MX7/MX7 Exp/MX7T/MX7S/MX7 Pro/ Vaus7/Zeus7/Zeus/ME7/ME7 Exp/Anesus ME7/Anesus ME7 Pro/Anesus ME7S/ Anesus ME7T/Ana/Anesus Vaus/Anesus Zeus/Crius ME7P/Crius ME7W/Anesus ME7P/Anesus ME7W/Emerus ME7P/ Emerus ME7W/MX7P/MX7W/ME7 Pro/ ME7S/ME7T

Diagnostic Ultrasound System

Operator's Manual

[Basic Volume]

Item	Model
Black/ white video printer (analog)	SONY UP-X898MD
Digital color video printer	SONY UP-D25MD
iVocal	SAMSON XPD1 Headset SAMSON XPD1 Presentation PYLE PUSBMIC43
External DVD R/W drive	DVDRW HP GP60NB60
Barcode reader	DS4308 LS2208 JADAK HS-1M JADAK HS-1R
Footswitch	971-SWNOM (2-pedals) 971-SWNOM (3-pedals) FS-81-SP-2 (1-pedal)

⚠WARNING

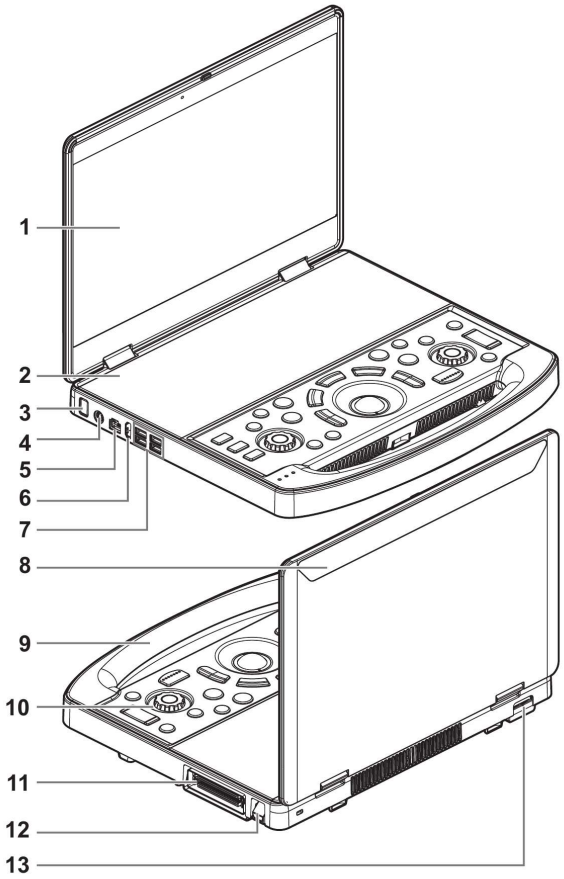
This system complies with IEC60601-1-2: 2014, and its RF emissions meet the requirements of CISPR11 Class B. In a domestic environment, the customer or user should ensure the system is connected to Class B peripheral devices, otherwise RF interference may occur, and the customer or user must take adequate measures accordingly.

2.6.5 Parts that can be used within patient environment

- The ultrasound system
- Video Printers

2.7 Introduction of Each Unit

Figure 2-1 Overview



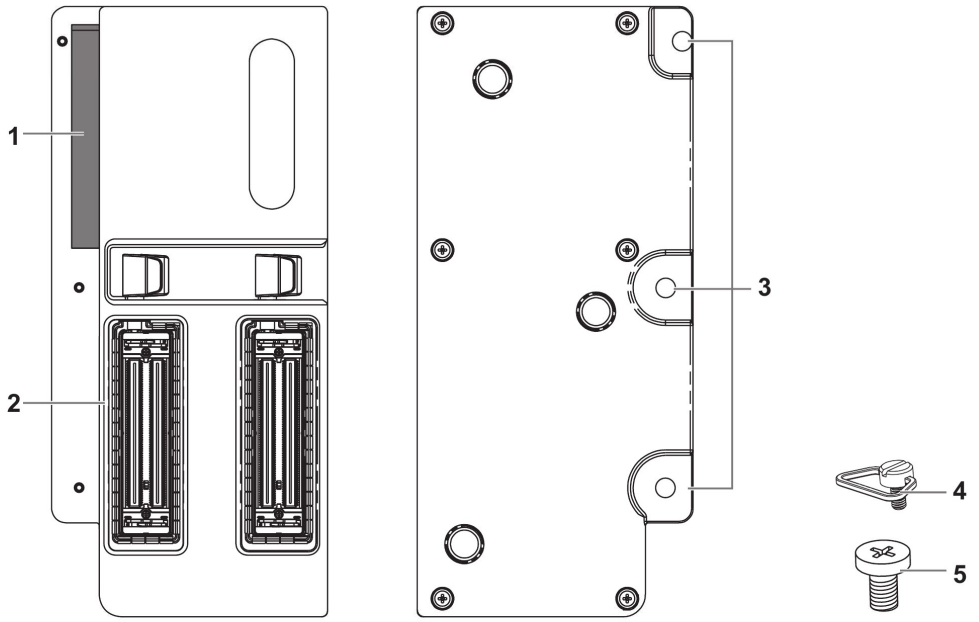
No.	Name	Description
1.	Display	Displays the images and parameters during scanning.
2.	Touch screen	Screen-touching operator-system interface or control.
3.	Power button/Power indicator	Used for turning on/ off the power. The indicator lights up when the system is powered on.
4.	S-Video	S-Video signal output. Used for separate video output, and connecting projector, ultrasound workstation video capture card, etc.
5.	Network port	Used for connecting router, ultrasound workstation, server, etc.
6.	HDMI	High definition multimedia interface. Used for connecting TV, projector, ultrasound workstation video capture card, etc.‘
7.	USB ports	Used for connecting storage device such as USB disk, bar code reader, printer, footswitch, DVD recorder, etc.

No.	Name	Description
8.	Secondary Display	Displays battery capacity, AC power status and product model, etc. **NOTE:** The actual remaining time of the battery varies depending on the actual operating modes.
9.	Handle	Used for carrying the system.
10.	Control Panel	Operator-system interface or control. **NOTE:** The buttons and knobs on the control panel may be different for different product models. Please refer to the control panel of the product for the actual buttons and knobs.
11.	Probe port	Connects a probe to the main unit; or connects a probe extend module.
12.	Probe locking lever	Locks or unlocks the probe connected with the main unit: • : locked symbol. • : unlocked symbol.
13.	Power input port	Connects the power adapter.

2.8 Dual-Probe Extend Module Overview

2.8.1 Parts and Names

Figure 2-2 Dual-Probe Extend Module



No.	Name	Description
1.	Connector	Connects to the probe port of the main unit, and extends the probe port to two.

6 Image Acquisition

⚠WARNING

- The images displayed in this system are only reference for diagnosis. Mindray is not responsible for the correctness of diagnostic results.
- In Dual-B imaging mode, the measurement results of the merged image may be inaccurate. Therefore, the results are provided for reference only, not for confirming a diagnosis.

TIP:

Operations for switching between different image modes and optimizing images, see “2.14 Basic Operations”.

6.1 B Mode

B mode is the basic imaging mode that displays real-time views of anatomical tissues and organs.

6.1.1 B-mode Image Scanning

Press <B> on the control panel to enter B mode.

If the system is in other imaging mode, press <B> to return B mode.

Adjust parameters to optimize the image.

6.1.2 B-mode Image Parameters

Image Quality

Used for switching B/THI and adjusting the frequency. The real-time value of frequency is displayed in the image parameter area, and if harmonic frequency is used, “F H” is displayed as harmonic frequency value.

The system provides a THI function using harmonics of echoes to optimize the image. Harmonic imaging enhances near field resolution and reduces low-frequency and large amplitude noise, so as to improve small parts imaging.

Please select the frequency according to the detection depth and current tissue features.

Gain

To adjust the gain of the whole receiving information in B mode. The real-time gain value is displayed in the image parameter area.

Depth

This function is used to adjust the display depth of sampling, the real-time value of which is displayed in the image parameter area.

Depth increase will cause a decrease in the frame rate.

TGC

The system compensates the signals from deeper tissue by segments to optimize the image.

There are 8-segment TGC sliders corresponding to the areas in the image.

Adjust the signal gain for the certain image area to get a balanced image.

Acoustic power

Refers to the power of ultrasonic wave transmitted by the probe, the real-time value of which is displayed in the upper left corner of the screen.

TIP:

You should perform exams according to actual situation and follow the ALARA Principle.

Scan range and FOV position

More information can be obtained without moving the probe or changing the sampling position.

TIP:

- The FOV position/range is available only for the convex and phased probes.
- When the scan range is adjusted to the widest, the FOV position cannot be changed.

Steer

To steer the beam the probe transmits.

TIP:

Steer is available only for linear probes.

Line Density

The function determines the quality and information of the image.

The higher the line density is, the higher the resolution becomes.

Dynamic Range

Adjusts contrast resolution of an image, compresses or expands gray display range.

The real-time dynamic range value is displayed on the image parameter area.

The more the dynamic range, the more specified the information, and the lower the contrast with more noise.

Smooth

This feature is used to reject the noise and smooth the image.

iClear

The function is used to enhance the image profile so as to distinguish the image boundary for optimization.

Persistence

Used to superimpose and average adjacent B images, so as to optimize the image and remove noises.

2. Press <M> on the control panel, and use the trackball/trackpad to adjust the sampling line.
3. Press <M> on the control panel again or <Update> to enter M mode, and then you can observe the tissue motion along with anatomical images of B mode. During the scanning process, you can also adjust the sampling line accordingly when necessary.
4. Adjust the image parameters to obtain optimized images.

6.4.2 M Mode Image Parameters

Gain

To adjust the gain of M mode image, the real-time gain value is displayed in the image parameter area.

Increasing the gain will brighten the image and you can see more received signals. However, noise may also be increased.

Display Format

To set the display format of B mode image and M mode image.

Adjust according to the actual situation and obtain a desired analysis through comparison.

Speed

This function is used to set the scan speed of M mode imaging, and the real-time speed value is displayed in the image parameter area.

Tint Map

This function provides an imaging process based on color difference rather than gray distinction.

Gray Map

Adjusting grayscale contrast to optimize the image.

Edge Enhance

This function is used to increase image profile, so as to distinguish the image boundary.

Larger edge enhance may lead to noise increase.

Dynamic Range

Adjusts contrast resolution of an image, compresses or expands gray display range. The real-time dynamic range value will be displayed on the image parameter area on the top of the screen.

M Soften

This feature is used to process the scan lines of M images to reject noise, making the image details to be clearer.

6.5 Color M Mode (CM)

To know the cardiac motion state, CM is overlaid with flow based on M mode, which is more sensitive to the instantaneous signal changes. Then, it shows the diagnosis information in detail.

TIP:

Linear probe does not support Color M mode.

Duplex/Triplex

This function is used to set if B image or B+Color image (Power) is scanned synchronously.

HPRF

HPRF mode is used when detected velocities exceed the processing capabilities of the currently selected PW Doppler scale or when the selected anatomical site is too deep for the selective PW Doppler scale.

Baseline

Refers to the area where the velocity in zero in the spectrum. The map changes after being edited.

Angle

This function is used to adjust the angle between Doppler vector and flow to make the velocity more accurate.

The real-time adjusting angle value is displayed in the image parameter area.

Quick Angle

Adjusts the angle faster in increments of 60°, and the real-time value of which is displayed in the image parameter area.

Dynamic Range

The dynamic range conveys the information that being transformed from echo intensity to gray scale.

Audio

Adjusts the output audio in spectrum Doppler.

Steer

Adjusts the scan angle in PW mode, so as to change the angle between the transmitting beam and flow direction.

Obtain more information with immobility of the probe.

Values of steer angles vary with the probe.

TIP:

Steer is available only for linear probes.

6.8 TDI

TDI mode is intended to provide information of low-velocity and high-amplitude tissue motion, specifically for cardiac movement.

There are 4 types of TDI mode available:

- Tissue Velocity Imaging (TVI): This imaging mode is used to detect tissue movement with direction and speed information. Generally the warm color indicates the movement towards the transducer, while the cool color indicates the movement away from the transducer.
- Tissue Energy Imaging (TEI): This imaging mode reflects the status of cardiac movement by providing the energy information, the larger the energy is, the brighter the color becomes.
- Tissue Velocity Doppler Mode (TVD): This imaging mode provides direction and speed information of the tissue.

- Tissue Velocity M Mode (TVM): This function assists to observe the cardiac motion through a direct angle.

TIP:

TDI is optional.

6.8.1 TDI Mode Image Scanning

Perform the following procedure:

1. Press <TDI> or the user-defined key to enter the TDI mode.
   - In B or B+Color mode: to enter TVI Mode, parameters of TVI mode will be displayed on the touch screen.
   - In Power mode: to enter TEI Mode, parameters of TEI mode will be displayed on the touch screen.
   - PW mode: Press <TDI> or the user-defined key and then press <PW> or <Update> to enter TVD. The parameters of TCD are displayed on the touch screen.
   - M mode: Press <TDI> or the user-defined key and then press <M> or <Update> to enter TVM. The parameters of TVM are displayed on the touch screen.
2. Adjust the image parameters to obtain optimized images.
3. Press <TDI> or the user-defined key to exit from TDI mode and enter general imaging modes.

   Or, press <B> on the control panel to return to B mode.

6.8.2 TDI Mode Image Parameters

In each TDI mode, the parameters that can be adjusted are similar to those in the color flow modes (Color, PW, and Power). See the relevant sections for details. The following introduces the specific items in TDI mode.

Tissue State

This function is used for fast image optimization.

6.8.3 TDI Quantitative Analysis

⚠CAUTION

TDI is provided for reference, not for confirming a diagnosis.

NOTE:

To perform the strain and strain curve, the ECG curve is in need in case of the deviation in curve.

TIP:

- TDI quantitative analysis is an option.
- The current image (in frozen state) and the saved image can be used in the quantitative analysis.
- Only after the user chooses the image review, the quantitative analysis is available.If the user chooses the static image (only one frame), the quantitative analysis is not available.

6.15 Tissue Tracking Quantitative Analysis

⚠CAUTION

Tissue Tracking Quantitative Analysis images are provided for reference only, not for confirming diagnoses.

Apart from TDI imaging function, the system also provides tissue tracking QA function for myocardial movement evaluation.

By tissue tracking QA function, the ultrasound system will scan each pixel position by frame within the cardiac cycle, and then use region matching method and auto-correlation searching method to trace each spot and calculate the movement, so as to determine myocardial motion in a more quantitative way.

Tissue tracking quantitative analysis is an option.

NOTE:

Only use the probes that support stress echo function under the cardiac mode to start Tissue Tracking QA function.

6.15.1 Basic Procedures for Tissue Tracking QA

Perform the following procedure:

1. Open a saved B mode cardiac cine file.

   A cin. format file which contains more than 1 cardiac cycle (with 2 R waves) and ECG signal.

2. Tap [Tissue Tracking QA] or press the user-defined key to activate the function:
   - You can determine the image of interest by previewing the image.
   - Use [Cycle] to select and find the image of interest.
3. Select the corresponding section name and locate one frame image with good image effect by cine play. Use the cursor to set the reference point:
   - Long axis section: use the “3-point” method or “Manual” method to set.
   - Short axis section: enter multiple points (at least 6 points) using the cursor manually to set.
4. After reference points are set, the system will display the boundary of the endocardium and epicardium. Adjust the thickness if necessary.

   If the traced result is poor, tap [Reload] to re-trace the reference points, or make fine adjustments to the points using the cursor.

   If the cycles are not adequate to provide the information, switch to another cycle to trace.

5. Tap [Start Tracking] on the soft menu to start the tracking function. Adjust the parameters if necessary.

   Tap [Edit] on the soft menu to display the cursor. Use the trackball/trackpad and press <Set> to re-select the trace reference points (inner dots of the curve). Move the cursor to the exact boundary position and press <Set> again to set the right place. Tap [Start Tracking] to start tracking again.

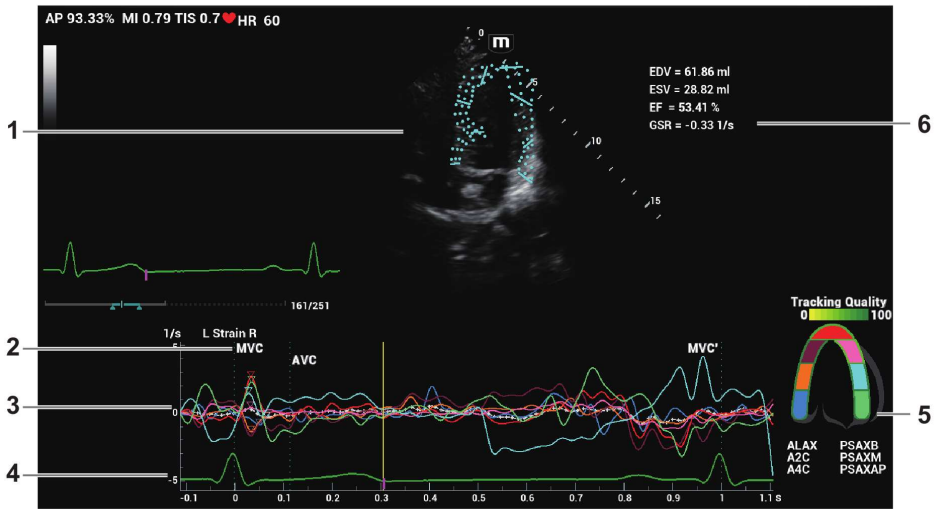
6. Tap [Accept & Compute] to calculate and display the curve.

   Adjust the parameters if necessary.

7. Tap [Bull’s Eye] to see the result.

8. Tap [Data Export] to export analyzed data.
9. Tap [Exit] to exit.

6.15.2 Screen Display of Tissue Tracking QA



1	Displays image used to generate trace curve	/
2	Displays corresponding time of AVO (aortic valve open)/AVC (aortic valve close)/MVO (mitral valve open)/ MVC (mitral valve close).	/
3	Display curve: Velocity/ Displacement/Strain/Strain Rate.	Each curve on the image is matched with a certain segment in the cardiac segmentation model (6), identified by different colors. • Velocity curve: X-axis represents time (s); Y-axis represents velocity (cm/s). • Displacement curve: X-axis represents time (s); Y-axis represents displacement (mm). • Strain curve: X-axis represents time (s); Y-axis represents deformation of the tissue (%). • Strain-rate curve: X-axis represents time (s); Y-axis represents strain by time (s^{-1}).
4	Displays ECG trace	/
5	Displays cardiac segmentation model, and each segment name is illustrated beneath the model.	• In the figure, ▽ marks the peak position of the curve. • Under tracking status, click on a segment in the cardiac segmentation model. The segment has “X” mark and its corresponding calculating is eliminated. • Tap certain segment in the cardiac segmentation model, the segment will turns grey and its corresponding curve no longer displays. • You can get the current X/Y axis value by moving the cursor onto one point on the curve; and if you press <Set> at this time, the frame marker will move to the spot. The segment boundary color indicates the tracking quality.

6	Displays measurement and calculation results	• EDV: Maximum value of the end diastolic volume during the trace. • EDA: Maximum value of the end diastolic area (Left Ventricular) during the trace. • ESV: Maximum value of the end systolic volume (Left Ventricular) during the trace. • ESA: Maximum value of the end systolic area (Left Ventricular) during the trace. • FAC (for short axis section): Fractional Area Change= (EDA — ESA)/EDA • EF (for long axis section): Ejection fraction • HR: Heart rate • Global strain of all segments. • Displays when strain rate curve is acquired. • Global strain rate of all segments. • Displays when strain rate curve rate is acquired. Also on Bull's Eye figure, the system displays TPSD value: Time to Peak Standard Deviation (TPSD): Where, standardized value of time to peak data: $\{TP_i \mid i \in [1, N]\}$. (N is the number of time to peak data) Average value of standardized value of time to peak data: $\overline{TP}$, and the standard deviation is $TPSD = \sqrt{\frac{\sum_{1}^{N}\left(TP_i - \overline{TP}\right)^2}{N}}$

6.15.3 Select Image and Cardiac Cycle

You can select images with a better image quality so as to guarantee the analysis result.

Switch the cine file

1. Tap [Review] to enter the review state on touch screen.
2. Double-click the target file.
3. The system closes current displayed file and switch to the newly selected file.

Switch cardiac cycle within the cine file

Tap [Circle] to select when opening a cine which includes multiple cardiac cycles.

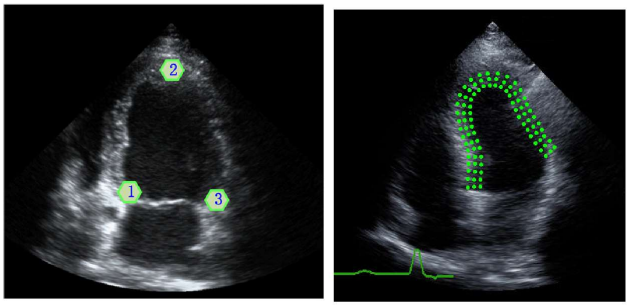
6.15.4 Myocardial Boundary Tracing

Tracing

The system provides 2 kinds of tracing method for 2 kind of sections. Long axis section (A4C, A2C, ALAX): 3-point method and manual tracing method are both available. Short axis section (PSAX B, PSAX M, PSAX AP): only manual tracing is available.

- 3-point method

  As shown in the following figure, after operation by pressing <Set> to place 3 points on the image, the system generates the trace automatically.



- Manual trace method

  Press <Set> and move the cursor by using the trackball/trackpad along the boundary to add the trace points gradually, after trace is finished, press <Set> twice to finish tracing.

  NOTE:

  At least 6 points should be determined by you before the system generates automated trace. Press <Set> to make the traces on the image clockwise or anticlockwise.

Retracing

If current trace is not satisfactory, tap [Reload] on the touch screen to clear the trace and to start another tracing.

During the tracing drawing, press <Clear> to clear already traced drawing.

Make fine adjustment to the trace

You can make fine adjustments to the trace after it is completed.

Perform the following procedure:

1. Under tracing curve adjusting status, the cursor turns into □.
2. Move the cursor to the editable point, press <Set>.
3. Use the trackball/trackpad to drag the curve to desired position, press <Set> again to set the point to the new position.
4. Repeat step 2~3 above to finish all points that need adjustment.

TIP:

Under tracking status, tap [Edit] on the touch screen to enter the status.

6.15.5 Basic Operations of TTQA

Switch among the operation controls

- [Start Tracking]: tap to start tracking.
- [Accept & Compute]: tap to start calculation and display the curve.
- [Exit]: tap to exit tissue tracking.
- [Parameter]: rotate to select the curve type.
- [Bull's Eye]: touch to turn on/off bull's eye and peak data table.
- [Auto Play]: change the speed of the play.

View Selection

Before tracing, touch the corresponding keys to select for the view.

- [A4C]: apical four chamber.

- [A2C]: apical two chamber.
- [ALAX]: apical long-axis view, also called 3-chamber view.
- [PSAX B]: short axis view of base section, short axis view of mitral valve.
- [PSAX M]: short axis view of base section, short axis view of papillary muscle.
- [PSAX AP]: short axis view of apex.

Parameter Adjustment

- [Thickness]: adjusts the tracing thickness, i.e., the distance between the endocardium wall and the tracking points on the epicardium.
- [Tracking Points]: adjusts the number of points within the segment.
- [Cycle]: select the next cycle.
- [Display Effect]: turns on/off the arrow vector graphical display of the myocardial movement.
- [Velocity Scale]: adjust the scale length of the velocity.
- [Display Style]: display the endometrial, the epicardium, the myocardial or all.
- [Tracking Cycles]: select the cycles to be tracked.
- [Average Cycles]: obtain the average parameter curves of the tissue.
- [Cycle Select]: select among different cycles.

Time Mark

According to the status of the current section, tap the corresponding key on the touch screen to check the matching time.

- [AVO]: displays aortic valve open time.
- [AVC]: displays aortic valve closure time.
- [MVO]: displays mitral valve open time.
- [MVC]: displays mitral valve closure time.

Curve Display

Select [Parameter], the system provides different curves of different segments for observation.

- General
  - Speed curve: The X-axis represents time (s); the Y-axis represents velocity (cm/s).
  - Displacement curve: The X-axis represents time (s); the Y-axis represents displacement (cm).
- Long axis section
  - Volume: The X-axis represents time(s); the Y-axis represents volume (ml).
  - Strain curve (Longitudinal, Transversal): The X-axis represents time (s); the Y-axis represents strain deformation of the tissue (%).
  - Strain-rate curve (Longitudinal, Transversal): The X-axis represents time (s); the Y-axis represents strain by time (s^{-1}).
- Short axis section
  - Area curve: The X-axis represents time(s); the Y-axis represents area (cm2).
  - Strain curve (Radial, Circumferential): The X-axis represents time (s); the Y-axis represents strain deformation of the tissue (%).
  - Strain-rate curve (Radial, Circumferential): The X-axis represents time (s); the Y-axis represents strain by time (s^{-1}).
  - Circumferential Rotation curve: The X-axis represents time (s); the Y-axis represents rotation of the tissue (Deg).

– Circumferential Rotation Rate curve: The X-axis represents time (s); the Y-axis represents rotation by time (Deg/s).

Torsion & Torsion Rate Curve

The system provides left ventricular torsion data based on short axis sections of PSAX AP and PSAX B. Torsion is acquired by calculating difference of apex and base of the heart.

Torsion = PSAX AP Rot. - PSA XB Rot.

- The X-axis represents time (s).
- The Y-axis represents tortion by time (Deg/s).

6.15.6 Bulleye

After tracking, the system can display Bull's Eye graph, so as to judge reverse movement or scope of myocardium.

1. Tap [Bull's Eye] on the touch screen to turn on the function:

   You can acquire:

   – Time to peak value and peak value of the 17 segments (similar to 16 segments);
   – Display measurement result EDV/ESV/EF/TPSD.

2. Use [Parameter] on the touch screen to see different parameter bull's eye graph.

   "-" will display in the table to indicate those segments that are not well tracked.

6.15.7 Measurement/Comment

Under tissue tracking QA mode, only Time measurement is available. For details, please refer to Operator's Manual *Advanced Volume*.

Comments and Body Mark operations are the same as in other modes.

6.15.8 Data Export

The system provides data exporting function, so that you can export calculation result for analysis (for instance, SPSS analysis).

Tap [Data Export] on the touch screen, to export analyzed data of each segment in .csv format.

6.16 Auto GA

NOTE:

Auto GA must be used with convex probe.

After acquired image(s) of gastric antrum, by freezing image and tapping the Auto GA button, the feature shows boundary of gastric antrum and calculates the area of gastric antrum.

Perform the following procedure:

1. Scan and obtain the gastric antrum image and freeze the image.
2. Select [Auto GA], the system will automatically recognize and trace the target boundary to calculate.

   The calculation result is displayed on the screen.

3. If the calculation result is not satisfactory, adjust the trace to recalculate.