

Consona N9/Consona N8/Consona N7/ Consona N6 Series

Diagnostic Ultrasound System

Operator's Manual

[Advanced Volume]

- Left ventricular endocardium at end-systolic, the ESV (A2C), SV(A2C), EF(A2C) is obtained automatically.
3. In apical four-chamber view, measure the following parameters:
- Left ventricular endocardium at end-diastolic, the EDV (A4C), SV(A4C), EF(A4C) is obtained automatically.
 - Left ventricular endocardium at end-systolic, the ESV (A4C), SV(A4C), EF(A4C) is obtained automatically.
- If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
4. Select the HR source: ECG or entered.
- ECG obtains the HR automatically. If ECG is not connected, it should start HR on the menu.
- The CO and CI are calculated automatically using the entered height and weight values.

5.4 Study Tool Operations

5.4.1 Left Ventricular Function

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

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

NOTE:

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

S-P Ellipse

Study Items:

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

Tools	Descriptions	Operations
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	Distance in 2D General measurements
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	Area in 2D General Measurements
HR	Heart Rate	Obtained by ECG, HR(R-R) measurement or entered di-rectly

Study Results:

Tools	Descriptions	Formulae
EDV(SP Ellipse)	End-diastolic Left Ventricular Volume	$EDV(SP\ Ellipse)(ml) = \frac{8}{3\pi} \times \frac{LVAd\ apical(cm^2)^2}{LVLd\ apical(cm)}$
ESV(SP Ellipse)	End-systolic Left Ventricular Volume	$ESV(SP\ Ellipse)(ml) = \frac{8}{3\pi} \times \frac{LVAs\ apical(cm^2)^2}{LVLs\ apical(cm)}$
EDV Index(SP Ellipse)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(SP Ellipse)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(SP Ellipse)	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO(SP Ellipse)	Cardiac Output	
EF(SP Ellipse)	Ejection Fraction	
SI(SP Ellipse)	SV Index	
CI(SP Ellipse)	CO Index	

Perform the following procedure:

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

The EDV value is then calculated.
3. In apical long-axis view at end-systole, measure the following parameters:
 - LVLs apical
 - LVAs apical

The ESV value is then calculated.

The system calculates the SV and EF.

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

4. Select the HR source: HR(R-R) measurement, ECG or entered.

The CO and CI are calculated automatically using the entered height and weight values.

B-P Ellipse

Study Items:

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

Study Results:

Tools	Descriptions	Formulae
EDV(BP Ellipse)	End-diastolic Left Ventricular Volume	*1
ESV(BP Ellipse)	End-systolic Left Ventricular Volume	*2
EDV Index(BP Ellipse)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(BP Ellipse)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(BP Ellipse)	Stroke Volume	see “5.4.1 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:

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

*2 means:

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

Perform the following procedure:

1. Select [B-P Ellipse] in the measurement 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 the SV and EF after the LVAs apical has been measured.

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

5. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

The CO and CI are calculated automatically using the entered height and weight values.

Bullet

Study Items:

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
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	Obtained by ECG, HR(R-R) measurement or entered directly

Study Results:

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

Tools	Descriptions	Formulae
ESV Index(Bullet)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(Bullet)	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO(Bullet)	Cardiac Output	
EF(Bullet)	Ejection Fraction	
SI(Bullet)	SV Index	
CI(Bullet)	CO Index	

Perform the following procedure:

1. Select [Bullet] in the measurement menu.

In apical long-axis view, measure the following parameters:

- At end diastole: LVLd apical
- At end systole: LVLs apical.

2. 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 the SV and EF.

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

3. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

The CO and CI are calculated automatically using the entered height and weight values.

Mod.Simpson

Study Items:

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
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	Obtained by ECG, HR(R-R) measurement or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(Mod.Simpson)	End-diastolic Left Ventricular Volume	*1
ESV(Mod.Simpson)	End-systolic Left Ventricular Volume	*2
EDV In-dex(Mod.Simpson)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV In-dex(Mod.Simpson)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(Mod.Simpson)	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO(Mod.Simpson)	Cardiac Output	
EF(Mod.Simpson)	Ejection Fraction	
SI(Mod.Simpson)	SV Index	
CI(Mod.Simpson)	CO Index	

*1 means:

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

*2 means:

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

Perform the following procedure:

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 the SV and EF.

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

5. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

The CO and CI are calculated automatically using the entered height and weight values.

Simpson

You may select to measure single plane (A2C or A4C) only or both planes (A2C and A4C) to study.

Study Items:

Tools	Descriptions	Operations
A2Cd	Left ventricular long-axis length at end diastole in A2C view	Simpson measurement (Trace/Spline/Auto)
A2Cs	Left ventricular long-axis length at end systole in A2C view	
A4Cd	Left ventricular long-axis length at end diastole in A4C view	
A4Cs	Left ventricular long-axis length at end systole in A4C view	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurements or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(A2C/A4C)	End-diastolic Left Ventricular Volume (A2C/A4C)	$EDV(ml) = \pi \times \frac{LVLd\ apical(cm)}{20} \times \sum_{i=1}^{20} r_i^2 (cm)$ <p>LVLd apical: Left Ventricular Long-axis Length at End-diastole in apical view, i.e. the long-axis length obtained in measurement. r_i: Radii obtained from diastolic measurement</p>
EDV (BP)	End-diastolic Left Ventricular Volume (BP)	*1
ESV(A2C/A4C)	End-systolic Left Ventricular Volume (A2C/A4C)	$ESV(ml) = \pi \times \frac{LVLs\ apical(cm)}{20} \times \sum_{i=1}^{20} r_i^2 (cm)$ <p>LVLs apical: Left Ventricular Long-axis Length at End-systole in apical view, i.e. the long-axis length obtained in measurement. r_i: Radii obtained from systolic measurement</p>
ESV (BP)	End-systolic Left Ventricular Volume (BP)	*2
EDV Index (A2C/A4C/BP)	End-diastolic Left Ventricular Volume Index (A2C/A4C/BP)	EDV Index=EDV/BSA
ESV Index (A2C/A4C/BP)	End-systolic Left Ventricular Volume Index (A2C/A4C/BP)	ESV Index=ESV/BSA
SV	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO	Cardiac Output	
EF	Ejection Fraction	
SI	SV Index	
CI	CO Index	

*1 means:

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

*2 means:

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

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

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

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

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

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

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

Where

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

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

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

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

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

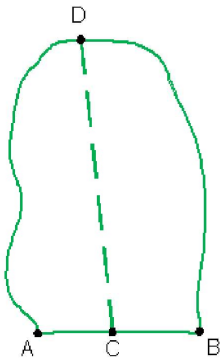


r_{4i} – Radii obtained by EDV (A4C) or ESV (A4C) at apical four-chamber view

Simpson: Simpson single plane measurement (measure apical A2C or A4C only)

Perform the following procedure:

1. Select [Simpson] in the measurement menu.
2. Measure the endocardium.

The endocardium can be measured using trace, spline or auto, click items on the menu to select the method.

Methods	Operations
Trace	Trace the endocardium along the edge of the target area using a method similar to Trace method in 2D Area measurements, then set the long axis.
Spline	Set reference points (up to 12) along the edge of the endocardium using a method similar to Spline method in 2D Area measurements, then set the long axis.
Auto	<p>Follow the steps below:</p> <ol style="list-style-type: none"> Set points A and B using the trackball and <Set> key, where A: Left ventricular interventricular septal and mitral valve junction; B: Left ventricular wall and mitral valve junction; After setting A and B, the cursor will be automatically displayed at point D (where is considered as the apical part by system detecting). After point D is set, the long axis (line segment CD) and the line that traces the endocardium are displayed. Where C: Midpoint of A and B. D: Apical part of left ventricle.  <ol style="list-style-type: none"> You can do the following operations: Adjust the long axis: Move the cursor on the long axis (which turns yellow), then press <Set>; Move the cursor to adjust point D (with point C unchanged) after the cursor changes to  Adjust the trace line: Move the cursor to position the cursor on the trace line (which turns yellow), and then press <Set>; Move the cursor along the endocardium edge to adjust the line after the cursor changes to  4. Press <Set> outside the line to confirm the adjustment.

- 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 the SV and EF.

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

3. Use the menu to select the HR source: ECG, HR (R-R) measurement or entered.

The CO and CI are calculated automatically using the entered height and weight values.

Simpson: Simpson Bi-plane measurement

CAUTION

When using Simpson 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.

Perform the following procedure:

1. Select [Simpson] 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 the height and weight have already been entered, the SV, EF, SI, EDV Index and ESV Index are calculated.

4. Use the touch screen to select the HR source: ECG, HR(R-R) measurement or entered.

The CO and CI are calculated automatically using the entered height and weight values.

LV (2D)

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	Obtained by ECG, HR(R-R) measurements or entered directly

Study Results:

Tools	Descriptions	Formulae
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	
IVSs	Interventricular Septal Thickness at End-systole	
LVPWs	Left Ventricular Posterior Wall Thickness at End-systole	
EDV	End-diastolic Left Ventricular Volume	$EDV(ml) = LVIDd(cm)^3$
ESV	End-systolic Left Ventricular Volume	$ESV(ml) = LVIDs(cm)^3$
EDV Index	End-diastolic Left Ventricular Volume	$EDV\ Index = EDV/BSA$
ESV Index	End-systolic Left Ventricular Volume	$ESV\ Index = ESV/BSA$
SV	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO	Cardiac Output	
EF	Ejection Fraction	
FS	Fractional Shortening	
MVCF	Mean Velocity of Circumferential Fiber Shortening	
SI	SV Index	
CI	CO Index	

TIP:

- In the [Setup] > [System] > [Application] screen, you can set the method for the Cube/Teichholz/HR study.
- Click [Property] in [Setup] > [Measure] to select formula for LV measurement by selecting result items: Cube, Teichholz or Gibson.

Taking the method using LVIDd, LVIDs, HR as an example.

Perform the following procedure:

1. Select [LV (2D)] in the measurement menu.
2. Measure LVIDd in 2D or M mode.
The LVIDd and EDV are obtained.
3. Measure the LVIDs in 2D or M mode.
 - The LVIDs and ESV are obtained.
 - The system calculates the SV, EF and FS.
4. Using the menu to select the HR source: ECG, HR(R-R) measurement or entered.

If the height and weight have already been entered, the SI, CO, CI, EDV Index and ESV Index are calculated.

The MVCF is calculated if the LVET is measured.