Vevo 770® High-Resolution Micro-Imaging System

Addendum for Operator Manual for Vevo 770 Software Version 2.3.0

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1 Overview of Release

The purpose of this software release is to expand and improve the functionality in Contrast Software Mode and to improve core functionality of the Vevo system.

Vevo 770 v2.3.0 is an incremental release to the Vevo system. Updating your Vevo system with this release will provide you with the new functionality as detailed in this manual. This document is intended as an addendum to the Vevo 770 Operator Manual and provides documentation specific to the new features and software improvements in this release.

2 New Features in Vevo Software Version 2.3.0

2.1 Contrast Mode

2.1.1 Linear Quantification

Vevo 770 v2.3.0 provides the support for analyzing linearized Contrast Mode video image data. A more complete and accurate analysis of MicroMarker contrast agent signal can be obtained with linearized data. The benefit is improved quantification of the amount of contrast agent in the region of interest. Previous versions only provided support for the analysis of the image data in a log compressed format as displayed in the software. Vevo 770 v2.3.0 includes the capability to analyze either log-compressed or linear video data.

To analyze linear contrast data in Contrast Mode, click the ‘Data Linearization’ check box in the Operator Preferences dialog. When this check box is not selected, the analysis will be performed on the log-compressed data.

The default setting for the Data Linearization analysis in Contrast Mode is set to "OFF" at installation (in the Operator Preferences and Region Graph). The Data Linearization setting for Contrast Mode is retained between imaging sessions (in the Operator Preferences and Region Graph).

If you have selected Data Linearization in the Operator Preferences then the TGC controls are locked at the default setting (10 dB). Contrast Mode data can
only be linearized at the default TGC settings. In other modes, the TGC’s can still be adjusted independent of the setting in the Operator Preferences.

If the TGC controls are not at the default setting and the Data Linearization is selected, then the controls will be reset to their default value. The previous TGC settings will be restored if you revert back to log-compressed Contrast Mode data acquisition.

There is also an option in the Contrast Region Graph to select between Log and Linear data analysis:

![Data Linearization analysis option in the Graph window](image)

If the TGC settings were customized during acquisition then the Log/Linear Contrast Display in the Contrast Region Graph is disabled.

The “Linear” check box will only be active when the “B-Mode” radio button is selected.

### 2.1.2 Curve Fitting for Perfusion Analysis

Data analysis for tumor or vascular perfusion requires calculation of the ‘perfusion curve’ that is defined by the following equation and parameters:

\[
y = C + A \left(1 - e^{-B(t - t_0)}\right)
\]

Where:

- \(y\) = Contrast signal (pixel intensity)
- \(A\) = peak of curve
- \(B\) = slope of the curve
- \(C\) = Contrast signal offset
- \(t\) = time
- \(t_0\) = time offset
The 2.3.0 release has the ability to fit this curve equation to the contrast signal in perfusion studies in the Region Curve graph window.

To fit the curve to the graph data, click the “Start Curve Fitting” button to switch graph display to the starting point selection mode on the graph. The starting point can be selected with the left mouse button on the graph and will be marked by the red-colored circle around one of the points on the graph – the starting point of the curve will be at the base of the slope of the graph. A displayed dialog box in the middle of the graph will notify the user of the presumed action. The prompt will disappear as soon as the cursor moves within the graph area.

To complete the curve fitting, specify the ending point of the curve on the graph by clicking on the desired point with the left mouse button, then click “Finish Curve Fitting”. The point selected as the ending point will be highlighted with a pink circle. When the starting point of the curve fit has been selected, the “Start Curve Fitting” changes to “Finish Curve Fitting”. The “Cancel Curve Fitting” button can be used at any time after setting the start point to cancel the curve fitting procedure.
Moving the cursor over any of the markers in the graph will highlight the point with an orange-colored circle. Clicking on any of the highlighted points will mark a new end point for the curve fitting algorithm.

It is not possible to place the ending point before or earlier than the starting point.

Once the curve fit is complete, the curve, the A & B parameters of the curve fit equation and the standard deviation will be displayed on the screen as in the figure below.

![Graph with completed curve fit](image)

The graph will support only one curve. If another curve is started on the graph, the existing curve on the graph will be erased.

The curve and curve fit equation can be exported to a .csv file by clicking “Export” in the Graph window and choosing the .csv option. All of the curve fit parameters – A, B, C, and t₀ – can be found at the bottom of the exported .csv file. Note that the t₀ value will be displayed as the ‘frame number’ that the curve starts at. To find the “Relative Time (ms)” of t₀, scroll up the .csv file and find the entry for that frame number and its associated “Relative Time (ms)”
2.1.3 Contrast Mode Threshold

The Contrast Mode Threshold sets the threshold value for Percent Area calculations for the Contrast Region measurement traced on the 2D cine loop or Percent Volume calculations for the volume measurements in 3D-Mode. The value for the Threshold can be adjusted by click-drag-click of the red slider or by typing a value in a range from 0 to the maximum threshold value. The maximum value varies depending on the intensity of the contrast data acquired.

![Threshold range in the Graph window](image)

The Contrast Threshold settings can not be changed for the Contrast 3D mode once the data has been loaded in the 3D view. However, the Contrast Threshold can be adjusted from the Contrast Mode setup dialog while in the Contrast 2D view prior to loading in 3D-Mode.

![Contrast Threshold set up](image)

The Contrast Threshold parameter can be changed from the Contrast Mode set up and also in the Region Curve Graph window. From the Contrast Mod set up, the Threshold can only be adjusted in review, when acquisition is paused. To adjust the Threshold in the Graph window, you need to process the Contrast data, trace a Contrast Region measurement, open the Region Curve graph and
enable the Percent Area display option. Changing the Threshold in the Contrast Mode setup dialog changes the value on the Region Curve, and vise versa.

### 2.1.4 External Contrast Mode Destruction

The Vevo system, with the 2.3.0 software release has the ability to integrate an external low frequency ultrasound device for integrated contrast agent destruction during an imaging sequence. For more information on the external contrast agent destruction device, contact [support@visualsonics.com](mailto:support@visualsonics.com).

If an external destruction device is connected to the Vevo system, you can choose between Internal and External contrast agent destruction in the Operator Preferences dialog:

![Contrast Mode Settings](image)

When using internal destruction, the RMV will be used as the source for the destruction pulse. Alternatively, when selecting the external destruction device option, the Vevo will provide a triggered signal to control this device.

From the Operator Preferences dialog, you can configure the duration of the destruction pulse as well as the frame in the imaging sequence where the destruction device will be activated.

**NOTE:** The external destruction device may have settings independent of the settings in the Vevo. Ensure that the settings on the Vevo are compatible with the settings on the external destruction device. Refer to the Operator Manual for the external destruction device for more info.

When the destroy sequence, using the external device, has been activated a progress bar is presented to indicate the relative amount of time left in the destruction sequence.

If required, you can cancel the external destruction sequence using the “Cancel” button on the progress bar.

**WARNING:** The External Destruction device may operate at low frequencies and **has the ability to heat tissue, in vivo, and thus can be harmful to the subject if not properly used.** Please refer to the Operator Manual of the destruction device for proper operating instructions and conditions.
2.1.5 “Auto Save” 2D Contrast Loop

When acquiring data for Contrast 3D mode, the Vevo software will first collect the data as a 2D data set. The 2.3.0 release has the option for the application to auto-save the 2D Contrast data set prior to its loading into the Contrast 3D mode window. This option is available in the Operator Preferences under the Mode tab.

![Auto-Save Settings in Operator Preferences]

- Check the box for **Auto UNFREEZE on Mode Entry**
- Check the box for **Auto SAVE on Image Label**
  - Image to Auto SAVE: **Entire Cine Loop**
- Check the box for **Auto SAVE Pre-triggered Cine Loop**
- Check the box for **Auto SAVE 2D Contrast loop on load into 3D**
2.1.6 Cancel Process Cine

Processing the Contrast Mode data is required for the Vevo software in order to display the Contrast overlay and farther contrast signal analysis. This process can sometimes take a few minutes depending on the size of the cine loops. If the data processing has been initiated but was not intended, this process can be cancelled by clicking on the cancel button in the progress dialog.

The following processing sequences can also be cancelled: Process Reference, Process Cine Loop and generating the Region Curve graph.
2.2 3D Mode

2.2.1 Copying the 3D Segmentation

When working in Contrast 3D Mode, it is important to create the same volume measurement on different 3D data sets of the same anatomy that may have been acquired at different times. Some typical examples include comparing:

- Pre-bolus injection vs. post-bolus injection with MicroMarker Non-Target contrast agent
- Pre-destruction vs. post destruction with MicroMarker Target-Ready contrast agent

Within the 2.3.0 software release, you can copy the 3D volume measurement from one 3D image to another. To copy a 3D volume measurement, select the volume from the measurement drop down and then click on the “Copy” button in the 3D mode setup dialog. Once the 3D Segmentation has been copied, it is available for pasting onto other 3D images by clicking the “Paste” button in the 3D mode setup dialog.

The 3D Segmentation copy/paste operation is **not** permitted in between images that are not compatible. In order to be compatible the source and target images have to have the same acquisition settings: FOV, Sector, Height, Range and Step Size. If the images are not compatible a message is displayed to indicate that the copy/paste operation is not available.
2.3 New Measurements and Calculations

The 2.3.0 software release has updates in the Measurements and Calculations for the Standard and Cardiac Measurements Packages.

2.3.1 Cardiology Measurement Package

2.3.1.1 Fractional Shortening Calculations

In the previous software release the B-Mode LV Trace tool included an automatic calculation for Fractional Shortening (FS). This is in fact a calculation for Fractional Area Change (FAC) when the LV Trace view selected is “short axis”. As such, the calculation label has been correctly renamed to “FAC”. There is no FS calculation available in the B-Mode LV Trace tool.

2.3.1.2 VTI Trace Calculations

In the previous release, when the auto VTI measurement was traced over multiple cardiac cycles in PW Doppler, the displayed calculation was for one cardiac cycle thus reporting an erroneous value.

In the Vevo v2.3.0 release the VTI measurement tool has been modified to allow the user to correctly identify the number of cardiac cycles to be averaged.

To use the new VTI measurement tool:
> Load the PW Doppler waveform
> Open the Measurement Tool
> Turn on the auto trace and select positive or negative
> Select the VTI-named measurement (i.e. MV VTI)
> Left click with the trackball at the start of the 1st waveform to be measured
> Left click at the end of the flow region of the 1st waveform
> Left click at the start of the 2nd waveform
> Left click at the end of the flow region of the 2nd waveform
> Left click at the start of the 3rd waveform
> Right click at the end of the flow region of the 3rd waveform to complete the VTI measurement across multiple (in this case 3) waveforms

The result will be the averaged VTI measurement for the number of cardiac cycles measured, an example follows:
2.3.1.3 LV Trace Measurements

The following, already available in the Standard Measurements Package, measurements and calculations have been added to the Cardiac Measurements Package:

- Endocardial Area; d
- Endocardial Area; s
- Endocardial major; d
- Endocardial major; s
- Epicardial Area; d
- Epicardial Area; s
- Epicardial major; d
- Epicardial major; s

From these measurements the software will automatically calculate:

- End systolic LV volume in microliters:
  \[
  \frac{4\pi}{3} \times \frac{\text{Endocardial Major; s}}{2} \times \left( \frac{\text{Endocardial Area; s}}{\pi \left( \frac{\text{Endocardial Major; s}}{2} \right)} \right)^2
  \]

- End diastolic LV volume in microliters:
  \[
  \frac{4\pi}{3} \times \frac{\text{Endocardial Major; d}}{2} \times \left( \frac{\text{Endocardial Area; d}}{\pi \left( \frac{\text{Endocardial Major; d}}{2} \right)} \right)^2
  \]

- Stroke Volume in microliters:
  \[
  \text{Endocardial Vol; d} - \text{Endocardial Vol; s}
  \]

- Ejection Fraction in percent (%):
  \[
  \frac{\text{Endocardial SV}}{\text{Endocardial Vol; d}} \times 100
  \]

- Fractional Area Change in percent (%):
  \[
  \frac{\text{Endocardial Area; d} - \text{Endocardial Area; s}}{\text{Endocardial Area; d}} \times 100
  \]
Cardiac Output in uL/min:

\[
\text{Endocardial SV} \times \text{Heart Rate}
\]

The heart rate for the CO calculation will be derived automatically from the ECG signal when the major dimension is made is diastole.

Average wall thickness in mm:

\[
\sqrt{\frac{\text{Epicardial Area}}{\pi}} - \sqrt{\frac{\text{Endocardial Area}}{\pi}}
\]

LV Mass from the Endocardial and Epicardial areas in mg:

\[
1.05 \times \left(\frac{5}{6} \times \text{Epicardial Area} \times d \times (\text{Epicardial Major}, d + T) - \left(\frac{5}{6} \times \text{Endocardial Area} \times d \times \text{Endocardial Major}, d\right)\right)
\]

2.3.1.4 Simpson’s Measurements

The Cardiology Measurement package now includes the Simpson’s measurements and calculations which are also available in the Standard Measurement Package:

- 4 Simpson’s systolic area measurements based on the polygon measurement type.
- 4 Simpson’s diastolic area measurements based on the polygon measurement type.

The system automatically calculates:

- Systolic volume in microliters.

**Error! Objects cannot be created from editing field codes.**
Where Height is computed as:
**Error! Objects cannot be created from editing field codes.**

- Diastolic volume in microliters.

**Error! Objects cannot be created from editing field codes.**
Where Height is computed as:
**Error! Objects cannot be created from editing field codes.**

- Stroke volume in microliters.

\[
\text{SimpsonVolume}, d - \text{SimpsonVolume}, s
\]
> Ejection Fraction in percent (%):
\[
100 \times \frac{SimpsonSV}{SimpsonVolume;d}
\]

> Fractional Area Change in percent (%):
\[
\left(\frac{SimpsonArea2;d - SimpsonArea2;s}{SimpsonArea2;d}\right) \times 100
\]

> Cardiac Output in ul/min.
\[
(SimpsonSV \times \text{EndocardialMajor;d.HeartRate})
\]

### 2.3.2 Generic Measurements

In the 2.3.0 software release there are two new generic measurements that are available in the B-Mode. They are both related angle type measurements.

> Angle measurement – available in B-Mode, EKV, Power Doppler, and Contrast Mode – measures the angle between three caliper points placed on the image in degrees.

> Radius measurement – available in B-Mode, EKV, Power Doppler, and Contrast Mode – measures the radius of a curved object on the image in mm.
New measurements listed in the Operator Preferences Measurement table

2.4 “Image Store” Prompt

M-Mode, AM-Mode, PW Doppler and Tissue Doppler Mode message prompts activated at Frame Store, “Continuing will save only the visible data, discarding the rest of the data”, now have the option that allows the user to turn off the warning during the imaging session. The option is available as a check box labeled “Don’t show this message again”.

New measurements listed in the Operator Preferences Measurement table

Saving Cine Loop dialog

Continuing will save only the visible data, and will discard the rest of the data.

Do you wish to continue?

Don’t show this message again.
3 Other Software Enhancements in v2.3.0

The following list provides an overview of other enhancements in the 2.3.0 software related to default settings and workflow improvements:

> If the **Power Doppler Auto Histogram** method is turned on, the manual controls for editing the Min/Max Settings are disabled.

> The system will retain the settings of the **Physiological Data display** from session to session.

> The **Tissue Doppler Wall filter** will have a default setting of 5Hz.

> The **Tissue Doppler frequency** will default to the lowest frequency for the currently active RMV probe.

> The software will set the **default B-Mode (and Power Doppler) loop size** to 100 frames when system defaults are reset.

> The **Smoothing function** in B-Mode will average the last 4 frames of B-mode data when enabled.

> The **Default Frame Rate** for the RMV’s intended for cardiac applications (RMV-707B, RMV-710B) is set to “max frame rate”.

> The **Trackball Sensitivity** of the Vevo system has been changed to be optimized for data analysis.

> While in **3D-Mode**, the software will use the respiration gating setting from B-Mode and display this setting in 3D-Mode setup.

Need help?

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