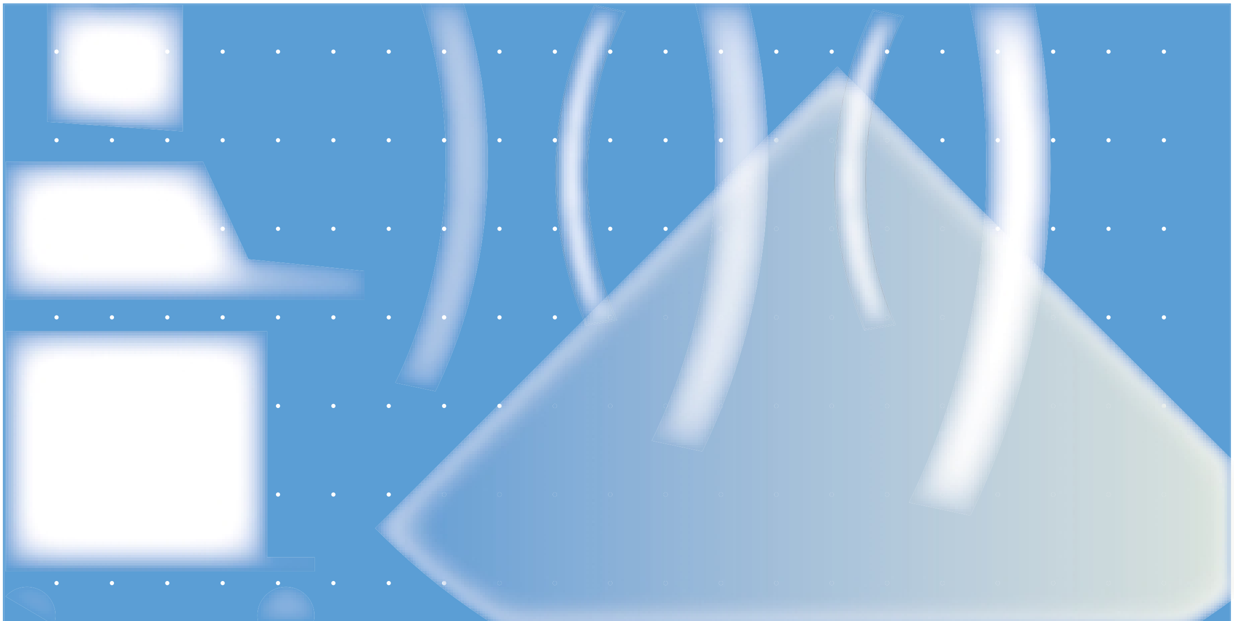

SONOS 7500/5500

Measurements and Calculations Reference

PHILIPS

System Reference Guide

Measurements and Calculations Reference

Philips SONOS 7500
Philips SONOS 5500

Publication number M2424-30000-mc-02

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WARNING

Electrical Shock Hazard

Do not remove system covers. To avoid electrical shock, use only supplied power cords and connect only to properly grounded wall (wall/mains) outlets.

Explosion Hazard

Do not operate the system in the presence of flammable anesthetics.

Safety Information

Before you use the Philips ultrasound system, be sure to read the *Safety and Standards Guide*.

Pay special attention to the "Warnings" and "Cautions."

The warnings explain the dangers of electrical shock and explosion hazard, the safety of ultrasound, applications, guidelines for fetal use, and guidelines for setting controls that affect acoustic output and accuracy of clinical measurements.

The cautions explain potential dangers to equipment.

Warning Symbol used in the Text:

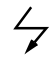
WARNING

Caution Symbol used in the Text:

CAUTION

Warning Symbols used on the System or its Probes:

Instruction manual symbol: The product is marked with this symbol when it is necessary for the user to refer to the user's guide.



Dangerous voltages symbol: Indicates potential for electrical shock.

Monitor Radiation

The monitor used in this system complies with the FDA regulations that were applicable at the date of manufacture (21 CFR Subcategory J).

Prescription Device

The United States Food and Drug Administration requires the following labeling statement:

Caution - Federal Law restricts this device to use by or on the order of a physician.

Important

CE 0123 marking is for Council Directive 93/42/EEC.

This system complies with the Medical Device Directive.

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Preface

This guide includes measurements and calculations reference material for the Philips SONOS 7500 and SONOS 5500 ultrasound imaging systems. Here you will find:

- Detailed information about the measurements and calculations included on the Philips systems, including intended use, accuracies, formulas, and references.
- Techniques for improving accuracy.
- The calibration procedure for AQ Dataport measurements on the SONOS systems.
- Information about Philips optical disk files and their use with non-Philips systems.

Use this guide in conjunction with the following books:

- *System Basics*—Describes the basic operation of the Philips SONOS 7500 and SONOS 5500 systems.
- *Controls Reference*—Provides a detailed description of all system controls.
- *Safety and Standards Guide*—Provides information on safety issues.
- *Transducer Reference*—Provides information on the operation, care, and cleaning of transducers.

Additionally, several specialty guides and multimedia products describe SONOS imaging applications and optional packages:

- *Using Integrated Digital Interface (IDI)*
- *Using Stress Echocardiography*
- *Using 3-Dimensional and BiPlane Imaging*
- *Using Contrast Imaging*
- *Using Acoustic Quantification*
- *Using Acoustic Densitometry*
- *LVO and Contrast CK: A Practical Approach* (a video guide to SONOS contrast echocardiography detection techniques)
- *Stress Audio CD* (a spoken guide to performing SONOS stress echocardiography studies)

Conventions Used in This Guide

The following conventions are used in this guide:

- Touch-panel and rotary control names appear in bold text. For example, **Acquire Loop.**
- Function controls appear in a box. For example, Enter.
- In this CD, clickable cross-references to tables and graphics are highlighted blue. Due to the large number of page cross-references, they are not highlighted in blue. But the page numbers can still be clicked, to go to the appropriate references.

Contents

1 Definitions and Accuracy

Contents

5 AQ Dataport

6 Optical Disk Files and Non-Philips Systems

1

Definitions and Accuracy

Contains the definitions and accuracy information for the measurements and calculations available on your Philips SONOS ultrasound system.

Intended Use

This system can be used to provide measurements and calculations derived from ultrasound images. The quantified image data is then used in conjunction with other clinical data to make a diagnosis.

Sole use of measurement data to make a diagnosis is not recommended. There are numerous factors to consider when using quantified data from any ultrasound imaging system. A list of those factors is provided in this chapter. A careful analysis of those factors indicates that the accuracy of each measurement and subsequent calculation is highly dependent on image quality. Image quality in turn is highly dependent on system design, operator scanning technique, familiarity with system controls and, most importantly, patient echogenicity. Three of these variables are independent of the system and therefore prevent specifying a clinical accuracy for the measurements and calculations produced by the system.

System accuracy specifications are given for the measurement primitives frequency, length, time. These specifications are based on data taken with optimum control settings. Accuracy specifications can be obtained at other control settings by repeating the calibration at the desired settings. The Depth and Sweep Speed controls have the biggest impact on measurement accuracy. The accuracy of a 1 cm length or 3 cm^2 area measurement on a 24 cm depth display is different than for the same measurements performed on a 4 cm depth display. Measurements taken at a sweep speed of 100 mm/second are more accurate then those taken at 25 mm/second.

The Analysis feature on this system can be used only with images produced on Philips phased array imaging systems, unless special calibration is performed on the images being analyzed.

Measurements, Calculations, and Primitives

To produce measurements and calculations, system controls are used to draw graphics on selected image displays. These graphics are processed by the system and converted into displayed measurement and calculations values.

The clinician can make and display a set of standard measurements and calculations without going into the Analysis package. Within Analysis, the clinician can generate a large variety of specific, labelled measurements and calculations for each application preset, and can display, edit, and print reports which collect and summarize the measurement and calculation values.

In this guide, the term “measurement” is used for both standard measurements which are displayed in the Measurements box without entering the Analysis package, and for Analysis package measurements, which appear in the Results box. “Calculations” are the values produced when measurements are entered into mathematical formulas. Certain standard calculations appear in the Measurement box (Quick Calcs) as well as in the Results box.

Measurement “Primitives” are the “building blocks” the system assembles to produce the measurement and calculation values associated with graphics drawn on the image by the clinician in the various imaging modes. For example, when the clinician draws a straight line on a Doppler spectrum, the system uses the frequency or velocity primitive to produce frequency or velocity measurements; on a sector in 2D mode, the system uses the length primitive to produce a length measurement. On a spectral trace, the system assembles several primitives to produce possible slope, time, and mean values. On a 2D sector trace, the length primitive is used to derive area and length values.

Some variables listed here as primitives, for example area and circumference, are derived from other primitives through simple calculations.

“Generic” measurements are Analysis package measurements which are not associated with an anatomical label, but which are available for use in Analysis and will appear in Analysis reports.

Measurement Primitives and Accuracies

Validation Methods

Philips performs software testing to validate that measurement values and calculations are implemented as specified. A phantom is used for the area and circumference validation. Velocity is validated using a frequency generator and a cosine multiplication table. Slope calculations are validated using a calculator. Methods used for other primitives are indicated in the discussion.

Primitives (Basic)

The system uses the following basic primitives (primary measurements) to produce the measurement and calculation values.

Frequency

The frequency measurement is calibrated using a frequency source traceable to NIST (National Institute of Science and Technology). The accuracy of this calibration is considerably greater than 99%. There is no need to recalibrate this measurement given the high amount of initial accuracy and the knowledge that drift due to equipment age or thermal issues should not be a routine concern.

Length

The system assumes that the speed of sound is 1540 M/sec and that this speed is homogeneous in all tissues. Several books on ultrasound cite that differences in the speed of sound do exist based on the type of tissue. One source[1] cites sound speeds from a range of 1500 to 1600 M/sec. These differences would produce an inaccuracy of up to 4%.

1. *Clinical Sonography - A Practical Guide,* Second Edition, Roger C. Sanders, ed., Little Brown and Company, 1991.

The length measurements on the system are verified using an AIUM standard phantom. The calibrations are performed using depth settings which give the greatest resolution for the phantom length being measured. The accuracy of this calibration should be within ±5%.

Time

Time measurements can be used for calculations performed in the following areas: physio channels, M-mode, and Doppler. The time calibration is performed using a time-interval signal generator with a calibration traceable to NIST. The calibration of the display is not expected to drift. Calibration of the time axis should be done by measuring 1-second pulses at the different sweep speeds. The accuracy of these measurements should be within ±5% independent of the sweep speed used.

Primitives (Calculated)

Angle Calculations

Table 1-1 Angle Calculations

Abbreviation	Meaning	Type
Angle		
Angle α	Bony acetabular root line angle (bony root angle)	Angle in degrees
Angle β	Cartilage root line angle (cartilage root angle)	Angle in degrees

Angle Formula and References

$$A_x = L_x - L_b$$

If $A_x < 0$, then $A_x = -A_x$

If $A_x > 180$, then $A_x = 360 - A_x$

Where A_x is the α or β Angle, L_x is the α or β line angle, and L_b is the baseline angle.[1]

Area

Area is derived through use of the length measurement primitive. Green's Theorem is used to calculate the area. The number of points that are used in the calculation is related to how slowly the operator traces the area of interest.

The clinical accuracy of the circumference measurements is highly dependent on the ability of the operator to accurately trace the area of interest.

There is an option in the software to use an ellipse to calculate area. This area will be calculated as follows:

$$\text{Area} = \pi \times \text{Major Semi Axis Length} \times \text{Minor Semi Axis Length}$$

Circumference

Circumference, for manual trace, is derived by the addition of several discrete length measurements.

The clinical accuracy of the circumference measurements is highly dependent on the ability of the operator to accurately trace the area of interest. The circumference measurement accuracy should be within ±5% when using a phantom.

1. P. Schuler, R. Graf, "Sonographic Diagnosis of Hip Dysplasia and Hip Dislocation," 4. Erg.Lig. 7, 1986, Ecomed Verlag. Reprint distributed by Siemens.P. Schuler, R. Graf, "Sonographic Diagnosis of Hip Dysplasia and Hip Dislocation," 4. Erg.Lig. 7, 1986, Ecomed Verlag. Reprint distributed by Siemens.

The ellipse circumference (C) is computed as follows if b > $\frac{a}{4}$

$$C = \pi\left[\frac{3}{2}(a+b) - \sqrt{ab}\right]$$

and as follows if b < or = $\frac{a}{4}$

$$C = 4a + b\left(\frac{11}{2}\pi - 16\right)$$

where a = Major Semi Axis Length and b = Minor Semi Axis Length.

Slope

Slope is derived from the length and time measurement primitives using a simple slope formula.

Velocity

The velocity value is provided by multiplication of the frequency primitive measurement and the cosine of the angle of blood flow. The blood flow angle is a control set by the system operator. The setting of this control varies by clinical application. There are some uncertainty and assumptions in the setting of this control. Unpredictable high velocity jet directions and tortuous vessel directions sometimes prevent use of a clinically accurate blood flow angle.

Acceleration

Doppler spectral acceleration is derived from the change in velocity divided by the change in time, using a simple slope formula.

Velocity-Time Integral

The velocity-time integral (or flow integral) is the integral of the Doppler spectral instantaneous velocity (V_i) over the total time interval (T). The integral is approximated by the following sum:

$$\mathrm{VTI} = \sum_{i=1}^{N} V_i \times t_i$$

where t is the total time interval (the sum of all t_i time increments).

Mean Pressure Gradient

Mean pressure gradient (PG mean) is proportional to the integral of the square of the Doppler spectral instantaneous velocity (V_i) over time (t_i). The integral is approximated by the following sum[1]:

$$PG_{mean} = \frac{4}{10,000T} \sum_{i=1}^{N} V_i^2 \times t_i$$

where T is the total time interval (the sum of all t_i time increments), 4 is the approximate units conversion factor for the Bernoulli equation, and 10,000 is the scaling factor from centimeters to meters squared.

Three-Axis Volume Calculation for Multispecialty Applications

For multispecialty applications, volumes of solids are calculated using the following formula:[2]

$$\text{Length} \times \text{Width} \times \text{Height} \times 0.523$$

1. Nanda, Navin C., *Doppler Echocardiography*, Second Edition, Lea and Febiger, Philadelphia, 1993, p. 29.
2. Emanian, S.A., et al, "Kidney Dimensions at Sonography: Correlation With Age, Sex, and Habitus in 665 Adult Volunteers," *American Journal of Radiology*, January, 1993, 160:83-86.

Clinically Referenced Calculations

Several references for calculations and formulas implemented on this system are provided. Clinical calculations are usually based on studies of large patient populations. The formulas that are derived have some uncertainty or inaccuracy based on the correlation coefficient for the study involved. In many cases these uncertainties are greater than the inaccuracies of the ultrasound system measurement. Clinicians should always be familiar with the clinical reference provided for each calculation before using the system measurement and analysis data to make a clinical decision.

Techniques for Improving Measurement Accuracy

This chapter contains all available measurements and calculations for your Philips ultrasound system. The ones actually displayed while using Analysis depend on your system's options.

Transducer Selection

Select a transducer appropriate for the application. When imaging, higher frequency transducers provide better resolution, but sacrifice penetration. Resolution is best where the ultrasound beam width is narrowest. This corresponds to the focal region of the transducer. For best results, use a high frequency transducer for measuring small distances (if depth of penetration allows), and use a transducer that focuses near the area of interest.

For Doppler, lower frequency transducers can measure higher maximum velocities, but resolution is less than for higher frequency transducers.

Display Size

Adjust the display so that the area of interest fills a large portion of the screen. Image displays can be adjusted using the Depth, Zoom, and Image Size controls. Time measurements in M-mode and spectral Doppler are improved at high Sweep settings.

Pulsed Doppler spectral magnification is controlled by Scale, Depth, Flow Angle, and Image Size controls.

Crosshair Placement

Measurement accuracy and precision ultimately depend on placing the crosshair (+) correctly on the image.

You will get the best results when using consistent technique, using control settings that optimize image quality, and avoiding artifacts that disguise tissue. Examples of consistent technique are as follows:

- For each type of measurement, use the same probe orientation in all examinations.
- The A.S.E. M-mode standard[1] recommends making length measurements using the leading edge to leading edge technique. Measure from the leading edge (closest to the transducer) of an image.
- When measuring slopes, use measurement points as far apart as the waveform permits.

ECG Trace

The ECG trace represents the heart's electrical activity, and the screen image represents the heart's mechanical activity. Use the ECG trace as a guide for locating the mechanical end of the diastolic and the systolic phases. Use the Loop function or the VCR SEARCH control to identify the actual mechanical phases.

1. Sahn, D., DeMaria, A., Kisslo, J., Weyman, A., The Committee on M-mode Standardization of the American Society of Echocardiography, "Recommendations Regarding Quantitation in M-mode Echocardiography: Results of a Survey of Echocardiographic Measurements," *Circulation*, 1978, Vol. 58, No. 6, pp. 1072-1083.

Sources of Error[1]

Operator Variability

A skilled sonographer can reduce the largest potential component of measurement variability, namely operator variability. With training and experience, a sonographer learns how to acquire the best view and image quality for each type of measurement. Identification of anatomical structures and correct, consistent cursor placement are needed. Techniques described in the previous section are strongly recommended.

Speed of Sound

Ultrasound imaging algorithms assume that the speed of sound in tissues is 1540 meters/second. However, the speed of sound varies for different tissues. Within soft tissues, the error is typically within 2%, but may be as high as 5%, particularly if fatty tissue is present in the measurement area.

Doppler Alignment

Doppler velocity measurements are most accurate when the direction of blood flow is aligned with the acoustic beam axis. Errors due to misalignment are typically about ±5%.

For best accuracy, aim the transducer so that the acoustic beam axis is aligned with blood flow as much as possible. With linear transducers, when alignment is not possible, use the Flow Angle control to compensate.

1. Feigenbaum, Harvey, *Echocardiography*, Fourth Edition, Lea and Febiger, Philadelphia, 1986, pp. 115-122.

Formulas

Some formulas used in clinical calculations are based on assumptions or approximations. For example, volume formulas may assume a particular three-dimensional shape. Circumference measurements approximate the actual shape by a polygon made up of many short line segments. In the next few pages, formulas used by the Philips SONOS Phased Array Imaging Systems are listed, with a brief discussion of inherent approximations and assumptions. References are provided for further information.

Screen Pixel Resolution

The ultrasound screen is actually composed of an array of (roughly) square picture elements known as pixels. We assume that the measurement pixel resolution error is ±1 pixel. The pixel error will be significant for small dimensions. Use of the imaging Zoom feature will minimize pixel resolution error. This error is 0.23% (or better) of the full-scale screen.

Sweep Speed

Time measurement errors will be larger when slower display sweep speeds are used.

Sphygmomanometer Error

Some pressure calculations require manual entry of blood pressure. We assume that these manually entered pressures are perfect. In fact, sphygmomanometer errors are typically ±5-10 mmHg.

Height, Weight, and Age Demographics

Height and weight values are manually entered to estimate body surface area for cardiac calculations. We assume that these manually entered values are perfect. However, adult weight values may vary over the course of the day.

Volumes

Cardiac Volumes

You can calculate cardiac volumes in two ways:

- Method of Discs (MOD)
  - Single plane method
  - Biplane method
- Area-Length Method (Non-MOD)

These two methods are illustrated in Figure 1-1.

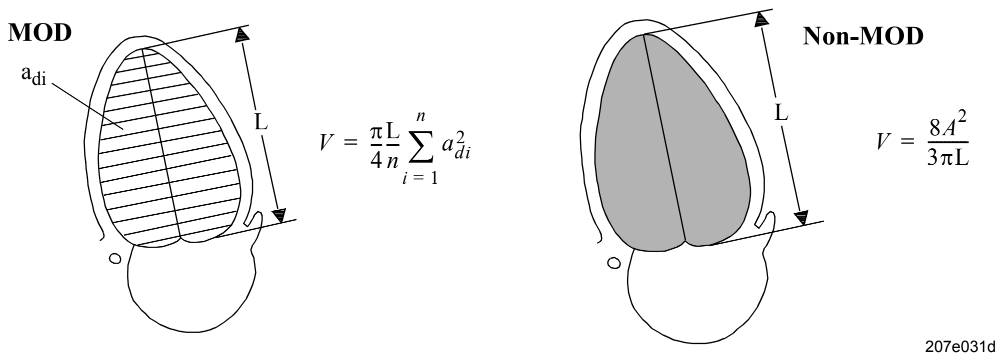


Figure 1-1 Methods for Calculating LV Volume

Method of Discs (MOD)

The Method of Discs single plane volume calculations uses one orthogonal plane for area (apical four chamber or apical two chamber), and a long-axis length. The area traces are divided into 20 elliptical disk segments. The Method of Discs biplane volume calculation uses two orthogonal-plane, area traces (the two-chamber apical view and the four-chamber apical view), and a long-axis length (the longest of the two long axes). The area traces are divided into 20 elliptical disk segments.

Area - Length Method

The non-MOD single-plane ellipse, biplane ellipse, and Bullet volume calculations. use *apical* measurements. When a two-chamber or four-chamber measurement is made, the area values are copied into the equivalent generic *apical* measurement using the meta-measurement feature. However, generic apical measurements are not copied back into either the two-chamber view or four-chamber view measurements.

Volumes for Vascular, Abdominal, and OB/GYN Applications

For Vascular, Abdominal, and OB/GYN applications, volumes of solids are calculated using the following formula[1]:

$$\text{Length} \times \text{Width} \times \text{Height} \times 0.523$$

1. Emamian, S.A., et al., “Kidney Dimensions at Sonography: Correlation With Age, Sex, and Habitus in 665 Adult Volunteers,” *American Journal of Radiology*, January, 1993, 160:83-86.

Automatic Doppler Trace

This section contains information about the SONOS system's automatic Doppler Trace measurements and calculations. (For detailed information on how to use Doppler Trace, please refer to Chapter 7 in your *System Basics Guide*.)

Doppler Trace Operation

Doppler Trace is available only in non-cardiac application presets. The Doppler Trace function automatically traces a frozen Doppler spectrum, and uses the automatic traces to make and display key Doppler measurements and calculations.

Doppler Trace is intended for use on spectral waveforms which are fully displayed above or below the baseline, for example, for studies of arterial grafts, and for carotid, umbilical, renal, and transcranial arteries.

When initiated on a frozen Doppler spectrum, Doppler Trace automatically detects the strongest Doppler complex in which the first and succeeding systolic points (S and S1) are similar. The system marks the first systolic, the end-diastolic, and the succeeding systolic point with S, D, and S1 bars. A peak trace is drawn in gray along the top of the waveform. A mean trace (weighted mean or "centroid") is drawn in black toward the middle of the waveform, marking the predominant velocities encountered in the complex. (See Figure 1-2.)

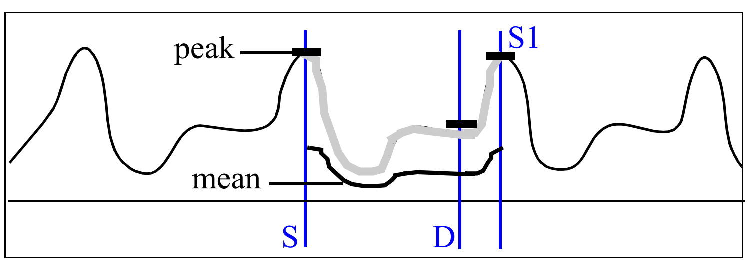


Figure 1-2 Doppler Trace

The peak trace is used to produce a time-averaged peak velocity measurement (MN). The mean trace is used to produce a time-averaged mean velocity measurement (TAVM).

On the SONOS system, the S, D, and S1 bars can be manually positioned to reflect the clinician's judgment. Moving the S bar to another complex selects that waveform to be automatically traced.

The S1 bar can be positioned to include multiple beats in the traces. In this case, all the information between S and S1 will be traced. Any calculations that require input based on S, D, or S1 position use the data marked by these bars.

The following tables show the measurements and calculations which are automatically reported when a Doppler Trace is performed.

Table 1-2 Doppler Trace Measurements

Label	Meaning	Type - Units
AS	Acceleration Slope	Acceleration - cm/sec2
AT	Acceleration Time	Time - sec
D	Diastolic Velocity	Velocity - cm/sec
MN	Time-averaged Peak Velocity	Velocity - cm/sec
S	Systolic Velocity	Velocity - cm/sec
TAVM	Time-averaged Mean Velocity	Centroid Velocity - cm/sec

Table 1-3 Doppler Trace Calculations

Label	Meaning
D/S	Diastolic to Systolic Ratio
PI	Pulsatility Index
RI	Resistivity Index
S/D	Systolic to Diastolic Ratio

Pulsatility Index and Resistivity Index

Doppler Trace uses the end-diastolic velocity (D) to calculate Pulsatility Index and Resistivity Index, NOT the minimum velocity, as recommended in some medical sources.

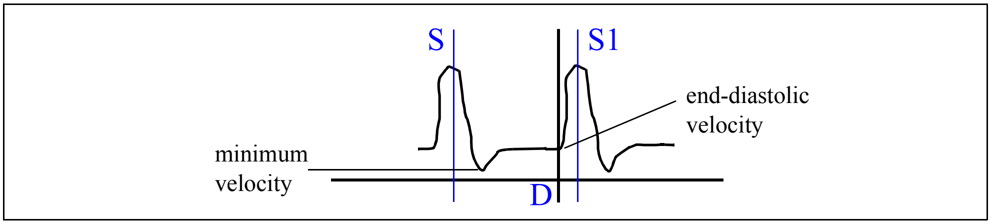


Figure 1-3 End-diastolic velocity vs. minimum velocity

On the SONOS 7500 and SONOS 5500 systems, the S, D, and S1 bars can be manually positioned. If you manually move the D-bar to select the minimum velocity in the situation shown in Figure B, PI and RI will be calculated according to PI and RI formulas which use the minimum velocity. However, Acceleration Time (AT), Acceleration Slope (AS), Diastolic/Systolic ratio (D/S) and Systolic/Diastolic ratio (S/D) will now be inaccurately reported, since these formulas require use of the end-diastolic rather than the minimum diastolic velocity.

Clinicians who wish to use the minimum velocity method, should use their best diagnostic judgement in making and using PI and RI calculations which come from the SONOS system's automatic Doppler Trace.

The manual trace function can also be used to produce PI and RI calculations.

Acoustic Quantification (AQ) Areas and Volumes

Measurement Error in AQ

Not all systems have the AQ feature.

This section presents accuracy information for area and left ventricular volume, assuming an experienced sonographer achieving accurate ROI and AQ border placement. This section also gives accuracy information about the time relationship between AQ waveforms, the patient ECG, and the 2-D sector image.

The AQ area and volume measurements are sampled values produced at the end of each acoustic frame. In both phantom and clinical studies, manual determinations of area and resulting volume have been shown to correlate well with AQ determinations of those measurements. Errors can be introduced in either manual tracing or AQ, and the effect of the same error is the same for either type of border generation.

The best way to reduce these measurement errors is:

- Make sure that the AQ displayed border marks the actual endocardial border as closely as possible.
- Draw the region of interest carefully to include as much of the blood pool of interest and as little of neighboring blood pools as possible.

For more detailed instructions, refer to the *Using Acoustic Quantification User's Guide* and training tool that shipped with your system.

Sources of Error

Because volumes are calculated from areas, they include the potential measurement errors associated with areas. Additionally, volumes have a potential geometric source of error which varies according to the shape of the patient's heart.

In the method of discs (VOL-MOD), a geometric error can occur because the discs, mathematical slices of the left ventricular cavity, are treated as if perfectly round, although the left ventricular chamber at most levels is rarely so.

In the case of volume by area-length (VOL-AL), a geometric error can occur because the left ventricle is treated as an ellipsoid, although the chamber's shape may be more irregular. The accuracy estimates given further in this chapter do not include this potential geometric error, since it varies from one patient to another.

Several parameters are calculated from the measured areas and volumes:

- Fractional area change (FAC)
- Time rate of area change (dA/dt)
- End Diastolic Area
- End Diastolic Volume
- Ejection fraction (EF)
- Time rate of volume change (dV/dt)
- Peak ejection rate (PER)
- Peak rapid filling rate (PRFR)
- Atrial Filling Fraction (AFF)

These calculations add no new source of error, though the formulas do modify the effect of errors already introduced during measurement.

ECG/AQ Timing

There are slight timing differences between the AQ waveform and the ECG waveform on both the AQ real-time waveform display and the Global Function Report.

On the AQ real-time waveform screen, the time delay between the ECG and the AQ waveform is + or - 1/2 frame time.

Table 1-4

Frame Rate	Frame Time
120 Hz	8.3 ms/frame
60 Hz	16.6 ms/frame
30 Hz	33.3 ms/frame
25 Hz	40 ms/frame

On the Global Function Report, the delay between the AQ waveforms and the physios is + or - 5 msec.

2

Cardiac Measurements and Calculations

Contains the definitions for the Cardiac measurements and calculations available on your Philips SONOS ultrasound system.

Cardiac Measurements

The following table shows all Cardiac measurements available on the Philips SONOS ultrasound system. You may not see all of these on your system, depending on the options purchased. These abbreviations appear on the left touch panel and in measurement boxes displayed on the screen during measurement and analysis operations.

Note that some measurements have **L**, **R**, or **M**/**Mn** (for Left, Right, or Middle/Main) before the acronym. You will not see these characters on the system touch panel; identification of a measurement as **L, R**, or **M/Mn** means that the **Left**, **Right**, or **Mid/Main** control is active at the time the measurement is accessed.

Table 2-1 **Cardiac Measurements**

Abbreviation	**Meaning**
2-D area	2-D area
2-D diam	2-D diameter
Accel slope	Acceleration slope
Accel time	Acceleration time
ACS	Aortic cusp separation
AI end-d vel	Velocity of aortic insufficiency jet at end diastole
AI max vel	Maximum velocity of aortic insufficiency
Ao acc slope	Aortic acceleration slope
Ao acc time	Aortic acceleration time
Ao dec slope	Aortic deceleration slope
Ao dec time	Aortic deceleration time
Ao isthmus	Aortic isthmus diameter
Ao root area	Aortic root area
Ao root diam	Aortic root dimension

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
Aortic arch	Transverse aortic arch diameter View: SSN LAX or SSN SAX
Aortic R-R	R-R interval measured when making measurements on the aortic valve
Ao V2 max	Maximum velocity measured distal to the aortic valve
Ao V2 mean	Mean velocity measured distal to the aortic valve
Ao V2 trace	Pressure gradient measured distal to the aortic valve
Ao V2 VTI	Velocity-time integral measured distal to the aortic valve
Area	Area
Area 1	Area
Area 2	Area
asc Aorta	Ascending aortic diameter View: PLAX or SSN LAX
AS max vel	Peak velocity of aortic stenosis jet
Circum	Circumference
d	Distance
Dec. max vel	Maximum velocity measured when measuring the deceleration slope
Decel slope	Deceleration slope
Decel time	Deceleration time
desc Aorta	Descending aortic diameter
Eject time	Onset-to-cessation time
EPSS	E point to septal separation
IVR time	Isovolume Relaxation Time
IVSd	Interventricular septal dimension at end diastole
IVSs	Interventricular septal dimension at end systole

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
LA dimension	Left atrial dimension
Length	Length
LPA diam	Left pulmonary artery diameter
LVAd ap2 MOD	Left ventricular area at end diastole, apical two-chamber, by Method of Discs
LVAd ap4 MOD	Left ventricular area at end diastole, apical four-chamber, by Method of Discs
LVAd apical	Left ventricular area at end diastole, apical
LVAd sax epi	Left ventricular epicardial area at the level of the papillary muscle tips at end diastole (See Figure 2-1 on page 2-28)
LVAd sax MV	Left ventricular short axis area at mitral valve level at end diastole
LVAd sax PM	Left ventricular short axis area at papillary muscle level at end diastole
LVAs ap2 MOD	Left ventricular area at end systole, apical two-chamber, by Method of Discs
LVAs ap4 MOD	Left ventricular area at end systole, apical four-chamber, by Method of Discs
LVAs apical	Left ventricular area at end systole, apical
LVAs sax epi	Left ventricular epicardial short axis area at the level of the papillary muscle tips at peak systole (See Figure 2-1 on page 2-28)
LVAs sax MV	Left ventricular short axis area at mitral valve level at end systole
LVAs sax PM	Left ventricular short axis area at papillary muscle level at end systole
LVET	Left ventricle ejection time
LVIDd	Left ventricular internal dimension at end diastole
LVIDs	Left ventricular internal dimension at end systole

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
LVLd apical	Left ventricular length at end diastole, apical
LVLs apical	Left ventricular length at end systole, apical
LVOT area	Left ventricular outflow tract area
LVOT diam	Left ventricular outflow tract diameter
LVPEP	Left ventricle pre-ejection period
LVPWd	Left ventricular posterior wall dimension at end diastole
LVPWs	Left ventricular posterior wall dimension at end systole
LV V1 max	Maximum velocity measured proximal to the aortic valve, with PW Doppler
LV V1 mean	Mean velocity measured proximal to the aortic valve, with PW Doppler
LV V1 trace	Velocity traced from a PW Doppler spectrum taken proximal to the aortic valve in the left ventricle
LV V1 VTI	Velocity-time integral measured proximal to the aortic valve with PW Doppler
Max vel	Maximum velocity
Max vel(TR)	Maximum velocity of tricuspid valve regurgitation
Mean PG	Mean pressure gradient
Mean vel	Mean velocity
Mitral R-R	R-R interval measured when making measurements on the mitral valve
MM R-R int	M-mode or 2D R-R interval
MM slope	MM slope
MPA diam	Main pulmonary artery diameter
MR max vel	Maximum velocity of mitral regurgitation
MV acc slope	Mitral valve acceleration slope

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
MV acc time	Time portion of the mitral valve acceleration slope
MV annu diam	Mitral valve annulus diameter View: Apical 4 ch or sub 4 ch
MV A point	Mitral valve A point velocity
MVA (traced)	Mitral valve area from a 2D trace
MV dec slope	Mitral valve deceleration slope
MV dec time	Time portion of the mitral valve deceleration slope
MV DFP	Mitral valve diastolic filling period
MV diam 1	Mitral valve orifice major diameter View: Apical 4 ch or PSAX
MV diam 2	Mitral valve orifice minor diameter View: Apical LAX (2 ch) or PLAX
MV E point	Mitral valve E point velocity
MV E-F slope	Mitral valve slope of E-F portion of Doppler spectrum
MV excursion	Mitral valve excursion
MV P$^1/_2$t max v	Mitral valve maximum velocity used for pressure half-time calculation
MV peak vel	Mitral valve overall peak velocity
MV V2 mean	Mean velocity measured distal to the mitral valve with CW Doppler
MV V2 trace	Velocity traced from a CW Doppler spectrum taken distal to the mitral valve
MV V2 VTI	Velocity-time integral measured distal to the mitral valve
PA acc slope	Pulmonary artery acceleration slope
PA acc time	Time portion of the pulmonary artery acceleration slope
PA dec slope	Pulmonary artery deceleration slope
PA dec time	Time portion of the pulmonary artery deceleration slope

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
PA V2 max	Maximum velocity measured distal to the pulmonary artery with CW Doppler
PA V2 mean	Mean velocity measured distal to the pulmonary artery with CW Doppler
PA V2 trace	Velocity traced from a CW spectrum taken distal to the pulmonary artery
PA V2 VTI	Velocity-time integral measured distal to the pulmonary artery with CW Doppler
PEP	Pre ejection period during filling of ventricle
PI end-d vel	End diastolic velocity of the pulmonic insufficiency
PI max vel	Maximum velocity of the pulmonic insufficiency
Pulm. R-R	R-R interval measured when making measurements on the pulmonary artery
Q-to-PVclose	Time from Q-wave to pulmonary valve closure
Q-to-TVopen	Time from Q-wave to tricuspid valve opening
RPA diam	Right pulmonary artery diameter View: PSAX or SSN SAX
R-R interval	R-R interval
RVAW	Right ventricular anterior wall dimension
RVDd	Right ventricular internal diameter at end diastole
RVDd major	Right ventricular diastolic major (LAX) dimension View: Sub 4 ch or apical 4 ch
RVDd minor	Right ventricular minor (SAX) dimension at end diastole
RVDs	Right ventricular systole
RVET	Right ventricle ejection time
RVOT diam	Right ventricular outflow tract diameter
RVPEP	Right ventricle pre-ejection period

Table 2-1 **Cardiac Measurements *(Continued)***

Abbreviation	Meaning
RV V1 max	Maximum velocity measured proximal to the pulmonic valve in the right ventricle
RV V1 mean	Mean velocity measured proximal to the pulmonic valve in the right ventricle
RV V1 trace	Velocity traced from a PW Doppler spectrum taken proximal to the pulmonic valve in the right ventricle.
RV V1 VTI	Velocity-time integral measured proximal to the pulmonic valve with PW Doppler in the right ventricle
Time	Time
Tricusp. R-R	R-R interval measured when making measurements on the tricuspid valve
TV acc slope	Tricuspid valve acceleration slope
TV acc time	Time portion of the tricuspid valve acceleration slope
TV annu diam	Tricuspid valve annulus diameter View: Apical 4 ch or sub 4 ch
TV dec slope	Tricuspid valve deceleration slope
TV dec time	Time portion of the tricuspid valve deceleration slope
TV DFP	Tricuspid valve diastolic filling period
TV flow diam	Tricuspid valve orifice diameter View: Apical 4 ch or sub 4 ch
TV P$^1/_2$t max v	Tricuspid valve maximum velocity used for pressure half-time calculation
TV V2 max	Maximum velocity measured distal to the tricuspid valve with CW Doppler
TV V2 mean	Mean velocity measured distal to the tricuspid valve with CW Doppler
TV V2 trace	Velocity traced from a CW Doppler spectrum taken distal to the tricuspid valve

Table 2-1 Cardiac Measurements *(Continued)*

Abbreviation	Meaning
TV V2 VTI	Velocity-time integral measured distal to the tricuspid valve with CW Doppler
V	Velocity
V1 max	Maximum velocity with PW Doppler
V1 mean	Mean velocity with PW Doppler
V1 trace	Velocity traced from a PW Doppler spectrum
V1 VTI	Velocity-time integral with PW Doppler
V2 max	Maximum velocity with CW Doppler
V2 mean	Mean velocity with CW Doppler
V2 trace	Velocity traced from a CW Doppler spectrum
V2 VTI	Velocity-time integral with CW Doppler
Vel slope	Velocity slope (Acceleration)
Volume	Volume
VSD max vel	Peak velocity of the ventricular septal defect
VTI	Velocity-time integral

Cardiac Calculations

This section lists in alphabetical order by abbreviation, the cardiac calculations, available on the Philips SONOS system. All calculation labels which display in Measurement and Results boxes on the imaging screen or on the control panel are listed. In addition to abbreviation and meaning, formulas and clinical references are given.

A: Area

The points on the circumference are assumed to be traced sufficiently close together to obtain good accuracy.

$$\left(\frac{1}{2}\right)\sum_{i=1}^{N-1} X_i(Y_i - Y_{i-1}) - Y_i(X_i - X_{i-1})$$

This calculation is a primitive, which is used to perform other calculations. Primitives are not displayed on the touch panel.

Accel slope: Acceleration Slope

Use the maximum possible display magnification for best accuracy.

$\Delta v / \Delta t$

where Δv is the change in Doppler velocity (cm/sec) and Δt is the time interval change (sec).

This calculation is a primitive, which are used to perform other calculations. Primitives are not displayed on the touch panel.

AccT1/AccT2: Acceleration Time 1 to Acceleration Time 2 Ratio

(see Misc. Ratios on page 2-35)

Ao LVETc: Left Ventricular Ejection Time, heart rate corrected

$$\frac{\text{LVET}}{\sqrt{\text{AortaR-R}}}$$

Bazett, H.C., “An Analysis of the Time Relations of the Electrocardiogram,” *Heart*, Vol. 7, pp. 353-370.

Ao LVPEPc: Left Ventricular Pre-ejection Period, heart rate corrected

$$\text{LVPEP} + 0.0004(\text{AorticHR})$$

Weissler, A.M., Harris, W.S., Schenfeld, C.D., “Systolic Time Intervals in Heart Failure in Man,” *Circulation*, 1968, Vol. 37, pp. 149-159.

Ao max PG: Aortic Flow Maximum Pressure Gradient (simplified Bernoulli)

$$4\left(\frac{\text{AoV2 max}}{100}\right)^2$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Ao max PG 2: Aortic Flow Maximum Pressure Gradient (full Bernoulli)

$$4\left(\left(\frac{\text{AoV2 max}}{100}\right)^2 - \left(\frac{\text{LVV1 max}}{100}\right)^2\right)$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Ao mean PG: Aortic Flow Mean Pressure Gradient (simplified Bernoulli)

AoV2 trace

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Ao mean PG 2: Aortic Flow Mean Pressure Gradient (full Bernoulli)

AoV2 trace – LV V1 trace

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Ao $P^1/2t$: Aortic Flow Pressure Half-time

(*see $P^1/2t$ on page 2-38)*

Ao root area: Aortic Root Area

$$\frac{\pi}{4}(\text{Ao root diam})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

Aortic HR: Aortic Heart Rate

$60/(\text{Aortic R-R})$

Dorland’s Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

Area (I,A): Valve Area (Continuity Equation)

$$(2\text{Darea})\frac{\text{V1 VTI}}{\text{V2 VTI}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

Area (I,D): Valve Area (Continuity Equation)

$$\pi\left(\frac{\text{2D diam}}{2}\right)^2\frac{\text{V1 VTI}}{\text{V2 VTI}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

Area (V,A): Valve Area (Continuity Equation)

$$(2D\ \text{area})\frac{V1\ \max}{V2\ \max}$$

Oh, J.K., “Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients,” *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., “Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation,” *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

Area (V,D): Valve Area (Continuity Equation)

$$\pi\left(\frac{2D\ \text{diam}}{2}\right)^2\frac{V1\ \max}{V2\ \max}$$

Oh, J.K., “Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients,” *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., “Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation,” *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

Area 1/Area 2: Area 1 to Area 2 Ratio

(see Misc. Ratios on page 2-35)

AVA (I,A): Aortic Valve Area (VTI, area)

$$(\text{LVOT area})\frac{\text{LVV1 VTI}}{\text{AoV2 VTI}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

AVA (I,D): Aortic Valve Area (VTI, diameter)

$$\pi\left(\frac{\text{LVOT diam}}{2}\right)^2 \frac{\text{LVV1 VTI}}{\text{AoV2 VTI}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

AVA (V,A): Aortic Valve Area (max velocity, area)

$$(\text{LVOT area})\frac{\text{LV V1 max}}{\text{Ao V2 max}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

AVA (V,D): Aortic Valve Area (max velocity, diameter)

$$\pi\left(\frac{\text{LVOT diam}}{2}\right)^2\frac{\text{LV V1 max}}{\text{Ao V2 max}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

BSA: Body Surface Area

The **BSA** calculation formulae are:

Enter height and weight on the Patient Information screen. (Press **Patient ID** in appropriate preset.)

Metric

The DuBois and DuBois body surface area, BSA (m^2), equation, given a metric weight, $\mathbf{W_{kg}}$ (range: 0.5 to 160.0 Kg), and a metric height, $\mathbf{H_{cm}}$ (range: 15.0 to 204.0 cm), is:

$$BSA = 0.007184(W_{kg}^{0.425}H_{cm}^{0.725})$$

English

The DuBois and DuBois body surface area, BSA (m^2), equation, given an "English" weight, $\mathbf{W}_{\mathbf{lbs}}$ (range: 1.1-350.0 Lbs), and an "English" height, $\mathbf{H}_{\mathbf{inches}}$ (range: 6.0-80.0 inches), is:

$$BSA = 0.007184\left(\frac{W_{Lbs}}{2.2}\right)^{0.425}(2.54H_{inches})^{0.725}$$

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

CI: Cardiac Index

CO ⁄ BSA

The Merck Manual of Diagnosis and Therapy, ed. 15, Robert Berkon, ed., Merck and Co., Rahway, NJ, 1987, p. 378.

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.

CI (Ao): Cardiac Index at the Aorta

(see CI on page 2-16)

Circ1/Circ2: Circumference 1 to Cicrcumference 2 Ratio

(see Misc. Ratios on page 2-35)

CO: Cardiac Output via 2D Method

$((EDV - ESV)/1000) \times HR$

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

CO: Cardiac Output via Doppler Method

The cardiac output, CO_x (1/min), using the Doppler velocity-time integral, VTI_x (cm), flow area, A_x (cm^2), and heart rate, HR_x (BPM), is:

$$CO_x = \frac{VTI_x \times HR_x \times A_x}{1000}$$

where:

	VTI_x	A_x	HR_x
CO(Ao)	Ao V2 VTI	Ao root area	Aortic HR
CO(LVOT)	LV VI VTI	LVOT area	Aortic HR
CO(MV)	MV V2 VTI	MV flow area	Mitral HR
CO(PV)	PA V2 VTI	MPA area	Pulm. HR
CO(TV)	TV V2 VTI	TV flow area	Tricusp. HR
CO	V2 VTI	Flow area	HR

Calafiore, P., Stewart, W.J., “Doppler Echocardiographic Quantitation of Volumetric Flow Rate,” *Cardiology Clinics*, May, 1990, Vol. 8, No. 2, pp. 191-202.

CO(Ao): Cardiac Output at the Aorta

(see CO via Doppler Method on page 2-17)

CO(LVOT): Cardiac Output at the LV Outflow Tract

(see CO via Doppler Method on page 2-17)

CO(MV): **Cardiac Output at the Mitral Valve**
(see CO via Doppler Method on page 2-17)

CO(PV): **Cardiac Output at the Pulmonary Valve**
(see CO via Doppler Method on page 2-17)

CO(TV): **Cardiac Output at the Tricuspid Valve**
(see CO via Doppler Method on page 2-17)

dA/dt: **Time Rate of Area Change**

$$\frac{\text{Blood Area(Frame}N) - \text{Blood Area(Frame(}N-1))}{\text{Time from Frame(}N-1)\text{to Frame }N}$$

Decel slope: **Deceleration Slope**

Use the maximum possible display magnification for best accuracy.

$$\Delta v / \Delta t$$

where Δv is the change in vertical dimension Doppler velocity (cm/sec) and Δt is the time interval change (sec).

This calculation is a primitive, which are used to perform other calculations. Primitives are not displayed on the touch panel.

DecT1/DecT2: **Deceleration Time 1 to Deceleration Time 2 Ratio**
(see Misc. Ratios on page 2-35)

dV/dt: **Time Rate of Volume Change**

$$\frac{\text{Blood Volume(Frame}N) - \text{Blood Volume(Frame(}N-1))}{\text{Time from Frame(}N-1)\text{to Frame }N}$$

EDV: Left Ventricular Volume at End Diastole

Cubed Formula:

$LVIDd^3$

Dodge, HT, Sandler, DW, 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.

Belenkie, Israel, et al., "Assessment of Left Ventricular Dimensions and Function by Echocardiography," *Amer J Cardiol*, June, 1973; 31.

Teichholz Formula:

$(7/(2.4 + LVIDd))(LVIDd^3)$

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

Single Plane Ellipse Formula:

$(8/(3\pi))(LVAd\ apical)^2/(LVLd\ apical)$

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.

Biplane Ellipse Formula:

$(8/(3\pi))(LV\ Ad\ sax\ MV \times LV\ Ad\ apical)/(LVIDd)$

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.

Bullet Formula:

$$(5/6)(\text{LVAd sax MV})(\text{LVLd apical})$$

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.

Modified Simpson's Formula:

$$\frac{\text{LVLd apical}}{9}\left(4(\text{LVAd sax MV}) + 2(\text{LVAd sax PM}) + \sqrt{(\text{LVAd sax MV})(\text{LVAd sax PM})}\right)$$

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.

Method of Discs, Single-Plane, Two-Chamber:

$$\frac{\pi}{4}\frac{L}{20}\sum_{i=1}^{20} a_{di}^2$$

where a_{di} is the *i*-th disc diameter of LVAd ap2 MOD and L is the length from LVAd ap2 MOD.

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.

Method of Discs, Single-Plane, Four-Chamber:

$$\frac{\pi}{4}\frac{L}{20}\sum_{i=1}^{20} b_{di}^2$$

where b_{di} is the i-th disc diameter of LVAd ap4 MOD and L is the length from LVAd ap4 MOD.

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.

Method of Discs, Biplane:

$$\frac{\pi}{4}\frac{L}{20}\sum_{i=1}^{20} a_{di} b_{di}$$

where a_{di} is the i-th disc diameter of LVAd ap2 MOD, b_{di} is the i-th disc diameter of LVAd ap4 MOD, and L is the maximum length from LVAd ap2 MOD or LVAd ap4 MOD.

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.

EF: Ejection Fraction

$(\mathrm{EDV} - \mathrm{ESV}) / \mathrm{EDV}$

Pombo, J.F., "Left Ventricular Volumes and Ejection by Echocardiography," *Circulation*, 1971, Vol. 43, pp. 480-490.

EjT 1/EjT 2: Ejection Time 1 to Ejection Time 2 Ratio

(see Misc. Ratios on page 2-35)

ESV: Left Ventricular Volume at End Systole

Cubed Formula:

$$LVIDs^3$$

Dodge, HT, Sandler, DW, 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.

Belenkie, Israel, et al., “Assessment of Left Ventricular Dimensions and Function by Echocardiography,” *Amer J Cardiol*, June, 1973; 31.

Teichholz Formula:

$$(7/(2.4 + LVIDs))(LVIDs^3)$$

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

Single Plane Ellipse Formula:

$$(8/(3\pi))(LVAs\ apical)^2/(LVLs\ apical)$$

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.

Biplane Ellipse Formula:

$$(8/(3\pi))(LVAs\ apical \times LVAs\ sax\ MV)/(LVIDs)$$

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.

Bullet Formula:

$$(5/6)(\text{LVAs sax MV})(\text{LVLs apical})$$

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.

Modified Simpson's Formula:

$$\frac{\text{LVLs apical}}{9}\left(4(\text{LVAs sax MV}) + 2(\text{LVAs sax PM}) + \sqrt{(\text{LVAs sax MV})(\text{LVAs sax PM})}\right)$$

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.

Method of Discs, Single-Plane, Two-Chamber:

$$\frac{\pi}{4}\sum_{i=1}^{20} a_{si}^2 \frac{L}{20}$$

where a_{si} is the i-th disc diameter of LVAs ap2 MOD and L is the length from LVAs ap2 MOD.

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.

Method of Discs, Single-Plane, Four-Chamber:

$$\frac{\pi}{4}\sum_{i=1}^{20} b_{si}^2 \frac{L}{20}$$

where b_{si} is the *i*-th disc diameter of LVAs ap4 MOD and L is the length from LVAs ap4 MOD.

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.

Method of Discs, Biplane:

$$\frac{\pi}{4}\sum_{i=1}^{20} a_{si} b_{si} \frac{L}{20}$$

where a_{si} is the *i*-th disc diameter of LVAs ap2 MOD, b_{si} is the *i*-th disc diameter of LVAs ap4 MOD, and L is the maximum length from LVAs ap2 MOD or LVAs ap4 MOD.

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.

FAC: Fractional Area Change

$$\left(\frac{\text{EndDiasArea} - \text{EndSysArea}}{\text{EndDiasArea}}\right) \times 100$$

where EndDiasArea is the maximum area for the R-R interval and EndSysArea is the minimum area for the R-R interval.

Flow Area: Flow Area from Diameter

$$A_x = \frac{\pi}{4}(\text{2-D diam})^2$$

FS: Fractional Shortening

$$100\frac{\text{LVIDd} - \text{LVIDs}}{\text{LVIDd}}$$

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

HR: Heart Rate

The equation for heart rate (BPM) given an R-R interval is:

$$60 / \text{R-R interval}$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

IVS/LVPW: Septum to LV Posterior Wall Ratio at End Diastole

$$\text{IVSd} / \text{LVPWd}$$

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.

L: Length

For best accuracy, use maximum permissible display magnification when making small length measurements.

$$\sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2}$$

where (X_1,Y_1) and (X_2,Y_2) are the end point coordinates of the line segment.

This calculation is a primitive, which are used to perform other calculations. Primitives are not displayed on the touch panel.

LA/AO: Left Atrium to Aortic Root Ratio

$$\frac{\text{LA dimension}}{\text{Ao root diam}}$$

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.

LAPs(MRmaxV): Left Atrial Systolic Pressure via maximum velocity of mitral regurgitation

$$\text{BP peak sys} - 4\left(\frac{\text{MR max vel}}{100}\right)^2$$

where MR max vel is the peak velocity of the mitral regurgitant jet, and BP peak sys is the systemic arterial peak-systolic pressure (manually entered).

Nishimura, R.A., Tajik, A.J., “Determination of Left-Sided Pressure Gradients by Utilizing Doppler Aortic and Mitral Regurgitant Signals: Validation by Simultaneous Dual Catheter and Doppler Studies,” *J Amer Coll Cardiol*, February, 1988, Vol. 11, No. 2, pp. 317-321.

Snider, A.R., Serwer, G.A., *Echocardiography in Pediatric Heart Disease*, Year Book Medical Publishers, Inc., Littleton, MA, 1990, p. 108.

Len 1/Len 2: Length 1 to Length 2 Ratio

(see Misc. Ratios on page 2-35)

LVLd % diff: **MOD long axis (at end diastole) length percentage difference between apical 4 and apical 2 views**

$$100\left(\frac{\max(\text{LVAd ap2 MOD, LVAd ap4 MOD}) - \min(\text{LVAd ap2 MOD, LVAd ap4 MOD})}{\max(\text{LVAd ap2 MOD, LVAd ap4 MOD})}\right)$$

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, pp. 358-367.

LVLs % diff: **MOD long-axis (at end systole) length percentage difference between apical 4 and apical 2 views**

$$100\left(\frac{\max(\text{LVAs ap2 MOD, LVAs ap4 MOD}) - \min(\text{LVAs ap2 MOD, LVAs ap4 MOD})}{\max(\text{LVAs ap2 MOD, LVAs ap4 MOD})}\right)$$

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, pp. 358-367.

LVmass(AL)d: **Left ventricular mass at end diastole**

$$1.05\left(\frac{5}{6}(A_1(L + t)) - \frac{5}{6}A_2 L\right)$$

where A_1 represents LVAd sax epi, the LV epicardial SAX area at the level of the papillary muscle tips at end diastole, A_2 represents LVAd sax PM, the LV endocardial SAX cavity area at the level of the papillary muscle tips at end diastole, L represents LVLd apical, the LV long-axis length at end diastole (via apical four-chamber or two-chamber views), and t is a representative myocardial wall thickness, with the formula:

$$\sqrt{\frac{A_1}{\pi}} - \sqrt{\frac{A_2}{\pi}}$$

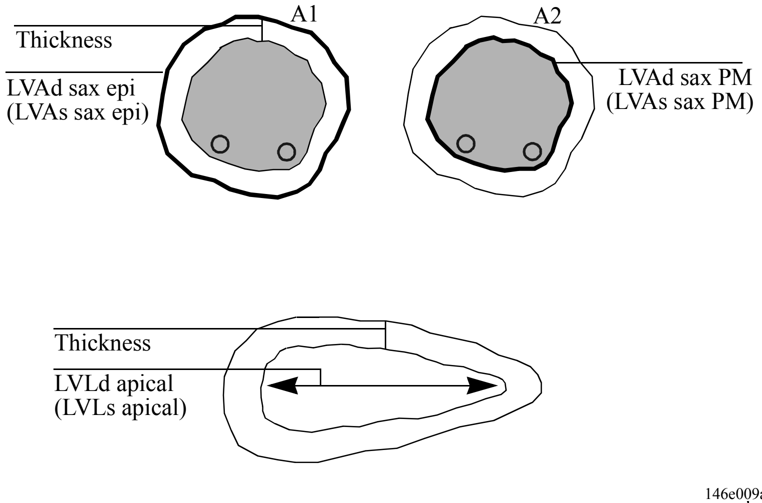


Figure 2-1 Cardiac Measurements: LVAd/LVAs sax epi, LVAd/LVAs sax PM, and LVLd/LVLs apical

Reichek, N., et al., “Anatomic Validation of Left Ventricular Mass Estimates from Clinical Two-Dimensional Echocardiography: Initial Results,” *Circulation*, February, 1983, Vol. 67, No. 2, pp. 348-352.

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, pp. 358-367.

Wyatt, H.L., Heng, K., Weerbaum, S., et al., “Cross-sectional Echocardiography - Analysis of Models for Quantifying Mass in the Left Ventricle in Dogs,” *Circulation*, 1979, Vol. 60, pp. 1104-1113.

LVmass(AL)dI: Left ventricular mass at end diastole, indexed by body surface area

$$\frac{\text{LVmass(AL)d}}{\text{BSA}}$$

LVmass(AL)s: Left ventricular mass at peak systole

$$1.05\left(\frac{5}{6}(A_1(L + t)) - \frac{5}{6}A_2L\right)$$

where A_1 represents LVAs sax epi, the LV epicardial SAX area at the level of the papillary muscle tips at peak systole, A_2 represents LVAs sax PM, the LV endocardial SAX cavity area at the level of the papillary muscle tips at peak systole, L represents LVLs apical, the LV long-axis length at peak systole (via apical four-chamber or two-chamber views), and t is a representative myocardial wall thickness, with the formula:

$$\sqrt{\frac{A_1}{\pi}} - \sqrt{\frac{A_2}{\pi}}$$

Reichek, N., et al., “Anatomic Validation of Left Ventricular Mass Estimates from Clinical Two-Dimensional Echocardiography: Initial Results,” *Circulation*, February, 1983, Vol. 67, No. 2, pp. 348-352.

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, pp. 358-367.

Wyatt, H.L., Heng, K., Weerbaum, S., et al., “Cross-sectional Echocardiography - Analysis of Models for Quantifying Mass in the Left Ventricle in Dogs,” *Circulation*, 1979, Vol. 60, pp. 1104-1113.

LVmass(AL)sI: Left ventricular mass at peak systole, indexed by body surface area

$$\frac{\text{LVmass(AL)s}}{\text{BSA}}$$

LVmass(C)d: Left ventricular mass via the cubic equation at end diastole

$$0.8(1.04)((IVS_d + LVID_d + LVPW_d)^3 - LVID_d^3) + 0.6$$

Devereux, R.B., et al., "Echocardiographic Assessment of Left Ventricular Hypertrophy: Comparison to Necropsy Findings," *American Journal of Cardiology*, 1986, Vol. 57, pp. 450-458.

Sahn, D., DeMaria, A., Kisslo, J., Weyman, A., The Committee on M-mode Standardization of the American Society of Echocardiography, "Recommendations Regarding Quantitation in M-Mode Echocardiography: Results of a Survey of Echocardiographic Measurements," *Circulation*, 1978, Vol. 58, No. 6, pp. 1072-1083.

LVmass(C)dI: Left ventricular mass via the cubic equation at end diastole, indexed by body surface area

$$\frac{LVmass(C)d}{BSA}$$

LVmass(C)s: Left ventricular mass via the cubic equation at peak systole

$$0.8(1.04)((IVSs + LVIDs + LVPWs)^3 - LVIDs^3) + 0.6$$

Devereux, R.B., et al., "Echocardiographic Assessment of Left Ventricular Hypertrophy: Comparison to Necropsy Findings," *American Journal of Cardiology*, 1986, Vol. 57, pp. 450-458.

Sahn, D., DeMaria, A., Kisslo, J., Weyman, A., The Committee on M-mode Standardization of the American Society of Echocardiography, "Recommendations Regarding Quantitation in M-Mode Echocardiography: Results of a Survey of Echocardiographic Measurements," *Circulation*, 1978, Vol. 58, No. 6, pp. 1072-1083.

LVmass(C)sI: Left ventricular mass via the cubic equation at peak systole, indexed by body surface area

$$\frac{\text{LVmass(C)s}}{\text{BSA}}$$

LVOT area: Left ventricular outflow tract area

$$\frac{\pi}{4}(\text{LVOT diam})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

LVPd(AIedV): Left ventricular pressure via aortic insufficiency end-diastolic velocity

$$\text{BPdiastolic} - 4\left(\frac{\text{AI end-d vel}}{100}\right)^2$$

where AI end-d vel is the peak velocity of the aortic regurgitant jet at end diastole and BP diastolic is the cuff diastolic pressure.

Nishimura, R.A., Tajik, A.J., "Determination of Left-Sided Pressure Gradients by Utilizing Doppler Aortic and Mitral Regurgitant Signals: Validation by Simultaneous Dual Catheter and Doppler Studies," *J Amer Coll Cardiol*, February, 1988, Vol. 11, No. 2, pp. 317-321.

Snider, A.R., Serwer, G.A., *Echocardiography in Pediatric Heart Disease*, Year Book Medical Publishers, Inc., Littleton, MA, 1990, p. 106.

LVPs(ASmaxV): Left ventricular systolic pressure via maximum velocity of aortic stenosis

$$4\left(\frac{\text{AS max vel}}{100}\right)^2 + \text{BP peak sys}$$

where AS max vel is the peak velocity of the aortic stenosis jet, and BP peak sys is the systemic arterial peak-systolic pressure (manually entered).

Nishimura, R.A., Tajik, A.J., "Determination of Left-Sided Pressure Gradients by Utilizing Doppler Aortic and Mitral Regurgitant Signals: Validation by Simultaneous Dual Catheter and Doppler Studies," *J Amer Coll Cardiol*, February, 1988, Vol. 11, No. 2, pp. 317-321.

Snider, A.R., Serwer, G.A., *Echocardiography in Pediatric Heart Disease*, Year Book Medical Publishers, Inc., Littleton, MA, 1990, p. 106.

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.

Max PG: Maximum Pressure Gradient (Short Form)

$$4\left(\frac{V_2\text{max}}{100}\right)^2$$

where V_2 is the maximum distal velocity (in cm/sec).

The short form is clinically applicable in the case of stenosis where $V_2 > 4V_1$.

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Max PG 2: Maximum Pressure Gradient (Long Form)

$$4\left(\left(\frac{V_2 max}{100}\right)^2 - \left(\frac{V_1 max}{100}\right)^2\right)$$

where V_2 is the maximum distal velocity (in cm/sec) and V_1 is the maximum proximal velocity (in cm/sec).

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Max PG(AI): Maximum Pressure Gradient of the aortic insufficiency

$$4\left(\frac{AI\,max\,vel}{100}\right)^2$$

Callahan, Mark J., et al., "Validation of Instantaneous Pressure Gradients Measured by Continuous-Wave Doppler in Experimentally Induced Aortic Stenosis," *American Journal of Cardiology*, 1985, Vol. 56, pp. 989-993.

Max PG(Dec): Maximum Pressure Gradient via deceleration slope

$$4\left(\frac{Dec.\,max\,vel}{100}\right)^2$$

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Max PG(MR): Maximum Pressure Gradient of the mitral regurgitation

$$4\left(\frac{MR\,max\,vel}{100}\right)^2$$

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.

Max PG(PI): Maximum Pressure Gradient of the pulmonary insufficiency

$$4\left(\frac{\text{PI max vel}}{100}\right)^2$$

Masuyama, T. et al., "Continuous-wave Doppler Echocardiographic Detection of Pulmonary Regurgitation and Its Application to Noninvasive Estimation of Pulmonary Artery Pressure," *Circulation*, 1986, Vol. 74, No. 3, pp. 484-492.

Max PG(TR): Maximum Pressure Gradient of the tricuspid regurgitation

$$4\left(\frac{\text{Max vel(TR)}}{100}\right)^2$$

Stevenson, J.G., "Comparison of Several Noninvasive Methods for Estimation of Pulmonary Artery Pressure," *J Am Soc Echo*, June 1989, Vol. 2, pp. 157-171.

Max V1/V2: Maximum Velocity 1 to Maximum Velocity 2 Ratio

(see Misc. Ratios on page 2-35)

Mean PG: Mean Pressure Gradient (Short Form)

$$PG = \text{V2 trace}$$

The short form is clinically applicable in the case of stenosis where $V_2 > 4V_1$.

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Mean PG1/PG2: Mean Pressure Gradient 1 to Mean Pressure Gradient 2 Ratio

(see Misc. Ratios on page 2-35)

Mean PG 2: Mean Pressure Gradient (Long Form)

$$PG = \text{V2 trace} - \text{V1 trace}$$

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

Mean V1/V2: **Mean Velocity 1 to Mean Velocity 2 Ratio**
(see Misc. Ratios on page 2-35.)

Misc. Ratios: **Generic Ratio Formula**

Several ratios in the Cardiac package use the following generic formula:

$$\text{measurement \#1} / \text{measurement \#2}$$

Mitral HR: **Mitral Valve Heart Rate**

$$60 / (\text{Mitral R-R})$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

MM HR: **M-mode or 2D Heart Rate**

$$60 / (\text{MM R-R int})$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

MM LVETc: **M-mode or 2D Left Ventricular Ejection Time, heart rate corrected**

$$\frac{\text{LVET}}{\sqrt{\text{MM R-R int}}}$$

Bazett, HC, "An Analysis of the Time Relations of the Echocardiogram," *Heart*, Vol. 7, pp. 353-370.

MM LVPEPc: **M-mode or 2D Left Ventricular Pre-ejection Period, heart rate corrected**

$$\text{LVPEP} + 0.0004(\text{MM HR})$$

Weissler, A.M., Harris, W.S., Schenfeld, C.D., "Systolic Time Intervals in Heart Failure in Man," *Circulation*, Vol. 37, 1968, pp. 149-159.

MM RVPEPc: M-mode or 2D Right Ventricular Pre-ejection Period, heart rate corrected

RVPEP + 0.00037(MM HR)

Riggs, T., Hirschfeld, S., Borkat, G., et al., "Assessment of the Pulmonary Vascular Bed by Echocardiographic Right Ventricular Systolic Time Intervals," *Circulation*, 1978, Vol. 57, pp. 939-947.

MM Slp1/Slp2: M-mode Slope 1 to M-mode Slope 2 Ratio

(see Misc. Ratios on page 2-35)

MPA area: Main Pulmonary Artery Area

$$\frac{\pi}{4}(\text{MPA diameter})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

MVA (2 diam): Mitral Valve Area via two diameters

$$\frac{\pi}{4}(\text{MV diam 1})(\text{MV diam 2})$$

Hagen-Ansert, Sandra L., *Textbook of Diagnostic Ultrasound*, ed. 3, The C.V. Mosby Co., 1989, p. 73.

MV annu area: Mitral Valve Annulus Area

$$\frac{\pi}{4}(\text{MV annu diam})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

MVA ($P^1/_2t$): Mitral Valve Area

Use points as far apart as possible on the deceleration slope.

$$\frac{220}{MVP\frac{1}{2}t}$$

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.

MV E/A: Mitral Valve E-to-A Ratio

$$\frac{\text{MV E point}}{\text{MV } A \text{ point}}$$

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 flow area: Mitral Valve Flow Area

One of the following three formulas, in order of precedence:

1. $\left(\frac{\pi}{4}\right)(\text{MVdiam1})(\text{MVdiam2})$

2. MVA(traced)

3. $\left(\frac{\pi}{4}\right)(\text{MVdiam1})^2$

Hagen-Ansert, Sandra L., *Textbook of Diagnostic Ultrasound*, ed. 3, The C.V. Mosby Co., 1989, p. 73.

MV max PG: Mitral Valve Maximum Pressure Gradient

$$4\left(\frac{\text{MV peak vel}}{100}\right)^2$$

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

MV mean PG: Mitral Valve Mean Pressure Gradient

MVV2trace

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

MV $P^1/_2t$: Mitral Valve Pressure Half-time

(see $P^1/_2t$ on page 2-38)

$P^1/_2t$: Pressure Half-time

$$1000\left(\frac{\text{max vel}\left(1-\frac{1}{\sqrt{2}}\right)}{\text{Decel slope}}\right)$$

For best accuracy, position the crosshair along the deceleration slope as far away as possible from the peak velocity point.

where max vel is the peak velocity on the spectrum and Decel slope is the slope of the spectrum as it declines from one of the max velocities listed below:

Pressure Half-time	Max vel	Decel slope	Flow
Ao $P^1/_2t$	AI max vel	Ao dec slope	aortic flow
MV $P^1/_2t$	MV $P^1/_2t$ max v	MV dec slope	mitral flow
PA $P^1/_2t$	PI max vel	PA dec slope	pulmonic flow
TV $P^1/_2t$	TV $P^1/_2t$ max v	TV dec slope	tricuspid flow
$P^1/_2t$	Dec max vel	Decel slope	other flow

Hatle, L. et al., "Non-invasive Assessment of Atrioventricular Pressure Halftime by Doppler Ultrasound," *Circulation*, Vol. 60, 1979, pp. 1096-1104.

PA max PG: Pulmonic Valve Maximum Pressure Gradient (simplified Bernoulli)

$$4\left(\frac{\text{PA V2 max}}{100}\right)^2$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

PA max PG 2: Pulmonic Valve Maximum Pressure Gradient (full Bernoulli)

$$4\left(\left(\frac{\text{PA V2 max}}{100}\right)^2 - \left(\frac{\text{RV V1 max}}{100}\right)^2\right)$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

PA mean PG: Pulmonic Valve Mean Pressure Gradient (simplified Bernoulli)

$$\text{PA V2 trace}$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

PA mean PG 2: Pulmonic Valve Mean Pressure Gradient (full Bernoulli)

$$\text{PA V2 trace} - \text{RV V1 trace}$$

Yoganathan, Ajit P., et al., “Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques,” *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

PA $P^1/_2t$: **Pulmonic Valve Pressure Half-time**
(see $P^1/_2t$ on page 2-38)

PAPd(PI edV): **Pulmonary artery pressure via the pulmonary valve insufficiency end-diastolic velocity**

$$4\left(\frac{V_{PI}}{100}\right)^2 + P_{RA}$$

where V_{PI} represents PI end-d vel, the velocity of the pulmonic insufficiency at end diastole, and P_{RA} represents RAP diastole, the right atrial end-diastolic pressure (manually entered).

Masuyama, T. et al., “Continuous-wave Doppler Echocardiographic Detection of Pulmonary Regurgitation and Its Application to Noninvasive Estimation of Pulmonary Artery Pressure,” *Circulation*, 1986, Vol. 74, No. 3, pp. 484-492.

Stevenson, J.G., “Comparison of Several Noninvasive Methods for Estimation of Pulmonary Artery Pressure,” *J Am Soc Echo*, June 1989, Vol. 2, pp. 157-171.

PA pr (Accel): **Pulmonary Artery Pressure via acceleration time**

$$79 - 0.45 \times \text{Accel time} \times 1000$$

where Accel time is in seconds.

Chan, Kwan-Leung, et al., “Comparison of Three Doppler Ultrasound Methods in the Prediction of Pulmonary Artery Pressure,” *Journal of American College of Cardiology*, Vol. 9, No. 3, March, 1987, pp. 549-554.

Stevenson, J.G., “Comparison of Several Noninvasive Methods for Estimation of Pulmonary Artery Pressure,” *J Am Soc Echo*, June, 1989, Vol. 2, pp. 157-171.

PER: Peak Ejection Rate

Area: $\frac{\left(\frac{dA}{dt}\right)_{min}}{\text{End Dias A}}$

where End DiasA is the maximum area for the R-R interval.

The division of dA/dt by End Dias A makes this a normalized rate.

Volume: $\frac{\left(\frac{dV}{dt}\right)_{min}}{\text{End Dias V}}$

where End DiasV is the maximum volume for the R-R interval.

The division of dV/dt by End Dias V makes this a normalized rate.

PFR: Peak Filling Rate

Area: $\frac{\left(\frac{dA}{dt}\right)_{max}}{\text{End Dias A}}$

where End Dias A is the maximum area for the R-R interval.

The division of dA/dt by End Dias A makes this a normalized rate.

Volume: $\frac{\left(\frac{dV}{dt}\right)_{max}}{\text{End Dias V}}$

where End Dias V is the maximum volume for the R-R interval.

The division of dV/dt by End Dias V makes this a normalized rate.

PI: Pulsatility Index

The pulsatility index, **PI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), a minimum velocity, $\mathbf{v}_{min}$ (cm/s), and a mean velocity, $\mathbf{v}_{mean}$ (cm/s), is:

$$PI = \frac{Vmax - Vmin}{Vmean}$$

Burns, Peter N., "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, Nov./Dec., 1987, Vol. 15, No. 9, p. 585.

Pulm. HR: Pulmonary Valve Heart Rate

$$60 / (Pulm. R\text{-}R)$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

PVA (I,A): Pulmonary Valve Area (VTI, area)

$$(RVOT\ area)\frac{RV\ V1\ VTI}{PA\ V2\ VTI}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

PVA (I,D): Pulmonary Valve Area (VTI, diameter)

$$\pi\left(\frac{\text{RVOT diam}}{2}\right)^2\frac{\text{RVV1 VTI}}{\text{PAV2 VTI}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

PVA (V,A): Pulmonary Valve Area (velocity, area)

$$(\text{RVOT area})\frac{\text{RV V1 max}}{\text{PA V2 max}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

PVA (V,D): Pulmonary Valve Area (VTI, diameter)

$$\pi\left(\frac{\text{RVOT diam}}{2}\right)^2\frac{\text{RV V1 max}}{\text{PA V2 max}}$$

Oh, J.K., "Prediction of the Severity of Aortic Stenosis by Doppler Aortic Valve Area Determination: Prospective Doppler-Catheterization Correlation in 100 Patients," *Journal of the American College of Cardiology*, Vol. 11, No. 6, June, 1988, pp. 1227-1234.

Richards, K.L., et al., "Calculation of Aortic Valve Area by Doppler Echocardiography: A Direct Application of the Continuity Equation," *Circulation*, Vol. 73, No. 5, May, 1986, pp. 964-969.

PV RVPEPc: Pulmonary Valve Right Ventricular Pre-ejection Period, heart rate corrected

$$RVPEP + 0.00037(Pulm.HR)$$

Riggs, T., Hirschfeld, S., Borkat, G., et al., “Assessment of the Pulmonary Vascular Bed by Echocardiographic Right Ventricular Systolic Time Intervals,” *Circulation*, 1978, Vol. 57, pp. 939-947.

Q_p/Q_sI,Ao: Ratio of pulmonic flow to systemic flow using CO(Ao)

$$\frac{CO(PV)}{CO(Ao)}$$

Silverman, N.H., Schmidt, K.G., “The Current Role of Doppler Echocardiography in the Diagnosis of Heart Disease in Children,” *Cardiology Clinics*, May, 1989, Vol. 7, No. 2, pp. 265-296.

Q_p/Q_sI,LVOT: Ratio of pulmonic flow to systemic flow using CO(PV) and CO(LVOT)

$$\frac{CO(PV)}{CO(LVOT)}$$

Silverman, N.H., Schmidt, K.G., “The Current Role of Doppler Echocardiography in the Diagnosis of Heart Disease in Children,” *Cardiology Clinics*, May 1989, Vol. 7, No. 2, pp. 265-296.

Q_p/Q_sV,Ao: **Ratio of pulmonic flow to systemic flow via Simplified Doppler Echocardiographic method**

$$\left(\frac{D_{PA}}{D_{Ao}}\right)^2\left(\frac{V_{PA}}{V_{Ao}}\right)$$

where D_{PA} represents MPA diam, the diameter of the effective flow area of the main pulmonary artery, D_{Ao} represents Ao root diam, the V2 diameter of the effective flow area of the aortic valve, V_{PA} represents PA V2 max, the V2 maximum velocity of the pulmonary flow, and V_{Ao} represents Ao V2 max, the V2 maximum velocity of the aortic flow.

Cloez J.L., Schmidt, K.G., Birk, E., Silverman, N.H., "Determination of Pulmonary to Systemic Blood Flow Ratio in Children By a Simplified Doppler Echocardiographic Method," *J Amer Coll Cardiol*, April, 1988, Vol. 11, No. 4, pp. 825-830.

Q_p/Q_sV,LVOT: **Ratio of pulmonic flow to systemic flow via Simplified Doppler Echocardiographic method, using LVOT**

$$\left(\frac{D_{PA}}{D_{LVOT}}\right)^2\left(\frac{V_{PA}}{V_{LVOT}}\right)$$

where D_{PA} represents MPA diam, the diameter of the effective flow area of the main pulmonary artery, D_{LVOT} represents LVOT diam, the V1 diameter of the effective flow area of the LVOT, V_{PA} represents PA V2 max, the V2 maximum velocity of the pulmonary flow, and V_{LVOT} represents LV V1 max, the V1 maximum velocity of the LVOT.

Cloez J.L., Schmidt, K.G., Birk, E., Silverman, N.H., "Determination of Pulmonary to Systemic Blood Flow Ratio in Children By a Simplified Doppler Echocardiographic Method," *J Amer Coll Cardiol*, April, 1988, Vol. 11, No. 4, pp. 825-830.

RF(Ao,PV): Fraction of aortic regurgitant flow, relative to pulmonic outflow

$$\frac{SV(Ao) - SV(PV)}{SV(Ao)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RF(LVOT,PV): Fraction of aortic valve regurgitant flow, relative to pulmonic outflow, using LVOT

$$\frac{SV(LVOT) - SV(PV)}{SV(LVOT)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RF(MV,Ao): Fraction of mitral regurgitant flow, relative to aortic outflow

$$\frac{SV(MV) - SV(Ao)}{SV(MV)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RF(MV,LVOT): LVOT Fraction of mitral regurgitant flow, relative to aortic inflow, using

$$\frac{SV(MV) - SV(LVOT)}{SV(MV)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RF(PV,Ao): Fraction of pulmonic regurgitant flow, relative to aortic outflow

$$\frac{SV(PV) - SV(Ao)}{SV(PV)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RF(PV,LVOT): Fraction of pulmonic regurgitant flow, relative to aortic inflow, using LVOT

$$\frac{SV(PV) - SV(LVOT)}{SV(PV)}$$

Kitabatake, Akira, et al., "A New Approach to Non-invasive Evaluation of Aortic Regurgitant Fraction by Two-dimensional Doppler Echocardiography," *Circulation*, 1985, Vol. 72, No. 3, pp. 523-529.

RVOT area: Right ventricular outflow tract area

$$\frac{\pi}{4}(\text{RVOT diam})^2$$

RVPs(VSD): max velocity — Right ventricular pressure at systole via ventricular septal defect

$$\text{BP peak sys} - 4\left(\frac{\text{VSD max vel}}{100}\right)^2$$

where VSD max vel is the peak velocity of the ventricular septal defect jet, and BP peak sys is the systemic arterial peak-systolic pressure (manually entered).

Murphy, D.J., Ludomirsky, A., Huhta, J.C., "Continuous-Wave Doppler in Children with Ventricular Septal Defect: Noninvasive Estimation of Interventricular Pressure Gradient," *Amer J Cardiol*, February 15, 1986, Vol. 57, pp. 428-432.

Snider, A.R., Serwer, G.A., *Echocardiography in Pediatric Heart Disease*, Year Book Medical Publishers, Inc., Littleton, MA, 1990, p. 103.

RV sys press: **Right ventricular systolic pressure via tricuspid regurgitation**

$\text{Max PG(TR)} + \text{RA press}$

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.

SI: **Stroke Index**

SV / BSA

Gorge, G., et al., "High Resolution Two-dimensional Echocardiography Improves Quantification of Left Ventricular Function," *J Am Soc Echo*, 1992, Vol. 5, pp. 125-134.

SI(Ao): **Stroke Index at the Aorta**
(see SI on page 2-48)

SI(LVOT): **Stroke Index at the LV Outflow Tract**
(see SI on page 2-48)

STI: **Systolic Time Interval**

$$\frac{\text{PEP}}{\text{Eject Time}}$$

Boudoulas, Harisios, et al., "Assessment of Ventricular Function by Combined Noninvasive Measures: Factors Accounting for Methodologic Disparities," *International Journal of Cardiology*, 1983, Vol. 2, pp. 493-501.

STI (left): **Systolic Time (left) Interval**

$\text{LVPEP} / \text{LVET}$

Boudoulas, Harisios, et al., "Assessment of Ventricular Function by Combined Noninvasive Measures: Factors Accounting for Methodologic Disparities," *International Journal of Cardiology*, 1983, Vol. 2, pp. 493-501.

STI (right): **Systolic Time (right) Interval**

RVPEP/RVET

Boudoulas, Harisios, et al., "Assessment of Ventricular Function by Combined Noninvasive Measures: Factors Accounting for Methodologic Disparities," *International Journal of Cardiology*, 1983, Vol. 2, pp. 493-501.

SV: **Stroke Volume**

$$SV_x = VTI_x A_x$$

where the stroke volume SV_x (ml), using Doppler flow give a velocity-time integral, VTI_x (cm), and the flow area, A_x (cm^2), is:

SV_x	VTI_x	A_x
SV	V2 VTI	Flow area
SV(Ao)	Ao V2 VTI	Ao root area
SV(LVOT)	LV V1 VTI	LVOT area
SV(MV)	MV V2 VTI	MV flow area
SV(PV)	PA V2 VTI	MPA area
SV(TV)	TV V2 VTI	TV flow area

Hatle, Liv, Angelsen, Bjorn., *Doppler Ultrasound in Cardiology: Physical Principles and Clinical Applications*, ed. 2, Lea and Febiger, Philadelphia, Pennsylvania, 1985, p. 306.

SV(Ao): **Stroke Volume at the Aorta**
(see SV on page 2-49)

SV(LVOT): **Stroke Volume at the LV Outflow Tract**
(see SV on page 2-49)

Time1/Time2: **Time 1 to Time 2 Ratio**
(see Misc. Ratios on page 2-35)

TPFR: Time to Peak Filling Rate

Area:

$$T_{\mathbf{Max\,dA/dt}} - T_{\mathbf{EndSys}}$$

where T_{EndSys} is the moment during the R-R interval at which the minimum area is observed.

Volume:

$$T_{\mathbf{Max\,dV/dt}} - T_{\mathbf{EndSys}}$$

where T_{EndSys} is the moment during the R-R interval at which the minimum volume is observed.

Tricusp. HR: Heart Rate

$$60 / \text{Tricusp.R-R}$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

TV annu area: Tricuspid Valve Annulus Area

$$\frac{\pi}{4}(\text{TV annu diam})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

TV flow area: Tricuspid Valve Flow Area

$$\frac{\pi}{4}(\text{TV flow diam})^2$$

Goldberg, Barry B., Kurtz, Alfred B., *Atlas of Ultrasound Measurements*, Year Book Medical Publishers, Inc., 1990, p. 78.

TV max PG: Tricuspid Valve Maximum Pressure Gradient

$$4\left(\frac{TVV2\,max}{100}\right)^2$$

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

TV mean PG: Tricuspid Valve Mean Pressure Gradient

TVV2 trace

Yoganathan, Ajit P., et al., "Review of Hydrodynamic Principles for the Cardiologist: Applications to the Study of Blood Flow and Jets by Imaging Techniques," *J Am Coll Cardiol*, 1988, Vol. 12, pp. 1344-1353.

TV $P^1/_2t$: Tricuspid Valve Pressure Half-time

(see $P^1/_2t$ on page 2-38)

Vcf mean: Mean Velocity of Circumferential Fiber Shortening

$$\frac{LVIDd - LVIDs}{(LVIDd)(MM\,LVET)}$$

Colan, S.D., Borow, K.M., Neumann, A., "Left Ventricular End-Systolic Wall Stress-Velocity of Fiber Shortening Relation: A Load-Independent Index of Myocardial Contractility," *J Amer Coll Cardiol*, October, 1984, Vol. 4, No. 4, pp. 715-724.

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

Vcfc mean: **Mean Velocity of Circumferential Fiber Shortening, heart-rate corrected**

$$\frac{\text{LVIDd} - \text{LVIDs}}{(\text{LVIDd})(\text{LVETc})}$$

Colan, S.D., Borow, K.M., Neumann, A., “Left Ventricular End-Systolic Wall Stress-Velocity of Fiber Shortening Relation: A Load-Independent Index of Myocardial Contractility,” *J Amer Coll Cardiol*, October, 1984, Vol. 4, No. 4, pp. 715-724.

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

Vol1/Vol2 AL: **Volume 1 to Volume 2 Ratio**
(*see Misc. Ratios on page 2-35)*

Vslp1/Vslp2: **Velocity Slope 1 to Velocity Slope 2 Ratio**
(*see Misc. Ratios on page 2-35)*

VTI 1/VTI 2: **Velocity Time Integral 1 to Velocity Time Integral 2 Ratio**
(*see Misc. Ratios on page 2-35)*

WS(merid.): **End Systolic Left Ventricular Meridional Wall Stress**

$$0.334\left(\frac{\text{BP end sys}}{\text{LVPWs}}\right)\left(\frac{\text{LVIDs}}{1 + \frac{\text{LVPWs}}{\text{LVIDs}}}\right)$$

Colan, S.D., Borow, K.M., Neumann, A., “Left Ventricular End-Systolic Wall Stress-Velocity of Fiber Shortening Relation: A Load-Independent Index of Myocardial Contractility,” *J Amer Coll Cardiol*, October, 1984, Vol. 4, No. 4, pp. 715-724.

Grossman, W., Jones, D., McLaurin, L.P., “Wall Stress and Patterns of Hypertrophy in the Human Left Ventricle,” *J Clin Invest*, 1975, Vol. 56, pp. 56-64.

Reichek, N., et al., “Non-Invasive Determination of Left Ventricular End-Systolic Stress: Validation of the Method and Initial Application,” *Circulation*, January, 1982, Vol. 65, No. 1, pp. 99-108.

%IVS thick: Percent of Interventricular Septum Thickening

Roelandt, Joseph, *Practical Echocardiology*, Ultrasound in Medicine Series, Vol. 1, Denis White, ed., Research Studies Press, 1977, p. 130.

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.

%LVPW thick: Percent of Left Ventricular Posterior Wall Thickening

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

Roelandt, Joseph, *Practical Echocardiology*, Ultrasound in Medicine Series, Vol. 1, Denis White, ed., Research Studies Press, 1977, p. 129.

3

Gynecological and Obstetrical Measurements and Calculations

Contains the definitions for the Gynecological and Obstetrical measurements and calculations available on your Philips SONOS ultrasound system.

Gynecological and Obstetrical Measurements

The following table shows all Gynecological and Obstetrical measurements available on the Philips SONOS ultrasound system. You may not see all of these on your system, depending on the options purchased. These abbreviations appear on the left touch panel and in measurement boxes displayed on the screen during measurement and analysis operations.

Note that some measurements have **L**, **R**, or **M**/**Mn** (for Left, Right, or Middle/Main) before the acronym. You will not see these characters on the system touch panel; identification of a measurement as **L, R**, or **M/Mn** means that the **Left**, **Right**, or **Mid/Main** control is active at the time the measurement is accessed.

Table 3-1 **Gynecological and Obstetrical Measurements**

Abbreviation	Meaning
2 beats Pk-to-Pk	Peak-to-Peak time interval over two beats
AC traced	Traced Abdominal Circumference
ADap	Anterior-Posterior Abdominal Diameter
ADtrv	Transverse Abdominal Diameter
Ao root diam	Aortic Root Diameter
BD	Binocular Distance
BPD	Biparietal Diameter
CD	Cerebellar Diameter
CRL	Crown Rump Length
CxH	Cervical Height
CxL	Cervical Length
CxW	Cervical Width
Desc. Aorta	Descending Aorta
DescAo accel T	Descending Aorta acceleration time

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
DescAo DV	Descending Aorta diastolic velocity
DescAo Mean V(PI)	Descending Aorta mean velocity
DescAo MnV PI, RI	Descending Aorta minimum velocity for the PI and RI calculations
DescAo MxV PI, RI	Descending Aorta maximum velocity for the PI and RI calculations
DescAo SV	Descending Aorta systolic velocity
Ductus	Ductus Arteriosus
Ductus Accel T	Ductus Arteriosus acceleration time
Ductus DV	Ductus Arteriosus diastolic velocity
Ductus mean vel	Ductus Arteriosus mean velocity
Ductus MnV PI, RI	Ductus Arteriosus minimum velocity for the PI and RI calculations
Ductus MxV PI, RI	Ductus Arteriosus maximum velocity for the PI and RI calculations
Ductus SV	Ductus Arteriosus systolic velocity
DV1	Diastolic Velocity #1
DV2	Diastolic Velocity #2
ET	Endometrial Thickness
Fetal Ao DV	Diastolic velocity of the Fetal Aorta
Fetal Ao meanV (PI)	Mean velocity of the Fetal Aorta
Fetal Ao SV	Systolic velocity of the Fetal Aorta
FetalAo MnV PI, RI	Fetal Aorta minimum velocity for the PI and RI calculations

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
FetalAo MxV PI, RI	Fetal Aorta maximum velocity for the PI and RI calculations
FL	Femur Length
FTL	Foot Length
GSD1	Gestational Sac Diameter 1
GSD2	Gestational Sac Diameter 2
GSD3	Gestational Sac Diameter 3
HC(traced)	Traced Head Circumference
HL	Humerus Length
L Ov A DV	Left Ovarian Artery diastolic velocity
L Ov A meanV (PI)	Left Ovarian Artery mean velocity
L Ov A MnV PI, RI	Left Ovarian Artery minimum velocity for the PI and RI calculations
L Ov A MxV PI, RI	Left Ovarian Artery maximum velocity for the PI and RI calculations
L Ov A SV	Left Ovarian Artery systolic velocity
L Ut A DV	Left Uterine Artery diastolic velocity
L Ut A mean V(PI)	Left Uterine Artery mean velocity
L Ut A MnV PI, RI	Left Uterine Artery minimum velocity for the PI and RI calculations
L Ut A MxV PI, RI	Left Uterine Artery maximum velocity for the PI and RI calculations
L Ut A SV	Left Uterine Artery systolic velocity
L. Follic Diam #	Left Follicular Diameter #
LOH	Left Ovarian Height

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
LOL	Left Ovarian Length
LOW	Left Ovarian Width
LPA	Left pulmonary artery
LPA Accel T	Left pulmonary artery acceleration time
LPA DV	Left pulmonary artery diastolic velocity
LPA mean vel	Left pulmonary artery mean velocity
LPA MnV PI, RI	Left pulmonary artery minimum velocity for the PI and RI calculations
LPA MxV PI, RI	Left pulmonary artery maximum velocity for the PI and RI calculations
LPA SV	Left pulmonary artery systolic velocity
LRH	Left Renal Height
LRL	Left Renal Length
LRPD	Left AP Diameter of the Renal Pelvis
LRW	Left Renal Width
LVIDd	Left Ventricular Interior Diameter at end-diastole
Mean vel 1	Mean Velocity 1
Mean vel 2	Mean Velocity 2
MPA	Main pulmonary artery
MPA Accel T	Main pulmonary artery acceleration time
MPA diam	Main pulmonary artery diameter
MPA DV	Main pulmonary artery diastolic velocity
MPA mean vel	Main pulmonary artery mean velocity

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
MPA MnV PI, RI	Main pulmonary artery minimum velocity for the PI and RI calculations
MPA MxV PI, RI	Main pulmonary artery maximum velocity for the PI and RI calculations
MPA SV	Main pulmonary artery systolic velocity
NT	Nuchal Thickness
OFD	Occipito-Frontal Diameter
QUAD1-4	Maximum pocket dimensions
R Ov A DV	Right Ovarian Artery diastolic velocity
R Ov A mean V(PI)	Right Ovarian Artery mean velocity
R Ov A MnV PI, RI	Right Ovarian Artery minimum velocity for the PI and RI calculations
R Ov A MxV PI, RI	Right Ovarian Artery maximum velocity for the PI and RI calculations
R Ov A SV	Right Ovarian Artery systolic velocity
R Ut A DV	Right Uterine Artery diastolic velocity
R Ut A meanV (PI)	Right Uterine Artery mean velocity
R Ut A MnV PI, RI	Right Uterine Artery minimum velocity for the PI and RI calculations
R Ut A MxV PI, RI	Right Uterine Artery maximum velocity for the PI and RI calculations
R Ut A SV	Right Uterine Artery systolic velocity
R. Follic Diam #	Right Follicular Diameter #
Renal L A accel T	Left renal artery acceleration time
Renal L A DV	Left renal artery diastolic velocity

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
Renal L A mean V (PI)	Left renal artery mean velocity
Renal L A MnV PI, RI	Left renal artery minimum velocity for the PI and RI calculations
Renal L A MxV PI, RI	Left renal artery maximum velocity for the PI and RI calculations
Renal L A SV	Left renal artery systolic velocity
Renal L Artery	Left renal artery
Renal R A Accel T	Right renal artery acceleration time
Renal R A DV	Right renal artery diastolic velocity
Renal R A mean V (PI)	Right renal artery mean velocity
Renal R A MnV PI, RI	Right renal artery minimum velocity for the PI and RI calculations
Renal R A MxV PI, RI	Right renal artery maximum velocity for the PI and RI calculations
Renal R A SV	Right renal artery systolic velocity
Renal R Artery	Right renal artery
ROH	Right Ovarian Height
ROL	Right Ovarian Length
ROW	Right Ovarian Width
RPA	Right pulmonary artery
RPA accel T	Right pulmonary artery acceleration time
RPA DV	Right pulmonary artery diastolic velocity
RPA mean vel	Right pulmonary artery mean velocity

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
RPA MnV PI, RI	Right pulmonary artery minimum velocity for the PI and RI calculations
RPA MxV PI, RI	Right pulmonary artery maximum velocity for the PI and RI calculations
RPA SV	Right pulmonary artery systolic velocity
RRH	Right Renal Height
RRL	Right Renal Length
RRPD	Right AP Diameter of the Renal Pelvis
RRW	Right Renal Width
RVDd	Right Ventricular Diameter at end-diastole
SV1	Systolic Velocity #1
SV2	Systolic Velocity #2
TC traced	Thoracic Circumference
TDap	Anterior-Posterior Thoracic Diameter
TDtrv	Transverse Thoracic Diameter
Thoracic Aorta	Thoracic Aorta
ThorAo accel T	Thoracic Aorta acceleration time
ThorAo DV	Thoracic Aorta diastolic velocity
ThorAo mean vel	Thoracic Aorta mean velocity
ThorAo MnV PI, RI	Thoracic Aorta minimum velocity for the PI and RI calculations
ThorAo MxV PI, RI	Thoracic Aorta maximum velocity for the PI and RI calculations
ThorAo SV	Thoracic Aorta systolic velocity
TL	Tibial Length

Table 3-1 **Gynecological and Obstetrical Measurements *(Continued)***

Abbreviation	Meaning
UL	Ulnar Length
Um A accel T	Umbilical Artery acceleration time
Um A DV	Umbilical Artery diastolic velocity
Um A meanV (PI)	Umbilical Artery mean velocity
Um A MnV PI, RI	Umbilical Artery minimum velocity for the PI and RI calculations
Um A MxV PI, RI	Umbilical Artery maximum velocity for the PI and RI calculations
Um A SV	Umbilical Artery systolic velocity
Umbilical Artery	Umbilical Artery
UTH	Uterine Height
UTL	Uterine Length
UTW	Uterine Width
VAD	Ventricular Atrial Diameter
YSD	Yolk Sac Diameter

Fetal Weight Percentiles

To aid the clinician in diagnosing fetal weight discrepancies and discordant growth, weight percentiles for each estimated fetal weight can be displayed on an Obstetrics report. These percentiles indicate where the fetus lies in relation to the normal range of values, based on both clinical (Expected GA or LMP) and ultrasound (AUA) data.

If the percentile is less than 10 percent or greater than 90 percent, the fetal weight value is displayed in a shaded box (inverse video). Using the Weight Percentiles control in Analysis Setup, you can turn off weight percentiles so they are not included in the report.

The following table of fetal weight smoothed percentiles is used by the system to determine weight percentiles. The weights in the table are represented in grams.

Table 3-2 **Fetal Weight Percentiles (Brenner)**

Gestational Age (wks)[a]	10%	25%	50%	75%	90%
8			6.1		
9			7.3		
10			8.1		
11			11.9		
12		11.1	21.1	34.1	
13		22.5	35.3	55.4	
14		34.5	51.4	76.8	
15		51.0	76.7	108	
16		79.8	117	151	
17		125	166	212	
18		172	220	298	
19		217	283	394	
20		255	325	460	
21	280	330	410	570	860
22	320	410	480	630	920
23	370	460	550	690	990
24	420	530	640	780	1080
25	490	630	740	890	1180
26	570	730	860	1020	1320
27	660	840	990	1160	1470
28	770	980	1150	1350	1660
29	890	1100	1310	1530	1890

Table 3-2 Fetal Weight Percentiles (Brenner) *(Continued)*

Gestational Age (wks)[a]	10%	25%	50%	75%	90%
30	1030	1260	1460	1710	2100
31	1180	1410	1630	1880	2290
32	1310	1570	1810	2090	2500
33	1480	1720	2010	2280	2690
34	1670	1910	2220	2510	2880
35	1870	2130	2430	2730	3090
36	2190	2470	2650	2950	3290
37	2310	2580	2870	3160	3470
38	2510	2770	3030	3320	3610
39	2680	2910	3170	3470	3750
40	2750	3010	3280	3590	3870
41	2800	3070	3360	3680	3980
42	2830	3110	3410	3740	4060
43	2840	3110	3420	3780	4100
44	2790	3050	3390	3770	4110

a. Brenner, William, et al, "A Standard of Fetal Growth for the United States of America," *Am. J. Obstet. Gynecol.*, November 1, 1976, 126:555-564.

Gynecological and Obstetrical Calculations

This section lists in alphabetical order by abbreviation, the obstetrical calculations, available on the Philips SONOS ultrasound system. All calculation labels which display in boxes on the imaging screen or on the control panel are listed. In addition to abbreviation and meaning, formulas and clinical references are listed.

Table 3-3 shows the available Biometries and GA Calculations.

Table 3-3 Biometries and GA Calculations

Biometry	GA calculations type
Femur Length	• GA(FL)Hadlock • GA(FL)Jeanty • GA (FL)Merz
Humerus Length	• GA(HL)Jeanty
Tibia Length	• GA(TL)Jeanty
Ulna Length	• GA(UL)Jeanty
Thoracic Circumference	• GA(TC)Nimrod
Head Circumference	• GA(HC)Hadlock
Mean Gestational Sac Diameter	• GA(MSD)Hellman
Abdominal Circumference	• GA(AC)Hadlock
Biparietal Diameter	• GA(BPD)Hadlock • GA(BPD)Jeanty
Crown Rump Length	• GA(CRL)Jeanty • GA(CRL)Robinson • GA(CRL)Rempen • GA (CRL)Nelson
Binocular Distance	• GA (BD) Jeanty
Transverse Abdominal Diameter	• GA (ADtrv)Merz

Table 3-3 Biometries and GA Calculations*(Continued)*

Biometry	GA calculations type
Gestational Sac Diameter	• GA(GSD)Rempen
Estimated Fetal Weight	• GA Brenner

AC: Abdominal Circumference

Abdominal Circumference (cm) may be computed by two means: if **AC(traced)** is present, then **AC = AC(traced)**. If the two abdominal diameters, **ADtrv** and **ADap**, are present, then:

$$\pi \times \sqrt{(\mathrm{ADtrv}^2 + \mathrm{ADap}^2)/2}$$

Kurtz, Alfred B., Goldberg, Barry B., *Obstetrical Measurements in Ultrasound: A Reference Manual*, Year Book Medical Publishers, Inc., 1988, p. 33.

Shields JR, et al., “Fetal Head and Abdominal Circumferences: Ellipse Calculations Versus Planimetry,” *Journal of Clinical Ultrasound*, May, 1987;15:237-239.

AC(GA)Hadl: Gestational Age via Hadlock using Abdominal Circumference

Gestational Age (wk+day) via Hadlock using Abdominal Circumference (**AC** range: 5.0 to 38.0 cm) equation is:

$$8.14 + 0.753(\mathrm{AC}) + 0.0036(\mathrm{AC}^2)$$

Hadlock FP, et al., “Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters,” *Radiology*, 1984; 152:497-501.

AD_{trv} (GA)Merz: Gestational Age via Merz using Transverse Abdominal Diameter

Gestational Age (wk+day) via Merz using Transverse Abdominal Diameter (**AD_{trv}** range: 1.9 to 11.1 cm). The following table lists the standard deviation in days:

Table 3-4 **Gestational Age via ADtrv (Merz)**

TD	GA	SD	TD	GA	SD	TD	GA	SD	TD	GA	SD
1.9	12.0	12	4.5	20.0	16	7.2	28.0	19	9.8	36.0	21
2.3	13.0	13	4.9	21.0	17	7.5	29.0	20	10.1	37.0	21
2.6	14.0	14	5.2	22.0	17	7.8	30.0	20	10.4	38.0	21
2.9	15.0	15	5.5	23.0	18	8.1	31.0	20	10.8	39.0	21
3.2	16.0	15	5.8	24.0	18	8.5	32.0	21	11.1	40.0	21
3.6	17.0	15	6.2	25.0	18	8.8	33.0	21			
3.9	18.0	16	6.5	26.0	19	9.1	34.0	21			
4.2	19.0	16	6.8	27.0	19	9.4	35.0	21			

German Society for Gynecology and Obstetrics, March 1991, Issue 15, Vol. 1, pp. 23-28.

NOTE

When using AD_{trv} (GA)Merz, the abdominal diameter measurement should be made by measuring the outer to outer boundaries in the abdomen.

AFI: Amniotic Fluid Index

The Amniotic Fluid Index (cm) equation is:

QUAD1 + QUAD2 + QUAD3 + QUAD4

The normal range for AFI is 8.1 to 18.0 cm.

Rutherford S., et al., “Four Quadrant Assessment of Amniotic Fluid Volume,” *J Reprod Med,* 1987; 32:587-589.

AI: Acceleration Index (also accel I)

The acceleration index, **AI** (m/s^2), given a systolic velocity, **Vs**(cm/s), a diastolic velocity **Vd**(cm/s), and an onset-to-peak time, **T**, for a vessel is:

$$AI = \frac{V_s - V_d}{T \times 100}$$

Stavros, A.T., et al., "Segmental Stenosis of the Renal Artery: Pattern Recognition of Tardus and Parvus Abnormalities with Duplex Sonography," *Radiology*, 1992; 184:487-492.

AUA: Average Ultrasound Age

The Average Ultrasound Age equation is:

$$AUA = (GA_1 + GA_2 + \ldots\ldots + GA_n)/n$$

where n varies from 1 to 12. The Average Ultrasound Age (AUA) is the average of all of the gestational ages that have been generated during an exam from acquired values. One exception is that the gestational ages generated from corrected BPD are not included in the AUA calculation. Also, only gestational ages that are generated from measurable values contribute to the AUA. Gestational ages based on fetal biometric parameters only are inputs to the AUA. GA(LMP) for instance is not an input to AUA.

You can mark gestational ages for inclusion in or exclusion from the AUA. An editable marker field allows you to select which gestational ages are to be included in the calculation of the AUA to be included in the report. The gestational age will be proceeded by a plus sign (+) indicating that the age will be included in the AUA, or a minus sign (-) indicating that the age will be excluded from the AUA. This feature allows you to decide during an obstetric exam that a particular gestational age is out of line with the others and would inappropriately skew the AUA calculation. In this case, you may enter the edit mode and cancel the calculation by replacing + with - for that particular gestational age.

When the system is powered on or you enter a new patient ID, the gestational ages are marked by default for selection or cancel. All gestational ages are marked for inclusion by default except for those biometries which have multiple associated authors. In these cases, only one will be marked on by default. This ensures that the AUA will never include gestational age calculations based on the same biometry via different authors.

The following table lists the gestational age calculations available and their default state. The table lists the calculations in their order of precedence.

Table 3-5 Gestational Age AUA Defaults

Gestational Age	AUA Default
GA(FL)Hadlock	+
GA(FL)Jeanty	-
GA(FL)Merz	-
GA(HL)Jeanty	+
GA(TL)Jeanty	+
GA(UL)Jeanty	+
GA(BD)Jeanty	+
GA(CD)Goldstein	+
GA(TC)Nimrod	+
GA(CRL)Robinson	+
GA(CRL)Jeanty	-
GA(CRL)Nelson	-
GA(CRL)Rempen	-
GA(BPD)Hadlock	+
GA(BPD)Jeanty	-
GA(HC)Hadlock	+
GA(AC)Hadlock	+

Table 3-5 Gestational Age AUA Defaults

Gestational Age	AUA Default
GA(MSD)Hellman	+
GA(GSD)Rempen	-
GA(ADtrv) Merz	+

If you choose to override the defaults, the system enforces mutual exclusion when necessary. For example, two gestational ages based on Biparietal Diameter are available: one by Hadlock and one by Jeanty. The default is the Hadlock calculation. If you choose to override the Hadlock calculation, and use the Jeanty calculation, the system automatically cancels the Hadlock calculation and marks it with a minus sign (-).

This calculation is performed automatically, and the value appears on the report header. This calculation does not appear on the touch panels.

BD(GA)Jeant: Gestational Age via Jeanty using Binocular Distance

Gestational Age (wk+day) via Jeanty using Binocular Distance (**BD** range: 1.5 to 6.5 cm) equation is:

Table 3-6 Gestational Age via BD (Jeanty)

BD	GA	BD	GA	BD	GA	BD	GA	BD	GA	BD	GA
1.5	10.4	2.5	16.4	3.5	22.3	4.5	28.3	5.5	34.1	6.5	40.1
1.6	11.0	2.6	17.0	3.6	22.9	4.6	28.9	5.6	34.9		
1.7	11.6	2.7	17.6	3.7	23.6	4.7	29.6	5.7	35.4		
1.8	12.1	2.8	18.1	3.8	24.1	4.8	30.1	5.8	36.0		
1.9	12.9	2.9	18.9	3.9	24.7	4.9	30.7	5.9	36.6		
2.0	13.4	3.0	19.4	4.0	25.3	5.0	31.3	6.0	37.1		
2.1	14.0	3.1	20.0	4.1	25.9	5.1	31.9	6.1	37.9		
2.2	14.6	3.2	20.6	4.2	26.6	5.2	32.6	6.2	38.4		
2.3	15.1	3.3	21.1	4.3	27.1	5.3	33.0	6.3	39.0		
2.4	15.9	3.4	21.7	4.4	27.7	5.4	33.6	6.4	39.6		

Jeanty, P. et al., "The Binocular Distance: A New Way to Estimate Fetal Age," *Journal Ultrasound Medicine*, June, 1984; 3:241-243.

Biophysical Profile Total

The Biophysical Profile Total (category ranges: 0 - 2, or NA, indicating the category will not contribute to the Biophysical Profile Total) equation is:

(Movement) + (Tone) + (Breath) + (AFVolume) + (NSTest)

Manning, F.A., et al., "Fetal Assessment Based on Fetal Biophysical Profile Scoring," *Am J Obstet Gynecol*, 1990; 162:703-709.

BPD(GA)Hadl: Gestational Age via Hadlock using Biparietal Diameter

Gestational Age (wk+day) via Hadlock using Biparietal Diameter (**BPD** range: 1.5 to 10.1 cm) equation is:

$$9.54 + 1.482(BPD) + 0.1676(BPD^2)$$

Hadlock FP, et al., “Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters,” *Radiology*, 1984; 152:497-501.

BPD(GA)Jeant: Gestational Age via Jeanty using Biparietal Diameter

Gestational Age (wk+day) via Jeanty using Biparietal Diameter (**BPD** range: 2.8 to 7.9 cm). The following table lists the associated percentiles in weeks for each value.

Table 3-7 Gestational Age via BPD (Jeanty)

BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %
2.8	11.3	14.0	16.5	4.8	16.9	19.5	22.3	6.8	23.9	26.4	29.0
2.9	11.5	14.1	16.9	4.9	17.1	19.9	22.5	6.9	24.0	26.7	29.4
3.0	11.9	14.5	17.1	5.0	17.5	20.3	22.9	7.0	24.4	27.1	29.9
3.1	12.1	14.9	17.4	5.1	17.9	20.5	23.1	7.1	24.9	27.5	30.1
3.2	12.3	15.1	17.7	5.2	18.1	20.9	23.5	7.2	25.1	27.9	30.5
3.3	12.5	15.3	18.0	5.3	18.5	21.1	23.9	7.3	25.5	28.3	30.9
3.4	12.9	15.5	18.3	5.4	18.9	21.5	24.1	7.4	26.0	28.7	31.3
3.5	13.1	15.9	18.5	5.5	19.1	21.9	24.5	7.5	26.4	29.1	31.7
3.6	13.5	16.1	18.9	5.6	19.5	22.1	24.9	7.6	26.9	29.5	32.1
3.7	13.7	16.4	19.1	5.7	19.9	22.5	25.1	7.7	27.1	29.9	32.5
3.8	14.0	16.7	19.4	5.8	20.1	22.9	25.5	7.8	27.5	30.3	33.0
3.9	14.3	17.0	19.7	5.9	20.5	23.1	25.9	7.9	28.0	30.7	33.4

Table 3-7 **Gestational Age via BPD (Jeanty)**

BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %
4.0	14.5	17.3	19.9	6.0	20.9	23.5	26.1				
4.1	14.9	17.5	20.1	6.1	21.1	23.9	26.5				
4.2	15.1	17.9	20.5	6.2	21.5	24.1	26.6				
4.3	15.4	18.1	20.9	6.3	21.9	24.5	27.1				
4.4	15.7	18.4	21.1	6.4	22.1	24.9	27.5				
4.5	16.0	18.7	21.4	6.5	22.5	25.3	27.9				
4.6	16.3	19.0	21.7	6.6	22.9	25.5	28.3				
4.7	16.5	19.3	22.0	6.7	23.3	26.0	28.5				

Jeanty, Philippe, *Obstetrical Ultrasound*, McGraw Hill, 1983, p. 58.

BPDa: Area Corrected Biparietal Diameter

The area corrected Biparietal Diameter (cm) equation is:

$$\sqrt{BPD \times OFD / 1.265}$$

Benson, Carol B., Doubilet, Peter M., “Sonographic Prediction of Gestational Age: Accuracy of Second and Third-Trimester Fetal Measurements,” *AJR*, 157:1275-1277, December, 1991.

Greenes, R.A., “OBUS: A Microcomputer System for Measurement, Calculation, Reporting, and Retrieval of Obstetric Ultrasound Examinations,” *Radiology*, 1982; 144:879-883.

BPDa(GA)Hadl: Gestational Age via Hadlock using Area Corrected Biparietal Diameter

Gestational Age (wk+day) via Hadlock using Area Corrected Biparietal Diameter (**BPD**a range: 1.5 to 10.1 cm) equation is:

$$9.54 + 1.482(BPDa) + 0.1676((BPDa)^2)$$

Hadlock, Frank P., et al., "Fetal Biparietal Diameter: A Critical Re-evaluation of the Relation to Menstrual Age by Means of Real-time Ultrasound," *Journal of Ultrasound in Medicine*, April, 1982; 1:97-104.

Benson, Carol B., Doubilet, Peter M., "Sonographic Prediction of Gestational Age: Accuracy of Second and Third-Trimester Fetal Measurements," *AJR*, 157:1275-1277, December, 1991.

BPDa(GA)Jeant: Gestational Age via Jeanty using Area Corrected Biparietal Diameter

Gestational Age (wk+day) via Jeanty using Area Corrected Biparietal Diameter (**BPD**a range: 2.8 to 7.9 cm). The following table lists the associated percentiles in weeks for each value.

Table 3-8 Gestational Age via BPDa (Jeanty)

BPDa	5th%	50th %	95th %	BPDa	5th%	50th %	95th %	BPDa	5th%	50th %	95th %
2.8	11.3	14.0	16.5	4.8	16.9	19.5	22.3	6.8	23.9	26.4	29.0
2.9	11.5	14.1	16.9	4.9	17.1	19.9	22.5	6.9	24.0	26.7	29.4
3.0	11.9	14.5	17.1	5.0	17.5	20.3	22.9	7.0	24.4	27.1	29.9
3.1	12.1	14.9	17.4	5.1	17.9	20.5	23.1	7.1	24.9	27.5	30.1
3.2	12.3	15.1	17.7	5.2	18.1	20.9	23.5	7.2	25.1	27.9	30.5
3.3	12.5	15.3	18.0	5.3	18.5	21.1	23.9	7.3	25.5	28.3	30.9
3.4	12.9	15.5	18.3	5.4	18.9	21.5	24.1	7.4	26.0	28.7	31.3
3.5	13.1	15.9	18.5	5.5	19.1	21.9	24.5	7.5	26.4	29.1	31.7

Table 3-8 **Gestational Age via BPDa (Jeanty)**

BPDa	5th%	50th %	95th %	BPDa	5th%	50th %	95th %	BPDa	5th%	50th %	95th %
3.6	13.5	16.1	18.9	5.6	19.5	22.1	24.9	7.6	26.9	29.5	32.1
3.7	13.7	16.4	19.1	5.7	19.9	22.5	25.1	7.7	27.1	29.9	32.5
3.8	14.0	16.7	19.4	5.8	20.1	22.9	25.5	7.8	27.5	30.3	33.0
3.9	14.3	17.0	19.7	5.9	20.5	23.1	25.9	7.9	28.0	30.7	33.4
4.0	14.5	17.3	19.9	6.0	20.9	23.5	26.1				
4.1	14.9	17.5	20.1	6.1	21.1	23.9	26.5				
4.2	15.1	17.9	20.5	6.2	21.5	24.1	26.6				
4.3	15.4	18.1	20.9	6.3	21.9	24.5	27.1				
4.4	15.7	18.4	21.1	6.4	22.1	24.9	27.5				
4.5	16.0	18.7	21.4	6.5	22.5	25.3	27.9				
4.6	16.3	19.0	21.7	6.6	22.9	25.5	28.3				
4.7	16.5	19.3	22.0	6.7	23.3	26.0	28.5				

Jeanty, Philippe, *Obstetrical Ultrasound*, McGraw Hill, 1983, p. 58.

Benson, Carol B., Doubilet, Peter M., "Sonographic Prediction of Gestational Age: Accuracy of Second and Third-Trimester Fetal Measurements," *AJR*, 157:1275-1277, December, 1991.

BPD(GA)Hadl: Gestational Age via Hadlock using Biparietal Diameter

Gestational Age (wk+day) via Hadlock using Biparietal Diameter (**BPD** range: 1.5 to 10.1 cm) equation is:

$$9.54 + 1.482(BPD) + 0.1676(BPD^2)$$

Hadlock FP, et al., "Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters," *Radiology*, 1984; 152:497-501.

BPD(GA)Jeant: Gestational Age via Jeanty using Biparietal Diameter

Gestational Age (wk+day) via Jeanty using Biparietal Diameter (**BPD** range: 2.8 to 7.9 cm). The following table lists the associated percentiles in weeks for each value.

Table 3-9 **Gestational Age via BPD (Jeanty)**

BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %	BPD	5th%	50th %	95th %
2.8	11.3	14.0	16.5	4.8	16.9	19.5	22.3	6.8	23.9	26.4	29.0
2.9	11.5	14.1	16.9	4.9	17.1	19.9	22.5	6.9	24.0	26.7	29.4
3.0	11.9	14.5	17.1	5.0	17.5	20.3	22.9	7.0	24.4	27.1	29.9
3.1	12.1	14.9	17.4	5.1	17.9	20.5	23.1	7.1	24.9	27.5	30.1
3.2	12.3	15.1	17.7	5.2	18.1	20.9	23.5	7.2	25.1	27.9	30.5
3.3	12.5	15.3	18.0	5.3	18.5	21.1	23.9	7.3	25.5	28.3	30.9
3.4	12.9	15.5	18.3	5.4	18.9	21.5	24.1	7.4	26.0	28.7	31.3
3.5	13.1	15.9	18.5	5.5	19.1	21.9	24.5	7.5	26.4	29.1	31.7
3.6	13.5	16.1	18.9	5.6	19.5	22.1	24.9	7.6	26.9	29.5	32.1
3.7	13.7	16.4	19.1	5.7	19.9	22.5	25.1	7.7	27.1	29.9	32.5
3.8	14.0	16.7	19.4	5.8	20.1	22.9	25.5	7.8	27.5	30.3	33.0
3.9	14.3	17.0	19.7	5.9	20.5	23.1	25.9	7.9	28.0	30.7	33.4
4.0	14.5	17.3	19.9	6.0	20.9	23.5	26.1				
4.1	14.9	17.5	20.1	6.1	21.1	23.9	26.5				
4.2	15.1	17.9	20.5	6.2	21.5	24.1	26.6				
4.3	15.4	18.1	20.9	6.3	21.9	24.5	27.1				
4.4	15.7	18.4	21.1	6.4	22.1	24.9	27.5				
4.5	16.0	18.7	21.4	6.5	22.5	25.3	27.9				
4.6	16.3	19.0	21.7	6.6	22.9	25.5	28.3				
4.7	16.5	19.3	22.0	6.7	23.3	26.0	28.5				

Jeanty, Philippe, *Obstetrical Ultrasound*, McGraw Hill, 1983, p. 58.

CD(GA)Gold: Gestational Age via Goldstein using Cerebellar Diameter

Gestational Age (wk+day) via Goldstein using Cerebellar Diameter (CD range: 1.0 to 5.5 cm) equation is:

$$6.329 + (4.807 \times CD) + (1.484 \times CD^2) - 0.2474 \times (CD)^3$$

The following table lists the associated percentiles in centimeters for each value.

Table 3-10 Gestational Age via CD (Goldstein)

GA	CD(cm) 10th%	CD(cm) 25th%	CD(cm) 50th%	CD(cm) 75th%	CD(cm) 90th%	GA	CD(cm) 10th%	CD(cm) 25th%	CD(cm)50th%	CD(cm) 75th%	CD(cm) 90th%
15.0	1.0	1.2	1.4	1.5	1.6	28.0	2.7	3.0	3.1	3.2	3.4
16.0	1.4	1.6	1.6	1.6	1.7	29.0	2.9	3.2	3.4	3.6	3.8
17.0	1.6	1.7	1.7	1.8	1.8	30.0	3.1	3.2	3.5	3.7	4.0
18.0	1.7	1.8	1.8	1.9	1.9	31.0	3.2	3.5	3.8	3.9	4.3
19.0	1.8	1.8	1.9	1.9	2.2	32.0	3.3	3.6	3.8	4.0	4.2
20.0	1.8	1.9	2.0	2.0	2.2	33.0	3.2	3.6	4.0	4.3	4.4
21.0	1.9	2.0	2.2	2.3	2.4	34.0	3.3	3.8	4.0	4.1	4.4
22.0	2.1	2.3	2.3	2.4	2.4	35.0	3.1	3.7	4.05	4.3	4.7
23.0	2.2	2.3	2.4	2.5	2.6	36.0	3.6	3.9	4.3	5.2	5.5
24.0	2.2	2.4	2.5	2.7	2.8	37.0	3.7	3.7	4.5	5.2	5.5
25.0	2.3	2.15	2.8	2.8	2.9	38.0	4.0	4.0	4.85	5.2	5.5
26.0	2.5	2.8	2.9	3.0	3.2	39.0					
27.0	2.6	2.85	3.0	3.1	3.2						

Goldstein I, et al., “Cerebellar Measurements with Ultrasonography in the Evaluation of Fetal Growth and Development,” *American Journal of Obstetrics and Gynecology*, 156:1065-1069, 1987.

CI(BPD,OFD): Cephalic Index

The Cephalic Index (unitless) equation is (**OFD** range: 0.001 to 36.0 cm; **BPD** range: 0.001 to 36.0 cm):

$(BPD / OFD) \times 100$

The **CI(BPD,OFD)** values for a normal human are: 75.9-81.0.

Bezjian, Alex A., "Normal and Abnormal Fetal Growth," presented at the Advanced Ultrasound Seminar, Lake Buena Vista, Florida, January, 1982.

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, Pennsylvania, 1988, p. 830.

Hadlock FP, et al., "Estimating Fetal Age: Effects on Head Shape on BPD," *Amer J Roetgen*, 1981; 137:83-85.

CRL(GA)Jeant: Gestational Age via Jeanty using Crown Rump Length

Gestational Age (wk+day) via Jeanty using Crown Rump Length (**CRL** range: 0.5 to 5.4 cm).

Table 3-11 Gestational Age via CRL (Jeanty)

CRL	GA	CRL	GA	CRL	GA	CRL	GA	CRL	GA
0.5	6.3	1.5	8.1	2.5	9.4	3.5	10.4	4.5	11.3
0.6	6.5	1.6	8.1	2.6	9.5	3.6	10.6	4.6	11.4
0.7	6.7	1.7	8.4	2.7	9.5	3.7	10.6	4.7	11.5
0.8	6.8	1.8	8.5	2.8	9.7	3.8	10.7	4.8	11.5
0.9	7.1	1.9	8.5	2.9	9.9	3.9	10.9	4.9	11.7
1.0	7.3	2.0	8.9	3.0	9.9	4.0	10.9	5.0	11.9
1.1	7.4	2.1	8.9	3.1	10.0	4.1	11.0	5.1	11.9
1.2	7.5	2.2	9.0	3.2	10.1	4.2	11.1	5.2	11.9
1.3	7.8	2.3	9.1	3.3	10.1	4.3	11.1	5.3	12.0
1.4	7.8	2.4	9.1	3.4	10.3	4.4	11.1	5.4	12.1

Jeanty, Philippe, *Obstetrical Ultrasound*, McGraw Hill, 1983, p. 56.

CRL(GA)Nel: Gestational Age via Nelson using Crown-Rump Length

Gestational Age (wk+day) via Nelson using Crown-Rump Length (**CRL** range: 1.5 to 9.0 cm) equation is:

$$(51.0008 + (6.0 \times CRL)) / 7$$

Nelson, L., "Comparison of Methods for Determining Crown-Rump Measurement by Real-Time Ultrasound." *Journal of Clinical Ultrasound*, 9:67-70, February, 1981.

CRL(GA)Remp: Gestational Age via Rempen Gestational Age (wk+day)

Gestational Age (wk+day) via Rempen using Crown-Rump Length (**CRL** range: 0.2 to 7.8 cm). The following table lists the associated standard deviation (SD) in days for each value.

Table 3-12 Gestational Age via CRL (Rempen)

CRL	GA	SD	CRL	GA	SD	CRL	GA	SD	CRL	GA	SD
0.2	6.0	6	1.8	8.1	6	3.8	10.4	6	6.2	12.6	6
0.3	6.1	6	1.9	8.3	6	3.9	10.5	6	6.4	12.7	6
0.4	6.3	6	2.0	8.4	6	4.1	10.7	6	6.6	12.9	6
0.5	6.4	6	2.1	8.5	6	4.2	10.9	6	6.8	13.0	6
0.6	6.5	6	2.3	8.7	6	4.4	11.0	6	7.0	13.1	6
0.7	6.7	6	2.4	8.9	6	4.5	11.1	6	7.2	13.3	6
0.8	6.9	6	2.5	9.0	6	4.7	11.3	6	7.4	13.4	6
0.9	7.0	6	2.6	9.1	6	4.8	11.4	6	7.7	13.6	6
1.0	7.1	6	2.7	9.3	6	5.0	11.6	6	7.8	13.7	6
1.1	7.3	6	2.9	9.4	6	5.2	11.7	6			
1.2	7.4	6	3.0	9.5	6	5.3	11.9	6			
1.3	7.5	6	3.1	9.7	6	5.5	12.0	6			
1.4	7.7	6	3.3	9.9	6	5.7	12.1	6			

Table 3-12 Gestational Age via CRL (Rempen)

CRL	GA	SD	CRL	GA	SD	CRL	GA	SD	CRL	GA	SD
1.6	7.9	6	3.4	10.1	6	5.8	12.3	6			
1.7	8.0	6	3.7	10.3	6	6.0	12.4	6			

German Society for Gynecology and Obstetrics, March 1991, Issue 15, Vol. 1, pp. 23-28.

CRL(GA)Robin: Gestational Age via Robinson using Crown-Rump Length

Gestational Age (wk+day) via Robinson using Crown-Rump Length (**CRL** range: 0.67 cm (6.3 weeks) to 8.2 cm (14.0 weeks)) equation is:

$$(8.052 \times \sqrt{CRL \times 10} + 23.73) / 7$$

Robinson, Philips, Fleming, JE, "A Critical Evaluation of Sonar Crown-Rump Length Measurements," *British Journal of Obstetrics and Gynecology*, 82:702-710, September, 1975.

Derived GA: Current GA Derived from Previous GA

The Gestational Age computed from that of an earlier exam, where Prev GA is in weeks, and the dates are in days, is:

$$\text{Prev GA} + ((\text{Current Date} - \text{Prev Exam Date}) / 7)$$

This calculation is also used to calculate **Expected EDC** when **Prev GA** and **Prev Exam** date are manually entered on the Patient Information screen or a report.

This calculation is performed automatically, and the value appears on the report header. This calculation does not appear on the touch panels.

DescAo accel I: **Acceleration Index**
(see AI on page 3-14)

DescAo DV/SV: **Descending Aorta Diastolic Velocity to Systolic Velocity Ratio**
(see D/S Ratio on page 3-27)

DescAo PI: **Descending Aorta Pulsatility Index**
(see PI on page 3-41)

DescAo RI: **Descending Aorta Resistivity Index**
(see RI on page 3-43)

DescAo SV/DV: **Descending Aorta Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

D/S Ratio: **Diastolic to Systolic Ratio**

The equation for the diastolic-to-systolic ratio, **r** (unitless), given the systolic velocity, $\mathbf{v_s}$ (cm/s), and the end-diastolic velocity, $\mathbf{v_d}$ (cm/s), is

$$r = \frac{v_d}{v_s}$$

Neumyer, Marsha M. et al., "The Differentiation of Renal Artery Stenosis from Renal Parenchymal Disease by Duplex Ultrasonography," *Journal of Vascular Technology*, Scientific Article, October, 1989, p. 205-216.

Ductus accel I: **Ductus Acceleration Index**
(see AI on page 3-14)

Ductus DV/SV: **Ductus Diastolic Velocity to Systolic Velocity Ratio**
(see D/S Ratio on page 3-27)

Ductus PI: **Ductus Pulsatility Index**
(see PI on page 3-41)

Ductus RI: **Ductus Resistivity Index**
(see RI on page 3-43)

Ductus SV/DV: **Ductus Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

EDC(AUA): **Estimated Date of Confinement given the Average Ultrasound Age**

The Estimated Date of Confinement (date) given the Average Ultrasound Age (date) equation is:

$$EDC(AUA) = DateToday + (40weeks - AUA)$$

This calculation is performed automatically, and the value appears in the report header. This calculation does not appear on the touch panels.

Hagen-Ansert, Sandra L., *Textbook of Diagnostic Ultrasonography*, ed. 3, The C. V. Mosby Co., 1989, p. 408.

Note: This formula is also used to calculate **Expected GA** and **Expected EDC** when one or the other is manually entered on the Patient Information screen or the OB Report. None of these labels appear on the touch panels.

EDC(LMP): Estimated Date of Confinement given the Last Menstrual Period

The Estimated Date of Confinement (date) given the Last Menstrual Period (date) equation is:

$$EDC(LMP) = LMP + 40weeks$$

This calculation is performed automatically, and the value appears on the report header. This calculation does not appear on the touch panels.

Hagen-Ansert, Sandra L., *Textbook of Diagnostic Ultrasonography*, ed. 3, The C. V. Mosby Co., 1989, p. 408.

EFW(AC,BPD)Hadl:

Estimated Fetal Weight via Hadlock using Abdominal Circumference

Estimated Fetal Weight (grams) via Hadlock using Abdominal Circumference (range: 15.5 to 40.0 cm) and Biparietal Diameter (range: 3.1 to 10.0 cm) equation is:

$$10^{(1.11 + (0.05845 \times AC) - (0.000604 \times AC^2) - (0.007365 \times BPD^2) + (0.000595 \times BPD \times AC) + (0.1694 \times BPD))}$$

Hadlock FP, et al., “Sonographic Estimation of Fetal Weight,” *Radiology,* 1984; 150:535-540.

EFW(AC,BPD)Sh:

Estimated Fetal Weight via Shephard using Abdominal Circumference

Estimated Fetal Weight (grams) via Shephard using Abdominal Circumference (range: 15.0 to 40.0 cm) and Biparietal Diameter (range: 3.1 to 10.0 cm) equation is:

$$1000 \times 10^{(-1.7492 + 0.166(\mathrm{BPD}) + 0.046(\mathrm{AC}) - 0.002646(\mathrm{AC})(\mathrm{BPD}))}$$

Shephard MJ, et al., “An Evaluation of Two Equations for Predicting Fetal Weight by Ultrasound,” *Amer J Ob Gyn*, January, 1982; 142 (1):47-54.

EFW(AC,FL)Hadl:

Estimated Fetal Weight via Hadlock using Abdominal Circumference

Estimated Fetal Weight (grams) via Hadlock using Abdominal Circumference (range: 15.0 to 40.0 cm) and Femur Length (range: 1.0 to 8.0 cm) equation is:

$$10^{(1.304 + (0.05281 \times AC) + (0.1938 \times FL) - (0.004 \times AC \times FL))}$$

Hadlock FP, et al., “Estimation of Fetal Weight with the Use of Head, Body, and Femur Measurements-A Prospective Study,” *Amer J Ob Gyn*, 1985; 151(3):333-7.

EFW(AC,HC,FL)Hadl:

Estimated Fetal Weight via Hadlock using Abdominal Circumference

Estimated Fetal Weight (grams) via Hadlock using Abdominal Circumference (range: 10.0 to 37.0 cm), Head Circumference (range: 10.0 to 40.0 cm), and Femur Length (range: 1.0 to 8.0 cm) equation is:

$$10^{(1.336 - 0.00326(\mathrm{AC})(\mathrm{FL}) + 0.0107(\mathrm{HC}) + 0.0438(\mathrm{AC}) + 0.158(\mathrm{FL}))}$$

Hadlock, Frank P. et al., “Estimation of Fetal Weight with the use of Head, Body, and Femur Measurements - a Prospective Study,” *American Journal of Obstetrics and Gynecology*, 1985, Vol. 151, No. 3, pp. 333-337.

EFW(B,H,A,F)Hadl:

Estimated Fetal Weight via Hadlock using Biparietal Diameter, Head Circumference, Abdominal Circumference, and Femur Length

Estimated Fetal Weight (grams) via Hadlock using Biparietal Diameter (range: 3.1-10.0), Head Circumference (range: 10.0-40.0), Abdominal Circumference (range: 15.0 to 40.0 cm), and Femur Length (range: 1.0-8.0) equation is:

$$10^{(1.5115 + 0.0436 \times AC + 0.1517 \times FL - 0.00321 \times AC \times FL + 0.0006923 \times BPD \times HC)}$$

Hadlock FP, et al., “Sonographic Estimation of Fetal Weight,” Radiology 1984; 150:535-540.

Expected EDC: Expected Date of Confinement

- Manually entered by Clinician on Patient Information or OB Report screen for automatic calculation of **Expected GA**
- Calculated from a manually entered **Expected GA.**
  (see EDC(AUA) formula on page 3-28, and Expected GA on page 3-31

Note: These labels do not appear on the touch panels.

Expected GA: Expected Gestational Age

- Manually entered by clinician on Patient Information or OB Report screen. When entered, **Expected EDC** is automatically calculated
- Calculated from a manually entered **Expected EDC**
  (see Expected EDC on page 3-31 and EDC(AUA) formula on page 3-28)

Note: These labels do not appear on the touch panels.

Fetal Ao PI: Fetal Aorta Pulsatility Index

(see PI on page 3-41)

Fetal Ao RI: Fetal Aorta Resistivity Index

(see RI on page 3-43)

Fetal Ao SV/DV: Fetal Aorta Systolic Velocity to Diastolic Velocity Ratio

(see S/D Ratio on page 3-45)

Fetal HR: Fetal Heart Rate

The equation for heart rate, r (BPM), given the Peak to Peak interval, t (sec) is:

$$r = \frac{120}{t}$$

Dorland's Illustrated Medical Dictionary, ed. 27, W. B. Sanders Co., Philadelphia, 1988, p. 1425.

FL/AC: FL to AC Ratio

The ratio (unitless) of Femur Length (cm) to Abdominal Circumference (cm) equation is:

$$FL / AC$$

Hadlock FP, et al., “Use of Femur Length/Abdominal Circumference Ratio in Detecting the Macrosomic Fetus,” *Radiology,* 1985; 154:503-505.

FL/BPD: FL to BPD Ratio

The ratio (unitless) of Femur Length (cm) to Biparietal Diameter (cm) equation is:

$$FL / BPD$$

The typical range for FL/BPD is 23 weeks Gestational Age to 40 weeks Gestational Age.

Hohler, C., Quetal, T., “Comparison of Fetal Femur Length and Biparietal Diameter in Late Pregnancy,” *American Journal of Obstetrics and Gynecology*, December, 1981, Vol. 141, No. 7:759-762.

FL(GA)Hadl: Gestational Age via Hadlock using Femur Length

Gestational Age (wk + day) via Hadlock using Femur Length (FL range: 0.7 to 8.2 cm) is:

$$10.35 + 2.460(FL) + 0.170(FL)^2$$

Hadlock FP, et al., “Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters,” *Radiology*, 1984; 152:497-501.

FL(GA)Jeant: Gestational Age via Jeanty using Femur Length

Gestational Age (wk + day) via Jeanty using Femur Length (**FL** range: 1.0 to 8.0 cm) equation is:

$$9.5411757 + 2.9774510 \times FL + 0.10388 \times (FL)^2$$

The following table lists the associated percentiles in weeks for each value.

Table 3-13 Gestational Age via FL (Jeanty)

FL	5th%	50th %	95th %	FL	5th%	50th %	95th %	FL	5th%	50th %	95th %
1.0	10.4	12.5	14.9	3.6	19.4	21.5	23.9	6.2	29.9	32.0	34.1
1.1	10.7	12.9	15.1	3.7	19.9	22.0	24.1	6.3	30.1	32.4	34.5
1.2	11.1	13.3	15.5	3.8	20.1	22.4	24.5	6.4	30.7	32.9	35.1
1.3	11.4	13.5	15.9	3.9	20.5	22.7	24.9	6.5	31.1	33.3	35.5
1.4	11.7	13.9	16.1	4.0	20.9	23.1	25.3	6.6	31.5	33.7	35.9
1.5	12.0	14.1	16.4	4.1	21.3	23.5	25.7	6.7	32.0	34.1	36.4
1.6	12.4	14.5	16.9	4.2	21.7	23.9	26.1	6.8	32.4	34.5	36.9
1.7	12.7	14.9	17.1	4.3	22.1	24.3	26.5	6.9	32.9	35.0	37.1
1.8	13.0	15.1	17.4	4.4	22.5	24.7	26.9	7.0	33.3	35.5	37.7
1.9	13.4	15.5	17.9	4.5	22.9	25.0	27.1	7.1	33.7	35.9	38.1
2.0	13.7	15.9	18.1	4.6	23.1	25.4	27.5	7.2	34.1	36.4	38.5
2.1	14.1	16.3	18.5	4.7	23.5	25.9	28.0	7.3	34.5	36.9	39.0
2.2	14.4	16.5	18.9	4.8	24.0	26.1	28.4	7.4	35.1	37.3	39.5
2.3	14.7	16.9	19.1	4.9	24.4	26.5	28.9	7.5	35.5	37.7	39.9
2.4	15.1	17.3	19.5	5.0	24.9	27.0	29.1	7.6	36.0	38.1	40.4
2.5	15.4	17.5	19.9	5.1	25.1	27.4	29.5	7.7	36.4	38.5	40.9
2.6	15.9	18.0	20.1	5.2	25.5	27.9	30.0	7.8	36.9	39.1	41.3

Table 3-13 **Gestational Age via FL (Jeanty)**

FL	5th%	50th %	95th %	FL	5th%	50th %	95th %	FL	5th%	50th %	95th %
2.7	16.1	18.3	20.5	5.3	26.0	28.1	30.4	7.9	37.3	39.5	41.3
2.8	16.5	18.7	20.9	5.4	26.4	28.5	30.9	8.0	37.9	40.0	42.1
2.9	16.9	19.0	21.1	5.5	26.9	29.1	31.3				
3.0	17.1	19.4	21.5	5.6	27.3	29.5	31.7				
3.1	17.5	19.9	22.0	5.7	27.7	29.9	32.1				
3.2	17.6	20.1	22.3	5.8	28.1	30.3	32.5				
3.3	18.3	20.5	22.7	5.9	28.5	30.7	32.9				
3.4	18.7	20.9	23.1	6.0	28.9	31.1	33.3				
3.5	19.0	21.1	23.1	6.1	29.4	31.5	33.9				

Jeanty, Philippe, et al., "Estimation of Gestational Age from Measurements of Fetal Long Bones," *J Ultrasound Med*, Feb., 1984; 3:75-79.

FL(GA)Merz: Gestational Age via Merz using Femur Length

Gestational Age (wk + day) via Merz using Femur Length (**FL** range: 0.9 to 7.8 cm). The following table lists the associated standard deviation (SD) in days:

Table 3-14 Gestational Age via FL (Merz)

FL	GA	SD	FL	GA	SD	FL	GA	SD	FL	GA	SD
0.9	12.0	7	3.2	20.0	12	5.3	28.0	16	7.1	36.0	21
1.2	13.0	8	3.5	21.0	12	5.6	28.0	17	7.3	37.0	21
1.5	14.0	8	3.8	22.0	13	5.8	30.0	17	7.5	38.0	21
1.8	15.0	9	4.1	23.0	13	6.0	31.0	18	7.6	39.0	21
2.1	16.0	9	4.3	24.0	14	6.3	32.0	19	7.8	40.0	21
2.4	17.0	10	4.6	25.0	16	6.5	33.0	19			
2.7	18.0	10	4.9	26.0	16	6.7	34.0	20			
3.0	19.0	11	5.1	27.0	16	6.9	35.0	20			

German Society for Gynecology and Obstetrics, March, 1991, Issue 15, Vol. 1, pp. 23-28.

GA(LMP): Gestational Age using today's date and the Last Menstrual Period

Gestational Age (wk+day) using today's date and the Last Menstrual Period (date) equation is:

Date Today – LMP

This calculation is performed automatically, and the value appears on the report header. This calculation does not appear on the touch panels.

Callen, Peter W., *Ultrasonography in Obstetrics and Gynecology*, W. B. Saunders Co., 1982, p. 22.

GSD(GA)Remp: Gestational Age via Rempen using Gestational Sac Diameter

Gestational Age (wk+day) via Rempen using Gestational Sac Diameter (**GS1** range: 0.2 to 7.3 cm). The following table lists the associated standard deviation (SD) in days:

Table 3-15 **Gestational Age via GSD (Rempen)**

GSD	GA	SD	GSD	GA	SD	GSD	GA	SD	GSD	GA	SD
0.2	4.9	10	2.1	7.0	10	3.8	9.1	10	5.6	11.6	10
0.3	5.0	10	2.2	7.1	10	3.9	9.4	10	5.8	11.9	10
0.4	5.1	10	2.3	7.3	10	4.0	9.4	10	5.9	12.0	10
0.6	5.3	10	2.4	7.4	10	4.1	9.6	10	6.0	12.1	10
0.7	5.4	10	2.6	7.6	10	4.2	9.7	10	6.2	12.4	10
0.8	5.6	10	2.7	7.7	10	4.4	9.9	10	6.3	12.6	10
1.0	5.7	10	2.8	7.9	10	4.5	10.0	10	6.4	12.7	10
1.1	5.9	10	2.9	8.0	10	4.7	10.3	10	6.5	12.9	10
1.2	6.0	10	3.0	8.1	10	4.8	10.4	10	6.6	13.0	10
1.3	6.1	10	3.1	8.3	10	4.9	10.5	10	6.8	13.3	10
1.4	6.3	10	3.3	8.4	10	5.0	10.7	10	6.9	13.4	10
1.6	6.4	10	3.4	8.6	10	5.1	10.9	10	7.0	13.5	10
1.7	6.6	10	3.5	8.7	10	5.2	11.0	10	7.1	13.7	10
1.8	6.7	10	3.6	8.9	10	5.4	11.3	10	7.2	14.0	10
2.0	6.9	10	3.7	9.0	10	5.5	11.4	10	7.3	14.1	10

German Society for Gynecology and Obstetrics, March 1991, Issue 15, Vol. 1, pp. 23-28.

HC: Head Circumference

Head Circumference (cm) (normal range: 8.0 to 36.0 cm) may be computed by two means: if **HC(traced)** is present, then **HC = HC(traced)**. If the two head diameters, **BPD** and **OFD**, are present, then:

$$\pi \times \sqrt{(BPD^2 + OFD^2)/2}$$

Hadlock FP, et al., “Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters,” *Radiology*, 1984; 152:497-501.

Kurtz, Alfred B., Goldberg, Barry B., *Obstetrical Measurements in Ultrasound: A Reference Manual*, Year Book Medical Publishers, Inc., 1988, p. 33.

Shields JR, et al., “Fetal Head and Abdominal Circumferences: Ellipse Calculations Versus Planimetry,” *Journal of Clinical Ultrasound*, May 1987;15:237-239.

HC/AC: Head Circumference to Abdominal Circumference Ratio

The ratio (unitless) of Head Circumference (cm) to Abdominal Circumference (cm) equation is:

$$HC/AC$$

The typical range for HC/AC is 0.96 (13 weeks Gestational Age) to 1.23 (41 weeks Gestational Age).

Campbell S, Thoms A, “Ultrasound Measurement of Fetal Head-to-Abdomen Circumference ratio in the Assessment of Growth Retardation,” *British Journal of Obstetrics and Gynecology*, 1977; 84:165-174.

HC(GA)Hadl: Gestational Age via Hadlock using the Head Circumference

The Gestational Age via Hadlock, **HC(GA)Hadl** (in weeks), using the Head Circumference (**HC** range: 5.6 to 35.7 cm), is:

$$8.96 + 0.540(HC) + 0.0003(HC^3)$$

Hadlock FP, et al., “Estimating Fetal Age: Computer Assisted Analysis of Multiple Fetal Growth Parameters,” *Radiology*, 1984; 152:497-501.

HL(GA)Jeant: Gestational Age via Jeanty using Humerus Length

Gestational Age (wk+day) via Jeanty using Humerus Length (**HL** range: 1.0 to 6.9 cm) equation is:

$$9.6519438 + 2.6200391(HL) + 0.26105367(HL)^2$$

The following table lists the associated percentiles in weeks for each value.

Table 3-16 Gestational Age via HL (Jeanty)

HL	5th%	50th %	95th %	HL	5th%	50th %	95th %	HL	5th%	50th %	95th %
1.0	9.9	12.5	15.3	3.0	17.1	19.9	22.5	5.0	26.5	29.3	32.0
1.1	10.1	12.9	15.5	3.1	17.5	20.3	23.0	5.1	27.1	29.9	32.5
1.2	10.4	13.1	15.9	3.2	18.0	20.7	23.5	5.2	27.5	30.3	33.1
1.3	10.9	13.5	16.1	3.3	18.4	21.1	23.9	5.3	28.1	30.9	33.5
1.4	11.1	13.9	16.5	3.4	18.9	21.5	24.3	5.4	28.7	31.4	34.1
1.5	11.4	14.1	16.9	3.5	19.3	22.0	24.9	5.5	29.1	32.0	34.7
1.6	11.9	14.5	17.3	3.6	19.7	22.5	25.1	5.6	29.9	32.5	35.3
1.7	12.1	14.9	17.5	3.7	20.1	22.9	25.7	5.7	30.3	33.1	35.9
1.8	12.5	15.1	18.0	3.8	20.5	23.4	26.1	5.8	30.9	33.5	36.5
1.9	12.9	15.5	18.3	3.9	21.1	23.9	26.5	5.9	31.4	34.1	36.9
2.0	13.1	15.9	18.7	4.0	21.5	24.3	27.1	6.0	32.0	34.9	37.5
2.1	13.5	16.3	19.1	4.1	22.0	24.9	27.5	6.1	32.5	35.3	38.1
2.2	13.9	16.7	19.4	4.2	22.5	25.3	28.0	6.2	33.1	35.9	38.7
2.3	14.3	17.1	19.9	4.3	23.0	25.7	28.5	6.3	33.9	36.5	39.3
2.4	14.7	17.4	20.1	4.4	23.5	26.1	29.0	6.4	34.4	37.1	39.9
2.5	15.1	17.9	20.5	4.5	24.0	26.7	29.5	6.5	35.0	37.7	40.5

Table 3-16 Gestational Age via HL (Jeanty)

HL	5th%	50th %	95th %	HL	5th%	50th %	95th %	HL	5th%	50th %	95th %
2.6	15.5	18.1	21.0	4.6	24.5	27.1	30.0	6.6	35.5	38.3	41.1
2.7	15.9	18.5	21.4	4.7	25.0	27.7	30.5	6.7	36.1	38.9	41.7
2.8	16.3	19.0	21.9	4.8	25.5	28.1	31.0	6.8	36.9	39.5	42.3
2.9	16.7	19.4	22.1	4.9	26.0	28.9	31.5	6.9	37.4	40.1	42.9

Jeanty, Philippe et al., "Estimation of Gestational Age from Measurements of Fetal Long Bones," *J Ultrasound Med*, Feb., 1984; 3:75-79.

LOV: Left Ovarian Volume

The Ovarian Volume (cc) equation is:

$$Length \times Width \times Thickness \times 0.5233$$

Andolf, Ellika, et al., "Ultrasound Measurement of the Ovarian Volume," *Acta Obstet Gynecol Scand*, 1987, 66:387-389.

L Ov A PI: Left Ovarian Artery Pulsatility Index

(see PI on page 3-41)

L Ov A RI: Left Ovarian Artery Resistivity Index

(see RI on page 3-43)

L Ov A SV/DV: Left Ovarian Artery Systolic Velocity to Diastolic Velocity Ratio

(see S/D Ratio on page 3-45)

LPA accel I: Left Pulmonary Artery Acceleration Index

(see AI on page 3-14)

LPA DV/SV: Left Pulmonary Artery Diastolic Velocity to Systolic Velocity Ratio

(see D/S Ratio on page 3-27)

LPA PI: **Left Pulmonary Artery Pulsatility Index**
(see PI on page 3-41)

LPA RI: **Left Pulmonary Artery Resistivity Index**
(see RI on page 3-43)

LPA SV/DV: **Left Pulmonary Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

LRV: **Left Renal Volume**

The Renal Volume (cc) equation is:

$$Length \times Width \times Thickness \times 0.5233$$

Jeanty, Philippe, "Measurement of Fetal Kidney Growth on Ultrasound," *Radiology*, July, 1982, 144:159-162.

L Ut A PI: **Left Uterine Artery Pulsatility Index**
(see PI on page 3-41)

L Ut A RI: **Left Uterine Artery Resistivity Index**
(see RI on page 3-43)

L Ut A SV/DV: **Left Uterine Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

MPA accel I: **Main Pulmonary Artery Acceleration Index**
(see AI on page 3-14)

MPA DV/SV: **Main Pulmonary Artery Diastolic Velocity to Systolic Velocity Ratio**
(see D/S Ratio on page 3-27)

MPA PI: Main Pulmonary Artery Pulsatility Index

(see PI on page 3-41)

MPA RI: Main Pulmonary Artery Resistivity Index

(see RI on page 3-43)

MPA SV/DV: Main Pulmonary Artery Systolic Velocity to Diastolic Velocity Ratio

(see S/D Ratio on page 3-45)

MSD(GA)Hellm: Gestational Age via Hellman using Mean Gestational Sac diameter

Gestational Age (wk+day) via Hellman using Mean Gestational Sac diameter (Gestational Sac Diameter range: 1.0 cm (5.0 weeks) to 6.0 cm (12.2 weeks)) equation is:

$$(10((GS1 + GS2 + GS3)/3) + 25.43)/7.02$$

Hellman LM, Kobayashi M, Fillisti L, Lavenhar M, and Cromb E, “Growth and Development of the Human Fetus Prior to the Twentieth Week of Gestation,” *Amer J Ob Gyn*, 1969; 103:789-800.

PI: Pulsatility Index

The pulsatility index, **PI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), a minimum velocity, $\mathbf{v}_{min}$ (cm/s), and a mean velocity, $\mathbf{v}_{mean}$ (cm/s), is:

$$PI = \frac{Vmax - Vmin}{Vmean}$$

Burns, Peter N., “The Physical Principles of Doppler and Spectral Analysis,” *Journal of Clinical Ultrasound*, Nov./Dec., 1987, Vol. 15, No. 9, p. 585.

Prev GA: **Gestational Age from a Previous Exam**

Manually entered by clinician on Patient Information or OB Report screen. Used to automatically calculate **Derived GA,** when previous exam (**Prev Exam**) date is entered.
(see Derived GA formula on page 3-26)

Note: These labels do not appear on the touch panels.

Pulsatility 1: **Pulsatility Index Calculation # 1**
(see PI on page 3-41)

Pulsatility 2: **Pulsatility Index Calculation # 2**
(see PI on page 3-41)

Renal L A accel I: Left Renal Artery Acceleration Index
(see AI on page 3-14)

Renal L A DV/SV: Left Renal Artery Diastolic Velocity to Systolic Velocity Ratio
(see D/S Ratio on page 3-27)

Renal L A PI: **Left Renal Artery Pulsatility Index**
(see PI on page 3-41)

Renal L A RI: **Left Renal Artery Resistivity Index**
(see RI on page 3-43)

Renal L A SV/DV: Left Renal Artery Systolic Velocity to Diastolic Velocity Ratio
(see S/D Ratio on page 3-45)

Renal R A accel I: Right Renal Artery Acceleration Index
(see AI on page 3-14)

Renal R A DV/SV: Right Renal Artery Diastolic Velocity to Systolic Velocity Ratio
(see D/S Ratio on page 3-27)

Renal R A PI: **Right Renal Artery Pulsatility Index**
(see PI on page 3-41)

Renal R A RI: **Right Renal Artery Resistivity Index**
(see RI on page 3-43)

Renal R A SV/DV: **Right Renal Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

RI: **Resistivity Index**

The resistivity index, **RI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), and a minimum velocity, $\mathbf{v}_{min}$ (cm/s), for a vessel is:

$$RI = \frac{Vmax - Vmin}{Vmax}$$

Burns, PN, "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, November/December, 1987, Vol. 15, No. 9, p. 586.

Resistivity 1: **Resistivity Index Calculation # 1**
(see RI on page 3-43)

Resistivity 2: **Resistivity Index Calculation # 2**
(see RI on page 3-43)

ROV: **Right Ovarian Volume**
(see LOV on page 3-39)

R Ov A PI: **Right Ovarian Artery Pulsatility Index**
(see PI on page 3-41)

R Ov A RI: **Right Ovarian Artery Resistivity Index**
(see RI on page 3-43)

R Ov A SV/DV: **Right Ovarian Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

RPA accel I: **Right Pulmonary Artery Acceleration Index**
(see AI on page 3-14)

RPA DV/SV: **Right Pulmonary Artery Diastolic Velocity to Systolic Velocity Ratio**
(see D/S Ratio on page 3-27)

RPA PI: **Right Pulmonary Artery Pulsatility Index**
(see PI on page 3-41)

RPA RI: **Right Pulmonary Artery Resistivity Index**
(see RI on page 3-43)

RPA SV/DV: **Right Pulmonary Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

RRV: **Right Renal Volume**
(see LRV on Table page 3-40)

R Ut A PI: **Right Uterine Artery Pulsatility Index**
(see PI on page 3-41)

R Ut A RI: **Right Uterine Artery Resistivity Index**
(see RI on page 3-43)

R Ut A SV/DV: **Right Uterine Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

S/D Ratio: Systolic to Diastolic Ratio

The equation for the systolic-to-diastolic ratio, **r** (unitless), given the systolic velocity, $\mathbf{v_s}$ (cm/s), and the end-diastolic velocity, $\mathbf{v_d}$ (cm/s), is:

$$r = \frac{v_s}{v_d}$$

Ameriso S, et al., "Pulseless Transcranial Doppler Finding in Takayasu's Arteritis," *J Clin Ultrasound*, September, 1990; 18:592-6.

TC: Thoracic Circumference

Thoracic Circumference may be computed by two means: if **TC (traced)** is present, then **TC = TC (traced)**. If the two thoracic diameters, **TDtrv** and **TDap** are present, then:

$$\pi \times \sqrt{(TDtrv^2 + TDap^2)/2}$$

Kurtz, Alfred B., Goldberg, Barry B., *Obstetrical Measurements in Ultrasound: A Reference Manual*, Year Book Medical Publishers, Inc., 1988, p. 33.

TC/AC: Thoracic Circumference to Abdominal Circumference Ratio

The ratio (unitless) of Thoracic Circumference (cm) to Abdominal Circumference (cm) is:

$$TC/AC$$

D'Alton, M. et al, "Serial Thoracic Versus Abdominal Circumference Ratios for the Prediction of Pulmonary Hypoplasia in Premature Rupture of the Membranes Remote from Term," *Am J Obstet Gynecol*, Volume 166, Number 2, February, 1992.

TC(GA)Nim: Gestational Age via Nimrod using Thoracic Circumference

Gestational Age (wk+day) via Nimrod using Thoracic Circumference (**TC** range: 13.0 to 35.0 cm) equation is:

$$(TC + 0.44)/0.79$$

Nimrod, C., et al., "Ultrasound Prediction of Pulmonary Hypoplasia," *Obstet Gynecol*, 1986; 68:495-498.

ThorAo accel I: Thoracic Aorta Acceleration Index

(see AI on page 3-14)

ThorAo DV/SV: Thoracic Aorta Diastolic Velocity to Systolic Velocity Ratio

(see D/S Ratio on page 3-27)

ThorAo PI: Thoracic Aorta Pulsatility Index

(see PI on page 3-41)

ThorAo RI: Thoracic Aorta Resistivity Index

(see RI on page 3-43)

ThorAo SV/DV: Thoracic Aorta Systolic Velocity to Diastolic Velocity Ratio

(see S/D Ratio on page 3-45)

TL(GA)Jeant: Gestational Age via Jeanty using Tibial Length

Gestational Age (wk+day) via Jeanty using Tibial Length (**TL** range: 1.0 to 6.9 cm) equation is:

$$10.055043 + 3.1317668 \times TL + 0.16814056 \times (TL)^2$$

The following table lists the associated percentiles in weeks for each value.

Table 3-17 Gestational Age via TL (Jeanty)

TL	5th%	50th %	95th %	TL	5th%	50th %	95th %	TL	5th%	50th %	95th %
1.0	10.5	13.4	16.3	3.0	18.1	21.0	23.9	5.0	27.0	29.9	32.9
1.1	10.9	13.7	16.5	3.1	18.5	21.4	24.3	5.1	27.5	30.4	33.3
1.2	11.1	14.1	17.0	3.2	18.9	21.9	24.7	5.2	28.0	30.9	33.9
1.3	11.5	14.4	17.3	3.3	19.3	22.1	25.1	5.3	28.5	31.4	34.3
1.4	11.9	14.9	17.7	3.4	19.7	22.5	25.5	5.4	29.0	31.9	34.9
1.5	12.1	15.1	18.0	3.5	20.1	23.1	26.0	5.5	29.5	32.4	35.3

Table 3-17 **Gestational Age via TL (Jeanty)**

TL	5th%	50th %	95th %	TL	5th%	50th %	95th %	TL	5th%	50th %	95th %
1.6	12.5	15.5	18.4	3.6	20.5	23.5	26.4	5.6	30.0	32.9	35.9
1.7	13.0	15.9	18.9	3.7	21.0	23.9	26.9	5.7	30.5	33.4	36.3
1.8	13.2	16.1	19.1	3.8	21.5	24.4	27.3	5.8	31.0	33.9	36.9
1.9	13.7	16.5	19.5	3.9	21.9	24.9	27.7	5.9	31.5	34.4	37.3
2.0	14.1	17.0	19.9	4.0	22.4	25.3	28.1	6.0	32.0	34.9	37.9
2.1	14.5	17.4	20.3	4.1	22.9	25.7	28.5	6.1	32.5	35.4	38.3
2.2	14.9	17.9	20.7	4.2	23.3	26.1	29.1	6.2	33.0	35.9	38.9
2.3	15.1	18.1	21.1	4.3	23.7	26.5	29.5	6.3	33.5	36.5	39.4
2.4	15.5	18.5	21.4	4.4	24.1	27.1	30.0	6.4	34.1	37.0	39.9
2.5	16.0	18.9	21.9	4.5	24.5	27.5	30.5	6.5	34.5	37.5	40.4
2.6	16.4	19.3	22.1	4.6	25.1	28.0	30.6	6.6	35.1	38.0	41.0
2.7	16.9	19.7	22.5	4.7	25.5	28.5	31.4	6.7	35.7	38.5	41.5
2.8	17.1	20.1	23.0	4.8	26.1	29.0	31.9	6.8	36.1	39.1	42.0
2.9	17.5	20.5	23.5	4.9	26.5	29.4	32.3	6.9	36.9	39.7	42.5

Jeanty, Philippe et al., “Estimation of Gestational Age from Measurements of Fetal Long Bones,” *J Ultrasound Med*, Feb., 1984; 3:75-79.

UL(GA)Jeant: Gestational Age via Jeanty using Ulnar Length

Gestational Age (wk+day) via Jeanty using Ulnar Length (**UL** range: 1.0 to 6.4 cm) equation is:

$$10.034368 + 2.8625722 \times UL + 0.2912470 \times (UL)^2$$

The following table lists the associated percentiles in weeks for each value.

Table 3-18 Gestational Age via UL (Jeanty)

UL	5th%	50th %	95th %	UL	5th%	50th %	95th %	UL	5th%	50th %	95th %
1.0	10.1	13.1	16.1	3.0	18.1	21.1	24.3	5.0	28.5	31.5	34.7
1.1	10.5	13.5	16.5	3.1	18.5	21.7	24.9	5.1	29.1	32.1	35.3
1.2	10.9	13.9	16.9	3.2	19.1	22.1	25.1	5.2	29.7	32.9	35.9
1.3	11.1	14.1	17.3	3.3	19.5	22.7	25.7	5.3	30.3	33.4	36.4
1.4	11.5	14.5	17.7	3.4	20.1	23.1	26.1	5.4	30.9	34.0	37.0
1.5	11.9	15.0	18.0	3.5	20.5	23.6	26.7	5.5	31.5	34.5	37.7
1.6	12.3	15.4	18.4	3.6	21.1	24.1	27.1	5.6	32.1	35.1	38.3
1.7	12.7	15.7	18.9	3.7	21.5	24.5	27.7	5.7	32.9	35.9	38.9
1.8	13.1	16.1	19.1	3.8	22.1	25.1	28.1	5.8	33.4	36.4	39.5
1.9	13.5	16.5	19.5	3.9	22.5	25.5	28.7	5.9	34.0	37.1	40.1
2.0	13.9	16.9	20.0	4.0	23.1	26.1	29.1	6.0	34.5	37.7	40.9
2.1	14.3	17.3	20.4	4.1	23.5	26.7	29.7	6.1	35.3	38.3	41.4
2.2	14.7	17.7	20.9	4.2	24.1	27.1	30.3	6.2	35.9	39.0	42.0
2.3	15.1	18.1	21.1	4.3	24.7	27.7	30.9	6.3	36.5	39.5	42.7
2.4	15.5	18.5	21.5	4.4	25.1	28.3	31.3	6.4	37.1	40.3	43.3
2.5	16.0	19.0	22.1	4.5	25.9	28.9	31.9				
2.6	16.4	19.4	22.5	4.6	26.3	29.4	32.4				
2.7	16.9	19.9	22.9	4.7	26.9	29.9	33.0				
2.8	17.3	20.3	23.4	4.8	27.4	30.5	33.5				
2.9	17.7	20.9	23.9	4.9	28.0	31.1	34.1				

Jeanty, Philippe et al., “Estimation of Gestational Age from Measurements of Fetal Long Bones,” *J Ultrasound Med*, Feb.1984; 3:75-79.

Um A accel I: **Umbilical Artery Acceleration Index**
(see AI on page 3-14)

Um A PI: **Umbilical Artery Pulsatility Index**
(see PI on page 3-41)

Um A RI: **Umbilical Artery Resistivity Index**
(see RI on page 3-43)

Um A SV/DV: **Umbilical Artery Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 3-45)

UTV: **Uterine Volume**

The Uterine Volume (cc) equation is:

$$Length \times Width \times Thickness \times 0.5233$$

Goldstein, S.R., et al., “Estimation of Nongravid Uterine Volume Based on a Nomogram of Gravid Uterine Volume: Its Value in Gynecologic Uterine Abnormalities,” *Obstetrics & Gynecology*, July, 1988, 72, No. 1:86-90.

Levine, Sandra, Filly, Roy, Creasy, Robert K., “Identification of Fetal Growth Retardation by Ultrasonographic Estimation of Total Intrauterine Volume,” *J Clin Ultrasound*, 1979, 7:21-26.

4

Vascular Measurements and Calculations

Contains the definitions for the Vascular measurements and calculations available on your Philips SONOS ultrasound system.

Vascular Measurements

The following table shows all Vascular measurements available on the Philips SONOS ultrasound system. You may not see all of these on your system, depending on the options purchased. These abbreviations appear on the left touch panel and in measurement boxes displayed on the screen during measurement and analysis operations.

Note that some measurements have **L**, **R**, or **M/Mn** (for Left, Right, or Middle/Main) before the acronym. You will not see these characters on the system touch panel; identification of a measurement as **L, R**, or **M/Mn** means that the **Left**, **Right**, or **Mid/Main** control is active at the time the measurement is accessed.

Table 4-1 **Abdominal Vascular Measurements**

Abbreviation	Meaning
Abdominal Vessels	
CA	Celiac Axis
DescAo	Descending Aorta
GDA	Gastroduodenal Artery
HA	Hepatic Artery
IMA	Inferior Mesenteric Artery
IMV	Inferior Mesenteric Vein
IVC	Inferior Vena Cava
LGA	Left Gastric Artery
LHV	Left Hepatic Vein
LPV	Left Portal Vein
LRA	Left Renal Artery
LRV	Left Renal Vein
LSegRA	Left Segmental Renal Artery
MHV	Middle Hepatic Vein

Table 4-1 **Abdominal Vascular Measurements *(Continued)***

Abbreviation	Meaning
MnPV	Main Portal Vein
RHV	Right Hepatic Vein
RPV	Right Portal Vein
RRA	Right Renal Artery
RRV	Right Renal Vein
RSegRA	Right Segmental Renal Artery
SA	Splenic Artery
SMA	Superior Mesenteric Artery
SMV	Superior Mesenteric Vein
SV	Splenic Vein
Doppler Velocity Measurements	
accel T	Acceleration Time
DV	Diastolic Velocity
Max vel	Maximum Velocity
SV	Systolic Velocity
Generic Doppler Velocity Measurements	
DV1	Diastolic Velocity 1
DV2	Diastolic Velocity 2
SV1	Systolic Velocity 1
SV2	Systolic Velocity 2
SV3	Systolic Velocity 3
V1 accel T	Acceleration Time 1

Table 4-1 **Abdominal Vascular Measurements *(Continued)***

Abbreviation	Meaning
V1 delay T	Delay Time 1
V2 accel T	Acceleration Time 2
V2 delay T	Delay Time 2
Pulsatility and Resistivity Measurements	
MeanV (PI)	Mean Velocity Pulsatility Index
MnV (PI,RI)	Minimum Velocity Pulsatility Index, Resistivity Index
MxV (PI,RI)	Maximum Velocity Pulsatility Index, Resistivity Index
Generic Pulsatility and Resistivity Measurements	
Max vel (PI,RI)	Maximum Velocity Pulsatility Index, Resistivity Index
Mean vel(PI)	Mean Velocity Pulsatility Index
Min vel (PI,RI)	Minimum Velocity Pulsatility Index, Resistivity Index
B-mode Measurements	
area resid	Residual Area
area true	True Area
diam resid	Residual Diameter
diam true	True Diameter
Renal Height	Renal Height
Renal Length	Renal Length
Renal Width	Renal Width

Table 4-1 **Abdominal Vascular Measurements *(Continued)***

Abbreviation	Meaning
Generic B-mode Measurements	
Area resid	Residual Area
Area true	True Area
Diam resid	Residual Diameter
Diam true	True Diameter
Flow Volume Measurements	
area (FloV)	Area Flow Volume
diam (FloV)	Diameter Flow Volume
MeanV (FloV)	Mean Velocity Flow Volume
Generic Flow Volume Measurements	
Area (FloV)	Area Flow Volume
Diam (FloV)	Diameter Flow Volume
Mean vel (FloV)	Mean Velocity Flow Volume
Frequency Measurements	
DF	Diastolic Frequency
Max freq	Maximum Frequency
SF	Systolic Frequency
Generic Frequency Measurements	
DF 1	Diastolic Frequency 1
DF 2	Diastolic Frequency 2

Table 4-1 **Abdominal Vascular Measurements *(Continued)***

Abbreviation	Meaning
SF 1	Systolic Frequency 1
SF 2	Systolic Frequency 2
SF 3	Systolic Frequency 3

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
Carotid	
CCA	Common Carotid Artery
ECA	External Carotid Artery
ICA	Internal Carotid Artery
IJV	Internal Jugular Vein
SCA	Subclavian Artery
VA	Vertebral Artery
Upper Extremity Vessels	
AA	Axillary Artery
AV	Axillary Vein
BA	Brachial Artery
BASV	Basilic Vein
BCA	Brachiocephalic Artery
BCV	Brachiocephalic Vein
BV	Brachial Vein
CCA	Common Carotid Artery
CV	Cephalic Vein
DPA	Deep Palmar Arch
ECA	External Carotid Artery
ICA	Internal Carotid Artery
IJV	Internal Jugular Vein
PBA	Profunda Brachialis Artery

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
PBV	Profunda Brachialis Vein
RA	Radial Artery
RV	Radial Vein
SCA	Subclavian Artery
SCV	Subclavian Vein
SPA	Superficial Palmar Arch
UA	Ulnar Artery
UV	Ulnar Vein
VA	Vertebral Artery
Lower Extremity Vessels	
ATA	Anterior Tibial Artery
ATV	Anterior Tibial Vein
CFA	Common Femoral Artery
CFV	Common Femoral Vein
CIA	Common Iliac Artery
CIV	Common Iliac Vein
DPA	Dorsalis Pedis Artery
EIA	External Iliac Artery
EIV	External Iliac Vein
IIA	Internal Iliac Artery
IIV	Internal Iliac Vein
PA	Popliteal Artery
PERA	Peroneal Artery

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
PERV	Peroneal Vein
PFA	Profunda Femoris Artery
PFV	Profunda Femoris Vein
PTA	Posterior Tibial Artery
PTV	Posterior Tibial Vein
PV	Popliteal Vein
SFA	Superficial Femoral Artery
SFV	Superficial Femoral Vein
Cranial Vessels	
ACA	Anterior Cerebral Artery
ACOM	Anterior Communicating
BA	Basilar Artery
ICA	Internal Carotid Artery
MCA	Middle Cerebral Artery
OA	Ophthalmic Artery
PCA	Posterior Cerebral Artery
PCOM	Posterior Communicating
VA	Vertebral Artery
B-Mode Measurements	
area (FloV)	Area Flow Volume
area resid	Residual Area
area true	True Area

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
diam (FloV)	Diameter Flow Volume
diam resid	Residual Diameter
diam true	True Diameter
Upper and Lower Extremity Vascular Arterial Doppler Measurements	
accel T	Acceleration Time
DF	End Diastolic Frequency
DV	End Diastolic Velocity
mean (FloV)	Mean Velocity for Flow Volume Calculations
mean v (PI)	Mean Velocity
MnV (PI,RI)	Minimum Velocity used in PI and RI Calculations
MxV (PI,RI)	Maximum Velocity used in PI and RI Calculations
Pk-Pk	Peak to Peak Time
SF	Peak Systolic Frequency
SV	Peak Systolic Velocity
Upper and Lower Extremity Vascular Venous Doppler Measurements	
delay T	Delay Time
Max Freq	Maximum Frequency
Max Vel	Maximum Velocity
Generic Doppler Measurements	
Accel Time 1	Acceleration Time 1
Accel Time 2	Acceleration Time 2

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
Accel Time 3	Acceleration Time 3
Delay Time 1	Delay Time 1
Delay Time 2	Delay Time 2
Delay Time 3	Delay Time 3
DF 1	End Diastolic Frequency 1
DF 2	End Diastolic Frequency 2
DF 3	End Diastolic Frequency 3
DV 1	End Diastolic Velocity 1
DV 2	End Diastolic Velocity 2
DV 3	End Diastolic Velocity 3
Max freq 1	Maximum Frequency 1
Max freq 2	Maximum Frequency 2
Max freq 3	Maximum Frequency 3
Max vel 1	Maximum Velocity 1
Max vel 2	Maximum Velocity 2
Max vel 3	Maximum Velocity 3
Mean Vel 1	Mean Velocity 1
Mean Vel 2	Mean Velocity 2
Mean Vel 3	Mean Velocity 3
Mean V(FloV)	Mean Velocity
Min freq 1	Minimum Frequency 1
Min freq 2	Minimum Frequency 2
Min freq 3	Minimum Frequency 3
Min vel 1	Minimum Velocity 1

Table 4-2 **Carotid, Upper and Lower Extremity, and Cranial Vascular Measurements**

Abbreviation	Meaning
Min vel 2	Minimum Velocity 2
Min vel 3	Minimum Velocity 3
SF 1	Peak Systolic Frequency 1
SF 2	Peak Systolic Frequency 2
SF 3	Peak Systolic Frequency 3
SV 1	Peak Systolic Velocity 1
SV 2	Peak Systolic Velocity 2
SV 3	Peak Systolic Velocity 3

Abdominal Vascular Calculations

This section lists in alphabetical order by abbreviation, the abdominal vascular calculations, available on the Philips SONOS ultrasound system. All calculation labels which display in Measurements and Results boxes on the imaging screen or on the control panel are listed. In addition to abbreviation and meaning, formulas and clinical references are listed.

%Area Sten: Percent Area Stenosis

The percentage of stenosis, **S** (%), equation, given a true lumen area, $\mathbf{A_{true}}$ (cm^2), and the residual lumen area, $\mathbf{A_{residual}}$ (cm^2), is:

$$S = 100\left(\frac{A_{true} - A_{residual}}{A_{true}}\right)$$

Diagnostic ranges: 0-20%, normal; 20-60%, mild; 60-80%, moderate; 80-90%, severe; 90-99%, critical; 100%, occluded.

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

%Diam Sten: Percent Diameter Stenosis

The percentage of stenosis, **S** (%), equation, given a true lumen diameter, $\mathbf{D_{true}}$ (cm), and the residual lumen diameter, $\mathbf{D_{residual}}$ (cm), is:

$$S = 100\left(\frac{D_{true} - D_{residual}}{D_{true}}\right)$$

Diagnostic ranges: 0-20%, normal; 20-60%, mild; 60-80%, moderate; 80-90%, severe; 90-99%, critical; 100%, occluded.

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

accel I: **Acceleration Index**
(see AI on page 4-13)

AI: **Acceleration Index**

The acceleration index, **AI** (m/s^2), given a systolic velocity, **Vs**(cm/s), a diastolic velocity **Vd**(cm/s), and an onset-to-peak time, **T**, for a vessel is:

$$AI = \frac{V_s - V_d}{T \times 100}$$

Stavros, A.T., et al., “Segmental Stenosis of the Renal Artery: Pattern Recognition of Tardus and Parvus Abnormalities with Duplex Sonography,” *Radiology*, 1992; 184:487-492.

area sten: **Percent Area Stenosis**
(see % Area Sten on page 4-12)

CA/DescAo: **Celiac Axis to Descending Aorta Ratio**
(see Systolic Ratio on page 4-18)

DF/SF: **Diastolic Frequency to Systolic Frequency Ratio**
(see D/S Ratio on page 4-14)

DF 1/DF 2: **Diastolic Frequency 1 to Diastolic Frequency 2 Ratio**
(see Diastolic Ratio on page 4-14)

DF 1/SF 1: **Diastolic Frequency 1 to Systolic Frequency 1 Ratio**
(see D/S Ratio on page 4-14)

DF 2/SF 2: **Diastolic Frequency 2 to Systolic Frequency 2 Ratio**
(see D/S Ratio on page 4-14)

diam sten: **Percent Diameter Stenosis**
(see % Diam Sten on page 4-12)

Diastolic Ratio

The equation for the Diastolic Ratio, **r** (unitless), given the end-diastolic velocity for vessel 1, $\mathbf{v_1}$ (cm/s), and the end-diastolic velocity for velocity 2, $\mathbf{v_2}$ (cm/s), is:

$$r = \frac{v_1}{v_2}$$

Daigle RJ, et al., "Velocity Criteria for Differentiation of 60%-70% Carotid Stenoses from 80% or Greater Stenoses," *J Vasc Technology*, July, 1988; 177-83.

D/S Ratio: Diastolic to Systolic Ratio

The equation for the diastolic-to-systolic ratio, **r** (unitless), given the systolic velocity, $\mathbf{v_s}$ (cm/s), and the end-diastolic velocity, $\mathbf{v_d}$ (cm/s), is

$$r = \frac{v_d}{v_s}$$

Neumyer, Marsha M. et al., "The Differentiation of Renal Artery Stenosis from Renal Parenchymal Disease by Duplex Ultrasonography," *Journal of Vascular Technology*, Scientific Article, October, 1989, p. 205-216.

DV/SV: Diastolic Velocity to Systolic Velocity Ratio

(see D/S Ratio on page 4-14)

DV 1/DV 2: Diastolic Velocity 1 to Diastolic Velocity 2 Ratio

(see Diastolic Ratio on page 4-14)

DV 1/SV 1: Diastolic Velocity 1 to Systolic Velocity 1 Ratio

(see D/S Ratio on page 4-14)

DV 2/SV 2: Diastolic Velocity 2 to Systolic Velocity 2 Ratio

(see D/S Ratio on page 4-14)

FlowV(D): Diameter Flow Volume

(see Flow vol(D) on page 4-15)

Flow vol(A): Area Flow Volume

The flow volume, **V** (l/min), equation, given a flow area, **A** (cm^2), and a flow mean velocity, **v** (cm/s), is:

$$V = \frac{60}{1000}Av$$

Burns, PN, "The Physical Principles of Doppler and Spectral Analysis," *J Clin Ultrasound*, November/December, 1987; 15(9):587.

NOTE

Mean-of-the-means velocity is used as the mean velocity in the flow volume calculation.

Gill, RW, "Measurement of Blood Flow by Ultrasound: Accuracy and Sources of Error," *Ultrasound in Med. & Biol.*, July/August, 1985; 11(4): 625-641.

Flow vol(D): Diameter Flow Volume

The flow volume, **V** (l/min), equation, given a flow diameter, **D** (cm), and a flow mean velocity, **v** (cm/s), is:

$$V = \frac{60}{1000}\pi\left(\frac{D}{2}\right)^2 v$$

Burns PN, "The Physical Principles of Doppler and Spectral Analysis," *J Clin Ultrasound*, November/December, 1987; 15(9):587.

NOTE

Mean-of-the-means velocity is used as the mean velocity in the flow volume calculation.

Gill, RW, "Measurement of Blood Flow by Ultrasound: Accuracy and Sources of Error," *Ultrasound in Med. & Biol.*, July/August, 1985; 11(4): 625-641

PI: Pulsatility Index

The pulsatility index, **PI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), a minimum velocity, $\mathbf{v}_{min}$ (cm/s), and a mean velocity, $\mathbf{v}_{mean}$ (cm/s), is:

$$PI = \frac{Vmax - Vmin}{Vmean}$$

Burns, Peter N., "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, Nov./Dec., 1987, Vol. 15, No. 9, p. 585.

Pulsatility: Pulsatility Index

(see PI on page 4-16)

RAR: Renal Aortic Systolic Velocity Ratio

(see Systolic Ratio on page 4-18)

Resistivity: Resistivity Index

(see RI page 4-16)

RI: Resistivity Index

The resistivity index, **RI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), and a minimum velocity, $\mathbf{v}_{min}$ (cm/s), for a vessel is:

$$RI = \frac{Vmax - Vmin}{Vmax}$$

Burns, PN, "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, November/December, 1987, Vol. 15, No. 9, p. 586.

S/D Ratio: **Systolic to Diastolic Ratio**

The equation for the systolic-to-diastolic ratio, **r** (unitless), given the systolic velocity, $\mathbf{v}_s$ (cm/s), and the end-diastolic velocity, $\mathbf{v}_d$ (cm/s), is:

$$r = \frac{v_s}{v_d}$$

Ameriso S, et al., "Pulseless Transcranial Doppler Finding in Takayasu's Arteritis," *J Clin Ultrasound*, September, 1990; 18:592-6.

SF/DF: **Systolic Frequency to Diastolic Frequency Ratio**
(see S/D Ratio on page 4-17)

SF 1/DF 1: **Systolic Frequency 1 to Diastolic Frequency Ratio 1**
(see S/D Ratio on page 4-17)

SF 1/SF 2: **Systolic Frequency 1 to Systolic Frequency 2 Ratio**
(see Systolic Ratio on page 4-18)

SMA/DescAo: **Superior Mesenteric Artery to Descending Aorta Ratio**
(see Systolic Ratio on page 4-18)

SV/DV: **Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 4-17)

SV 1/DV 1: **Systolic Velocity 1 to Diastolic Velocity 1 Ratio**
(see S/D Ratio on page 4-17)

SV 1/SV 2: **Systolic Velocity 1 to Systolic Velocity 2 Ratio**
(see Systolic Ratio on page 4-18)

Systolic Ratio:

The equation for the systolic ratio, **r** (unitless), given the end-systolic velocity for vessel 1, $\mathbf{v_1}$ (cm/s), and the end-systolic velocity for velocity 2, $\mathbf{v_2}$ (cm/s), is:

$$r = \frac{v_1}{v_2}$$

Garth K, Carroll B, et al., "Duplex Ultrasound Scanning of the Carotid Arteries with Velocity Spectrum Analysis," *Radiology*, June, 1983; 147:826.

V1 accel I:

Acceleration Index
(see AI on page 4-13)

V2 accel I:

Acceleration Index
(see AI on page 4-13)

Carotid Upper/Lower Extremity and Cranial Vascular Calculations

%Area Sten: Percent Area Stenosis

The percentage of stenosis, **S** (%), equation, given a true lumen area, $\mathbf{A_{true}}$ (cm^2), and the residual lumen area, $\mathbf{A_{residual}}$ (cm^2), is:

$$S = 100\left(\frac{A_{true} - A_{residual}}{A_{true}}\right)$$

Diagnostic ranges: 0-20%, normal; 20-60%, mild; 60-80%, moderate; 80-90%, severe; 90-99%, critical; 100%, occluded.

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

%Diam Sten: Percent Diameter Stenosis

The percentage of stenosis, **S** (%), equation, given a true lumen diameter, $\mathbf{D_{true}}$ (cm), and the residual lumen diameter, $\mathbf{D_{residual}}$ (cm), is:

$$S = 100\left(\frac{D_{true} - D_{residual}}{D_{true}}\right)$$

Diagnostic ranges: 0-20%, normal; 20-60%, mild; 60-80%, moderate; 80-90%, severe; 90-99%, critical; 100%, occluded.

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

accel I: **Acceleration Index**
(see AI on page 4-13)

Accel Index: **Acceleration Index**
(see AI on page 4-13)

area sten: **Percent Area Stenosis**
(see % Area Sten on page 4-19)

DF 1/DF 2: **Diastolic Frequency 1 to Diastolic Frequency 2 Ratio**
(see Diastolic Ratio on page 4-14)

DF 1/SF 1: **Diastolic Frequency 1 to Systolic Frequency 1 Ratio**
(see D/S Ratio on page 4-14)

DF 1/SF 2: **Diastolic Frequency 1 to Systolic Frequency 2 Ratio**
(see D/S Ratio on page 4-14)

DF 2/DF 1: **Diastolic Frequency 2 to Diastolic Frequency 1 Ratio**
(see Diastolic Ratio on page 4-14)

DF 2/SF 1: **Diastolic Frequency 2 to Systolic Frequency 1 Ratio**
(see D/S Ratio on page 4-14)

diam sten: **Percent Diameter Stenosis**
(see% Diam Sten on page 4-19)

DV 1/DV 2: **Diastolic Velocity 1 to Diastolic Velocity 2 Ratio**
(see Diastolic Ratio on page 4-14)

DV 1/SV 1: **Diastolic Velocity 1 to Systolic Velocity 1 Ratio**
(see D/S Ratio on page 4-14)

DV 2/SV 2: **Diastolic Velocity 2 to Systolic Velocity 2 Ratio**
(see D/S Ratio on page 4-14)

DV 2/DV 1: **Diastolic Velocity 2 to Diastolic Velocity 1 Ratio**
(see Diastolic Ratio on page 4-14)

DV 2/SV 1: **Diastolic Velocity 2 to Systolic Velocity 1 Ratio**
(see D/S Ratio on page 4-14)

FlowV(A): **Area Flow Volume**
(see Flow vol(A) on page 4-15)

FlowV(D): **Diameter Flow Volume**
(see Flow vol(D) on page 4-15)

ICA/CCA DF: **Internal Carotid Artery Diastolic Frequency to Common Carotid Artery Diastolic Frequency**
(see Diastolic Ratio on page 4-14)

ICA/CCA DV: **Internal Carotid Artery Diastolic Velocity to Common Carotid Artery Diastolic Velocity**
(see Diastolic Ratio on page 4-14)

ICA/CCA SF: **Internal Carotid Artery Systolic Frequency to Common Carotid Artery Systolic Frequency**
(see Systolic Ratio on page 4-18)

ICA/CCA SV: **Internal Carotid Artery Systolic Velocity to Common Carotid Artery Systolic Velocity**
(see Systolic Ratio on page 4-18)

Max Frq1/Max Frq2:
Maximum Frequency 1 to Maximum Frequency 2 Ratio
(see Systolic Ratio on page 4-18)

Max Frq1/Max Frq3:
Maximum Frequency 1 to Maximum Frequency 3 Ratio
(see Systolic Ratio on page 4-18)

Max Frq1/Min Frq1:
Maximum Frequency 1 to Minimum Frequency 1 Ratio
(see S/D Ratio on page 4-17)

Max Frq1/Min Frq2:
Maximum Frequency 1 to Minimum Frequency 2 Ratio
(see S/D Ratio on page 4-17)

Max Frq2/Max Frq1:
Maximum Frequency 2 to Maximum Frequency 1 Ratio
(see Systolic Ratio on page 4-18)

Max Frq2/Max Frq3:
Maximum Frequency 2 to Maximum Frequency 3 Ratio
(see Systolic Ratio on page 4-18)

Max Frq2/Min Frq1:
Maximum Frequency 2 to Minimum Frequency 1 Ratio
(see S/D Ratio on page 4-17)

Max Frq3/Max Frq1:
Maximum Frequency 3 to Maximum Frequency 1 Ratio
(see Systolic Ratio on page 4-18)

Max Frq3/Max Frq2:
Maximum Frequency 3 to Maximum Frequency 2 Ratio
(see Systolic Ratio on page 4-18)

Max Vel1/Max Vel2:
Maximum Velocity 1 to Maximum Velocity 2 Ratio
(see Systolic Ratio on page 4-18)

Max Vel1/Max Vel3:
Maximum Velocity 1 to Maximum Velocity 3 Ratio
(see Systolic Ratio on page 4-18)

Max Vel1/Min Vel1:
Maximum Velocity 1 to Minimum Velocity 1 Ratio
(see S/D Ratio on page 4-17)

Max Vel1/Min Vel2:
Maximum Velocity 1 to Minimum Velocity 2 Ratio
(see S/D Ratio on page 4-17)

Max Vel2/Max Vel1:
Maximum Velocity 2 to Maximum Velocity 1 Ratio
(see Systolic Ratio on page 4-18)

Max Vel2/Max Vel3:
Maximum Velocity 2 to Maximum Velocity 3 Ratio
(see Systolic Ratio on page 4-18)

Max Vel2/Min Vel1:
Maximum Velocity 2 to Minimum Velocity 1 Ratio
(see S/D Ratio on page 4-17)

Max Vel3/Max Vel1:
Maximum Velocity 3 to Maximum Velocity 1 Ratio
(see Systolic Ratio on page 4-18)

Max Vel3/Max Vel2:
Maximum Velocity 3 to Maximum Velocity 2 Ratio
(see Systolic Ratio on page 4-18)

Min Frq1/Max Frq1:
Minimum Frequency 1 to Maximum Frequency 1 Ratio
(see D/S Ratio on page 4-14)

Min Frq1/Max Frq2:
Minimum Frequency 1 to Maximum Frequency 2 Ratio
(see D/S Ratio on page 4-14)

Min Frq1/Min Frq2:
Minimum Frequency 1 to Minimum Frequency 2 Ratio
(see Diastolic Ratio on page 4-14)

Min Frq2/Max Frq1:
Minimum Frequency 2 to Maximum Frequency 1 Ratio
(see D/S Ratio on page 4-14)

Min Frq2/Min Frq1:
Minimum Frequency 2 to Minimum Frequency 1 Ratio
(see Diastolic Ratio on page 4-14)

Min Vel1/Max Vel1:
Minimum Velocity 1 to Maximum Velocity 1 Ratio
(see D/S Ratio on page 4-14)

Min Vel1/Max Vel2:
Minimum Velocity 1 to Maximum Velocity 2 Ratio
(see D/S Ratio on page 4-14)

Min Vel1/Min Vel2:
Minimum Velocity 1 to Minimum Velocity 2 Ratio
(see Diastolic Ratio on page 4-14)

Min Vel2/Max Vel1:
Minimum Velocity 2 to Maximum Velocity 1 Ratio
(see D/S Ratio on page 4-14)

Min Vel2/Min Vel1:
Minimum Velocity 2 to Minimum Velocity 1 Ratio
(see Diastolic Ratio on page 4-14)

PI: Pulsatility Index

The pulsatility index, **PI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), a minimum velocity, $\mathbf{v}_{min}$ (cm/s), and a mean velocity, $\mathbf{v}_{mean}$ (cm/s), is:

$$PI = \frac{Vmax - Vmin}{Vmean}$$

Burns, Peter N., "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, Nov./Dec., 1987, Vol. 15, No. 9, p. 585.

PI 1: Pulsatility Index #1

(see PI on page 4-25)

PI 2: Pulsatility Index #2

(see PI on page 4-25)

PI 3: Pulsatility Index #3

(see PI on page 4-25)

RI: Resistivity Index

The resistivity index, **RI** (unitless), equation, given a maximum velocity, $\mathbf{v}_{max}$ (cm/s), and a minimum velocity, $\mathbf{v}_{min}$ (cm/s), for a vessel is:

$$RI = \frac{Vmax - Vmin}{Vmax}$$

Burns, PN, "The Physical Principles of Doppler and Spectral Analysis," *Journal of Clinical Ultrasound*, November/December, 1987, Vol. 15, No. 9,
p. 586.

RI 1: Resistivity Index #1

(see RI on page 4-25)

RI 2: Resistivity Index #2

(see RI on page 4-25)

RI 3: **Resistivity Index #3**
(see RI on page 4-25)

SF/DF: **Systolic Frequency to Diastolic Frequency Ratio**
(see S/D Ratio on page 4-17)

SF 1/DF 1: **Systolic Frequency 1 to Diastolic Frequency Ratio 1**
(see S/D Ratio on page 4-17)

SF 1/DF 2: **Systolic Frequency 1 to Diastolic Frequency Ratio 2**
(see S/D Ratio on page 4-17)

SF 1/SF 2: **Systolic Frequency 1 to Systolic Frequency 2 Ratio**
(see Systolic Ratio on page 4-18)

SF 1/SF 3: **Systolic Frequency 1 to Systolic Frequency 3 Ratio**
(see Systolic Ratio on page 4-18)

SF 2/DF 1: **Systolic Frequency 2 to Diastolic Frequency Ratio 1**
(see S/D Ratio on page 4-17)

SF 2/SF 1: **Systolic Frequency 2 to Systolic Frequency 1 Ratio**
(see Systolic Ratio on page 4-18)

SF 2/SF 3: **Systolic Frequency 2 to Systolic Frequency 3 Ratio**
(see Systolic Ratio on page 4-18)

SF 3/SF 1: **Systolic Frequency 3 to Systolic Frequency 1 Ratio**
(see Systolic Ratio on page 4-18)

SF 3/SF 2: **Systolic Frequency 3 to Systolic Frequency 2 Ratio**
(see Systolic Ratio on page 4-18)

SV/DV: **Systolic Velocity to Diastolic Velocity Ratio**
(see S/D Ratio on page 4-17)

SV 1/DV 1: **Systolic Velocity 1 to Diastolic Velocity 1 Ratio**
(see S/D Ratio on page 4-17)

SV 1/DV 2: **Systolic Velocity 1 to Diastolic Velocity 2 Ratio**
(see S/D Ratio on page 4-17)

SV 1/SV 2: **Systolic Velocity 1 to Systolic Velocity 2 Ratio**
(see Systolic Ratio on page 4-18)

SV 1/SV 3: **Systolic Velocity 1 to Systolic Velocity 3 Ratio**
(see Systolic Ratio on page 4-18)

SV 2/DV 1: **Systolic Velocity 2 to Diastolic Velocity 1 Ratio**
(see S/D Ratio on page 4-17)

SV 2/SV 1: **Systolic Velocity 2 to Systolic Velocity 1 Ratio**
(see Systolic Ratio on page 4-18)

SV 2/SV 3: **Systolic Velocity 2 to Systolic Velocity 3 Ratio**
(see Systolic Ratio on page 4-18)

SV 3/SV 1: **Systolic Velocity 3 to Systolic Velocity 1 Ratio**
(see Systolic Ratio on page 4-18)

SV 3/SV 2: **Systolic Velocity 3 to Systolic Velocity 2 Ratio**
(see Systolic Ratio on page 4-18)

5

AQ Dataport

Describes the calibration procedure for AQ Dataport measurements on the Philips SONOS ultrasound system.

Description and Specifications

The AQ Dataport option provides an electrical analog output of the AQ waveform signal. Depending on the study type selected, the Dataport will produce either Area or Volume measurement data.

The nominal performance for the waveform output portion of the AQ Dataport is as follows:

Area

-1 volt = minimum Area scale value

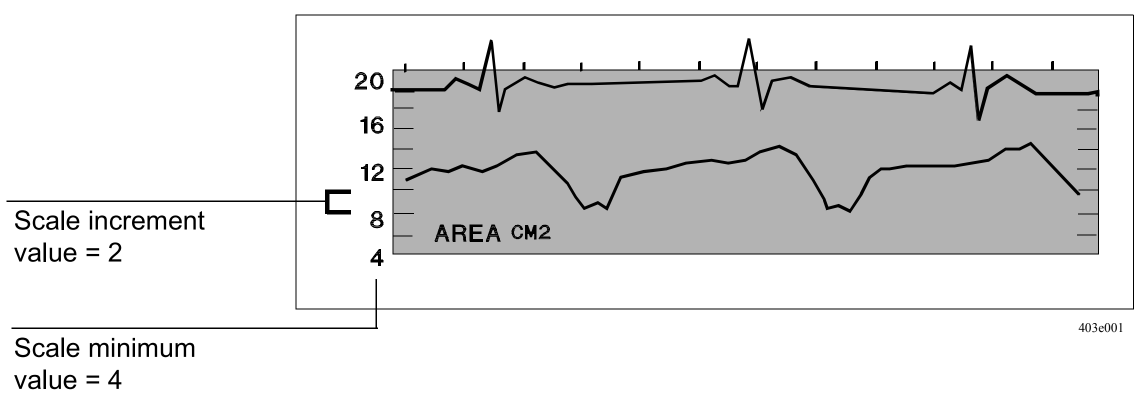
1 volt = min Area scale value + 9 x (Area scale increment value)

Volume

-1 volt = minimum Volume scale value

1 volt = min Volume scale value + 9 x (Volume scale increment value)

Refer to the following figure for the location of these values on the AQ waveform display.



Scale Minimum Value and Scale Increment Value

The specifications are as follows:

- Recommended minimum sampling rate is 200 samples/second to adequately represent waveform data.
- Maximum delay between the ECG output through the ECG jack and the AQ dataport waveform data is two frame times.

For information on timing of the AQ screen waveform data and the ECG, refer to the Acoustic Quantification (AQ) Area and Volume Measurements section of the Cardiac Measurements and Calculations chapter.

NOTE

If you touch **Rescale** or change **Area Inc** or **Area Min**, be sure to recalculate your readings using the new values. You do not have to recalibrate when you change these values. Calibration procedures are discussed in the next section.

Calibration Procedure for AQ Dataport Measurements

To calibrate the receiving device for Volume measurements, follow this procedure, substituting the word "Volume" for "Area" and using a region of interest of approximately 300 ml.

The area waveform output should have a very linear performance, but could have a small offset and gain variation. Your receiving device can be calibrated by making two measurements as follows:

1 Draw an ROI of approximately 25 cm^2.

2 Set the TGC and LGC controls so that the entire area within the ROI is considered blood. Select Image BLD (image display) to verify this. The numeric readout will indicate the size of the ROI.

3 Touch **Waveform**. Touch **Secondary** and adjust **Area Min** so that the waveform is off the top of the scale.

4 Take a reading from the device receiving the waveform signal. Denote this reading as Reading 2.

5 Adjust **Area Min** so that the waveform is off the bottom of the scale.

6 Take a reading from the device receiving the waveform signal. Denote this reading as Reading 1.

You can adjust Area Inc and Area Min to any values. You can convert a reading from the device receiving the waveform signal into the actual area using the following formula:

$$\text{Area} = \left(\frac{\text{Reading} - \text{Reading1}}{\text{Reading2} - \text{Reading1}} \times 9(\text{Area scale increment})\right) + (\text{Area minimum value})$$

6

Optical Disk Files and Non-Philips Systems

Philips optical disk files are stored as Tagged Image File Format (TIFF) graphic files and can be used with programs that accept TIFF files.

Overview

Philips optical disk files are stored as Philips DSR-Tagged Image File Format (TIFF) graphic files with a .TIF file extension. Philips DSR-TIFF image format is an extension of the Tagged Image File Format. While there are many third-party software packages that can handle TIFF images, many packages do not properly handle Philips DSR-TIFF images.

NOTE

To avoid possible file corruption, Philips recommends that you write protect the optical disk medium prior to installing or retrieving files on a Philips SONOS system when using a third party program.

To fully acquire and manipulate the Philips DSR-TIFF files outside the Philips optical disk system requires knowledge of specialized information not within the scope of this manual. Philips will make specific information about its optical disk file structure available to qualified users. For more information, contact your local Philips ultrasound sales representative.

File Naming Conventions

The Philips optical disk system automatically creates an eight-character file name for each file. The first six characters of this file name are the first six non-blank, non-punctuation characters from the patient ID entered at the time of the image acquisition. The seventh and eighth characters in the file name are a sequence number. The sequence number is incremented from 00 to 99 and then from AA to ZZ for each new file stored for each patient ID. If there is no patient ID, digits representing the month, day, and hour of the store are automatically assigned by the system as the six-character prefix. In addition, all optical disk files have a .TIF extension.

The following table lists examples of the file naming conventions.

Table 6-1

Patient ID	System Information	File Name Assigned
John Jones	12th file stored for this patient	JOHNJO12.TIF
No ID entered	Nov. 12, 9:00 AM, 15th file stored for this patient	11220915.TIF

Other Information

The *TIFF Developer's Tool Kit* from Aldus Corporation provides useful documentation and software for hardware and software developers reading or writing image data in the TIFF format. It also includes information and software to help when converting TIFF files between Intel and Motorola formats.

For information contact:

The Developer's Desk
Aldus Corporation
411 First Avenue South
Seattle, WA 98104
(206) 628-6593 (direct line to Developer's Desk)

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