Z6 Vet/ Z60 Vet

Diagnostic Imaging Ultrasound System

Operator’s Manual

[Advanced Volume]

Content

Content ..... **i**
Intellectual Property Statement I
Preface II
Customer Service Department II
Safety Precautions III
1 Overview **1-1**
1.1 Basic Operations and Buttons 1-1
1.2 Measurement Menu 1-2
1.2.1 Menu Title 1-2
1.2.2 Location Tags 1-3
1.2.3 Measurement Tools 1-3
1.2.4 Other 1-4
1.3 Measurement, Calculation and Study 1-4
1.4 Measure Caliper 1-4
1.5 Result Window 1-5
1.5.1 Result Display 1-5
1.5.2 Moving Result Window 1-5
1.5.3 Result Assignment 1-5
1.6 Cross-window Measurement 1-7
1.7 Exam Report 1-7
1.7.1 Viewing Report 1-7
1.7.2 Editing Report 1-7
1.7.3 Viewing History Report 1-9
1.7.4 Printing Report 1-9
1.7.5 Exporting Report 1-9
2 Preset **2-1**
2.1 Basic Preset Procedures 2-1
2.2 Measurement Parameters 2-1
2.3 Measure Preset 2-2
2.3.1 Preset of General Measurement 2-2
2.3.2 Application Measurement Preset 2-5
3 General Measurement **3-1**
3.1 Basic Procedures of General Measurement 3-1
3.2 2D General Measurements 3-1
3.2.1 Depth 3-1
3.2.2 Distance 3-1
3.2.3 Angle 3-2
3.2.4 Area&Circ 3-2
3.2.5 Volume 3-3
3.2.6 Double Dist 3-4
3.2.7 Cross 3-5
3.2.8 Parallel 3-5
3.2.9 Trace Length 3-5
3.2.10 Ratio (D) 3-6
3.2.11 Ratio (A) 3-6

3.2.12 B-Profile 3-6
3.2.13 B-Hist 3-7
3.2.14 Color Vel 3-7
3.2.15 Volume Flow 3-8
3.2.16 IMT 3-8
3.3 M General Measurements 3-8
3.3.1 Distance 3-8
3.3.2 Time 3-8
3.3.3 Slope 3-8
3.3.4 Velocity 3-9
3.3.5 HR 3-9
3.4 Doppler General Measurements 3-9
3.4.1 Time 3-9
3.4.2 HR 3-10
3.4.3 D Vel 3-10
3.4.4 Acceleration 3-10
3.4.5 D Trace 3-10
3.4.6 PS/ED 3-13
3.4.7 Volume Flow 3-13
3.5 References 3-14

4 Abdomen 4-1

4.1 Abdomen Exam Preparations 4-1
4.2 Basic Abdomen Measurement Procedures 4-1
4.3 Abdomen Measurement Tools 4-1
4.4 Abdomen Measurement Operations 4-4
4.5 Abdomen Exam Report 4-4

5 Reproduction 5-1

5.1 Reproduction Exam Preparations 5-1
5.2 Basic Measurement Procedures 5-1
5.3 Reproduction Measurement Tools 5-1
5.4 Reproduction Measurement Operations 5-2
5.5 Multi-fetus Exam 5-2
5.6 Reproduction Exam Report 5-3
5.7 GA Formulae and References 5-3
5.7.1 GA Formulae and Reference for Dog 5-3
5.7.2 GA Formulae and Reference for Cat 5-3
5.7.3 GA Formulae and Reference for Equine 5-3
5.7.4 GA Formulae and Reference for Bovine 5-3
5.7.5 GA Formulae and Reference for Ovine 5-4

6 Cardiology 6-1

6.1 Cardiac Exam Preparations 6-1
6.2 Basic Cardiac Measurement Procedures 6-1
6.3 Cardiac Measurement Tools 6-1
6.3.1 2D Cardiac Measurements 6-2
6.3.2 M Cardiac Measurements 6-4
6.3.3 Doppler Cardiac Measurements 6-6
6.3.4 TDI Cardiac Measurements 6-10
6.4 Cardiac Measurement Operations 6-10
6.4.1 Measurement Tool Operations 6-10
6.4.2 Calculation Tool Operations 6-11

6.4.3 Study Tool Operations 6-11
6.5 Cardiac Exam Report 6-34
6.6 References 6-34

7 Vascular 7-1

7.1 Vascular Exam Preparations 7-1
7.2 Basic Vascular Measurement Procedures 7-1
7.3 Vascular Measurement Tools 7-1
7.4 Vascular Measurement Operations 7-4
7.4.1 Measurement Tool Operations 7-4
7.4.2 Calculation Tool Operations 7-4
7.4.3 Study Tool Operations 7-4
7.5 Vascular Exam Report 7-6
7.6 References 7-6

8 Small Parts 8-1

8.1 Small Parts Exam Preparations 8-1
8.2 Basic Small Parts Measurement Procedures 8-1
8.3 Small Parts Measurement Tools 8-1
8.4 Small Parts Measurement Operations 8-2
8.4.1 Measurement Tool Operations 8-2
8.4.2 Calculation Tool Operations 8-3
8.4.3 Study Tool Operations 8-3
8.5 Small Parts Exam Report 8-3
8.6 References 8-4

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Preface

This manual details the procedures for operating the Z6 Vet/ Z60 Vet Diagnostic Imaging Ultrasound System. Carefully read and understand the manual before using the system to ensure its safe and correct operation.

NOTE: When you operate the system, you can refer to the following manuals:

- Operator's Manual (Basic Volume)
- Operation Note

Depending on the software version, the preset settings, and optional configuration, the actual interfaces may appear different from those shown in this manual.

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

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

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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's safety when using this system.

⚠**CAUTION:**

1. **Select the proper animal image and measurement tools. Only the 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. Otherwise, new animal data will be combined with the previous animal.**
4. **When the system is turned OFF or the < End Exam> key is pressed, all the data that have not been saved 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.**

8. **Pressing the < Clear> key will clear the measurement caliper, all data in the result window, comments and body mark.**

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 a diagnosis.**

10. **Quality of the extended image constructed in iScape (panoramic imaging) dependents on the skill of 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. **The auto measurement might not be accurate when the result doesn't match the image exactly, please make the measurement manually.**

1 Overview

1.1 Basic Operations and Buttons

Tips:	The following descriptions for buttons and keys are used in this manual: ■ < >: Denotes key/ button on the control panel or keyboard. E.g. <Set>. ■ [ ]: Denotes button/item on the screen menu. 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 start a new exam.
2. Press <Patient> and input the animal information.

   It includes animal ID, name, height, weight etc. Type in 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, refer to "Exam Preparation -> Animal Information" in the Operator's Manual [Basic Volume].
3. Press <Probe> and select a proper exam mode.

   For more details, refer to "Exam Preparation" in the Operator's Manual [Basic Volume].
4. Measure preset.

   To preset measurement parameters, general/ application measurement packages etc. For details, refer to "2 Preset".
5. Press <Measure> to start measurement.
6. Select an item in the measure menu.

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

   For report editing and browsing, see "1.7 Exam Report";

Button Functions

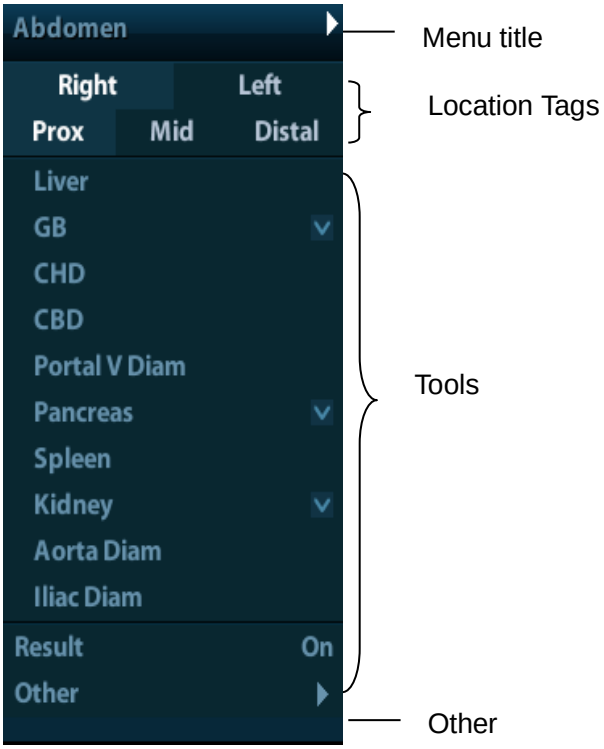
Key	Basic operations
Caliper	Enters/exits general measurement. Press <Esc> to exit measurement status.
Measure	To enter/exit the application measurement. Press <Esc> to exit measurement status.
Update	Press <Update> to switch between the fixed end and active end of the caliper during a measurement.
Set	To select an item on the measurement menu and press <Set> to activate it. Press <Set> confirm and end the current operation during measurement.

Key	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 result window.
Report	To enter/ exit the report page.
Cursor	To show the cursor.
Palm Switch	To move the cursor.
Multifunction knob	To enable the commonly used measure function or used for selecting measurement item by rotating.

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

1.2 Measurement Menu

Menus of General and Application measurement are different. measurement menu, refer to "3 General Measurement" and the specified application measurement chapter. Measurement menu items are as follows:



1.2.1 Menu Title

It displays the name of the measure menu, i.e. name of the measurement package.

- To switch to other measurement menus
  1. Move cursor to the menu title and the submenu pops up displaying other measure packages available.
  2. Move the cursor to an item and press <Set>.

1.2.2 Location Tags

The location widgets are used to select locations of the measurement.

- Side (Left/Right): Used to the item (e.g. kidney) that contains measurement of left/ right side parameters respectively.
- Location (Prox/Mid/Dist): Used to items (e.g. vascular) contains measurement of Proximal, Middle or Distal parameters.

- To Select the Measurement Location:
  1. Move the cursor to the location widgets (e.g. Side).
  2. Press <Set> to select the Measurement location.

Tips:	The location widgets are applicable only in application measurement.

1.2.3 Measurement Tools

There are two kinds of measurement tools.

- General tool: Basic measure tool 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 package such as Abdomen, Cardiology, etc. E.g.

Tips:	1. Actually, most application tools use the general measurement method while measuring, e.g. an "Distance" tool is used when measuring the Liver. Only the application measurement results are recorded in the report. 2. For definition of the measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".

Supported application measurement categories:

- Abdomen
- Reproduction
- Cardiology
- Small Parts
- Vascular

To Active the Measurement Tools

The procedures are as follows:

1. Move the cursor to the item and press <Set>.
2. Click on item and enter the submenu.
3. Click [Return] to return to the upper menu after measurement.

Other Features

Feature	Description
Current measurement tool/item	Highlighted.
Measured item	Performed application item/tool are 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	A scroll bar displays if the items can not be displayed in one page.
Item unavailable	Greyed out. Need switch to the proper imaging mode to enable it.

1.2.4 Other

During application measurement in multiple modes, the [Other] item appears at the bottom of the menu in multiple imaging modes is used to switch to other available measure menu.

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 " ".

Calculation

Results of calculations are automatically derived by the system, using other measured or calculated values as parameters, they are indicated by " ".

If all measurement tools related to a calculation tool are completed, the system will automatically complete the calculation 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.

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

1.4 Measure Caliper

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

Fixed/ Active End

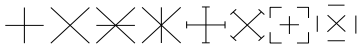
The ends of calipers can be active or fixed. The active end is called a Cursor.

Caliper Color

An active caliper appears in green, and a fixed caliper appears in white.

Symbols of the Caliper Ends

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



These symbols display in calipers as well as in the result window to indentify different measurements.

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

1.5 Result Window

Two types of result windows are used to display results numerically or graphically.

1.5.1 Result Display

Set [Result] to "ON" and the latest results display in the result window.

When viewing the results:

- If the result window is full, the oldest value will be replaced according to the "first in, first out" rule.

  A maximum of 8 results display in the result window, and a maximum of 2 graphical result windows can appear in the screen.
- To indentify the measurement results, symbols or numbers are used in the numerical result window while "No:1" or "No:2" is used in the graphical result window.

The results can display in the following type:

- No result displays when a measurement item/tool is activated but without the start point fixed.
- The result displays as numbers when the value obtained is within the clinical range.
- The result displays as "value!" when it's out of the clinical range but is still within the ultrasound range.
- The result displays as "?" when it is out of the ultrasonic range.

1.5.2 Moving Result Window

To move the result window,

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

1.5.3 Result Assignment

A general measurement result can be assigned to an application measurement item in the result window.

System-defined Application Item Assignment

The procedures are as follows:

1. Move the cursor to a general measurement result in the result window, press <Set> when the item highlighted in green, the matching list pops up as shown below.

   Matching application items that meet the following requirements are displayed:

   a) Preset in current application package.

   b) Use the same general measurement tool with the result.

   Application items in the Abdomen measurement that use the "Distance" method are listed as shown above.

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

Tips:	You can perform an assignment directly to the latest general measurement result by: 1. Enter an application measure menu (e.g. Abdomen), when a general measurement (e.g. "Distance") is completed. 2. Click the desired application item in the menu. The selected application item also has to meet the matching rules in step 1. 3. If the application item(s) is/are preset 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 procedures are as follows:

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

   a) Type in the new name.

   b) Select the application region.

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> in the keyboard, or select [Cancel] in the matching list to exit.

Auto Spectrum Calculation Assignment

Like a general measurement result, you can assignment the auto spectrum calculation results to an application item, with the same steps described above.

For details about auto spectrum calculation, please refer to “3.4.5 D Trace”.

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

1.6 Cross-window Measurement

For linear probe, 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.

1.7 Exam Report

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

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

1.7.1 Viewing Report

- Each measurement contains three latest values and a final value.
- The report only displays results of the tools that preset in the report template and completed.
- Select [Previous] or [Next] to display the previous or next page if the report is more than one page. Click [Previous] or [Next] to display the previous or next page.

1.7.2 Editing Report

Available operations of report editing are as follows:

- Editing Measurement Data
- Entering Ultrasound Remarks
- Adding/ Removing Images
- Analyzing Report Data

Editing Measurement Data

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

- The 3 measurement values in text boxes are editable, move the cursor to the text box and press <Set>.
- Modified values are underlined.
- The final value display 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

To clear all data except the animal information in the report dialog box, select [Clear All].

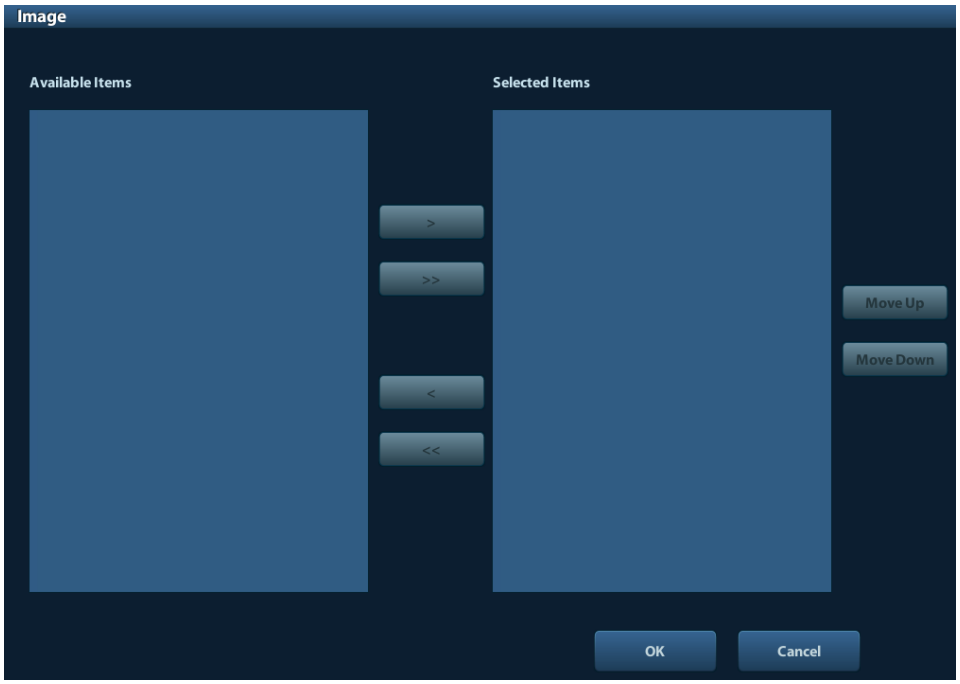
Entering Ultrasound Remarks

You can input corresponding information in the [Comments] box on the report page.

Adding/ Removing Images

Image(s) saved in current exam can be added to the report.

1. Select [Image Select] to pop up the following dialog box.



Left Column: Image(s) saved in current exam.

Right Column: Images selected to add into the report.

2. Select the image.

(1) Adding/ Removing the image by pressing:

[>]	To add the selected image in the left column into the right column.
[>>]	Add all images in the left column into the right column.
[<]	To remove selected image in the right column.
[<<]	To remove all images in the right column.

(2) Adjust the image arrangement.

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

3. Click [OK] to confirm.

Analyzing Report Data

You can preset and edit OB anatomy information in the report.

1. Click [Analyze].

   Items of preset ultrasound anatomy (OB or vascular) are listed in the page popped up.
2. Select anatomy descriptions.
3. Click [OK] to confirm. Analysis information displays following the measurement values in the report.

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

1.7.3 Viewing History Report

If more than one exam is performed to an animal, a drop-down list of [Exam] appears in the report.

1. Select history 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 an OB report template that preset without any abdomen measurement items.
3. Viewing the history report.

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

1.7.4 Printing Report

Click [Print] in the report page to print the report.

Or, click [Print View] in the report page to preview. In preview page, you can:

Print Report	Click [Print].
Page up/down:	Select [Prev Page] or [Next Page] to view the previous or next page.
Zoom in/out:	Select a zoom ratio from the drop-down list.
Exit the preview:	Click [Close].

1.7.5 Exporting Report

The reports can be exported in PDF or RTF documents, which can be viewed and edited on a PC.

1. In the report dialog box, select [Export].

2. Select the drive, directory and file name in the dialogbox popped up.
3. Select a file type.
4. Click [OK].

You can create, delete or rename the directory by pressing:

[New]:	To create a new template.
[Delete]:	To delete the selected directory. Multi-selection can be performed by using <Shift> and <Set> key. ）
[Rename]:	To rename a selected directory.

2 Preset

Before measuring, preset the following parameters:

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

2.1 Basic Preset Procedures

The basic measure preset procedures are as follows:

1. Enter the Setup menu by pressing <Setup> on the keyboard.
2. Preset the measurement parameters.

   Enter [Setup] -> [System Preset] -> [Application] to preset the Measure ruler etc. See "2.2 Measurement Parameters" for details.
3. Measure preset.

   Enter [Setup] -> [Measure Preset] -> [Caliper] and [Measure] to preset the measurement menu, and items. See "2.3 Measure Preset" for details.
4. Return from the setup to make the settings taking effect.

   Select [Return] on the [Setup] menu to return from the setup.

NOTE:	The settings take effect only by clicking [Return] to exit the [Setup] menu.

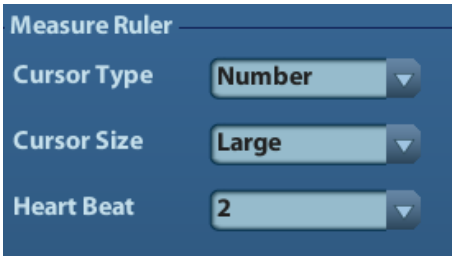
2.2 Measurement Parameters

Basic operation steps:

1. Press <Setup> to show the setup menu.
2. Select [Setup] -> [System Preset] -> [Application] to preset the following parameters:
   - Measure Ruler
   - Left ventricular study
   - Comment
3. Click [Save] to confirm.

The following are function descriptions of the parameters.

Measure Caliper



You can preset:

Item	Description
Cursor Type	Types of cursor displays on the measurement caliper and result 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 indentify different measurements.
Cursor Size	The size of the cursor. Value options: Large, Medium, Small
Heart Beat	The number of cardiac cycles in the heart rate calculation. (In the heart rate measurement, the cardiac cycles set should be the same as the preset.)

Left Ventricle function study tool setting

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

Comment

Set if clear the comment or bodymark when unfreezing the image or switching probe or exam mode.

2.3 Measure Preset

Basic Procedures:

1. Press <Setup> to show the setup menu.
2. Select [Measure Preset] in the [Setup] menu.
3. Preset the general and application measurement parameters.

   For details, refer to "2.3.1 Preset of General Measurement" and "2.3.2 Application Measurement Preset".
4. Click [OK] to confirm.
5. Continue other presets; or click [Return] on the [Setup] menu to make the settings take effect.

2.3.1 Preset of General Measurement

You can preset the General Measurement packages for 2D and M Mode respectively.

1. Select the [Caliper] in the [Measure Preset] page. As shown in figure below.

NOTE: The exam mode here are the default value of [Setup]-> [Exam Preset].

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

   [Available Items]: available general measurement tools configured by the system in the current scanning mode, but they are 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 by the following buttons:

[>]	To add the tool selected from the [Available Items] into the [Selected Items].
[>>]	To add all tools (need not selected) in the [Available Items] into the [Selected Items].
[<]	To remove the tool selected from the [Selected Items] to the [Available Items].
[<<]	To remove all tools in the [Selected Items] to the [Available Items]. You need not select any item before removing.

4. Set the default item.

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

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

5. Adjust the item position.

   Select an item in the right column and click [Move Up]/ [Move Down] to adjust the sequence in which the items are arranged in the corresponding general measurement menu.

6. Modify the property of measurement item.

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

a) Enter the [Measure Preset] -> [Caliper] -> [Doppler] page.

b) Select [D Trace] in the [Selected Items] and click [Property] to pop 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 result window. ■ If PV is selected, other results become deselected (except the temporary result “velocity”). ■ Some results such as PS and ED can derived via simply method (e.g. Velocity); but others such as TAMAX can only derived via complicated method like Manual, Spline, Auto etc. ● Only Vel in the [Method] is available if only PS or ED is selected. ● Only 2 PT in the [Method] is available if both PS and ED are selected (with others deselected). ● More complicated methods to obtain PS and TAMAX simultaneously are available if both PS and TAMAX are selected.
Unit	Select the unit of the measurement value.

Attributes	Descriptions
CalcMethod	Select the measurement method for the tool.

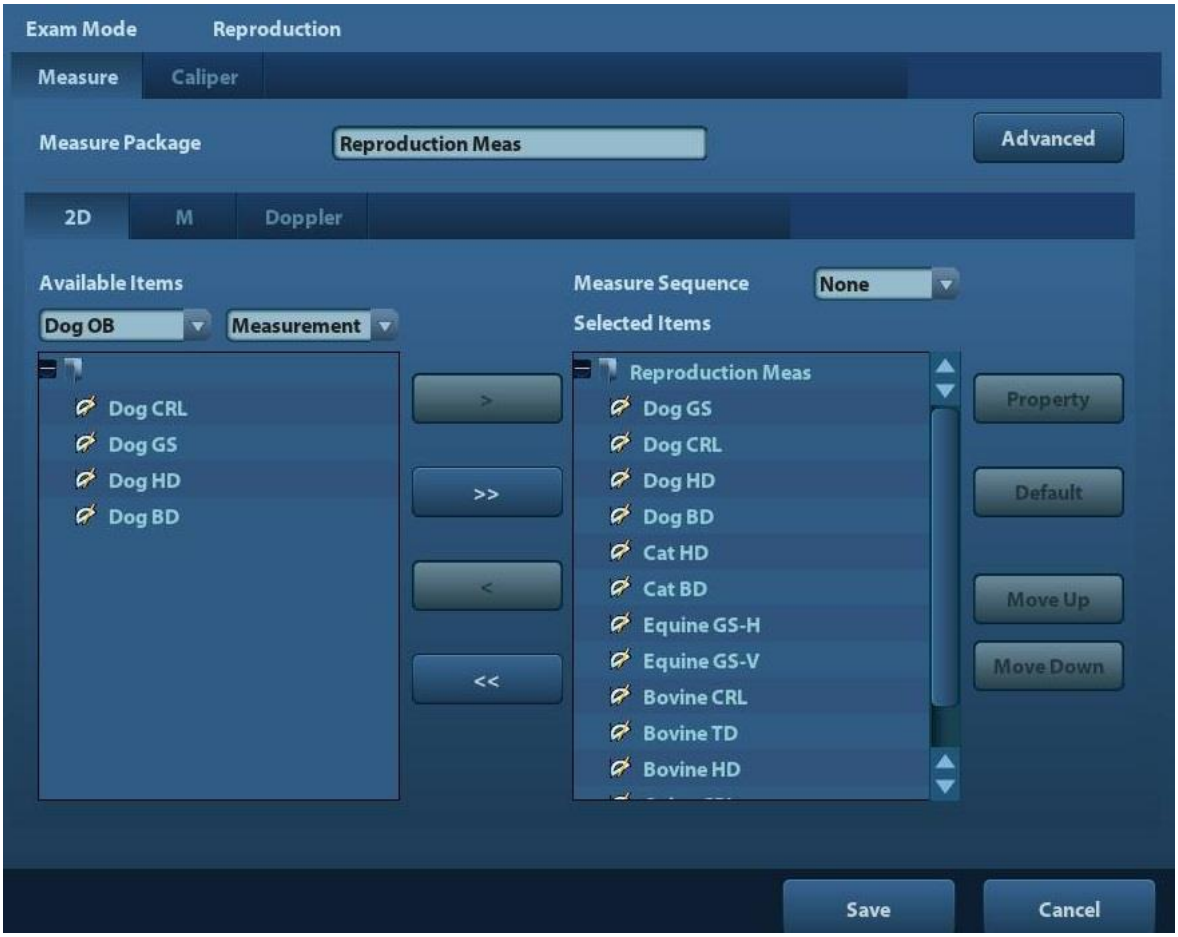
c) Click [OK] to confirm the setting.

6. Select the measure 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 on the whole screen. And the cursor will automatically return to the menu of the corresponding measurement.
7. Click [Save] to confirm.

2.3.2 Application Measurement Preset

2.3.2.1 Basic Procedures

1. Select the [Measure] in the [Measure Preset] page. As shown in figure below.



2. Select the 2D, M or Doppler scanning mode.
3. Choose or edit the Measurement Package.

Generally, the corresponding package appears in the [Measure Package] when the [Exam Mode] is selected.

- If no package appears, a default measurement package for the current exam mode needs to be added. You can input the package name directly in the [Measure Package] text box then add items into it; or click [Advanced] to enter the dialog box to add a new package.
- If the package appears is not the one desired, click [Advanced] and select a new default package for current exam mode.

For details about creating, deleting and setting 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] or [All] from the drop-down list under [Available Items], the corresponding items appear in the list.

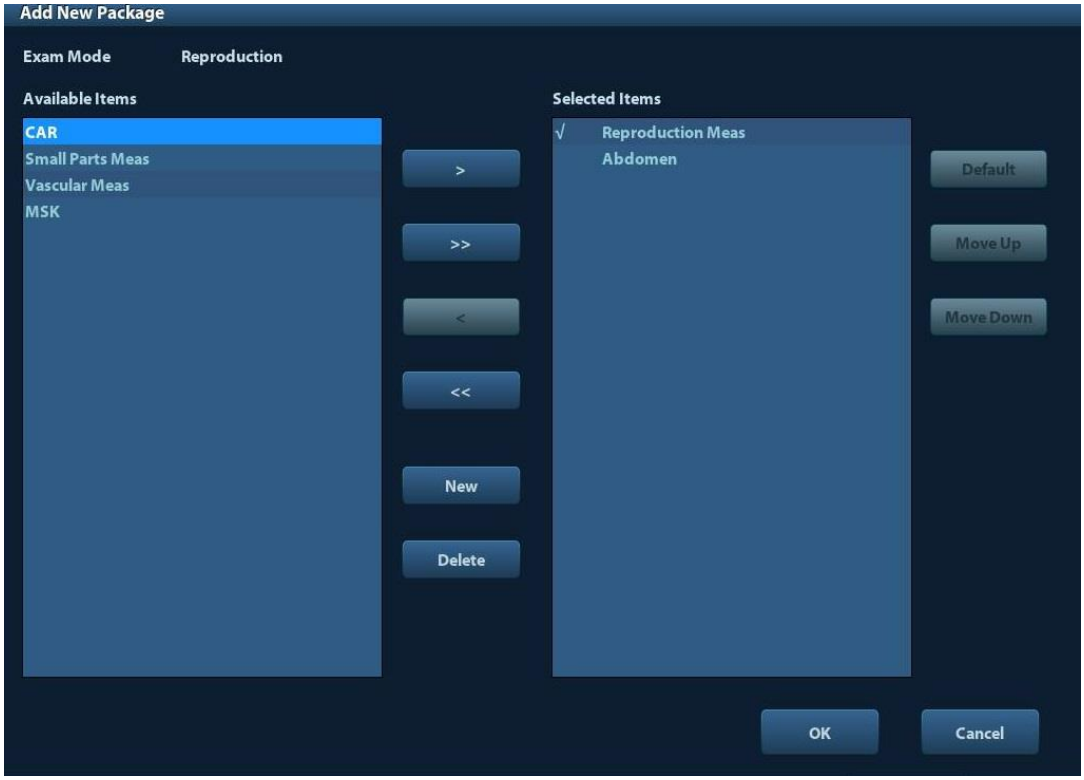
   For details about measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".
6. Preset the measurement menu.

   For details on adding, creating and setting default item, see “2.3.2.3 Measurement Menu Preset”.
7. Select the measure 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 on 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 in menu. Items in package are presettable and may belong to different application region.

1. Click [Advanced] in the [Measure Preset] page to enter the following page.



Where,

- [Available Items]: shows application packages configured in the system but not assigned to the current mode yet.
- [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 package via the menu title in the measuring status. See section “1.2.1 Menu Title”.

The package editing includes Creating Package, Add/ Remove the item, Deleting Measurement Package, Setting Default Package, Adjusting Package Position.

Creating Package

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

   New package displays in the [Available Items] list as shown in the following figure.

Adding/ Removing Package

Adding/ removing the package by pressing:

[>]	To add the package selected from the [Available Items] into the [Selected Items].
[>>]	To add all packages (need not be selected) in the [Available Items] into the [Selected Items].
[<]	To remove the package selected from the [Selected Items] to the [Available Items].
[<<]	To remove all packages (need not be selected) in the [Selected Items] to the [Available Items].

Deleting Package

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

Tips:	To delete an item in [Selected Items], you need to remove it to the [Available Items] first.

Setting Default Package

1. Select a package in the [Selected Items] list, click [Default].
2. The default package is marked with a √.

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

Adjusting Package Position

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

2.3.2.3 Measurement Menu Preset

In the [Measure Preset] -> [Selected Items] field, you can:

- Adding/ Removing Item
- Setting Default Item
- Adjusting Item Position

Adding/ Removing Item

- Adding Item

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

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

[>]	To add the tool selected from the [Available Items] into the [Selected Items].
[>>]	To add all tools (need not selected) in the [Available Items] into the [Selected Items].
[<]	To remove the tool selected from the [Selected Items] to the [Available Items].
[<<]	To remove all tools in the [Selected Items] to the [Available Items]. You need not select any item before removing.

Setting Default Item

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

1. Select an item in the [Selected Items].
2. Click [Default], and the defaulted item is marked with a √ .

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

Tips:	If a certain study is set to the default item, it displays the submenu of the study automatically when entering this measurement menu.

Adjusting Item Position

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

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

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

3 General Measurement

General Measurement Tools:

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

3.1 Basic Procedures of General Measurement

1. Preset the general measurement parameters and start the exam.
2. Select the imaging mode (B/M/Doppler), then scan the image.
3. Press <Caliper> to enter the general measurement menu.
4. Select an item from the general measurement menu to start the measurement.

Tips:	1.	You can perform general measurements on real-time image, or a frozen image.
	2.	The order of the measurement items is presettable, see "2.3.1 Preset of General Measurement" for details.

3.2 2D General Measurements

3.2.1 Depth

Function:

- Sectorial surface probe: The depth is the distance from the center of 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 ultrasonic wave.

1. Click [Depth] in the measurement menu, and 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 result window.

3.2.2 Distance

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

1. Click [Distance] in the measurement menu, and 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. Here,

   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.

3.2.3 Angle

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

1. Click [Angle] in the measurement menu, and the cursor appears on the screen.
2. Set two line segments as described in "3.2.2 Distance".

   The angle appears in the result window after setting the line segments.

3.2.4 Area&Circ

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.

Tips:	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. 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. Here,

   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. Move 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, and the measure result will be displayed in the results window.

Trace

1. Select [Trace] from the measurement menu. 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, please rotate the <Nav.Rot> Multi-Functional knob:

   Anticlockwise: to cancel a series of points.

   Clockwise: to resume a series of points.
5. Press <Set> and the trace line will be closed with a straight line connecting the starting and end points. The trace will also be closed when the cursor is very near to the starting point.

Spline

1. Select [Spline] from the measurement menu. 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, 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 close 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 result window.

Cross

1. Select [Cross] from the measurement menu. 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>. Here,

   Press <Update> to switch between the starting 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 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. Here,

   Press <Update> to switch between the starting 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:

- 3Dist

  To calculate the object's volume with 3 axes of two images scanned in the plane perpendicular to each other in B mode. Calculation formulae are as follow:

  $$\mathrm{V}olume(cm^3)=\frac{\pi}{6}\times D1(cm)\times D2(cm)\times D3(cm)$$

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

  To calculate the object's volume by its horizontal section area. Calculation formula is as follow:

  $$\mathrm{V}olume(cm^3)=\frac{\pi}{6}\times a(cm)\times b^2(cm)$$

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

- EDist

  To calculate the object's volume by its horizontal and vertical section area. Calculation formula is as follow:

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

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

Operations:

3Dist

1. Select [Volume (3Dist)] from the measurement menu. The cursor appears on the screen.
2. Measure D1, D2, D3, which are length of three axes of the target object.

   See "3.2.2 Distance" for detailed procedures.

   Generally, D1, D2, D3 should belong to different scanning plane.

Ellipse

1. Select [Volume(Ellipse)] from the measurement menu. The cursor appears on the screen.
2. The procedures are similar to that of Ellipse in the volume measurement, see "3.2.4 Area" for details.

EDist

1. Select [Volume(Ellispe Dist.)] from the measurement menu. The cursor appears on the screen.
2. Use the Ellipse method to measure the vertical section area.

   The procedures are similar to that of Ellipse in the Area measurement, see "3.2.4 Area" for details.
3. 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. Click [Double Dist] in the measurement menu, and the cursor appears on the screen.
2. Move the cursor to the measure 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>. Here,

   Press <Update> to switch between the starting 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 the <Update> or <Clear> to return to the last step.
8. Move the cursor to the end point of the second line segment. Here,

   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 Cross

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

1. Click [Cross] in the measurement menu, and the cursor appears on the screen.
2. Move the cursor to the measure 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>. Here,

   Press <Update> to switch between the starting 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 the <Update> or <Clear> to return to the last step.
8. Move the cursor to the end point of the second line segment. Here,

   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.

3.2.8 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, and then two lines perpendicular to each other appear on the screen. The intersection is the starting point of the line segment.
2. Rotate the Multifunctional 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, press <Set> to confirm the other four parallel lines, when the last parallel line is set, also 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.

3.2.9 Trace Length

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

Trace

1. Select [Trace Len (Trace)] from the measurement menu. 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, please rotate the <Nav.Rot> Multi-Functional knob:

   Anticlockwise: to cancel a series of points.

   Clockwise: to resume a series of points.

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

Spline

1. Select [Trace Len (Spline)] from the measurement menu. 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 … 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.

3.2.10 Ratio (D)

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

1. Click [Ratio (D)] in the measurement menu, and the cursor appears on the screen.
2. Measure the length of the two line segments, see "3.2.2 Distance" for detailed procedures.

   The result displays in the result window after the measurement of the second line is completed.

3.2.11 Ratio (A)

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

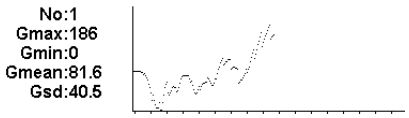
1. Select method from the drop-down list on the right of [Ratio (A)] in the menu. The cursor appears on the screen.
2. Measure the area of the two closed regions, see "3.2.4 Area" for detailed procedures.

3.2.12 B-Profile

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

1. Click [B-Profile] in the measurement menu, and the cursor appears on the screen.
2. Set a line segment, see "3.2.2 Distance" for detailed procedures.

   The result is shown in 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.

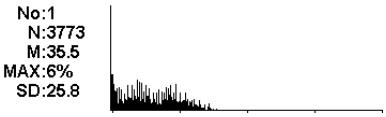
3.2.13 B-Hist

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).

B-Hist (Rectangle)

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

1. Click [B-Hist] in the measurement menu, and 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:	$M = \sum Di / N$;
MAX:	MAX = the pixel number in the maximum gray/ N×100%
SD:	Standard deviation. $SD=(\sum Di^2/N-(\sum Di/N)^2)^{1/2}$
	Di: The gray at each pixel point;
	$\sum Di$: The total grays of all pixels.

B-Hist (Ellipse)

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

B-Hist (Trace)

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

B-Hist (Spline)

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

3.2.14 Color Vel

Tips:	1. This measurement item is meant for a general estimation, not for accurate measurement. 2. The following operations are performed on frozen image.

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

1. Click [Color Vel] in the measurement menu, and 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 0°at the moment; you can change the angle (0°-80°) by rotating the <Nav.Rot> Knob to align the floating line in the direction same to that of blood flow at the point to be measured.
4. Press <Set> to set the direction of the blood flow, and the result displays in the result window.

3.2.15 Volume Flow

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

For details, please refer to “3.4.7 Volume Flow”.

3.2.16 IMT

IMT (Intima-Media Thickness) measures the distance between LI (Lumen-Intima) and MA (Media-Adventia). For details, please refer to “7.4.3 IMT”

3.3 M General Measurements

3.3.1 Distance

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

1. Click [Distance] in the measurement menu, and 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, and then the crossing point can only be moved in vertical direction. Here,

   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. Click [Time] in the measurement menu, and 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 the horizontal direction. Here,

   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. Click [Slope] in the measurement menu, and 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 cross point is connected to the starting point by a dashed line. Here,

   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. Click [Velocity] in the measurement menu, and 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, and then the crossing point can only be moved in vertical direction.

   Here, 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

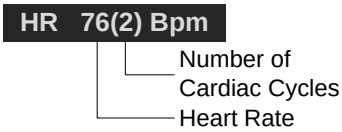
Function: Measures the time of n (n≤8) cardiac cycles on the M Mode image and calculates the heart rate.

The number of cardiac cycles "n" can be preset in the [System Preset] -> [Application] preset dialog box, see "2.2 Measurement Parameters" for details.

⚠**CAUTION:**	**During the measurement, the number of cardiac cycles between the measurement starting and end points must be exactly the same as preset. Otherwise, misdiagnosis may occur.**

1. Click [HR] in the measurement menu, and two dotted lines perpendicular to each other appear on the screen.
2. Select n cardiac cycles.

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



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≤8) cardiac cycles on the M 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.

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

1. Click [D Vel] in the measurement menu, and 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 result window.

3.4.4 Acceleration

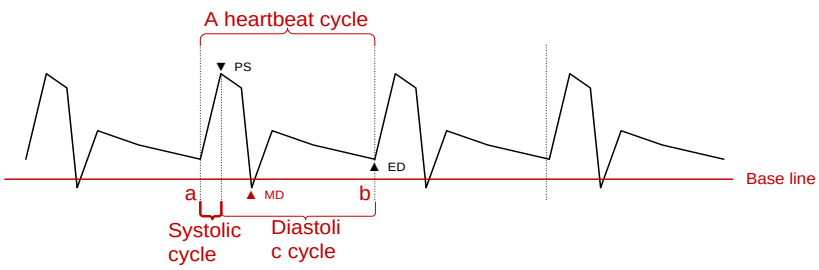
Function: Measures the velocities of two points and their time interval on the Doppler image, and calculates the acceleration, pressure gradient, velocity difference and correction angle.

1. Click [Acceleration] in the measurement menu, and 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 displays in the result window.

3.4.5 D Trace

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

The sketch map of Doppler spectrum is shown as below:



NOTE:	The heartbeat of the traced spectrum should equal to that is preset, otherwise the obtained HR (Heart Rate) is incorrect. See "2.2 Measurement Parameters" for relevant preset.

■ Operations:

1. Click [D Trace] in the measurement menu, and 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 (or rotate the <Angle> anticlockwise to correct the trace line already drawn.

4. Trace the end point to be measured and press <Set> to fix the point.

Result parameters

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 diastolic cycle.
Vel	/	Flow velocity
Average velocity	/	The average flow velocity in the whole traced Doppler spectrum. ■ TAMAX (Time Averaged Maximum Velocity): $\mathrm{TAMAX}(cm/s)=\int_{Ta}^{Tb}V(t)dt\Big/(T_b-T_a)$ Where V(t) is the maximum velocity ■ TAMEAN (Time Averaged Mean Velocity): Obtained by auto spectrum calculation. $\mathrm{TAMEAN}(cm/s)=\int_{Ta}^{Tb}V(t)dt\Big/(T_b-T_a)$ Where V(t) is the mean velocity.
PPG	Peak Pressure Gradient	It is the corresponding pressure gradient of the peak systolic velocity. PPG (mmHg) = 4 × PS $(m/s)^2$
Average Pressure Gradient	/	Average pressure gradient in the whole traced Doppler spectrum. ■ MPG: Maximum Pressure Gradient. $\mathrm{MPG}(mmHg)=\int_{Ta}^{Tb}4(V(t))^2dt\Big/(T_b-T_a)$ Where V(t) is the peak systolic velocity. ■ MMPG: Mean velocity Mean Pressure Gradient. (Obtained during auto-spectrum calculation.) $\mathrm{MMPG}(mmHg)=\int_{Ta}^{Tb}4(V(t))^2dt\Big/(T_b-T_a)$ ■ Where V(t) is the mean systolic velocity.
VTI	Velocity-Time Integral	Velocity-time Integral. It is the integral of the product of Doppler instantaneous velocity and the total time interval. $VTI(m)=\int_{T_a}^{T_b}V(t)dt$
AT	Acceleration Time	It is the time of the blood velocity accelerating from the end of diastole to the systolic peak. Generally, it's 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 existing the systolic cycle.
DT	Deceleration Time	Deceleration Time.

Parameters	Descriptions	
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	Pulsative Index	Pulsatile Index. PI (No unit) = |(PS (m/s) – ED (m/s)) / TAMAX (m/s)|
RI	Resistive Index	Resistance index. RI (No unit) = |(PS (m/s) – ED (m/s)) / PS (m/s)|
θ	/	Correction angle is the spectrum angle during measurement, which is a result obtained from a non D trace measurement tool and usually is displayed together with the spectral measurement results.
PV	Peak Velocity	The peak velocity in systolic or diastolic cycle (with no difference), which is the highest velocity of the red blood cell(s) that cross the sample volume, and 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 operation and preset.

Measurement Method

The measurement method varies by the result selected, where,

- 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
  1. Select [2 PT] on the measurement menu, the cursor displays as a “+”.
  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.

- Manual
  1. Select [Manual] from the drop-down list on the right of [D Trace] in 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 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.

- Spline
  1. Select [Spline] from the drop-down list on the right of [D Trace] in 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 … point (50 points at most) of spectrum.
4. Press <Set> twice to anchor the last reference point. Or,

   The measurement ends automatically when there are 50 reference points.

- Auto
  1. Select [Auto] from the drop-down list on the right of [D Trace] in the measurement menu, the measure cursor appears on the screen.
  2. Move the cursor to the starting point to be measured and press <Set> to fix the point.
  3. Press <Set> to anchor the end point of the trace line. The spectrum between the start point and the end point is traced.

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. Click [PS/ED] in the measurement menu, and 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 some vascular cross section per unit time.

1. Click [Volume Flow] in the measure menu.
2. Select the measurement method of the [Vas Area] and select [PW Scope]
3. Measure the vascular area.
4. Click [TAMEAN] or [TAMAX] to calculation the volume flow.

Item		Description	Method or formula
Vas Area	Dist	Acquire the area by measuring the vascular diameter.	Vas Area=π × Vas Diam (cm)^2/ 4
	Trace	Acquire the area by trace method.	Area in 2D General Measurements
TAMEAN		Vol Flow(Area)-TAMEAN	Vol Flow(A) (ml/min) = |Vas TAMEAN (cm/s)| × Vas Area (cm^2) × 60 (s) Vas TAMEAN - Time Averaged Mean Velocity, obtained from Vas Trace measurement.
TAMAX		Vol Flow(Area)-TAMAX	Vol Flow(A) (ml/min) = |Vas TAMAX (cm/s)| × Vas Area (cm^2) × 60 (s) Vas TAMAX - Time Averaged Maximum Velocity, obtained from Vas Trace measurement.

3.5 References

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RI:	Burns, P.N., "The Physical Principles of Doppler and Spectral Analysis," Journal of Clinical Ultrasound, November/December 1987, Vol. 15, No. 9, p. 586
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Volume Flow(Diam)-TAMAX	Burns, P.N., "The Physical Principles of Doppler and Spectral Analysis," Journal of Clinical Ultrasound, November/December 1987, 15(9):587.
Volume Flow(Area)-TAMAX	Burns, P.N., "The Physical Principles of Doppler and Spectral Analysis," Journal of Clinical Ultrasound, November/December 1987, 15(9):587.

4 Abdomen

4.1 Abdomen Exam Preparations

Make the following preparations before measurement:

1. Confirm that the current probe is appropriate.
2. Check if the current date of the system is correct.
3. Press <Patient>, register the animal information in [Animal Info] -> [ABD] dialog box.

   For more details, refer to "Exam Preparation -> Animal Information" in the Operator's Manual [Basic Volume].
4. Switch to the correct exam mode.

4.2 Basic Abdomen Measurement Procedures

1. Press <Patient>, register the animal information in [Animal Info] -> [ABD] dialog box.
2. Press <Measure> to enter the Application Measurements.

   If the current menu is not the one containing Abdomen Measurement tools, move the cursor to the menu title and select the package having Abdomen Measurement tools.
3. Select measurement tool in the menu 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: 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 Measurement Package Preset".

Measurement, calculation and study 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	

Types	Tools	Descriptions	Methods or Formulae
	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	Distance in 2D General Measurements
	Panc duct	Pancreatic duct	
	Panc head	Pancreatic head	
	Panc body	Pancreatic body	
	Panc tail	Pancreatic tail	
	Spleen	/	
	Aorta Diam	Aorta Diameter	
	Aorta Bif	/	
	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	
	Ureter	/	
Calculation	Renal Vol	Renal Volume	
	Pre-BL Vol	Pre-void Bladder Volume	

Types	Tools	Descriptions	Methods or Formulae
	Post-BL Vol	Post-void Bladder Volume	
	Mictur.Vol	Micturated Volume	
Study	Kidney	/	
	Adrenal	/	
	Bladder	/	

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	
Calculation	/	/	
Study	/	/	

4.4 Abdomen Measurement Operations

Tips:	1.	See the table above for measurement tools and methods.
	2.	For the definitions of measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".
	3.	The order of the measurement items is presettable, see "2.3.2 Application Measurement Preset" for details.

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

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 Exam Report".

5 Reproduction

5.1 Reproduction Exam Preparations

1. Make the following preparations before measurement:
2. Check if the current date of the system is correct.
3. Press <Patient>, register the animal information in [Animal Info] -> [REP] dialog box.

   For more details, refer to "Exam Preparation -> Animal Information" in the Operator's Manual [Basic Volume].
4. Switch to the correct exam mode.

⚠**CAUTION:**	**Ensure the date of the system is correct, otherwise, GA and EDD calculated will be wrong.**

5.2 Basic Measurement Procedures

1. Press <Patient>, register the animal information in [Animal Info] -> [REP] dialog box.
2. Press <Measure> to enter the Application Measurements.

   If the current menu is not the one having Reproduction Measurement tools, move the cursor to the menu title and select the package having Reproduction Measurement tools.
3. Select measurement tool in the menu to start the measurement.

   See the table in "5.3 Reproduction Measurement Tools" below for measurement tools.

   See section "5.4 Reproduction Measurement Operations" and steps in "3 General Measurement" for measurement methods.
4. Press <Report> to view the exam report, see "5.6 Reproduction Exam Report" for details.

5.3 Reproduction Measurement Tools

The system supports the following obstetric measurements.

NOTE:	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 Application Measurement Preset".

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	

Types	Tools	Descriptions	Methods or formulae
	Dog BD	Dog Body Cavity Diameter	
Cat obstetric measurements	Cat BD	Cat Body Cavity Diameter	
	Cat HD	Cat 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	

5.4 Reproduction Measurement Operations

1. Select a measurement tool in the menu.
2. Refer to the methods listed in the table above to complete the measurement.

   After measurements, the result window displays measurement values, GA and EDD.

   If the calculated GA exceeds the threshold, it will display as OOR (out of range) in the result window and will not display in the report.

5.5 Multi-fetus Exam

The system allows multi-fetus (15 at most) examination.

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

Similar to the OB measurement,

1. Set the number of fetuses in [Gestations] via [Animal Info] -> [REP].

   If the [Gestations] is set to a value larger than 1, the [Fetus] widget displays in the OB measurement menu , as shown in the figure below.

   You can switch among [Fetus A], [Fetus B] etc… via the widget.
2. Perform measurement to the fetus respectively.

   The measurement results in the result window are marked with fetus label A, B, C...

3. In the Obstetric report, select [Fetus A], [Fetus B], [Fetus C]… to switch among results of different fetuses.

5.6 Reproduction Exam Report

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

See "5.5 Multi-fetus Exam" for multi-fetus exam report.

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

5.7 GA Formulae and References

5.7.1 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 (day) = 3 × Dog CRL (cm) + 27
- Dog GS: GA (day) = 6 × Dog GS (cm) + 20
- Dog HD: GA (day) = 15 × Dog HD (cm) + 20
- Dog BD: GA (day) = 7 × Dog BD (cm) + 29
- Dog HD&BD: GA (day) = 6 × Dog HD (cm) + 3 × Dog BD (cm) + 30

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

5.7.2 GA Formulae and Reference for Cat

Cat's standard GA is 58 days.

- Cat BD: GA (day) = 11 × Cat BD (cm) + 21
- Cat HD: GA (day) = 25 × Cat HD (cm) + 3

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

5.7.3 GA Formulae and Reference for Equine

Equine's standard GA is 330 days.

- Equine GS-H: GA (day) = (Equine GS-H (cm) + 0.55) / 0.15
- Equine GS-V: GA (day) = (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.

5.7.4 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 (day) = ln(Bovine CRL (cm)) × 16.73 + 27.5
- Bovine TD: GA (day) = ln(Bovine TD (cm)) × 37.21 + 39.7
- Bovine HD: GA (day) = ln(Bovine HD(cm)) × 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.

5.7.5 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 × Ovine CRL (cm) - 0.012 × (Ovine CRL (cm))^2
- Ovine BPD: GA (day) = 21.4 + 18.5 × 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 measurement:

1. Confirm that the current probe is appropriate.
2. Check if the current date of the system is correct.
3. Press <Patient>, input animal information in [Animal Info] -> [CARD] page.

   For more details, refer to "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>, input animal information in [Animal Info] -> [CARD] page.
2. Press <Measure> to enter the Application Measurement.

   If the current menu is not the one containing Cardiac Measurement tools, move the cursor to the menu title and select the package containing Cardiac Measurement tools.
3. Select measurement tool in the menu to start the measurement.

   See the table in "6.3 Cardiac Measurement Tools" for measurement tools.

   See section "6.4 Cardiac Measurement Operations" 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. 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 Application Measurement Preset".
2. The heartbeat of the traced spectrum in VTI measurement should equal to that is preset, otherwise the obtained HR (Heart Rate) is incorrect. See "2.2 Measurement Parameters" for relevant preset.
3. Some application items in the measurement preset library (and matching list in result assignment) are displayed different from that in the measurement menu and result window.

   In preset library (and matching list in result assignment), the item is followed with the word indicating the mode or location. Such as LA Diam (2D) means that the item is measured during 2D mode; LA Diam(LA Vol A-L) means that the item is contained in a study named LV Vol(A-L).

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	
	RA Major	Right Atrium major Diameter	
	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	

Types	Tools	Descriptions	Methods or formulae
	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	
	Ao st junct	Aorta ST junct 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	
	MVA	Mitral Valve area	Area in 2D General Measurements
	MCS	Mitral Valve Cusp Separation	Distance in 2D General Measurements
	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	Distance in 2D General Measurements
	IVC Diam(Expir)	Inferior vena cava expiration Diameter	

Types	Tools	Descriptions	Methods or formulae
Measurement	SVC Diam(Insp)	Superior vena cava inspiration Diameter	
	SVC Diam(Expir)	Superior vena cava expiration Diameter	
	LCA	Left Coronary Artery	
	RCA	Right Coronary Artery	
	VSD Diam	Ventricular Septal defect Diameter	Distance in 2D General Measurements
	ASD Diam	Atrial Septal defect Diameter	
	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	Type in (The HR value inputted manually should be within the range of 1~999)
	Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode
	Systole	End-systolic Left Ventricular Measurement	
Calculation	LA/Ao	Left Atrium Diameter/Aorta Diameter	LA Diam (cm) / Ao Diam (cm)
	Ao/LA	Aorta Diameter/Left Atrium Diameter	Ao Diam (cm) / LA 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	

Types	Tools	Descriptions	Methods or formulae
	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 junct 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	
	MV A Amp	Amplitude of the Mitral Valve A wave	
	MV E-F Slope	Mitral Valve E-F slope	Slope in M General Measurements
	MV D-E Slope	Mitral Valve D-E slope	
	MV DE	Amplitude of the Mitral Valve DE wave	Distance in M General Measurements
	MCS	Mitral Valve Cusp Separation	
	EPSS	Distance between point E and the interventricular septum	
	PEd	Pericardial effusion at diastole	
	PEs	Pericardial effusion at systole	

Types	Tools	Descriptions	Methods or formulae
	LVPEP	Left Ventricular pre-ejection period	Time in 2D General Measurements
	LVET	Left Ventricular ejection time	
	RVPEP	Right Ventricular pre-ejection period	
	RVET	Right Ventricular ejection time	
	HR	Heart Rate	Type in HR (heart rate) or measure HR value in M mode. (The HR value inputted manually should be within the range of 1~999)
	Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode
	Systole	End-systolic Left Ventricular Measurement	
Calculation	LA/Ao	Left Atrium diameter/Aorta diameter	LA Diam (cm) / Ao Diam (cm)
	Ao/LA	Aorta Diameter/Left Atrium Diameter	Ao Diam (cm) / LA 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	
	MV AccT	Mitral Valve Acceleration Time	Acceleration in Doppler General Measurements
	MV DecT	Mitral Valve Deceleration Time	
	IVRT	Isovelocity Relaxation Time	Time in Doppler General Measurements
	IVCT	Isovelocity Compression Time	
	MV E Dur	Mitral Valve E-wave Duration	

Types	Tools	Descriptions	Methods or formulae
	MV A Dur	Mitral Valve A-wave Duration	
	LVOT Vmax	Left Ventricular Outflow Tract 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	Time 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	
	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	
	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

Types	Tools	Descriptions	Methods or formulae
	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	
	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
	MS Vmax	Mitral Valve Stenosis Maximum Velocity	D Vel in Doppler General Measurements
	dP/dt	Rate of Pressure change	dP/dt Measurement

Types	Tools	Descriptions	Methods or formulae
	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 input a value manually. See RAP measurement in “RVSP”
Calculation	MV E/A	Mitral Valve E-Vel/A-Vel	MV E Vel (cm/s) / MV A Vel (cm/s)

Types	Tools	Descriptions	Methods or formulae
	MVA(PHT)	Mitral Valve Orifice Area (PHT)	MVA(PHT) (cm^2) = 220 / MV PHT (ms)
	TV E/A	Tricuspid Valve E-Vel/A-Vel	
	TVA(PHT)	Tricuspid Valve Orifice Area (PHT)	
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	Ea(medial)	Mitral Valve medial Early diastolic motion	D Vel in Doppler General Measurements
	Aa(medial)	Mitral Valve medial Late diastolic motion	
	Sa(medial)	Mitral Valve medial Systolic motion	
	ARa(medial)	Mitral Valve medial Acceleration Rate	
	DRa(medial)	Mitral Valve medial Deceleration Rate	D Vel in Doppler General Measurements
	Ea(lateral)	Mitral Valve lateral Early diastolic motion	
	Aa(lateral)	Mitral Valve lateral Late diastolic motion	
	Sa(lateral)	Mitral Valve lateral Systolic motion	
	ARa(lateral)	Mitral Valve lateral Acceleration Rate	
	DRa(lateral)	Mitral Valve lateral Deceleration Rate	
Calculation	/	/	
Study	See below		

6.4 Cardiac Measurement Operations

Tips:

1. See the table in "6.3 Cardiac Measurement Tools" above for measurement tools and methods.
2. For the definitions of measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".
3. The order of the measurement items is presettable, see "2.3.2 Application Measurement Preset" for details.
4. Measurements of some tools described in this Chapter are to be performed in several imaging modes, please select appropriate imaging modes in measurement.

6.4.1 Measurement Tool Operations

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

6.4.2 Calculation Tool Operations

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

6.4.3 Study Tool Operations

6.4.3.1 Left Ventricular Function

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

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

NOTE: The HR value inputted manually should be within the range of 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	Obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(SP Ellipse)	End-diastolic Left Ventricular Volume	$\mathrm{EDV(SP\ Ellipse)}(ml)=\frac{8}{3\pi}\times\frac{\mathrm{LVAd\ apical}(cm^2)^2}{\mathrm{LVLd\ apical}(cm)}$
ESV(SP Ellipse)	End-systolic Left Ventricular Volume	$\mathrm{ESV(SP\ Ellipse)}(ml)=\frac{8}{3\pi}\times\frac{\mathrm{LVAs\ apical}(cm^2)^2}{\mathrm{LVLs\ apical}(cm)}$
SV(SP Ellipse)	Stroke Volume	See table in “6.4.3.1 Left Ventricular Function”
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.
2. In apical long-axis view at end-diastole, measure the following parameters:
   LVLd apical
   LVAd apical
   EDV value is then calculated.
3. In apical long-axis view at end-systole, measure the following parameters:
   LVLs apical
   LVAs apical
   ESV value is then calculated.
   The system calculates SV and EF;
   If height and weight have been input already, SI is calculated.
4. Type in HR (heart rate) or obtain by ECG..
   The CO and CI are calculated automatically.

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	

Tools	Descriptions	Operations
HR	Heart Rate	Obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(BP Ellipse)	End-diastolic Left Ventricular Volume	*1
ESV(BP Ellipse)	End-systolic Left Ventricular Volume	*2
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:

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

*2 means:

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

■ Operating Procedures

1. Select [B-P Ellipse] in the menu.
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 SV and EF after LVAs apical has been measured;
   If height and weight have been input already, SI is calculated.
5. Type in HR (heart rate) or obtain by ECG..
   The CO and CI are calculated automatically.

Bullet

■ Study Items

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

Tools	Descriptions	Operations
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
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	
HR	Heart Rate	Obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Bullet)	End-diastolic Left Ventricular Volume	EDV(ml)= 5/6×LVLd apical(cm)×LVAd sax MV(cm^2)
ESV(Bullet)	End-systolic Left Ventricular Volume	ESV(ml)= 5/6×LVLs apical(cm)×LVAs sax MV(cm^2)
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

1. Select [Bullet] in the measurement menu.
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, the EDV is calculated
   At end systole: LVAs sax MV, the ESV is calculated
   The system calculates SV and EF; If height and weight have been input already, SI is calculated.
4. Type in HR (heart rate) or obtain by ECG..
   The CO and CI are calculated automatically.

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	

Tools	Descriptions	Operations
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 sax PM	Left Ventricular Area at Papillary Muscle level at end-diastole in short axis view	
LVAs sax PM	Left Ventricular Area at Papillary Muscle level at end-systole in short axis view	
HR	Heart Rate	Obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Mod.Simpson)	End-diastolic Left Ventricular Volume	*1
ESV(Mod.Simpson)	End-systolic Left Ventricular Volume	*2
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:

$$EDV[mL] = \frac{\text{LVLd apical}[cm]}{9} \times \left(\begin{array}{l} 4 \times \text{LVAd sax MV}[cm^2] + 2 \times \text{LVAd} \\ \text{sax PM}[cm^2] + \sqrt{\text{LVAd sax MV}[cm^2] \times \text{LVAd sax PM}[cm^2]} \end{array} \right)$$

*2 means:

$$ESV[mL] = \frac{\text{LVLs apical}[cm]}{9} \times \left(\begin{array}{l} 4 \times \text{LVAs sax MV}[cm^2] + 2 \times \text{LVAs} \\ \text{sax PM}[cm^2] + \sqrt{\text{LVAs sax MV}[cm^2] \times \text{LVAs sax PM}[cm^2]} \end{array} \right)$$

■ Operating Procedures

1. Select [Mod.Simpson] in the measurement menu.
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 SV and EF;

If height and weight have been input already, SI is calculated.

5. Type in HR (heart rate) or obtain by ECG..

   The CO and CI are calculated automatically.

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	Obtain by ECG or input directly

■ Study Results

Tools	Descriptions	Formulae
EDV(Simp SP)	End-diastolic Left Ventricular Volume	$\mathrm{EDV}(ml)=\pi\times\frac{\mathrm{LVLd\ apical}(cm)}{20}\times\sum_{i=1}^{20}r_i^{\,2}(cm)$ 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	$\mathrm{ESV}(ml)=\pi\times\frac{\mathrm{LVLs\ apical}(cm)}{20}\times\sum_{i=1}^{20}r_i^{\,2}(cm)$ 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
SV	Stroke Volume	See table in “6.4.3.1 Left Ventricular Function“
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 is calculated.

3. Type in HR (heart rate) or obtain by ECG..

   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,

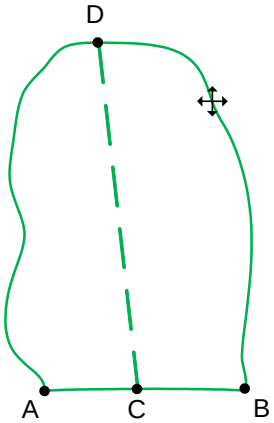
   - A: Left ventricular interventricular septal and mitral valve junction;
   - B: Left ventricular wall and mitral valve junction;

(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).



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	Obtain 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
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:

$$\mathrm{EDV}(ml)=\pi\times{}^{MAX\{LVLd_{2i}(cm),LVLd_{4i}(cm)\}}\!/_{20}\times\sum_{i=1}^{20}(r_{2i}(cm)\times r_{4i}(cm))$$

*2 means:

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

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

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

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

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

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

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

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 and SI are calculated.
4. Type in HR (heart rate) or obtain by ECG..
   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
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. Type in HR (heart rate), measure HR value in M mode, or obtain HR by ECG.
   If height and weight have been input already, SI, CO and CI 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×(LVIDd(cm))^3)/(2.4+LVIDd (cm))
ESV(Teichholz)	End-systolic Left Ventricular Volume	ESV(ml)=(7×(LVIDs(cm))^3)/(2.4+LVIDs(cm))
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 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(Gibson)	End-diastolic Left Ventricular Volume	$\mathrm{EDV}(ml)=\pi/6\times(0.98\times LVIDd(cm)+5.90)\times LVIDd(cm)^2$
ESV(Gibson)	End-systolic Left Ventricular Volume	$\mathrm{ESV}(ml)=\pi/6\times(1.14\times LVIDs(cm)+4.18)\times LVIDs(cm)^2$
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	

Tools	Descriptions	Formulae
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 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 × ((LVPWd(cm) + IVSd(cm) + LVIDd(cm))^3 - LVIDd(cm)^3) - 13.6
LV MASS-I (Cube)	Index of Left Ventricular Mass	See LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

■ Operating Procedures

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

   IVSd

   LVIDd

   LVPWd

   The LV Mass (Cube) is calculated.

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

LV Mass (A-L)

■ 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	
LVLd 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 LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

*1 means:

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

Where,

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

■ Operating Procedures

1. Select [LV Mass (A-L)] in the measurement menu.
2. In long-axis view at end diastole, measure LVLd apical；
3. 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

   The LV Mass (A-L) is calculated.

   If height and weight have been input already, 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 values in 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 LV Mass-I formula in “Left Ventricular Mass (LV Mass)”

*1 means:

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

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

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

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

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

■ Operating Procedures

1. Select [LV Mass(T-E)] in the measurement menu.
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 height and weight have been input already, LV Mass-I(T-E) is calculated.

6.4.3.3 Mitral Valve Area (MVA)

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

Tips:	See MVA(PHT) in “6.3.3 Doppler Cardiac Measurement” for formula of MVA Calculation by 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 values in upper table, the following results can be obtained in this study:

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

■ Operating Procedures

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

6.4.3.4 AVA(VTI)

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

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

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

■ Operating Procedures

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

6.4.3.5 LA Vol

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

LA Vol(A-L)

Estimates Left Atrium Volume using area and length.

■ Study Items

Tools	Descriptions	Operations
LA Diam	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 values in upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
LA Vol(A-L)	Left Atrium Area	$\mathrm{LA\ Vol(A-L)(ml)} = \dfrac{8\pi}{3} \mathrm{LAA(A4C)(cm^2)} \times \mathrm{LAA(A2C)(cm^2)} \Big/ \mathrm{LA\ Diam(cm)}$

■ Operating Procedures

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

LA Vol (Simp)

Estimates the left atrium volume using 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 Simpson SP measurement
LA Vol(A4C)	Left Atrium Volume at apical 4-chamber view	

■ Operating Procedures

See “Simpson SP” for measurement procedures.

6.4.3.6 RA Vol (Simp)

Estimates right atrium volume using Simpson methods, performed at apical four-chamber view.

■ Study Items and Results

Tools	Descriptions	Operations
RA Vol(A4C)	Right Atrium Volume at apical 4-chamber view	Same as Simpson SP measurement

■ Operating Procedures

See “Simpson SP” for measurement procedures.

6.4.3.7 LVIMP

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

Tools	Descriptions	Formulae
LVIMP	Left Ventricular Index of Myocardial Performance	$\mathrm{LVIMP(No\,unit)} = \frac{\mathrm{MVC\text{-}O\,dur(s)\text{-}LVET(s)}}{\mathrm{LVET(s)}}$

■ Operating Procedures

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

6.4.3.8 RVSP

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

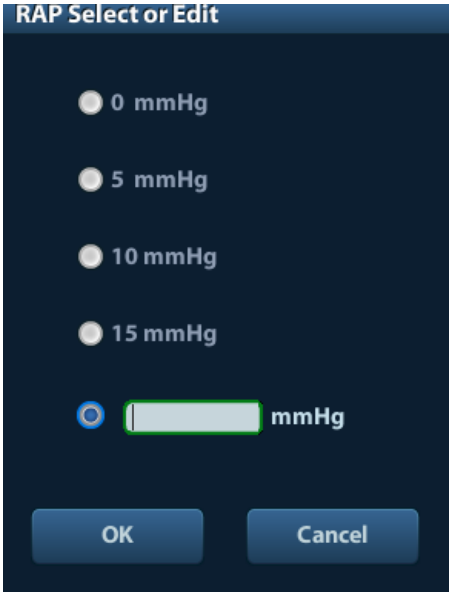
Except for values in upper table, the following results can be obtained in this study:

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

■ Operating Procedures

1. Select [RVSP] in the measurement menu.
2. Measure 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 popped up. As shown in figure below:



   Range of input values is [0, 50.0mmHg].
4. Click [OK] after selecting (or inputting) the pressure, the RAP is obtained.

   RVSP is calculated.

6.4.3.9 PAEDP

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

Tools	Descriptions	Operations
RAP	Right Atrium Pressure	See RAP measurement in “RVSP”

■ Study Results

Except for values in 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	$\mathrm{PAEDP(mmHg)} = RAP(mmHg) + 4 \times (PRVed(m/s))^2$

■ Operating Procedures

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

6.4.3.10 RVIMP

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

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

■ Operating Procedures

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

6.4.3.11 Qp/Qs

Flow ration of pulmonary circulation and systemic circulation.

■ Study Items

Tools	Descriptions	Operations
AV Diam	Aorta Valve Diameter	Distance in 2D General Measurements
PV Diam	Pulmonary Valve Diameter	
AV VTI	Aortic Valve Velocity-Time Integral	D Trace in Doppler General Measurements
PV VTI	Pulmonary Valve Velocity-Time Integral	

■ Study Results

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

Tools	Descriptions	Operations
AV HR	Aortic Valve Heart Rate	Obtained from AV VTI measurement
AV SV	Aortic Valve Stroke Volume	
AV CO	Aortic Valve Cardiac Output	
PV HR	Pulmonary Valve Heart Rate	Obtained from PV VTI measurement
PV SV	Pulmonary Valve Stroke Volume	
PV CO	Pulmonary Valve Cardiac Output	
Qp/Qs	Flow ration of Pulmonary circulation and Systemic circulation	Qp/Qs(No unit) = PV CO(l/min)/AV CO(l/min)
Qp-Qs	Flow difference of Pulmonary circulation and Systemic circulation	Qp-Qs(l/min) = PV CO(l/min) - AV CO(l/min)

■ Operating Procedures

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

6.4.3.12 PISA

PISA (Proximal Isovelocity Surface Area) is used in 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 procedures are as follows:

1. Start PISA, move the semicircular caliper by rotating the trackball.
2. Fix the center of the semicircular by pressing <Set>.
3. Adjust the radius length orientation of the semicircular 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 mode.

■ 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 select to use top aliasing velocity or bottom aliasing velocity or input the value directly.

■ Study Results

Tools	Descriptions	Formulae
MR Vmax	Mitral Regurgitation Maximum Velocity	Obtained from MR VTI measurement
MR Flow	Mitral Regurgitation Flow	$MR\,Flow(ml) = \frac{2\pi MR\,Rad(cm)^2 \times MR\,Als.Vel(cm/s)}{\lvert MR\,Vmax(cm/s)\rvert} \times \lvert MR\,VTI(cm)\rvert$

Tools	Descriptions	Formulae
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	$\text{MRFraction (No unit)} = \frac{\text{MRFlow(ml)}}{\text{MVSV(ml)}} \times 100\%$
MR EROA	Mitral Valve Effective Regurgitant Orifice Area	$\text{MREROA(cm)}^2 = \frac{2\pi \text{MRRad(cm)}^2 \times \text{MRAls.Vel(cm/s)}}{\lvert \text{MRVmax(cm/s)} \rvert}$

■ Operating Procedures

1. Enter color mode, adjust the color map until the aliasing appears.
2. Select [PISA MR] in the measurement menu.
3. Measure MR Rad using PISA caliper.
   Input MR Als.Vel.
4. Measure the MR spectrum by D trace to obtain:
   MR Vmax
   MR VTI
   MR Flow, MR Flow Rate and MR EROAare calculated automatically.
   If MV SV is measured, MR Fraction will be calculated automatically.

PISA AR

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

■ 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 select to use top aliasing velocity or bottom aliasing velocity or input the value directly.

■ Study Results

Tools	Descriptions	Formulae
AR Vmax	Aortic Regurgitation Maximum Velocity	Obtained from AR VTI measurement
AR Flow	Aortic Regurgitation Flow	$\text{AR Flow(ml)} = \frac{2\pi \text{AR Rad(cm)}^2 \times \text{AR Als.Vel(cm/s)}}{\lvert \text{ARV max(cm/s)} \rvert} \times \lvert \text{AR VTI(cm)} \rvert$
AR Flow Rate	Aortic Regurgitation Flow Rate	$\text{AR Flow Rate(ml/s)} = 2\pi \text{AR Rad(cm)}^2 \times \text{AR Als.Vel(cm/s)}$
AR Fraction	Aortic Valve Regurgitation Fraction	$\text{ARFraction (No unit)} = \frac{\text{ARFlow(ml)}}{\text{AVSV(ml)}} \times 100\%$

Tools	Descriptions	Formulae
AR EROA	Aortic Valve Effective Regurgitant Orifice Area	$\text{AREROA}(\text{cm}^2) = \frac{2\pi \text{ARRad}(\text{cm})^2 \times \text{AR Als.Vel}(\text{cm/s})}{\lvert \text{ARVmax}(\text{cm/s}) \rvert}$

■ Operating Procedures

Same with the PISA MR measurement.

PISA TR

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

■ 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
TR Als.Vel	Tricuspid Valve Regurgitation Aliasing Maximum Velocity	You can select to use top aliasing velocity or bottom aliasing velocity or input the value directly.

■ Study Results

Tools	Descriptions	Formulae
TR Vmax	Tricuspid Regurgitation Maximum Velocity	Obtained from TR VTI measurement
TR Flow	Tricuspid Regurgitation Flow	$\text{TR Flow}(\text{ml}) = \frac{2\pi \text{TR Rad}(\text{cm})^2 \times \text{TR Als.Vel}(\text{cm/s})}{\lvert \text{TRV max}(\text{cm/s}) \rvert} \times \lvert \text{TR VTI}(\text{cm}) \rvert$
TR Flow Rate	Tricuspid Regurgitation Flow Rate	$\text{TR Flow Rate}(\text{ml/s}) = 2\pi \text{TR Rad}(\text{cm})^2 \times \text{TR Als.Vel}(\text{cm/s})$
TR Fraction	Tricuspid Valve Regurgitation Fraction	$\text{TR Fraction (No unit)} = \frac{\text{TR Flow}(\text{ml})}{\text{TV SV}(\text{ml})} \times 100\%$
TR EROA	Tricuspid Valve Effective Regurgitant Orifice Area	$\text{TREROA}(\text{cm}^2) = \frac{2\pi \text{TR Rad}(\text{cm})^2 \times \text{TR Als.Vel}(\text{cm/s})}{\lvert \text{TRVmax}(\text{cm/s}) \rvert}$

■ Operating Procedures

Same with the PISA MR measurement.

PISA PR

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

■ Study Items

Tools	Descriptions	Operations
PR Rad	Pulmonary Valve Stenosis Radius	PISA measurement

Tools	Descriptions	Operations
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 select to use top aliasing velocity or bottom aliasing velocity or input the value directly.

■ Study Results

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

■ Operating Procedures

Same with the PISA MR measurement.

6.4.3.13 TDI

■ Study Items

Tools	Descriptions	Operations
Sa(medial)	Mitral Valve medial Systolic motion	D Vel in Doppler General Measurements
Ea(medial)	Mitral Valve medial Early diastolic motion	
Aa(medial)	Mitral Valve medial Late diastolic motion	
ARa(medial)	Mitral Valve medial Acceleration Rate	Acceleration in Doppler General Measurements
DRa(medial)	Mitral Valve medial Deceleration Rate	
Sa(lateral)	Mitral Valve lateral Systolic motion	D Vel in Doppler General Measurements
Ea(lateral)	Mitral Valve lateral Early diastolic motion	
Aa(lateral)	Mitral Valve lateral Late diastolic motion	
ARa(lateral)	Mitral Valve lateral Acceleration Rate	Acceleration in Doppler General Measurements
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 ARa(medial) measurement
DTa(medial)	MV medial E-wave Deceleration Time	Obtained from DRa(medial) measurement
Ea/Aa(lateral)	MV lateral E-Vel/ A-Vel	$Ea/Aa(lateral)(Nounit) = \frac{Ea(lateral l)}{Aa(lateral l)}$
ATa(lateral)	MV lateral E-wave Acceleration Time	Obtained from ARa(lateral) measurement
DTa(lateral)	MV lateral E-wave Deceleration Time	Obtained from DRa(lateral) measurement

- Operating Procedures

See table above for methods and formulae of 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 Exam Report".

6.6 References

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Cardiac output Index (CI):

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- 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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EDV (Bullet):

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ESV (Bullet):

- Folland, E.D., et al., "Assessment of Left Ventricular Ejection Fraction and Volumes by Real-Time, Two-Dimensional Echocardiography," Circulation, October 1979, Vol. 60, No.4, pp. 760-766

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- Weyman, Arthur E., Cross-Sectional Echocardiography, Lea & Febiger, 1985, p. 295.Folland, E.D., et al., "Assessment of Left Ventricular Ejection Fraction and Volumes by Real-Time, Two-Dimensional Echocardiography," Circulation, October 1979, Vol. 60, No.4, pp. 760-766

ESV (Simpson):

- Weyman, Arthur E., Cross-Sectional Echocardiography, Lea & Febiger, 1985, p. 295.Folland, E.D., et al., "Assessment of Left Ventricular Ejection Fraction and Volumes by Real-Time, Two-Dimensional Echocardiography," Circulation, October 1979, Vol. 60, No.4, pp. 760-766

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- Dodge, H.T., Sandler, D.W., et al., "The Use of Biplane Angiography for the Measurement of Left Ventricular Volume in Man," American Heart Journal, 1960, Vol. 60, pp. 762-776.
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ESV (Cube):

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Fractional Shortening (FS):

- Belenkie, Israel, et al., "Assessment of Left Ventricular Dimensions and Function by Echocardiography," American Journal of Cardiology, June 1973, Vol. 31.

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.LV MASS-I:

- John H. Phillips, “Practical Quantitative Doppler Echocardiography” , CRC Press, 1991, .Page 96.

LA/Ao:

- Roelandt, Joseph, Practical Echocardiology, 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.

MV CA/CE:

- Maron, Barry J., et al., “Noninvasive Assessment of Left Ventricular Diastolic Function by Pulsed Doppler Echocardiography in Patients with Hypertrophic
- Cardiomyopathy, J Am Coll Cardio, 1987, Vol. 10, pp. 733-742.

MV E/A:

- Maron, Barry J., et al., "Noninvasive Assessment of Left Ventricular Diastolic Function by Pulsed Doppler Echocardiography in Patients with Hypertrophic Cardiomyopathy," Journal of the American College of Cardiology, 1987, Vol. 10, pp. 733-742.

Pressure Half Time (PHT):

- Oh, J.K., Seward, J.B., Tajik, A.J. The Echo Manual. Boston: Little, Brown and Company, 1994, p.59-60

Mitral valve area:

- 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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- Stevenson, J.G., "Comparison of Several Noninvasive Methods for Estimation of Pulmonary Artery Pressure," Journal of the American Society of Echocardiography, June 1989, Vol. 2, pp. 157-171.
- Yock, Paul G. and Popp, Richard L., "Noninvasive Estimation of Right Ventricular Systolic Pressure by Doppler Ultrasound in Patients with Tricuspid Regurgitation," Circulation, 1984, Vol. 70, No. 4, pp. 657-662.

7 Vascular

7.1 Vascular Exam Preparations

Make the following preparations before measurement:

1. Confirm that the current probe is appropriate.
2. Check if the current date of the system is correct.
3. Press <Patient>, input animal information in [Animal Info] -> [VAS] page.

   For more details, refer to "Exam Preparation -> Animal Information" in the Operator's Manual [Basic Volume].
4. Switch to the correct exam mode.

7.2 Basic Vascular Measurement Procedures

1. Press <Patient>, input animal information in [Animal Info] -> [VAS] page.
2. Press <Measure> to enter the Application Measurement.

   If the current menu is not the one having Vascular Measurement tools, move the cursor to the menu title and select the package having Vascular Measurement tools.
3. Select measurement tool in the menu to start the measurement.

   See table in "7.3 Vascular Measurement Tools" below for measurement tools.

   See section "7.4 Vascular Measurement Operations" and steps in "3 General Measurement" for measurement methods.
4. Press <Report> to view the exam report, see "7.5 Vascular Exam Report" for details.

7.3 Vascular Measurement Tools

Vascular measurements are mainly used for carotid, cerebral, upper and lower extremities vessels.

The system supports the following vascular measurements.

NOTE: 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 Application Measurement Preset".

2D Vascular Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	CCA IMT	Common Carotid Artery IMT	ROI measurement in IMT
	Bulb IMT	Bulbillate IMT	
	ICA IMT	Internal Carotid Artery IMT	

Types	Tools	Descriptions	Methods or formulae
	ECA IMT	External Carotid Artery IMT	
Calculation	Stenosis D	Stenosis Diameter	Stenosis D (No unit) = (Normal Diam(cm) − Resid Diam (cm)) / Normal Diam (cm) × 100%
	Stenosis A	Stenosis Area	Stenosis A (No unit) = (Normal Area(cm^2) – Resid Area (cm^2)) / Normal Area (cm^2) × 100%
Study	IMT	Intima-Media Thickness	See below

Doppler Vascular Measurements

Types	Tools	Descriptions	Methods or formulae
Measurement	CCA	Common Carotid Artery	D trace in General D measurements
	Bulb	Bulbillate	
	ICA	Internal Carotid Artery	
	ECA	External Carotid Artery	
	Vert A	Vertebral Artery	
	Innom A	Innominate Artery	
	Subclav A	Subclavian Artery	
	Axill A	Axillary Artery	
	Brachial A	Brachial Artery	
	Ulnar A	Ulnar Artery	
	Radial A	Radial Artery	
	Subclav A	Subclavian Artery	
	Axill V	Axillary Vein	
	Cephalic V	Cephalic Vein	
	Basilic V	Basilic Vein	
	Ulnar V	Ulnar Vein	
	Radial V	Radial Vein	
	C.Iliac A	Common Iliac Artery	
	Ex.Iliac A	External Iliac Artery	
	CFA	Common Femoral Artery	
	SFA	Superficial Femoral Artery	
	Pop A	Popliteal Artery	

Types	Tools	Descriptions	Methods or formulae
	TP Trunk A	Tibial Peroneal Trunk Artery	
	Peroneal A	Peroneal Artery	
	P.Tib A	Posterior Tibial Artery	
	A.Tib A	Anterior Tibial Artery	
	Dors.Ped A	Dorsalis Pedis Artery	
	C.Iliac V	Common Iliac Vein	
	Ex.Iliac V	External Iliac Vein	
	Femoral V	Femoral Vein	
	Saph V	Great Saphenous Vein	
	Pop V	Popliteal Vein	
Measurement	TP Trunk V	Tibial Peroneal Trunk Vein	D trace in General D measurements
	Sural V	Sural Vein	
	Soleal V	Soleal Vein	
	Peroneal V	Peroneal Vein	
	P.Tib V	Posterior Tibial Vein	
	A.Tib V	Anterior Tibial Vein	
	ACA	Anterior Cerebral Artery	
	MCA	Middle Cerebral Artery	
	PCA	Posterior Cerebral Artery	
	AComA	Ant.communicating br.	
	PComA	Post.communicating br.	
	BA	Basilar Artery	
	IIA	Internal Iliac Artery	
	PFA	Deep Femoral Artery	
	Ba V	Basilar Vein	
	Brachial V	Brachial Vein	
	IIV	Internal Iliac Vein	
	CFV	Common Femoral Vein	
	SFV	Superficial Femoral Vein	
	PFV	Deep Femoral Vein	
	SSV	Small Saphenous Vein	
	ASP	Ankle Systolic Pressure	Type in
	BSP	Brachial Systolic Pressure	

Types	Tools	Descriptions	Methods or formulae
Calculation	ICA/CCA(PS)	/	See below
Study	ABI	Ankle Brachial Index	See below

7.4 Vascular Measurement Operations

Tips:

1. See the table in "7.3 Vascular Measurement Tools" above for measurement tools and methods.
2. For the definitions of measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".
3. The order of the measurement items is presettable, see "2.3.2 Application Measurement Preset" for details.
4. Measurements of some tools described in this Chapter are to be performed in several imaging modes, please select appropriate imaging modes in measurement.

7.4.1 Measurement Tool Operations

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

7.4.2 Calculation Tool Operations

Stenosis D

Function: Measures Normal Diam and Resid Diam, calculates Stenosis D.

1. Select [Stenosis D] in the measurement menu.
2. Use the method of Distance measurement of 2D General Measurements to measure Normal(D) and Resid(D).

   Stenosis D is calculated automatically.

Stenosis A

Function: Measures Normal Area and Resid Area, calculates Stenosis A.

1. Select [Stenosis A] in the measurement menu.
2. Use the method of Area measurement of 2D General Measurements to measure Normal(A) and Resid(A).

   Stenosis A is calculated automatically.

ICA/CCA

Function: measures the flow velocity ratio between ICA and CCA to calculate ICA/CCA.

1. Select [ICA/CCA] in the measure menu.
2. Measure PS value of ICA and CCA distal, and the system calculates ICA/CCA. Where, ICA value adopts the maximum PS value of proximal, middle and distal.

7.4.3 Study Tool Operations

IMT

NOTE:	1.	The IMT function is unavailable on the product not configured with IMT.
	2.	IMT measurement is available on frozen (or history) linear array image only.

Function: IMT (Intima-Media Thickness) measures the distance between LI (Lumen-Intima) and MA (Media-Adventia).

The IMT values at 4 positions: CCA (common Carotid Artery), ICA (Internal Carotid Artery), ECA (External Carotid Artery) and Bulb (Bulbillate) need to be measured here.

1. Enter IMT exam mode, scan and freeze the image (or review a history image).
2. Select [IMT] in the measurement menu and enters the IMT measurement.
3. Select the side (Left/ Right), angle and vessel wall (Near/ Far).
4. Select an item such as [ICC IMT], the ROI box displays on screen.

   It appears as when Near is selected;

   It appears as when Far is selected;

Tips	1.	Make sure that you select the right vessel wall (Near/ Far) before IMT measurement; otherwise the intima may be recognized incorrectly due to different algorithm that applied in near/ far wall recognition.
	2.	Enter [Setup]-> [Measure Preset], and the Angle and ROI Width of an IMT item can be preset in the property dialog box of the measurement item.

5. Move ROI box to the desired position, press <Set>. Two auto trace lines appear in the box.

   The ROI box is green while you can:

   Adjust the size of the ROI box.

   Erase the trace lines inside the box by pressing <Clear>.

   Trace manually

   (a) Move the cursor to a trace line. The trace line turns yellow. Press <Set>.

   (b) Move the cursor along the interface of vessel. Press <Set> to confirm the trace after re-adjusting.
6. Press <Set> outside the box to confirm the adjustment result after the manual-trace is completed. The results are recorded in IMT report.

   The system calculates:

   - IMT Max
   - IMT Min
   - IMT Mean
   - IMT SD
   - IMT ROI Length
   - IMT Measure Length
   - IMT Quality Index

   Quality Index indicates the reliability of one measurement, the manual trace or re-scan an image with clear endocardium edges are recommended if the Quality Index value is small.

Tips:	To achieve a good tracing result, try to place the ROI box parallel with vessel and adjust the box size to reduce unwanted interferences.

For multiple measurements in the same side, vessel and angle, the system calculates the following parameters in report:

- Average Mean IMT

- Average Max IMT
- Standard deviation

Also it provides Composite Mean IMT, which is an overall mean value of all IMT mean values derived from the measured items.

ABI

Function: Calculates Ankle Brachial Index (ABI) by measuring Ankle Systolic Pressure (ASP) and Brachial Systolic Pressure (BSP) on Doppler image.

ABI = ASP/BSP

NOTE: Need to be measured in left and right side respectively.

Select [ABI] in the measurement menu.

1. Click [ASP] from the [ABI] menu and type in the value.
2. Click [BSP] from the [ABI] menu and type in the value.

   The ABI is calculated by the system automatically.

7.5 Vascular 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 Exam Report".

7.6 References

Stenosis D: Honda, Nobuo, et al., "Echo-Doppler Velocimeter in the Diagnosis of Hypertensive Patients: The Renal Artery Doppler Technique," Ultrasound in Medicine and Biology, 1986, Vol. 12(12), pp. 945-952.

Stenosis A: Jacobs, Norman M., et al., "Duplex Carotid Sonography: Criteria for Stenosis, Accuracy, and Pitfalls," Radiology, 1985, 154:385-391.

8 Small Parts

8.1 Small Parts Exam Preparations

Make the following preparations before measurement:

1. Confirm that the current probe is appropriate.
2. Check if the current date of the system is correct.
3. Press <Patient>, register the animal information in [Animal Info] -> [SMP] dialog box.

   For more details, refer to "Exam Preparation -> Animal Information" in the Operator's Manual [Basic Volume].
4. Switch to the correct exam mode.

8.2 Basic Small Parts Measurement Procedures

1. Press <Patient>, register the animal information in [Animal Info] -> [SMP] dialog box.
2. Press <Measure> to enter the Application Measurements.

   If the current menu is not the one having Small Parts Measurement tools, move the cursor to the menu title and select the package having Small Parts Measurement tools.
3. Select measurement tool in the menu to start the measurement.

   See table in "8.3 Small Parts Measurement Tools" below for measurement tools.

   See section "8.4 Small Parts Measurement Operations" and steps in "3 General Measurement" for measurement methods.
4. Press <Report> to view the exam report, see "8.5 Small Parts Exam Report" for details.

8.3 Small Parts Measurement Tools

The system supports the following small parts measurements.

NOTE: 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 Application Measurement Preset".

Modes	Types	Tools	Descriptions	Methods or formulae
2D	Measurem ent	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	

Modes	Types	Tools	Descriptions	Methods or formulae
		Testis W	Testicular Width	
		Breast Mass1 d1-d3	/	
		Breast Mass2 d1-d3	/	
		Breast Mass3 d1-d3	/	
		Thyroid Mass1 d1~d3	/	
		Thyroid Mass2 d1~d3	/	
		Thyroid Mass3 d1~d3	/	
	Calculation	Thyroid Vol	Thyroid Volume	Thyroid Vol (cm^3) = k × Thyroid L (cm) × Thyroid H (cm) × Thyroid W (cm) Where in, k= 0.479 or 0.523
	Study	Thyroid	/	Same formulae as in Thyroid Vol calculation
		Testis	/	See “Testis”.
		Breast Mass1~3	/	Volume (3 Dist) in 2D General Measurements
		Thyroid Mass1~3	/	
M	/	/	/	
Doppler	Measurement	STA	Superior Thyroid Artery	D trace in General D measurements
		ITA	Inferior Thyroid Artery	
	Calculation	/	/	/
	Study	/	/	/

8.4 Small Parts Measurement Operations

Tips:

1. See table "8.3 Small Parts Measurement Tools" above for measurement tools and methods.
2. For the definitions of measurement, calculation and study, refer to "1.3 Measurement, Calculation and Study".
3. The order of the measurement items is presettable, see "2.3.2 Application Measurement Preset" for details.

8.4.1 Measurement Tool Operations

Take measurement "Thyroid L" for example; the measurement procedures are as follows:

1. Select [Thyroid L] in the measurement menu.
2. Use the Distance of 2D General Measurements to measure Thyroid L. The value displays in the result window and exam report.

8.4.2 Calculation Tool Operations

Thyroid Vol

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

Tips:	Need to be measured in left and right side respectively.

1. Select [Thyroid Vol] in the measurement menu.
2. Use the Distance of 2D General Measurements to measure Thyroid L, Thyroid H and Thyroid W.

   Two Thyroid Vols are calculated automatically.

8.4.3 Study Tool Operations

Thyroid

Function: measures Thyroid L, Thyroid H and Thyroid W respectively, and calculates Thyroid Vol. See “8.3 Small Parts Measurement Tools” for calculation formulae.

Tips:	Need to be measured in left and right side respectively.

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

Breast Mass

Function: measures Mass D1, Mass D2 and Mass D3. Up to 3 masses can be measured.

Take Mass1 as an example, the procedures are as follows:

1. Select [Breast Mass1] in the measurement menu.
2. Use the Distance tool in the 2D General Measurement to measure Breast Mass1 D1, Breast Mass1 D2 and Breast Mass1 D3.

   The measurements are recorded in the report.

Thyroid Mass

Same as the Breast Mass.

Testis

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

NOTE: Need to be measured in left and right side respectively.

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

8.5 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 Exam Report".

8.6 References

Thyroid Vol: (k= 0.479) Volumetrie der Schilddruesenlappn mittels Realtime-Sonographie; J Brunn, U. Block, G. Ruf, et al.; Dtsch.med. Wschr.106 (1981), 1338-1340.)

Thyroid Vol: (k=0.523) Gomez JM, Gomea N, et al. Determinants of thyroid volume as measured by ultrasonography in healthy adults randomly selected. Clin Endocrinol(Oxf), 2000;53:629-634)