VTI	Pulmonary Vein S-wave Velocity-time Integral	D Trace in Doppler General measurements
	PVein D VTI	Pulmonary Vein D-wave Velocity-time Integral	
	PVein DecT	Pulmonary Vein Deceleration Time	Time in Doppler General Measurements
	IVC Vel. (Insp.)	Inferior Vena Cava Inspiration Maximum Velocity	D Vel. in Doppler General Measurements
	IVC Vel. (Expir.)	Inferior Vena Cava Expiration Maximum Velocity	
	SVC Vel. (Insp.)	Superior Vena Cava Inspiration Maximum Velocity	
	SVC Vel. (Expir.)	Superior Vena Cava Expiration Maximum Velocity	
	MR Vmax	Mitral Valve Regurgitation Maximum Velocity	
	MR VTI	Mitral Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements

Types	Tools	Descriptions	Methods or formulae
	MS Vmax	Mitral Valve Stenosis Maximum Velocity	D Vel. in Doppler General Measurements
	dP/dt	Rate of Pressure change	dP/dt Measurement
	AR Vmax	Aortic Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
	AR VTI	Aortic Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
	AR DecT	Aortic Valve Regurgitation Deceleration Time	Acceleration in Doppler General Measurements
	AR PHT	Aortic Valve Regurgitation Pressure Half Time	Doppler Measurement
	AR Ved	Aortic Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
	TR Vmax	Tricuspid Valve Regurgitation Maximum Velocity	
	TR VTI	Tricuspid Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
	PR Vmax	Pulmonary Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
	PR VTI	Pulmonary Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
	PR PHT	Pulmonary Valve Regurgitation Pressure Half Time	Doppler Measurement
	PR Ved	Pulmonary Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
	VSD Vmax	Ventricular Septal Defect Maximum Velocity	
	ASD Vmax	Atrial Septal Defect Maximum Velocity	
	PDA Vel(d)	Patent Ductus Arteriosus Velocity at End-diastole	
	PDA Vel(s)	Patent Ductus Arteriosus Velocity at End-systole	
	Coarc. Pre-Duct.	Coarctation of Pre-Ductus	
	Coarc. Post-Duct.	Coarctation of Post-Ductus	
	HR	Heart Rate	
	RAP	Right Atrium Pressure	Select from the pop-up dialog box or enter a value manually. See RAP measurement in "RVSP"

Types	Tools	Descriptions	Methods or formulae
	Hepatic V S Vel.	Hepatic Vein Systolic Peak Velocity	D Vel. in Doppler General Measurements
	Hepatic V D Vel.	Hepatic Vein Diastolic Peak Velocity	
Calculation	MV E/A	Mitral Valve E-Vel./A-Vel.	MV E Vel. (cm/s)/MV A Vel. (cm/s)
	MVA(PHT)	Mitral Valve Orifice Area (PHT)	$MVA(PHT) (cm^2) = 220 / MV PHT (ms)$
	TV E/A	Tricuspid Valve E-Vel./A-Vel.	$TV E/A = TV E Vel(cm/s) / TV A Vel(cm/s)$
	TVA(PHT)	Tricuspid Valve Orifice Area (PHT)	$TVA(PHT) = 220 / TV PHT(cm^2)$
Study	See below	/	/

6.3.4 TDI Cardiac Measurements

The following measurement items are performed in TDI mode.

Types	Tools	Descriptions	Methods or formulae
Measurement	MV Aa(medial)	Mitral Valve medial Late diastolic motion	D Vel. in Doppler General Measurements
	MV Sa(medial)	Mitral Valve medial Systolic motion	
	MV Aa(lateral)	Mitral Valve lateral Late diastolic motion	
	MV Sa(lateral)	Mitral Valve lateral Systolic motion	
	MV ARa(medial)	Mitral Valve medial Acceleration Rate	Acceleration in Doppler General Measurements
	MV DRa(medial)	Mitral Valve medial Deceleration Rate	
	MV ARa(lateral)	Mitral Valve lateral Acceleration Rate	
	MV DRa(lateral)	Mitral Valve lateral Deceleration Rate	
	MV Ea(lateral)	Mitral Valve lateral Early diastolic motion	Measure MV E Vel item to get E/Ea result. D Vel. in Doppler General Measurements *1

Types	Tools	Descriptions	Methods or formulae
Measurement	MV Ea(medial)	Mitral Valve medial Early diastolic motion	Measure MV E Vel item to get E/Ea result. D Vel. in Doppler General Measurements *2
Calculation	/	/	/
Study	See below	/	/

*1 means:

$$E / Ea(lateral)(Nounit) = \frac{MV E Vel(cm / s)}{Ea(lateral)(cm / s)}$$

*2 means:

$$E / Ea(medial + lateral)(Nounit) = \frac{MV E Vel(cm / s)}{(Ea(medial)(cm / s) + Ea(lateral)(cm / s)) / 2}$$

6.4 Cardiac Measurement Operations

Tip:	- See the table in “6.3 Cardiac Measurement Tools” above for measurement tools and methods. - For the definitions of measurement, calculation and study, see “1.3 Measurement, Calculation and Study.” - The order of the measurement items can be preset. See “2.3.2 Application Measurement Preset” for details. - A measurement tool can be activated by clicking the item in the measurement menu or on the touch screen. It is described as “Select/Click ... in the measurement menu” in the following procedures. - The measurements of some tools described in this chapter are to be performed in several imaging modes. Select the appropriate imaging mode before measurement.
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6.4.1 Measurement Tool Operations

1. Select the item/tool in the measurement menu or the touch screen.
2. Perform the measurement referring to the methods in the table above.

6.4.2 Calculation Tool Operations

1. Select the item/tool in the measurement menu or the touch screen.
2. The system calculates and displays the results after the measurement items have been completed.

6.4.3 Study Tool Operations

6.4.3.1 Left Ventricular Function

This group of studies estimates the Left Ventricular (LV) diastolic and systolic capabilities using a series of clinical indices measured on the B or M image. As well as calculating the left ventricular volume and end diastole and end systole, they may calculate the following indices (not all indices are calculated in every study, see the Study Results table for each study for reference).

Results	Descriptions	Formulae
SV	Stroke Volume	$SV(ml) = EDV(ml) - ESV(ml)$
CO	Cardiac Output	$CO(l/min) = SV(ml) \times HR(bpm) / 1000$
EF	Ejection Fraction	$EF(\text{No unit}) = SV(ml) / EDV(ml)$
SI	SV Index	$SI(\text{No unit}) = SV(ml) / \text{Body Surface Area (m}^2\text{)}$
CI	Cardiac output index	$CI(\text{No unit}) = CO(l/min) / \text{Body Surface Area (m}^2\text{)}$
FS	Fractional Shortening	$FS(\text{No unit}) = (LVIDd(cm) - LVIDs[cm]) / LVIDd(cm)$
MVCF	Mean Velocity of Circumferential Fiber Shortening	$MVCF = (LVIDd(cm) - LVIDs(cm)) / (LVIDd(cm) \times ET(s))$

NOTE: The HR value entered manually should be within the range 1~999.

S-P Ellipse

■ Study Items

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVAd apical	Left Ventricular Long-axis Area at End-diastole in apical view	Area in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	Distance in 2D General Measurements
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	Area in 2D General Measurements
HR	Heart Rate	Obtained by ECG or entered directly

■ Study Results

Tools	Descriptions	Formulae
EDV(SP Ellipse)	End-diastolic Left Ventricular Volume	$EDV(SP\ Ellipse)(ml) \square \frac{8}{3\pi} \times \frac{LVAd\ apical(cm^2)^2}{LVLd\ apical(cm)}$
ESV(SP Ellipse)	End-systolic Left Ventricular Volume	$ESV(SP\ Ellipse)(ml) \square \frac{8}{3\pi} \times \frac{LVAs\ apical(cm^2)^2}{LVLs\ apical(cm)}$
EDV Index(SP Ellipse)	End-diastolic Left Ventricular Volume Index	$EDV\ Index = EDV / BSA$
ESV Index(SP Ellipse)	End-systolic Left Ventricular Volume Index	$ESV\ Index = ESV / BSA$
SV(SP Ellipse)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"

Tools	Descriptions	Formulae
CO(SP Ellipse)	Cardiac Output	
EF(SP Ellipse)	Ejection Fraction	
SI(SP Ellipse)	SV Index	
CI(SP Ellipse)	CO Index	

■ Operating Procedures

1. Select [S-P Ellipse] in the measurement menu or the touch screen.
2. In apical long-axis view at end-diastole, measure the following parameters:
LVLd apical
LVAd apical
The EDV value is then calculated.
3. In apical long-axis view at end-systole, measure the following parameters:
LVLs apical
LVAs apical
The ESV value is then calculated.
The system calculates the SV and EF.
If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
4. Use the menu to select the HR source: ECG or entered.
The CO and CI are calculated automatically using the entered height and weight values.

B-P Ellipse

■ Study Items

Tools	Descriptions	Operations
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D General Measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
LVAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General Measurements
LVAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
LVAd apical	Left Ventricular Long-axis Area at End-diastole in apical view	
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	
HR	Heart Rate	Obtained by ECG, or entered directly

■ Study Results

Tools	Descriptions	Formulae
EDV(BP Ellipse)	End-diastolic Left Ventricular Volume	*1

Tools	Descriptions	Formulae
ESV(BP Ellipse)	End-systolic Left Ventricular Volume	*2
EDV Index(BP Ellipse)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(BP Ellipse)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(BP Ellipse)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"
CO(BP Ellipse)	Cardiac Output	
EF(BP Ellipse)	Ejection Fraction	
SI(BP Ellipse)	SV Index	
CI(BP Ellipse)	CO Index	

*1 means:

$$\text{EDV(BP Ellipse)}(ml) = \frac{8}{3\pi} \times \text{LVAd apical}(cm^2) \times \text{LVAd sax MV}(cm^2) / \text{LVIDd}(cm)$$

*2 means:

$$\text{ESV(BP Ellipse)}(ml) = \frac{8}{3\pi} \times \text{LVAs apical}(cm^2) \times \text{LVAs sax MV}(cm^2) / \text{LVIDs}(cm)$$

■ Operating Procedures

1. Select [B-P Ellipse] in the menu or the touch screen.
2. In left ventricular short-axis view, measure the following parameters:
At end diastole: LVIDd
At end systole: LVIDs
3. In short-axis view at mitral valve level, measure the following parameters:
At end diastole: LVAd sax MV
At end systole: LVAs sax MV
4. In apical long-axis view, measure the following parameters:
LVAd apical, the EDV is calculated
LVAs apical, the ESV is calculated
The system calculates the SV and EF after the LVAs apical has been measured.
If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
5. Use the menu to select the HR source: ECG or entered.
The CO and CI are calculated automatically using the entered height and weight values.

Bullet

■ Study Items

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	

Tools	Descriptions	Operations
LVA _d sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General Measurements
LVA _s sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
HR	Heart Rate	Obtained by ECG or entered directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Bullet)	End-diastolic Left Ventricular Volume	$EDV(ml) = 5/6 \times LVL_d \text{ apical}(cm) \times LVA_d \text{ sax MV}(cm^2)$
ESV(Bullet)	End-systolic Left Ventricular Volume	$ESV(ml) = 5/6 \times LVL_s \text{ apical}(cm) \times LVA_s \text{ sax MV}(cm^2)$
EDV Index(Bullet)	End-diastolic Left Ventricular Volume Index	$EDV \text{ Index} = EDV/BSA$
ESV Index(Bullet)	End-systolic Left Ventricular Volume Index	$ESV \text{ Index} = ESV/BSA$
SV(Bullet)	Stroke Volume	See table in “6.4.3.1 Left Ventricular Function”
CO(Bullet)	Cardiac Output	
EF(Bullet)	Ejection Fraction	
SI(Bullet)	SV Index	
CI(Bullet)	CO Index	

■ Operating Procedures

- Select [Bullet] in the measurement menu or the touch screen.
In apical long-axis view, measure the following parameters:
At end diastole: LVL_d apical
At end systole: LVL_s apical.
- In short-axis view at mitral valve level, measure the following parameters:
At end diastole: LVA_d sax MV, the EDV is calculated
At end systole: LVA_s sax MV, the ESV is calculated
The system calculates the SV and EF. If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
- Use the menu to select the HR source: ECG or entered.
The CO and CI are calculated automatically using the entered height and weight values.

Mod.Simpson

■ Study Items

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
LVAAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General Measurements
LVAAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
LVAAd sax PM	Left Ventricular Area at Papillary Muscle level at end-diastole in short axis view	
LVAAs sax PM	Left Ventricular Area at Papillary Muscle level at end-systole in short axis view	
HR	Heart Rate	Obtained by ECG or entered directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Mod.Simpson)	End-diastolic Left Ventricular Volume	*1
ESV(Mod.Simpson)	End-systolic Left Ventricular Volume	*2
EDV Index(Mod.Simpson)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(Mod.Simpson)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(Mod.Simpson)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"
CO(Mod.Simpson)	Cardiac Output	
EF(Mod.Simpson)	Ejection Fraction	
SI(Mod.Simpson)	SV Index	
CI(Mod.Simpson)	CO Index	

*1 means:

$$EDV[mL] = \frac{LVLd_{apical} [cm]}{9} \times \left(4 \times LVA_{sax\ MV} [cm^2] + 2 \times LVA_{Ad} \right. \\ \left. sax\ PM [cm^2] + \sqrt{LVA_{sax\ MV} [cm^2] \times LVA_{sax\ PM} [cm^2]} \right)$$

*2 means:

$$ESV[mL] = \frac{LVLs_{apical} [cm]}{9} \times \left(4 \times LVA_{sax\ MV} [cm^2] + 2 \times LVA_{As} \right. \\ \left. sax\ PM [cm^2] + \sqrt{LVA_{sax\ MV} [cm^2] \times LVA_{sax\ PM} [cm^2]} \right)$$

■ Operating Procedures

1. Select [Mod.Simpson] in the measurement menu or the touch screen.
2. In apical long-axis view, measure the following parameters:
 - At end diastole: LVLd apical
 - At end systole: LVLs apical

3. In short-axis view at mitral valve level, measure the following parameters:
 At end diastole: LVAd sax MV
 At end systole: LVAs sax MV
4. In short-axis view at papillary muscle level, measure the following parameters:
 At end diastole: LVAd sax PM, the EDV is calculated
 At end systole: LVAs sax PM, the ESV is calculated
 The system calculates the SV and EF.
 If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
5. Use the menu to select the HR source: ECG or entered.
 The CO and CI are calculated automatically using the entered height and weight values.

Simpson SP

This method includes two studies: Simp SP(A4C) and Simp SP(A2C).

■ Study Items

Tools	Descriptions	Operations
EDV(A2C/A4C)	End-diastolic Left Ventricular Volume (apical 2-chamber/ 4-chamber)	Simpson measurement (Trace/ Spline/ Auto)
ESV(A2C/A4C)	End-systolic Left Ventricular Volume (apical 2-chamber/ 4-chamber)	
HR	Heart Rate	Obtained by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Simp SP)	End-diastolic Left Ventricular Volume	$EDV(ml) = \pi \times \frac{LVLd\ apical(cm)}{20} \times \sum_{i=1}^{20} r_i^2 (cm)$ LVLd apical: Left Ventricular Long-axis Length at End-diastole in apical view, i.e. the long-axis length obtained in measurement. r_i : Radiuses obtained from diastolic measurement
ESV(Simp SP)	End-systolic Left Ventricular Volume	$ESV(ml) = \pi \times \frac{LVLs\ apical(cm)}{20} \times \sum_{i=1}^{20} r_i^2 (cm)$ LVLs apical: Left Ventricular Long-axis Length at End-systole in apical view, i.e. the long-axis length obtained in measurement. r_i : Radiuses obtained from systolic measurement
EDV Index (A2C/A4C)	End-diastolic Left Ventricular Volume Index (A2C/A4C)	EDV Index=EDV/BSA
ESV Index (A2C/A4C)	End-systolic Left Ventricular Volume Index (A2C/A4C)	ESV Index=ESV/BSA
SV	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"

Tools	Descriptions	Formulae
CO	Cardiac Output	
EF	Ejection Fraction	
SI	SV Index	
CI	CO Index	

■ Operating Procedures

1. Select [Simp SP] in the measurement menu.

2. Measure the endocardium.

Measure the left ventricular endocardium at end-diastolic, and set the long axis, the EDV is obtained;

Measure the left ventricular endocardium at end-systolic, and set the long axis, the ESV is obtained;

The system calculates SV and EF;

If height and weight have been input already, SI, EDV Index and ESV Index are calculated.

3. Obtain HR (heart rate) from ECG or input directly.

The CO and CI are calculated automatically.

■ Measurement Methods

The endocardium can be measured using the following methods.

● Trace

Trace the endocardium along the edge of the target area using the method similar to the "Trace" method in 2D Area measurements; and then set the long axis.

● Spline

Set reference points (up to 12) along the edge of the endocardium using the method similar to the "Spline" method in 2D Area measurements; and then set the long axis.

● Auto

(1) Set point A and B using the trackball and <Set> key, where in,

- A: Left ventricular interventricular septal and mitral valve junction;
- B: Left ventricular wall and mitral valve junction;

(2) After setting A and B, the cursor positions automatically at point D where is considered as the apical part by system detecting, also the long axis (line segment CD) and the line that traces the endocardium are displayed at the same time. Where in,

- C: Midpoint of A and B.
- D: Apical part of left ventricle.

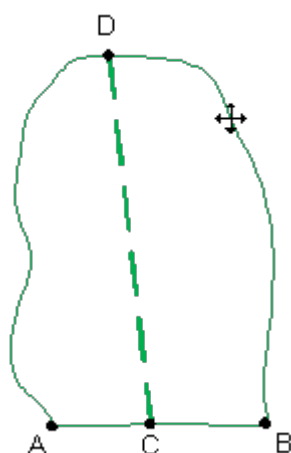
You can:

● Adjust the long axis

- a) Rotate the trackball to position the cursor on the long axis (which turns yellow), and then press <Set>;
- b) Rotate the trackball, adjust the point D (with point C unchanged) after the cursor changes to ↕.

● Adjust the trace line

- a) Rotate the trackball to position the cursor on the trace line (which turns yellow), and then press <Set>;
- b) Rotate the trackball, move the cursor along the endocardium edge to adjust the line after the cursor changes to ↕ (with ABD points unchanged).



c) Press <Set> outside the line to confirm the adjustment.

Simpson BP

Study Items

Tools	Descriptions	Operations
EDV(A2C)	End-diastolic Left Ventricular Volume (apical 2-chamber)	Simpson measurement (Trace/ Spline) See "Simpson SP" for endocardium measurement
ESV(A2C)	End-systolic Left Ventricular Volume (apical 2-chamber)	
EDV(A4C)	End-diastolic Left Ventricular Volume (apical 4-chamber)	
ESV(A4C)	End-systolic Left Ventricular Volume (apical 4-chamber)	
HR	Heart Rate	Obtained by ECG or input directly

Study Results

Tools	Descriptions	Formulae
EDV(Simpson BP)	End-diastolic Left Ventricular Volume	*1
ESV(Simpson BP)	End-systolic Left Ventricular Volume	*2
EDV Index (Simpson BP)	End-diastolic Left Ventricular Volume	EDV Index=EDV/BSA
ESV Index (Simpson BP)	End-systolic Left Ventricular Volume	ESV Index=ESV/BSA
SV(Simpson BP)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"
CO(Simpson BP)	Cardiac Output	
EF(Simpson BP)	Ejection Fraction	
SI(Simpson BP)	SV Index	
CI(Simpson BP)	CO Index	

*1 means:

$$EDV(ml) = \pi \times \frac{\text{MAX}\{LVLd_{2i}(cm), LVLd_{4i}(cm)\}}{20} \times \sum_{i=1}^{20} (r_{2i}(cm) \times r_{4i}(cm))$$

*2 means:

$$ESV(ml) = \pi \times \frac{MAX\{LVLs_{2i}(cm), LVLs_{4i}(cm)\}}{20} \times \sum_{i=1}^{20} (r_{2i}(cm) \times r_{4i}(cm))$$

Calculate the LV volume on the apical 2-chamber view image:

$$EDV2(ml) = \pi \times \frac{LVLd_{2i}(cm)}{20} \times \sum_{i=1}^{20} r_{2i}^2(cm)$$

$$ESV2(ml) = \pi \times \frac{LVLs_{2i}(cm)}{20} \times \sum_{i=1}^{20} r_{2i}^2(cm)$$

Calculate the LV volume on the apical 4-chamber view image:

$$EDV4(ml) = \pi \times \frac{LVLd_{4i}(cm)}{20} \times \sum_{i=1}^{20} r_{4i}^2(cm)$$

$$ESV4(ml) = \pi \times \frac{LVLs_{4i}(cm)}{20} \times \sum_{i=1}^{20} r_{4i}^2(cm)$$

Where,

$LVLd_{2i}$ – Left ventricular long-axis length at end diastole at apical two-chamber view, which is the long-axis length obtained by EDV(A2C) measurement

$LVLd_{4i}$ – Left ventricular long-axis length at end diastole at apical four-chamber view, which is the long-axis length obtained by EDV(A4C) measurement

$LVLs_{2i}$ – Left ventricular long-axis length at end systole at apical two-chamber view, which is the long-axis length obtained by ESV(A2C) measurement

$LVLs_{4i}$ – Left ventricular long-axis length at end systole at apical four-chamber view, which is the long-axis length obtained by ESV(A4C) measurement

r_{2i} – Radiuses obtained by EDV(A2C) or ESV(A2C) at apical two-chamber view

r_{4i} – Radiuses obtained by EDV(A4C) or ESV(A4C) at apical four-chamber view



CAUTION:

When using Simpson BP to measure LV function, be sure to keep the apical four-chamber view and apical two-chamber view perpendicular. Otherwise the measurement result will be incorrect.

■ Operating Procedures

1. Select [Simpson BP] in the measurement menu.
2. In apical two-chamber view, measure the following parameters:
Left ventricular endocardium at end-diastolic, and set the long axis, the EDV(A2C) is obtained;
Left ventricular endocardium at end-systolic, and set the long axis, the ESV(A2C) is obtained;
3. In apical four-chamber view, measure the following parameters:
Left ventricular endocardium at end-diastolic, and set the long axis, the EDV(A4C) is obtained;
Left ventricular endocardium at end-systolic, and set the long axis, the ESV(A4C) is obtained;
If height and weight have been input already, SV, EF, SI, EDV Index and ESV Index are calculated.
4. Obtain HR (heart rate) from ECG or input directly.
The CO and CI are calculated automatically.

Cube

■ Study Items

Tools	Descriptions	Operations
Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode Parallel method in M mode
Systole	End-systolic Left Ventricular Measurement	
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D/M General Measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
HR	Heart Rate	Measure in M mode, obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVIDd	Left Ventricular Internal Diameter at End-diastole	
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	
IVSs	Interventricular Septal Thickness at End-systole	
LVIDs	Left Ventricular Internal Diameter at End-systole	
LVPWs	Left Ventricular Posterior Wall Thickness at End-systole	
EDV(Cube)	End-diastolic Left Ventricular Volume	$EDV(ml) = LVIDd(cm)^3$
ESV(Cube)	End-systolic Left Ventricular Volume	$ESV(ml) = LVIDs(cm)^3$
EDV Index (Cube)	End-diastolic Left Ventricular Volume	$EDV\ Index = EDV/BSA$
ESV Index (Cube)	End-systolic Left Ventricular Volume	$ESV\ Index = ESV/BSA$
SV(Cube)	Stroke Volume	See table in “6.4.3.1 Left Ventricular Function”
CO(Cube)	Cardiac Output	
EF(Cube)	Ejection Fraction	
FS(Cube)	Fractional Shortening	
MVCF(Cube)	Mean Velocity of Circumferential Fiber Shortening	
SI(Cube)	SV Index	
CI(Cube)	CO Index	

■ Operating Procedures

1. Select [Cube] in the measurement menu.
2. Measure Diastole in 2D or M mode.
The IVSd, LVIDd, LVPWd and EDV are obtained.
3. Measure Systole in 2D or M mode.
IVSs, LVSS, LVIDs, LVPWs and ESV are obtained.
The system calculates SV, EF and FS;
4. Measure HR in M mode, obtain from ECG or input directly.
If height and weight have been input already, SI, CO, CI, EDV Index and ESV Index are calculated.
MVCF is calculated if LVET is measured.

In [Preset]-> [System Preset]-> [Application] screen, you can set the method for Cube/Teichholz/Gibson study.

Teichholz

■ Study Items

Tools	Descriptions	Operations
Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode Parallel method in M mode
Systole	End-systolic Left Ventricular Measurement	
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D/M General Measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
HR	Heart Rate	Measure in M mode, obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVIDd	Left Ventricular Internal Diameter at End-diastole	
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	
IVSs	Interventricular Septal Thickness at End-systole	
LVIDs	Left Ventricular Internal Diameter at End-systole	
LVPWs	Left Ventricular Posterior Wall Thickness at End-systole	
EDV(Teichholz)	End-diastolic Left Ventricular Volume	$EDV(ml) = (7 \times (LVIDd(cm))^3) / (2.4 + LVIDd(cm))$

Tools	Descriptions	Formulae
ESV(Teichholz)	End-systolic Left Ventricular Volume	$ESV(ml) = (7 \times (LVIDs(cm))^3) / (2.4 + LVIDs(cm))$
EDV Index (Teichholz)	End-diastolic Left Ventricular Volume	EDV Index=EDV/BSA
ESV Index (Teichholz)	End-systolic Left Ventricular Volume	ESV Index=ESV/BSA
SV(Teichholz)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"
CO(Teichholz)	Cardiac Output	
EF(Teichholz)	Ejection Fraction	
FS(Teichholz)	Fractional Shortening	
MVCF(Teichholz)	Mean Velocity of Circumferential Fiber Shortening	
SI(Teichholz)	SV Index	
CI(Teichholz)	CO Index	

■ Operating Procedures

See table above for methods and formulae of the measurement items.

See section "Cube" for measurement procedures.

In [Preset]-> [System Preset]-> [Application] screen, you can set the method for Cube/Teichholz/Gibson study.

Gibson

■ Study Items

Tools	Descriptions	Operations
Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode
Systole	End-systolic Left Ventricular Measurement	Parallel method in M mode
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D/M General Measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
HR	Heart Rate	Measure in M mode, obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVIDd	Left Ventricular Internal Diameter at End-diastole	

Tools	Descriptions	Formulae
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	
IVSs	Interventricular Septal Thickness at End-systole	
LVIDs	Left Ventricular Internal Diameter at End-systole	
LVPWs	Left Ventricular Posterior Wall Thickness at End-systole	
EDV(Gibson)	End-diastolic Left Ventricular Volume	$EDV(ml) = \frac{\pi}{6} \times (0.98 \times LVIDd(cm) + 5.90) \times LVIDd(cm)^2$
ESV(Gibson)	End-systolic Left Ventricular Volume	$ESV(ml) = \frac{\pi}{6} \times (1.14 \times LVIDs(cm) + 4.18) \times LVIDs(cm)^2$
EDV Index (Gibson)	End-diastolic Left Ventricular Volume	EDV Index=EDV/BSA
ESV Index (Gibson)	End-systolic Left Ventricular Volume	ESV Index=ESV/BSA
SV(Gibson)	Stroke Volume	See table in "6.4.3.1 Left Ventricular Function"
CO(Gibson)	Cardiac Output	
EF(Gibson)	Ejection Fraction	
SI(Gibson)	SV Index	
CI(Gibson)	CO Index	
MVCF(Gibson)	Mean Velocity of Circumferential Fiber Shortening	
FS(Gibson)	Fractional Shortening	

■ Operating Procedures

See table above for methods and formulae of the measurement items.

See section "Cube" for measurement procedures.

6.4.3.2 Left Ventricular Mass (LV Mass)

Estimates the Index of Left Ventricular Mass (LV Mass-I) by calculating the LV Mass.

$$LV\ MASS-I\ (No\ unit) = LV\ Mass\ (g) / Body\ Surface\ Area\ (m^2)$$

LV Mass (Cube)

■ Study Items

Tools	Descriptions	Operations
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVIDd	Left Ventricular Internal Diameter at End-diastole	
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	

■ Study Results

Tools	Descriptions	Formulae
LV Mass (Cube)	Left Ventricular Mass	$LV\ Mass\ (g) = 1.04 \times ((LVPWd(cm) + IVSd(cm) + LVIDd(cm))^3 - LVIDd(cm)^3) - 13.6$
LV MASS-I (Cube)	Index of Left Ventricular Mass	See the LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

■ Operating Procedures

1. Select [LV Mass (Cube)] in the measurement menu or the touch screen.
2. At end diastole, measure the following parameters:

IVSd

LVIDd

LVPWd

The LV Mass (Cube) is calculated.

If the height and weight have already been entered, the LV Mass-I(Cube) is calculated.

LV Mass (A-L)

■ Study Items

Tools	Descriptions	Operations
LVA _d sax Epi	Left Ventricular Epicardial Area at Papillary Muscle level at end-diastole in Short-axis view	Area in 2D General Measurements
LVA _d sax Endo	Left Ventricular Endocardial Area at Papillary Muscle level at end-diastole in Short-axis view	
LVL _d apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements

■ Study Results

Tools	Descriptions	Formulae
LV Mass (A-L)	Left Ventricular Mass	*1
LV MASS-I (A-L)	Index of Left Ventricular Mass	See the LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

*1 means:

$$LV\ Mass(g) = 1.05 \times 5/6 \times (LVA_{d\ sax\ Epi}(cm^2) \times (LVL_{d\ apical}(cm) + t(cm)) - LVA_{d\ sax\ Endo}(cm^2) \times LVL(cm))$$

Where

$$t\ (cm) = \sqrt{(LVA_{d\ sax\ Epi}(cm^2) / \pi)} - \sqrt{(LVA_{d\ Sax\ Endo}(cm^2) / \pi)}$$

■ Operating Procedures

1. Select [LV Mass (A-L)] in the measurement menu or the touch screen.
2. In long-axis view at end diastole, measure the LVL_d apical.
3. In short-axis view at papillary muscle level at end diastole, measure the following parameters:
Endocardium area: LVA_d sax Endo
Epicardium area: LVA_d sax Epi

The LV Mass (A-L) is calculated.

If the height and weight have already been entered, the LV Mass-I(A-L) is calculated.

LV Mass (T-E)

■ Study Items

Tools	Descriptions	Operations
LVAd sax Epi	Left Ventricular Epicardial Area at Papillary Muscle level at end-diastole in Short-axis view	Area in 2D General Measurements
LVAd sax Endo	Left Ventricular Endocardial Area at Papillary Muscle level at end-diastole in Short-axis view	
a	Semi-major axis from widest minor axis radius to apex	Distance in 2D General Measurements
d	Truncated semi-major axis from widest minor axis radius to mitral annulus plane	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
LV Mass (T-E)	Left Ventricular Mass	*1
LV MASS-I (T-E)	Index of Left Ventricular Mass	See the LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

*1 means:

$$\text{LV Mass(g)} = 1.05\pi \times \left\{ (b+t)^2 \times \left[\frac{2(a+t)}{3} + d - \frac{d^3}{3(a+t)^2} \right] - b^2 \times \left(\frac{2a}{3} + d - \frac{d^3}{3a^2} \right) \right\}$$

Where units of a, b, d, t are cm.

a: Semi-major axis from widest minor axis radius to apex

d: Truncated semi-major axis from widest minor axis radius to mitral annulus plane

t: Thickness of the myocardium

$$t(\text{cm}) = \sqrt{(\text{LVAd sax Epi}(\text{cm}^2) / \pi)} - \sqrt{(\text{LVAd Sax Endo}(\text{cm}^2) / \pi)}$$

b: Short axis radius, usually measured where the radius is largest.

$$b(\text{cm}) = \sqrt{(\text{LVAd Sax Endo}(\text{cm}^2) / \pi)}$$

■ Operating Procedures

1. Select [LV Mass(T-E)] in the measurement menu or the touch screen.
2. In short-axis view at papillary muscle level at end diastole, measure the following parameters:
Endocardium area: LVAd sax Endo
Epicardium area LVAd sax Epi
3. Measure a and d.
The LV Mass(T-E) is calculated.
If the height and weight have already been entered, the LV Mass-I(T-E) is calculated.

6.4.3.3 Mitral Valve Area (MVA)

The Mitral Valve Area (MVA) can be calculated using two methods: pressure half time (PHT) or velocity-time integral (VTI).

Tip: The MVA Calculation by PHT method should be performed in CW mode. See MVA(PHT) in “6.3.3 Doppler Cardiac Measurement” for the formula for MVA calculated using the PHT method.

MVA(VTI)

■ Study Items

Tools	Descriptions	Operations
LVOT Diam.	Left Ventricular Outflow Tract Diameter	Distance in 2D General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D trace in General D measurements
MV VTI	Mitral Valve Velocity-Time Integral	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
MVA(VTI)	Mitral Valve Area	$\text{MVA(VTI)}(\text{cm}^2) = \frac{\pi \times \text{LVOT VTI}(\text{cm}) \times \text{LVOT Diam}(\text{cm})^2}{4 \times \text{MV VTI}(\text{cm}) }$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.4 Aortic Valve Area (AVA)

The Aortic Valve Area (AVA) can be calculated by velocity-time integral (VTI). The measurements should be performed on 2D and Doppler images

■ Study Items

Tools	Descriptions	Operations
LVOT Diam.	Left Ventricular Outflow Tract Diameter	Distance in 2D General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D trace in General D measurements
AV VTI	Aortic Valve Velocity-Time Integral	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
AVA(VTI)	Aortic Valve Area	$\text{AVA(VTI)}(\text{cm}^2) = \frac{\pi \times \text{LVOT VTI}(\text{cm}) \times \text{LVOT Diam}(\text{cm})^2}{4 \times \text{AV VTI}(\text{cm}) }$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.5 LA Vol.

LA Vol. (Left Atrium Volume) used to estimate the size of the left atrium.

LA Vol.(A-L)

Estimates the Left Atrium Volume using area and length.

■ Study Items

Tools	Descriptions	Operations
LA apical	Left Atrium Diameter	Distance in 2D General Measurements
LAA(A2C)	Left Atrium Area at apical 2-chamber view	Area in 2D General Measurements
LAA(A4C)	Left Atrium Area at apical 4-chamber view	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
LA Vol.(A-L)	Left Atrium Area	$LA\ Vol(A-L)(ml) = \frac{8}{3\pi} LAA(A4C)(cm^2) \times LAA(A2C)(cm^2) / LA\ apical(cm)$
LA Vol. Index (A-L)	Left Atrium Area	LA Vol. Index = LA Vol./BSA

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

LA Vol. (Simp)

Estimates the left atrium volume using the Simpson method. Performed at apical two-chamber view and apical four-chamber view.

■ Study Items and Results

Tools	Descriptions	Operations
LA Vol.(A2C)	Left Atrium Volume at apical 2-chamber view	Same as the Simpson SP measurement
LA Vol.(A4C)	Left Atrium Volume at apical 4-chamber view	
LA Vol. Index (A2C/A4C)	Left Atrium Volume Index	LA Vol. Index = LA Vol./BSA

■ Operating Procedures

See "Simpson SP" for measurement procedures.

6.4.3.6 LVIMP (LV TEI)

The LVIMP (Left Ventricular Index of Myocardial Performance) is used to analyze the integrative ventricular diastolic and systolic capabilities.

■ Study Items

Tools	Descriptions	Operations
MV C-O Dur.	Mitral Valve Close-Open Duration	Time in M/Doppler General Measurements
LVET	Left Ventricular Ejection Time	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
LVIMP	Left Ventricular Index of Myocardial Performance	$LVIMP(\text{Nounit}) = \frac{MV\ C - O\ dur(s) - LVET(s)}{LVET(s)}$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.7 RVSP

The RVSP measures the right ventricular systolic pressure.

■ Study Items

Tools	Descriptions	Operations
TR Vmax	Tricuspid Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
RAP	Right Atrium Pressure	See below

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
TR PGmax	Tricuspid Valve Regurgitation Pressure Gradient	$TR\ PGmax\ (mmHg) = 4 \times TR\ Vmax\ (m/s)^2$
RVSP	Right Ventricular Systolic Pressure	$RVSP(mmHg) = RAP(mmHg) + 4 \times (TR\ V\ max(m/s))^2$

■ Operating Procedures

1. Select [RVSP] in the measurement menu or the touch screen.
2. Measure the TR Vmax in Doppler mode.
The TR PGmax is calculated.
3. Select [RAP] in the [RVSP] sub-menu and select (or enter) the pressure in the dialog box which appears. The range of input values is [0, 50.0 mmHg].
4. Click [OK] after selecting (or entering) the pressure. The RAP is obtained.
RVSP is calculated.

6.4.3.8 PAEDP

The PAEDP measures the pulmonary artery end diastolic pressure.

■ Study Items

Tools	Descriptions	Operations
PR Ved	Pulmonary Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
RAP	Right Atrium Pressure	See RAP measurement in “RVSP”

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
PR PGed	Pulmonary Valve Regurgitation Pressure Gradient at end-Diastole	/
PAEDP	Pulmonary Pressure at end-Diastole	$PAEDP(mmHg) = RAP(mmHg) + 4 \times (PR Ved(m/s))$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.9 RVIMP (RV TEI)

The measurement of RVIMP (Right Ventricular Index of Myocardial Performance) is similar to that of LVIMP.

■ Study Items

Tools	Descriptions	Operations
TV C-O Dur.	Tricuspid Valve Close-Open Duration	Time in Doppler General Measurements
RVET	Right Ventricular Ejection Time	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
RVIMP	Right Ventricular Index of Myocardial Performance	$RVIMP(Nounit) = \frac{TV\ C-O\ dur(s) - RVET(s)}{RVET(s)}$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.10 Qp/Qs

Flow ratio of pulmonary circulation and systemic circulation.

■ Study Items

Tools	Descriptions	Operations
RVOT Diam.	Right Ventricular Outflow Tract Diameter	Distance in 2D General Measurements
LVOT Diam.	Left Ventricular Outflow Tract Diameter	
RVOT VTI	Right Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General Measurements

Tools	Descriptions	Operations
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	

■ Study Results

Except for the values in the upper table, the following results can be obtained in this study:

Item	Description	Operations
RVOT SV	Right Ventricular Outflow Tract Stroke Volume	Obtained from the RVOT VTI measurement
RVOT CO	Right Ventricular Outflow Tract Cardiac Output	
RVOT SI	Right Ventricular Outflow Tract SV Index	
RVOT CI	Right Ventricular Output Tract CO Index	
RVOT Vmax	Right Ventricular Outflow Tract Maximum Velocity	
RVOT Vmean	Right Ventricular Outflow Tract Minimum Average Velocity	
RVOT PGmax	Right Ventricular Outflow Tract Maximum Pressure Gradient	
RVOT PGmean	Right Ventricular Outflow Tract Average Pressure Gradient	
LVOT SV	Left Ventricular Outflow Tract Stroke Volume	Obtained from the LVOT VTI measurement
LVOT SI	Left Ventricular Outflow Tract SV Index	
LVOT CO	Left Ventricular Outflow Tract Cardiac Output	
LVOT CI	Left Ventricular Output Tract CO Index	
LVOT Vmax	Left Ventricular Outflow Tract Maximum Velocity	
LVOT PGmax	Left Ventricular Outflow Tract Maximum Pressure Gradient	
LVOT Vmean	Left Ventricular Outflow Tract Average Velocity	
LVOT PGmean	Left Ventricular Outflow Tract Minimum Pressure Gradient	
Qp/Qs	Flow ratio of Pulmonary circulation and Systemic circulation	See below
Qp-Qs	Flow difference of Pulmonary circulation and Systemic circulation	

Where

$$Qp(ml) = RVOT \text{ SV}(ml) = \pi(RVOT \text{ Diam}(cm)/2)^2 \times RVOT \text{ VTI}(cm)$$

$$Qs(ml) = LVOT \text{ SV}(ml) = \pi(LVOT \text{ Diam}(cm)/2)^2 \times LVOT \text{ VTI}(cm)$$

$$Qp / Qs(Nounit) = \frac{RVOT \text{ SV}(ml)}{LVOT \text{ SV}(ml)}$$

$$Qp - Qs(Nounit) = RVOT \text{ SV}(ml) - LVOT \text{ SV}(ml)$$

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.4.3.11 PISA

The PISA (Proximal Isovelocity Surface Area) is used in the quantitative analysis of the mitral valve regurgitation (PISA MR), aortic valve regurgitation (PISA AR), tricuspid valve regurgitation (PISA TR) and pulmonary valve regurgitation (PISA PR) in color mode.

The PISA measurement procedure is as follows:

1. Start PISA and move the semicircular caliper by rotating the trackball.
2. Fix the center of the semicircular caliper by pressing <Set>.
3. Adjust the radius length orientation of the semicircular caliper by rotating the trackball.
4. Press <Set> to fix the caliper.

PISA MR

Mitral valve regurgitation (PISA MR) needs to be measured in Color and Doppler modes.

■ Study Items

Tools	Descriptions	Operations
MR Rad	Mitral Valve Stenosis Radius	PISA measurement
MR VTI	Mitral Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
MR Als.Vel.	Mitral Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

■ Study Results

Tools	Descriptions	Formulae
MR Vmax	Mitral Regurgitation Maximum Velocity	Obtained from the MR VTI measurement
MR Flow	Mitral Regurgitation Flow	$\text{MR Flow(ml)} = \frac{2\pi \text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}}{ \text{MR V max(cm/s)} } \times \text{MR VTI(cm)} $
MR Flow Rate	Mitral Regurgitation Flow Rate	$\text{MR Flow Rate(ml/s)} = 2\pi \text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}$
MR Fraction	Mitral Valve Regurgitation Fraction	$\text{MR Fraction (Nounit)} = \frac{\text{MR Flow(ml)}}{\text{MV SV(ml)}} \times 100\%$
MR EROA	Mitral Valve Effective Regurgitant Orifice Area	$\text{MR EROA(cm}^2\text{)} = \frac{2\pi \text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}}{ \text{MR Vmax(cm/s)} }$

■ Operating Procedures

1. Enter color mode and adjust the color map until the aliasing appears.
2. Select [PISA MR] in the measurement menu or the touch screen.
3. Measure MR Rad using the PISA caliper.
Input MR Als.Vel.

4. Measure the MR spectrum using D trace to obtain:

MR Vmax

MR VTI

The MR Flow, MR Flow Rate and MR EROA are calculated automatically.

If the MV SV is measured, the MR Fraction will be calculated automatically.

PISA AR

Aortic valve regurgitation (PISA AR) needs to be measured in Color and Doppler modes.

■ Study Items

Tools	Descriptions	Operations
AR Rad.	Aortic Valve Stenosis Radius	PISA measurement
AR VTI	Aortic Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
AR Als.Vel.	Aortic Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

■ Study Results

Tools	Descriptions	Formulae
AR Vmax	Aortic Regurgitation Maximum Velocity	Obtained from the AR VTI measurement
AR Flow	Aortic Regurgitation Flow	$AR\ Flow(ml) = \frac{2\pi AR\ Rad(cm)^2 \times AR\ Als.Vel(cm/s)}{ ARV\ max(cm/s) } \times AR\ VTI(cm)$
AR Flow Rate	Aortic Regurgitation Flow Rate	$AR\ Flow\ Rate(ml/s) = 2\pi AR\ Rad(cm)^2 \times AR\ Als.Vel(cm/s)$
AR Fraction	Aortic Valve Regurgitation Fraction	$AR\ Fraction\ (Nounit) = \frac{AR\ Flow(ml)}{AV\ SV(ml)} \times 100\%$
AR EROA	Aortic Valve Effective Regurgitant Orifice Area	$AREROA(cm^2) = \frac{2\pi ARRad(cm)^2 \times ARAls.Vel(cm/s)}{ ARVmax(cm/s) }$

■ Operating Procedures

Same as the PISA MR measurement.

PISA TR

Tricuspid valve regurgitation (PISA TR) needs to be measured in Color and Doppler modes.

■ Study Items

Tools	Descriptions	Operations
TR Rad.	Tricuspid Valve Stenosis Radius	PISA measurement
TR VTI	Tricuspid Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements

Tools	Descriptions	Operations
TR Als.Vel.	Tricuspid Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

■ Study Results

Tools	Descriptions	Formulae
TR Vmax	Tricuspid Regurgitation Maximum Velocity	Obtained from TR VTI measurement
TR Flow	Tricuspid Regurgitation Flow	$\text{TR Flow(ml)} = \frac{2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}}{ \text{TRV max(cm/s)} } \times \text{TR VTI(cm)} $
TR Flow Rate	Tricuspid Regurgitation Flow Rate	$\text{TR Flow Rate(ml/s)} = 2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}$
TR Fraction	Tricuspid Valve Regurgitation Fraction	$\text{TR Fraction (Nounit)} = \frac{\text{TR Flow(ml)}}{\text{TV SV(ml)}} \times 100\%$
TR EROA	Tricuspid Valve Effective Regurgitant Orifice Area	$\text{TR EROA(cm}^2\text{)} = \frac{2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}}{ \text{TRVmax(cm/s)} }$

■ Operating Procedures

Same as the PISA MR measurement.

PISA PR

Pulmonary valve regurgitation (PISA PR) needs to be measured in Color and Doppler modes.

■ Study Items

Tools	Descriptions	Operations
PR Rad.	Pulmonary Valve Stenosis Radius	PISA measurement
PR VTI	Pulmonary Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
PR Als.Vel.	Pulmonary Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

■ Study Results

Tools	Descriptions	Formulae
PR Vmax	Pulmonary Regurgitation Maximum Velocity	Obtained from PR VTI measurement
PR Flow	Pulmonary Regurgitation Flow	$\text{PR Flow(ml)} = \frac{2\pi \text{PR Rad(cm)}^2 \times \text{PR Als.Vel(cm/s)}}{ \text{PRV max(cm/s)} } \times \text{PR VTI(cm)} $

Tools	Descriptions	Formulae
PR Flow Rate	Pulmonary Regurgitation Flow Rate	$PR \text{ Flow Rate(ml/s)} = 2\pi PR \text{ Rad(cm)}^2 \times PR \text{ Als.Vel(cm/s)}$
PR Fraction	Pulmonary Valve Regurgitation Fraction	$PR \text{ Fraction (Nounit)} = \frac{PR \text{ Flow(ml)}}{PV \text{ SV(ml)}} \times 100\%$
PR EROA	Pulmonary Valve Effective Regurgitant Orifice Area	$PR \text{ EROA(cm)}^2 = \frac{2\pi PR \text{ Rad(cm)}^2 \times PR \text{ Als.Vel(cm/s)}}{ PR \text{ Vmax(cm/s)} }$

■ Operating Procedures

Same as the PISA MR measurement.

6.4.3.12 TDI

■ Study Items

Tools	Descriptions	Operations
MV Sa(medial)	Mitral Valve medial Systolic motion	D Vel. in Doppler General Measurements
MV Ea(medial)	Mitral Valve medial Early diastolic motion	
MV Aa(medial)	Mitral Valve medial Late diastolic motion	
MV ARa(medial)	Mitral Valve medial Acceleration Rate	Acceleration in Doppler General Measurements
MV DRa(medial)	Mitral Valve medial Deceleration Rate	
MV Sa(lateral)	Mitral Valve lateral Systolic motion	D Vel. in Doppler General Measurements
MV Ea(lateral)	Mitral Valve lateral Early diastolic motion	
MV Aa(lateral)	Mitral Valve lateral Late diastolic motion	
MV ARa(lateral)	Mitral Valve lateral Acceleration Rate	Acceleration in Doppler General Measurements
MV DRa(lateral)	Mitral Valve lateral Deceleration Rate	

■ Study Results

Tools	Descriptions	Formulae
Ea/Aa(medial)	MV medial E-Vel./A-Vel.	$Ea/Aa(medial)(Nounit) = \frac{Ea(medial)}{Aa(medial)}$
ATa(medial)	MV medial E-wave Acceleration Time	Obtained from the ARa(medial) measurement
DTa(medial)	MV medial E-wave Deceleration Time	Obtained from the DRa(medial) measurement
MV E/Ea(medial)	Used to estimate the diastolic function of left ventricular	Calculate after measuring MV E Vel and MV Ea(medial): $MV \text{ E/Ea(medial)}(Nounit) = \frac{MV \text{ E Vel}}{MV \text{ Ea(medial)}}$

Tools	Descriptions	Formulae
MV E/Ea(lateral)		Calculate after measuring MV E Vel and MV Ea(lateral): $MV\ E/Ea(lateral)(Nounit) = \frac{MV\ E\ Vel}{MV\ Ea(lateral)}$
MV E/Ea(medial+lateral)		Calculate after measuring MV E Vel, MV Ea(medial) and MV Ea(lateral) $E / Ea(medial + lateral)(Nounit) = \frac{MV\ E\ Vel(cm / s)}{(MVEa(medial)(cm / s) + MVEa(lateral)(cm / s))/2}$
Ea/Aa(lateral)	MV lateral E-Vel./A-Vel.	$Ea/Aa(lateral)(Nounit) = \frac{Ea(laterall)}{Aa(laterall)}$
ATa(lateral)	MV lateral E-wave Acceleration Time	Obtained from the ARa(lateral) measurement
DTa(lateral)	MV lateral E-wave Deceleration Time	Obtained from the DRa(lateral) measurement

■ Operating Procedures

See the table above for methods and formulae for the measurement items.

6.5 Cardiac Exam Report

During or after a measurement, press <Report> on the Control Panel to browse the report.

For details about report browsing, printing and exporting, etc., see “1.7 Report.”

6.6 References

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- DuBois, D., DuBois, E.F., “A Formula to Estimate the Approximate Surface Area if Height and Weight Be Known,” Nutrition, Sept-Oct 1989, Vol. 5, No. 5, pp. 303-313.

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- Snider, A.R., Serwer, G.A., Echocardiography in Pediatric Heart Disease, Year Book Medical Publishers, Inc., Littleton, MA, 1990, p. 83.

Teichholz:

- Teichholz, L.E., et al., "Problems in Echocardiographic Volume Determinations: Echocardiographic-Angiographic Correlations in the Presence or Absence of Asynergy," American Journal of Cardiology, January 1976, Vol. 37, pp. 7-11

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LV MASS-I:

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LA/Ao:

- Roelandt, Joseph, Practical Echocardiography, Ultrasound in Medicine Series, Vol. 1, Denis White, ed., Research Studies Press, 1977, p. 270.
- Schiller, N.B., et al., "Recommendations for Quantification of the LV by Two-Dimensional Echocardiography," J Am Soc Echo, Sept-Oct, 1989, Vol. 2, No. 5, p. 364.

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MV E/A:

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- Goldberg, Barry B., Kurtz, Alfred B., Atlas of Ultrasound Measurements, Year Book Medical Publishers, Inc., 1990, p. 65.
- Stamm, R. Brad, et al., "Quantification of Pressure Gradients Across Stenotic Valves by Doppler Ultrasound," J Am Coll Cardiol, 1983, Vol. 2, No. 4, pp. 707-718.

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- Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography" 2009 Published by Elsevier Inc. on behalf of the American Society of Echocardiography.

7 Small Parts

7.1 Small Parts Exam Preparations

Make the following preparations before measuring:

1. Confirm that the current probe is appropriate.
2. Check that the current system date is correct.
3. Press <Patient> and register the animal information in the [Animal Info] → [SMP] dialog box.
For more details, see “Exam Preparation → Animal Information” in the Operator's Manual [Basic Volume].
4. Switch to the correct exam mode.

7.2 Basic Small Parts Measurement Procedures

1. Press <Patient> and register the animal information in the [Animal Info] → [SMP] dialog box.
2. Press <Measure> to enter the Application Measurements.
3. Select the measurement tool in the menu or on the touch screen to start the measurement.
See the table in “7.3 Small Parts Measurement Tools” below for measurement tools.
See section “7.4 Small Parts Measurement Operations” and steps in “3 General Measurement” for measurement methods.
4. Press <Report> to view the exam report. See “7.5 Small Parts Exam Report” for details.

7.3 Small Parts Measurement Tools

The system supports the following small parts measurements.

NOTE: The measurement tools mentioned below are configured in the system. The application measurement packages provided in this system are generally different combinations of measurement tools. For more information about package preset, see “2.3.2.2 Application Measurement Preset.”

Modes	Types	Tools	Descriptions	Methods or formulae
2D	Measurement	Thyroid L	Thyroid Length	Distance in 2D General Measurements
		Thyroid H	Thyroid Height	
		Thyroid W	Thyroid Width	
		Isthmus H	Isthmus height	
		Testis L	Testicular Length	
		Testis H	Testicular Height	
		Testis W	Testicular Width	
		Epididymis L	Epididymis Length	
		Epididymis W	Epididymis Width	
		Epididymis H	Epididymis Height	
		Scrotal Wall Thickness	/	
		Mass1~10 L	Mass Length	Distance in 2D General Measurements
		Mass1~10 W	Mass Width	
		Mass1~10 H	Mass Height	
	Calculation	Thyroid Vol.	Thyroid Volume	Thyroid Vol. (cm ³) = k × Thyroid L (cm) × Thyroid H (cm) × Thyroid W (cm) Where k= 0.479 or 0.523
	Study	Thyroid	/	Same formulae as in the Thyroid Vol. calculation
		Testis	/	See below
		Mass1~10	/	Volume (3 Dist.) in 2D General Measurements
		Epididymis	/	See below
M	/	/	/	/
Doppler	Measurement	STA	Superior Thyroid Artery	D trace in General D measurements
		ITA	Inferior Thyroid Artery	
	Calculation	/	/	/

Modes	Types	Tools	Descriptions	Methods or formulae
	Study	/	/	/

7.4 Small Parts Measurement Operations

- Tip:**
1. See table “7.3 Small Parts Measurement Tools” above for measurement tools and methods.
 2. For the definitions of measurement, calculation and study, see “1.3 Measurement, Calculation and Study.”
 3. The order of the measurement items can be preset. See “2.3.2 Application Measurement Preset” for details.
 4. A measurement tool can be activated by clicking the item in the measurement menu or on the touch screen. It is described as “Select/Click ... in the measurement menu” in the following procedures.

7.4.1 Measurement Tool Operations

Take the measurement “Thyroid L” for example. The measurement procedure is as follows:

1. Select [Thyroid L] in the measurement menu or on the touch screen.
2. Use the Distance tool in 2D General Measurements to measure the Thyroid L. The value displays in the results window and exam report.

7.4.2 Calculation Tool Operations

Thyroid Vol.

Function: measures Thyroid L, Thyroid H and Thyroid W respectively, and calculates Thyroid Vol.

Tip: Needs to be measured on the left and right sides respectively.

1. Select [Thyroid Vol.] in the measurement menu or the touch screen.
2. Use the Distance tool in 2D General Measurements to measure the Thyroid L, Thyroid H and Thyroid W.
Two Thyroid Vols are calculated automatically.

7.4.3 Study Tool Operations

Thyroid

Function: measures Thyroid L, Thyroid H and Thyroid W respectively, and calculates Thyroid Vol. See “7.3 Small Parts Measurement Tools” for calculation formulae.

Tip: Needs to be measured on the left and right sides respectively.

1. Select [Thyroid] in the measurement menu or the touch screen
2. Use the Distance tool in 2D General Measurements to measure the Thyroid L, Thyroid H and Thyroid W. The Thyroid Vol. is calculated automatically.

Mass

Function: measures the Mass L, Mass W and Mass H to calculate the Mass Volume.

Taking Mass1 as an example, the procedure is as follows:

1. Select [Mass1] in the measurement menu or the touch screen.
2. Use the Distance tool in the 2D General Measurement to measure Mass1 L, Mass1 W and Mass1 H.

Testis

Function: measures the Testis L, Testis H and Testis W, calculates the Testis Vol.

NOTE: needs to be measured on the left and right sides respectively.

1. Select [Testis] in the measurement menu or the touch screen.
2. Use the Distance measurement method in 2D General Measurements to measure the Testis L, Testis H and Testis W. The Testis Vol. is calculated automatically.

Epididymis

Function: measures the Epididymis L, Epididymis H and Epididymis W.

NOTE: needs to be measured on the left and right sides respectively.

1. Select [Epididymis] in the measurement menu or the touch screen.
2. Use the Distance measurement method in 2D General Measurements to measure Epididymis L, Epididymis H and Epididymis W.

7.5 Small Parts Exam Report

During or after a measurement, press <Report> on the Control Panel to browse the report.

For details about report browsing, printing and exporting, etc., see "1.7 Report."

7.6 References

Thyroid Vol: Volumetrie der Schilddruesenlappn mittels Realtime-Sonographie; J Brunn, U. Block, G. Ruf, et al.; Dtsch.med. Wschr.106 (1981), 1338-1340.)
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(**k=0.523**)

