VisualSonics
Vevo 770® Digital RF Option

Operator Manual
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Chapter 1: Digital RF-Mode

Digital RF-Mode provides the operator with the ability to acquire, digitize and export the raw RF data for spectral analysis. This mode is typically used to study the frequency content of the returning echo.

Fundamentals

Digital RF-Mode imaging displays the radio frequency (RF) signal that is detected by the ultrasound transducer used to create each line of the B-Mode image.

The following illustration describes the features of the RF-Mode acquisition/review window:
Defining The RF-Mode ROI

The RF-Mode region-of-interest (ROI) is the region from which the RF data will be collected. This can be set up in B-Mode while acquiring data.

To define the RF-Mode ROI in B-Mode:
1. Press <Scan/Freeze> to begin acquiring B-Mode data.
2. Click Overlay > Digital RF-Mode Box Wire-frame or press <Overlay> until the RF-Mode ROI is displayed. A check mark is displayed beside this menu item.

The box indicates the region from which the RF data will be collected and digitized. The RF-Mode ROI details are displayed in the parameters display.

Note: The RF-Mode ROI can only be repositioned or resized during acquisition.
3. Position the cursor inside the ROI. The cursor will be displayed as a four-arrow icon when it is within a region that will allow for repositioning. Left-click and use the trackball to move the overlay. Left-click again to place the ROI.
4. Position the cursor over one edge or corner of the ROI. The cursor will be displayed as a double arrow in the directions that the ROI can be resized. Left-click and use the trackball to resize the ROI. Left-click again when the ROI is the desired size.

The following information about the ROI is listed in the parameters display:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>The depth to the top of the ROI from the transducer face.</td>
</tr>
<tr>
<td>Length</td>
<td>The length of the ROI.</td>
</tr>
<tr>
<td>Position</td>
<td>The position of the center of the ROI.</td>
</tr>
<tr>
<td>Width</td>
<td>The width of the ROI.</td>
</tr>
</tbody>
</table>

Setting Up RF-Mode

To start RF-Mode, click Mode > Digital RF-Mode.

Scout Window

The Scout window displays the position of the RF-Mode region-of-interest (ROI) within the B-Mode image.

To update the Scout window when scanning in the ROI window:
Press <Toggle Scout>. The Scout window border turns white during scanning and grey when not scanning.

To update the Scout window when viewing previously acquired RF Data:
1. Click Study > Frame Store, or press <Frame Store> to store the currently acquired RF data to the study. The current RF data will be lost if the data is not stored.
2. Select Mode > Freeze, or press <Scan/Freeze>. The Scout window border becomes white during scanning and grey when not scanning.

3. Adjust the RF-Mode ROI and position as required. Adjust the TGC sliders if required.

4. Select Mode > Freeze, or press <Scan/Freeze> to acquire RF data.

**To adjust the RF-Mode ROI in the Scout:**

*Note: The RF-Mode ROI can only be repositioned or resized when the Scout is scanning.*

1. Position the cursor inside the ROI. The cursor will be displayed as a four-arrow icon when it is within a region that will allow for repositioning. Left-click and use the trackball to move the overlay. Left-click again to place the ROI.

2. Position the cursor over one edge or corner of the ROI. The cursor will be displayed as a double arrow in the directions that the ROI can be resized. Left-click and use the trackball to resize the ROI. Left-click again when the ROI is the desired size.

---

**Time-Gain Compensation (TGC)**

TGC sliders appear next to the RF-Mode Scout window and are used to control the receive gain of the B-Mode image and the subsequently acquired RF-Mode data.

When the Scout window is being continuously updated, use the TGC sliders to update the gain. Alternatively press <GAIN> to adjust the position of the TGC sliders.

---

**Adjusting the TGC Value**

**To adjust the TGC:**

1. Begin acquiring B-Mode Scout data.

2. Drag a TGC slider to the left or right to decrease or increase the receive gain for the 'band' of the B-Mode Scout image associated with that slider.

   Use <GAIN> to adjust the positions of all the TGC sliders simultaneously. <GAIN> will adjust the slider positions to represent a gain increase or decrease of 5dB. To adjust the slider positions to represent a gain change of 1.0 dB, press and hold <Shift> while pressing <GAIN>.
**Chapter 1: Digital RF-Mode: Setting Up RF-Mode**

**Settings**

The RF-Mode Setup dialog is displayed by default.

To turn off the setup display, click Setup > Digital RF-Mode Setup, or press <Mode Setup>.

**Smooth** tool. To create a smooth, curved effect centered on the selected slider, click this tool and then drag any slider.

**Reset** tool. To reset the sliders to their default positions, click this tool.

**Lock** tool. To lock all sliders together so the operator can drag them simultaneously, click this tool and then drag any slider.

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Transmit Settings

- **Power**: 1.00 dB
- **RF Cycles**: 1

Acquisition Settings

- **Frames**: 1
- **Lines**: 10
- **Acq. / Lthp**: 1
Chapter 1: Digital RF-Mode: Setting Up RF-Mode

**Transmit Settings**

**Power**
Set the power of the transmit signal by selecting a value between 3% and 100%.

**RF Cycles**
The number of cycles output by the transmitter. The default setting is 1 cycle.

**Acquisition Settings**

**Frames**
The number of frames of RF data to acquire.

**Lines**
The number of lines of RF data to acquire within a frame.

**Acq./Line**
The number of RF data acquisitions to acquire at each line position.

**Hot Keys**

When the RF-Mode parameters are adjusted using the system hot keys, the associated parameter displayed in the display parameters section shall be updated when the next image is acquired.

The following table describes the step sizes for the hot key functions:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Hot Key</th>
<th>Step Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain (Coarse)</td>
<td>&lt;GAIN&gt;</td>
<td>5 dB (this can be seen by the movement of the TGC sliders)</td>
</tr>
<tr>
<td>Gain (Fine)</td>
<td>&lt;Shift&gt;+&lt;GAIN&gt;</td>
<td>1.0 dB (this can be seen by the movement of the TGC sliders)</td>
</tr>
<tr>
<td>Adjust Transmit Frequency</td>
<td>&lt;FREQ&gt;</td>
<td>Adjusts up or down to available transmit frequencies (depends on active RMV scanhead)</td>
</tr>
</tbody>
</table>

**ROI Window**

A ruler is located above the ROI window. The magnified view of the ROI in B-Mode is displayed in the ROI window. The positions at which the RF data lines will be collected are displayed as red lines across the ROI.

**To update the ROI Window when scanning in the Scout window:**
Press <Toggle Scout>. The ROI window border turns white during scanning and grey when not scanning.

**To update the ROI window when viewing previously acquired RF Data:**
1. Store the currently acquired RF data to the study (select Study > Frame Store, or press <Frame Store>). The current RF data will be lost if the data is not stored.
2. Click Mode > Freeze, or press <Scan/Freeze>. The ROI window border turns white during scanning and grey when not scanning.
3. Adjust the RF-Mode ROI and position as required. Adjust the TGC sliders if required.

4. Click Mode > Freeze, or press <Scan/Freeze> to acquire RF data.

When the subject is highly reflective, the returning echoes may saturate the electronics. A saturation overlay can be displayed in blue to indicate the areas where the signal is saturated. To decrease the amount of saturation, decrease the gain or lower the transmit power.

To toggle the saturation overlay:
Click Overlay > Saturation, or press <Overlay>.

**Acquiring RF Data**

When RF-Mode is first started, the Scout window unfreezes and starts scanning automatically if the Auto Unfreeze setting is enabled in the Operator Preferences. If Auto Unfreeze is disabled, a single scan is performed to update the Scout window.

**To acquire RF Data:**

1. Click Mode > Freeze, or press <Scan/Freeze> when scanning in the Scout window or the ROI window.

2. Wait for the data to be acquired. The acquisition status will be displayed in the status area in the upper right region of the screen, beside the time and date.

**Reviewing RF Data**

**Frame Selection**

Frame Selection control is used to view different frames within the acquired data set. The Frame Selection slider appears below the ROI window after RF data acquisition when the system has acquired more than one frame.

**To select a specific frame within the data set:**

1. Drag the Frame Index Indicator to the desired frame or click on the Acquired Frame Indicator at the location of the desired frame.

**Line Selection**

Use the red lines in the ROI window to select an individual RF data line to review from the current frame.

**To select a specific RF data line:**

Left click on the desired RF data line in the ROI window. The selected line appears in yellow. By default, the system selects the line located closest to the middle of the ROI.

**Graph Window**

After the RF data is acquired, each RF data line can be individually reviewed in the Graph window in the RF-Mode window.
As shown in the following illustration, by default the system layers the FFT graph of the selected RF data line over the amplitude graph and background grid.

To zoom in/out any of the four axes:

1. Left click on the desired axis. The cursor will change into a double arrow in the direction that you can drag the axis.

2. Drag the axis to zoom in or out:
   - Drag the horizontal axis left to zoom out and right to zoom in.
   - Drag the vertical axis up to zoom in and down to zoom out.

3. Left click again to complete the zoom.
Chapter 1: Digital RF-Mode: Typical RF-Mode Data Acquisition

To pan the graph:
1. Left click inside the graph window on the desired graph.
2. Move the cursor and the graph will pan in the direction of movement.
3. Left click again to complete the action.

When the mouse pointer enters the Graph window, a vertical cursor line appears and follows the mouse movement. A coordinate indicator appears at the top right corner of the Graph window and displays the data value at the cursor line position. When the mouse pointer leaves the Graph window, the cursor line and the coordinate indicator disappear.

Storing RF data

To store the currently viewed frame of the RF data:
Click Study > Frame Store, or press <Frame Store>.

When multiple frames of RF data are acquired and a single frame out of the data is saved using Frame Store, the Frame Index Indicator identifies the frame index of the saved frame when the frame is recalled. The Acquired Frame Indicator is disabled and the operator cannot select a different frame index.

To store all the frames of the RF data:
Click Study > Cine Store, or press <Cine Store>.

To export RF data:
1. Click Study > Export Image or press <Export>.
2. Select the directory.
3. Select Raw Image Data as the file type.
4. Modify the file name, if desired.
5. Click OK.

To export the currently viewed frame as an image:
1. Select Study > Export Image… or press <Export>.
2. Select the directory.
3. Select the appropriate imaging file type.
4. Modify the file name, if desired.
5. Click OK.

Typical RF-Mode Data Acquisition

The following procedure describes a typical RF-Mode image acquisition session. The description assumes that the animal is prepared for imaging and that an acquisition session is open in the current study.

1. Click Mode > Digital RF-Mode to start RF-Mode.
2. In the Scout window, localize the target region for RF-Mode acquisition.
3. Position and size the RF-Mode ROI at the desired location.
4. Press <Toggle Scout> to update the ROI window, and view the saturation overlay to ensure that the gains are set such that saturation does not occur.

5. Press <Toggle Scout> and adjust the TGC sliders, if necessary.

6. Select the desired parameter settings for data acquisition.

7. Click Mode > Freeze, or press <Scan/Freeze> to acquire RF-Mode data. Wait for the data to be acquired. The acquisition status will be displayed in the status area in the upper right corner next to the time and date.

8. Select the frame and the position of RF data line to review in the Graph window.

9. Store data for further study.
   • For multiple frame data, select Study > Cine Store, or press <Cine Store>.
   • For the current frame being viewed, select Study > Frame Store, or press <Frame Store>.

10. Export the acquired data for further analysis.
    • Click Study > Export Image… or press <Export>.

11. Save the study.
    • Click Study > Close Study or press <Close> to close the study and click Commit Session Data to save the data.
    • To copy the study to a storage location, click Copy To.

*Note: To copy a study to removable media, refer to the Data Archiving chapter in the *VisualSonics Vevo 770™ High-Resolution Imaging System Operator Manual.*

12. Click Exit to close the application.
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Chapter 2: Raw Data Export Format

The raw data export for RF-Mode generates two output files for each exported image: a raw data binary file, and a raw data text file.

RDB (Raw Data - Binary) File

The RDB binary data file contains the raw RF data as well as the processed B-Mode data for the region of interest (ROI).

RDI (Raw Data - Information) File

The RDI text file is generated in a CSV (common separated value) format and contains information that describes the study and the image, as well as the values of the system settings at the time of acquisition. Each system setting entry in the text file indicates the setting's name, its value(s), and its unit(s) if applicable.

The RDI file also includes information that describes each block of image data in the binary file. This information includes:

- The offset into the binary file at which each block of data begins
- The size of the data block
- The acquisition timestamp for the block of data.

The RDI file includes three sections:

- Image Info
- Image Data
- Image Parameters

Image Information

The values in the Image Info section describe high-level attributes of the image and the study within which it resides:

--- IMAGE INFO ---

| Study Name | - the name of the study, as assigned by the system (as for a Quick Study) or as specified by the operator |
| Image Label | - the operator-assigned label (may be blank) |
| Image Frames | - the number of RF data frames acquired |
| Image Lines | - the number of RF data lines in each frame |
| Image Acquisition Per Line | - the number of RF data acquisitions for each line |
| Image Acquisition Size | - the number of RF data sample bytes per acquisition |
| Animal ID | - the operator-assigned ID for the subject animal to which the image's study pertains (may be blank) |
| Acquisition Mode | - always set to "Digital RF-Mode" |
| Acquisition Date | - the calendar date, in GMT format, on which the image was acquired |
Image Data

The values in the Image Data section describe the blocks of raw image data that have been written to the corresponding binary data file:

--- IMAGE DATA ---

The following group of entries occurs once at the start of the RF data for the ROI data:

- **ROI Data Offset - ** the offset into the binary data file at which the raw acquired B-Mode image data for the ROI begins; the format of this data is described in “ROI Image Data Format” on page 22
- **ROI Data Size - ** the size of the block of raw acquired B-Mode image data for the ROI

The following entry occurs once for each RF data acquisition:

- **Image Data Offset - Frame x - Line y - Acq z** - the offset into the binary data file at which the raw acquired RF data for a single acquisition begins where x is the frame number, y is the line number and z is the acquisition number; the format of this data is described in “RF Data Format” on page 23

The following entry occurs once for each line of RF data:

- **Image Data Offset - Frame x - Line y - Average** - the offset into the binary data file at which the averaged data of all acquisitions of a line begins where x is the frame number and y is the line number; the format of this data is described in “RF Data Format” on page 23; this parameter is not available if “Image Acquisition Per Line” is 1

Image Parameters / System Settings

The Image Parameters section describes the system settings at the time the image was acquired and/or the last time it was modified in a review session.

The following section presents the RF-Mode image parameters and system settings, with sample values:
"RF-Mode/3D/Action","4"
"RF-Mode/3D/Clear-Error","1"
"RF-Mode/3D/Direction","8"
"RF-Mode/3D/Error","0"
"RF-Mode/3D/Max-Scan-Steps","500"
"RF-Mode/3D/Motor-Enable","0"
"RF-Mode/3D/Position","0"
"RF-Mode/3D/Scan-Distance","10.00","mm"
"RF-Mode/3D/SPEED","20"
"RF-Mode/3D/Status","0"
"RF-Mode/3D/Steps","0"
"RF-Mode/3D/Steps","0.25","mm"
"RF-Mode/Acqiris/Acquire","1"
"RF-Mode/Acqiris/Available","1"
"RF-Mode/Acqiris/Control","1"
"RF-Mode/Acqiris/Mode","2"
"RF-Mode/Acqiris/SamplesNom","1451"
"RF-Mode/Acqiris/TS7-SegmentPad","181"
"RF-Mode/Acqiris/Wait-Acq","1"
"RF-Mode/ActiveProbe/Acc-Time-Factor","0.2"
"RF-Mode/ActiveProbe/Accl-Limit-Constant","197680"
"RF-Mode/ActiveProbe/Accl-Limit-Slope","0"
"RF-Mode/ActiveProbe/Axial-Res","40","µm"
"RF-Mode/ActiveProbe/Axial-Res-Factor-Target","0.5"
"RF-Mode/ActiveProbe/Cutoff-Scan-Speed","1125","Hz"
"RF-Mode/ActiveProbe/Default-Fov","10","mm"
"RF-Mode/ActiveProbe/Default-Rx-Gain","10","dB"
"RF-Mode/ActiveProbe/Default-Rx-Gain-Doppler","10","dB"
"RF-Mode/ActiveProbe/Default-SvSize-MMode","4"
"RF-Mode/ActiveProbe/Derivative-Time","5"
"RF-Mode/ActiveProbe/Detect-Ratio-Max","0.3454"
"RF-Mode/ActiveProbe/Detect-Ratio-Min","0.3311"
"RF-Mode/ActiveProbe/Encoder-Range-Max","11.5","mm"
"RF-Mode/ActiveProbe/Encoder-Range-Min","10.5","mm"
"RF-Mode/ActiveProbe/Encoder-Separation","0.001","mm"
"RF-Mode/ActiveProbe/Filter","40","MHz"
"RF-Mode/ActiveProbe/Filter-Doppler","40","MHz"
"RF-Mode/ActiveProbe/Filter-Doppler-Cutoff","4","cycles"
"RF-Mode/EModeSoft/Target-Field-Of-View","2.89","mm"
"RF-Mode/EModeSoft/V-Relative-Frame-Rate","6"
"RF-Mode/Diag/Build-Version","17.0"
"RF-Mode/Diag/ICB-FFPGA-Revision","15"
"RF-Mode/Diag/ICB-PCB-ID","11"
"RF-Mode/Diag/ICB-PCB-Revision","3"
"RF-Mode/Diag/MAX1137","11"
"RF-Mode/Diag/Monitor-15V","14.94","V"
"RF-Mode/Diag/Monitor-3point3V","3.23","V"
"RF-Mode/Diag/Monitor-5V","4.97","V"
"RF-Mode/Diag/Monitor-GDI-Objects","155"
"RF-Mode/Diag/Monitor-Neg15V","-14.96","V"
"RF-Mode/Diag/Monitor-Neg5V","-5.02","V"
"RF-Mode/Diag/Monitor-Temperature","27"
"RF-Mode/Diag/Monitor-USER-Objects","138"
"RF-Mode/Diag/Motor-FFPGA-Revision","9"
"RF-Mode/Diag/Motor-PCB-ID","4"
"RF-Mode/Diag/Motor-PCB-Revision","3"
"RF-Mode/Diag/NE1619","11"
"RF-Mode/Diag/Product-Name","Vevo 770"
"RF-Mode/Diag/Receive-FFPGA-Revision","12"
"RF-Mode/Diag/Receive-PCB-ID","2"
"RF-Mode/Diag/Receive-PCB-Revision","3"
"RF-Mode/Diag/Software-Version","1.4.0"
"RF-Mode/Diag/Switch-FFPGA-Revision","1"
"RF-Mode/Diag/Switch-PCB-ID","5"
"RF-Mode/Diag/Switch-PCB-Revision","1"
"RF-Mode/Diag/Transmit-PCB-ID","3"
"RF-Mode/Diag/Transmit-PCB-Revision","3"
"RF-Mode/Display/Direction","3"
"RF-Mode/Display/Dynamic-Range","8"
"RF-Mode/Display/Gain","0"
"RF-Mode/Display/Window-Time","2000.000000","ms"
"RF-Mode/ECG/ECG-HP-Filter","100","Hz"
"RF-Mode/ECG/ECG-Range","32768","mV"
"RF-Mode/ECG/ECG-Frequency","8000","Hz"
"RF-Mode/ECG/Heart-Period","0","ms"
"RF-Mode/ECG/Heart-Rate","0.056","bpm"
"RF-Mode/ECG/Pressure-Amplification","100","mV/mmHg"
"RF-Mode/ECG/Pressure-Diastolic","40","ms"
"RF-Mode/ECG/Pressure-Range","6473","mmHg"
"RF-Mode/ECG/Pressure-Show-Event","0"
"RF-Mode/ECG/Pressure-Systolic","40","ms"
"RF-Mode/ECG/Respiration-Beats-To-Average","4","beats"
"RF-Mode/ECG/Respiration-Blank-Period","5000","samples"
"RF-Mode/ECG/Respiration-Gate-Delay","1","ms"
"RF-Mode/ECG/Respiration-Minimal-Peak-2-Peak","70000"
"RF-Mode/ECG/Respiration-Percent-Peak","85","%"
"RF-Mode/ECG/Respiration-Period","110","ms"
"RF-Mode/ECG/Respiration-Range","4144","mV"
"RF-Mode/ECG/Respiration-Show-Event","0"
"RF-Mode/ECG/Respiration-Subsample-Rate","100","samples"
"RF-Mode/ECG/Respiration-Threshold","35000"
"RF-Mode/ECG/Respiration-Threshold-Change","50","%"
"RF-Mode/ECG/Respiration-Time-To-Average","5000","ms"
"RF-Mode/ECG/Respiration-Window-End","0.75","s"
"RF-Mode/ECG/Respiration-Blank-Time","0.06","sec"
"RF-Mode/ECG/Respiration-Minimal-Peak","10000"
"RF-Mode/ECG/Respiration-Maximal-Peak","25","%"
"RF-Mode/ECG/Respiration-Period","0.25","sec"
"RF-Mode/ECG/Respiration-Maxima-Block-Time","0.1","sec"
"RF-Mode/ECG/Respiration-Noise-Threshold","135"
"RF-Mode/ECG/Respiration-Thresh-Trigger","60","%
"RF-Mode/ECG/Respiration-Max-Change-Factor","25","%"
"RF-Mode/ECG/Respiration-Max-Change","0.25","sec"
"RF-Mode/ECG/Respiration-Max-Change-Percent","25","%"
"RF-Mode/ECG/Respiration-Max-Change-Period","0.1","sec"
"RF-Mode/ECG/Respiration-Maxima-Block-Time","135"
"RF-Mode/ECG/Respiration-Thresh-Trigger-Percent","60","%
"RF-Mode/ECG/Respiration-Threshold","0.02","sec"
"RF-Mode/ECG/Respiration-Maxima-Block","135"
"RF-Mode/ECG/Respiration-Future-Search","0.02","sec"
"RF-Mode/ECG/Respiration-Threshold-Change","25","%"
"RF-Mode/ECG/Respiration-Max-Change","0.25","sec"
"RF-Mode/ECG/Respiration-Threshold","135"
"RF-Mode/ECG/Respiration-Maxima-Block","135"
"RF-Mode/ECG/Respiration-Thresh-Trigger","60","%"
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF-Mode/MIS/ECG-Available</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/MIS/ECG-Gain</td>
<td>&quot;4&quot;</td>
</tr>
<tr>
<td>RF-Mode/MIS/Respiration-Available</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/MIS/Respiration-Gating</td>
<td>&quot;0&quot;</td>
</tr>
<tr>
<td>RF-Mode/MIS/Temperature-Available</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Acceleration</td>
<td>&quot;42950&quot;, &quot;cnt/cyc2&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Acceleration-Stationary</td>
<td>&quot;42950&quot;, &quot;cnt/cyc2&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Actual-Position</td>
<td>&quot;-3566&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Alarm-Clear</td>
<td>&quot;2&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Axis-Out-Source</td>
<td>&quot;640&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Breakpoint</td>
<td>&quot;2624&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Breakpoint-Value</td>
<td>&quot;4194304&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Buffer-Length</td>
<td>&quot;512&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Buffer-Read-Index</td>
<td>&quot;0&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Buffer-Start</td>
<td>&quot;512&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Clear-Interrupt</td>
<td>&quot;0&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Derivative-Time</td>
<td>&quot;5&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Error</td>
<td>&quot;4&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Event-Status</td>
<td>&quot;769&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Integration-Limit</td>
<td>&quot;100000&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Interrupt-Mask</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Kd</td>
<td>&quot;25&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Ki</td>
<td>&quot;5&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Kp</td>
<td>&quot;8&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Limit-Switch-Mode</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Motion-Complete-Mode</td>
<td>&quot;1&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/No-Operation</td>
<td>&quot;0&quot;</td>
</tr>
<tr>
<td>RF-Mode/Motor/Output-Mode</td>
<td>&quot;0&quot;</td>
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<td>RF-Mode/Motor/Position</td>
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<td>RF-Mode/Motor/Position-Forward</td>
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<td>RF-Mode/Motor/R-Setup-Trace</td>
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<td>RF-Mode/Motor/R-Wait-Finish-Scan-Move</td>
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<td>RF-Mode/Motor/Settle-Time</td>
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<td>RF-Mode/Motor/Settle-Time-3d</td>
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<td>RF-Mode/Motor/Settle-Window</td>
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<td>RF-Mode/Motor/Settle-Window-3d</td>
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<td>RF-Mode/Motor/Y-Switch-Limit</td>
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<td>RF-Mode/RfModeSoft/Amplitude-Height</td>
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<td>RF-Mode/RfModeSoft/Amplitude-Origin</td>
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<td>RF-Mode/RfModeSoft/Digitizer</td>
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<td>RF-Mode/RfModeSoft/Magnitude-Height</td>
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<td>RF-Mode/RfModeSoft/Magnitude-Origin</td>
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<td>RF-Mode/RfModeSoft/SamplesPerSec</td>
<td>&quot;420&quot;, &quot;MHz&quot;</td>
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<td>RF-Mode/RfModeSoft/Samples</td>
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<td>RF-Mode/RfModeSoft/Saturation</td>
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<td>RF-Mode/RfModeSoft/Saturation-Threshold</td>
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<td>RF-Mode/RfModeSoft/Shift-RF-Data</td>
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<td>RF-Mode/RfModeSoft/SV-Center</td>
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<td>RF-Mode/RfModeSoft/SV-Center-Depth</td>
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"RF-Mode/RfModeSoft/SV-Length-Limits","4.00","mm"  
"RF-Mode/RfModeSoft/Vertical-Scale","5","mm"  
"RF-Mode/RfModeSoft/V-Lines","10"  
"RF-Mode/RfModeSoft/V-Lines-Pos","-0.818182,-0.636364,-0.454545,-0.272727,-0.090909,0.090909,0.272727,0.454545,0.636364,0.818182"  
"RF-Mode/RX/ADCA-Out","1"  
"RF-Mode/RX/ADCB-Out","0"  
"RF-Mode/RX/AD-Clock-Div","0"  
"RF-Mode/RX/AD-DCS","0"  
"RF-Mode/RX/AD-Gate-Width","136","samples"  
"RF-Mode/RX/AD-IF","0"  
"RF-Mode/RX/AD-In","0"  
"RF-Mode/RX/AD-TestIn","0","V"  
"RF-Mode/RX/Current-Channel","0"  
"RF-Mode/RX/Current-Mode","0"  
"RF-Mode/RX/DDRS","0"  
"RF-Mode/RX/Delay","6.57","µs"  
"RF-Mode/RX/DTB-Error-Clr","0"  
"RF-Mode/RX/DTB-Test-Enable","0"  
"RF-Mode/RX/DTB-Tfr-Enable","1"  
"RF-Mode/RX/Error","0"  
"RF-Mode/RX/Frequency","39.3750","MHz"  
"RF-Mode/RX/HP-Clutter","100","Hz"  
"RF-Mode/RX/IF-Filter","3","MHz"  
"RF-Mode/RX/Image-FIFO-Status","0"  
"RF-Mode/RX/Imaging-Mode","0"  
"RF-Mode/RX/IQ-Select","0"  
"RF-Mode/RX/Line-Number","464"  
"RF-Mode/RX/Low-Speed-FIFO-Status","0"  
"RF-Mode/RX/Packet-Format","240"  
"RF-Mode/RX/Pulse-Rep-Frequency","10","kHz"  
"RF-Mode/RX/RF-Amp","1"  
"RF-Mode/RX/Trigger-Control","1"  
"RF-Mode/RX/Trigger-Counter","0"  
"RF-Mode/RX/Trigger-Counter-Clear","1"  
"RF-Mode/RX/Unblank-Cycles","14","cycles"  
"RF-Mode/RX/Unblank-Time","350","ns"  
"RF-Mode/RX/V-Frequency","40","MHz"
The following are the B-Mode image parameters and system settings, with sample values. These parameters describe the settings for the ROI image data that is included in the exported data. This set of values is included with all exported images, regardless of acquisition mode.

"B-Mode/3D/Action", "4"
"B-Mode/3D/Clear-Error", "1"
"B-Mode/3D/Direction", "8"
"B-Mode/3D/Error", "0"
"B-Mode/3D/Max-Scan-Steps", "500"
"B-Mode/3D/Motor-Enable", "0"
"B-Mode/3D/Position", "0"
"B-Mode/3D/Scan-Distance", "10.00", "mm"
"B-Mode/3D/Speed", "20"
"B-Mode/3D/Status", "0"
"B-Mode/3D/Steps", "0"
"B-Mode/3D/Step-Size", "0.25", "mm"
"B-Mode/3Dotor/Class", "1"
"B-Mode/3Dotor/Dilation-Iteration", "45"
"B-Mode/3Dotor/External-Force", "1"
"B-Mode/3Dotor/Internal-Force", "0.3"
"B-Mode/3Dtor/Interpolation-Resolution", "10"
"B-Mode/3Dotor/Iteration", "200"
"B-Mode/3Dotor/Orientation-Length", "0.5"
"B-Mode/3Dotor/Parallel-Direction", "1"
"B-Mode/3Dotor/Parallel-Recon-Resolution", "35"
"B-Mode/3Dotor/Parallel-Step-Size", "0.25", "mm"
"B-Mode/3Dotor/Rotation-Direction", "1"
"B-Mode/3Dotor/Rotation-Step-Size", "10"
"B-Mode/3Dotor/Sigma", "3"
"B-Mode/3Dotor/Steps", "1"
"B-Mode/3Dotor/Type", "0"
"B-Mode/ActiveProbe/ Acceleration-Limit-Constant", "197680"
"B-Mode/ActiveProbe/ Acceleration-Limit-Slope", "0"
"B-Mode/ActiveProbe/ Acc-Time-Factor", "0.2"
"B-Mode/ActiveProbe/ Attenuation-Shift", "0"
"B-Mode/ActiveProbe/ Axial-Res", "40", "µm"
"B-Mode/ActiveProbe/ Axial-Res-Factor-Target", "0.5"
"B-Mode/ActiveProbe/ Cutoff-Scan-Speed", "1125", "Hz"
"B-Mode/ActiveProbe/ Default-FOV", "10", "mm"
"B-Mode/ActiveProbe/ Default-Rx-Gain", "10", "dB"
"B-Mode/ActiveProbe/ Default-Rx-Gain-Doppler", "10", "dB"
"B-Mode/ActiveProbe/ Default-Scan-Speed", "40", "fps"
"B-Mode/ActiveProbe/ Default-SvSize-MMode", "4"
"B-Mode/ActiveProbe/ Derivative-Time", "5"
"B-Mode/ActiveProbe/ Detect-1d", ""
"B-Mode/ActiveProbe/ Detect-Ratio-Max", "0.3454"
"B-Mode/ActiveProbe/ Detect-Ratio-Min", "0.3311"
"B-Mode/ActiveProbe/ Encoder-Range-Max", "11.5", "mm"
"B-Mode/ActiveProbe/ Encoder-Range-Min", "10.5", "mm"
"B-Mode/ActiveProbe/ Encoder-Separation", "0.001", "mm"
"B-Mode/ActiveProbe/ Filter", "40", "MHz"
"B-Mode/ActiveProbe/ Filter-Doppler", "40", "MHz"
"B-Mode/ActiveProbe/ Filter-Doppler-Cutoff", "4", "cycles"
"B-Mode/ActiveProbe/ Filter-Doppler-Low", "30", "MHz"
"B-Mode/ActiveProbe/ Filter-High", "40", "MHz"
"B-Mode/ActiveProbe/ Filter-Low", "40", "MHz"
"B-Mode/ActiveProbe/ F-Number", "2"
"B-Mode/ActiveProbe/ Focal-Length", "6", "mm"
"B-Mode/ActiveProbe/ Frequency", "40", "MHz"
"B-Mode/ActiveProbe/ Frequency-Doppler", "40", "MHz"
"B-Mode/ActiveProbe/ Frequency-Doppler-Default", "30", "MHz"
"B-Mode/ActiveProbe/ Frequency-Doppler-Low", "30", "MHz"
"B-Mode/ActiveProbe/ Frequency-High", "45", "MHz"
"B-Mode/ActiveProbe/ Frequency-Low", "35", "MHz"
"B-Mode/ActiveProbe/ Integration-Limit", "25600000"
"B-Mode/ActiveProbe/K1-Power", "120"
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"B-Mode/ActiveProbe/
Lateral-Res","80","µm"
"B-Mode/ActiveProbe/
Lateral-Res-Factor-Max","1"
"B-Mode/ActiveProbe/
Lateral-Res-Factor-Target","0.25"
"B-Mode/ActiveProbe/
Max-Scan-Distance","9.9","mm"
"B-Mode/ActiveProbe/
Motor-Overhead","0.75","ms"
"B-Mode/ActiveProbe/Name","RMV-704"
"B-Mode/ActiveProbe/Notes","High Resolution Near"
"B-Mode/ActiveProbe/
Overshoot","0.25","mm"
"B-Mode/ActiveProbe/
Peak-Bandwidth-Correction","1.3"
"B-Mode/ActiveProbe/
Peak-Vel-Correction","1.6"
"B-Mode/ActiveProbe/
PID-KD-High","25"
"B-Mode/ActiveProbe/PID-KD-Low","25"
"B-Mode/ActiveProbe/PID-KI-High","5"
"B-Mode/ActiveProbe/PID-KI-Low","5"
"B-Mode/ActiveProbe/PID-KP-High","8"
"B-Mode/ActiveProbe/PID-KP-Low","6"
"B-Mode/ActiveProbe/
Pivot-Encoder-Dist","40","mm"
"B-Mode/ActiveProbe/
Pivot-Transducer-Face-Dist","50","mm"
"B-Mode/ActiveProbe/
Sample-Time","154","µs"
"B-Mode/ActiveProbe/
Scan-Speeds","2,6,10,15,20,30,40,50,60,70","fps"
"B-Mode/ActiveProbe/
Type","RMV Scanhead"
"B-Mode/ActiveProbe/
Version","6.3"
"B-Mode/BModeSoft/
Acquisition-Mode","0","mode"
"B-Mode/BModeSoft/
Actual-Scan-Rate","34","fps"
"B-Mode/BModeSoft/Default-Frame-Number","300","frames"
"B-Mode/BModeSoft/Flip-Image","0"
"B-Mode/BModeSoft/
Overlay-Mode","15","mode"
"B-Mode/BModeSoft/
Refresh-Rate","50","frames/sec"
"B-Mode/BModeSoft/
Relative-Frame-Rate","4"
"B-Mode/BModeSoft/
Sector-Convert","1"
"B-Mode/BModeSoft/
Sector-X-Res","512","pixels"
"B-Mode/BModeSoft/
Sector-X-Start","0","pixels"
"B-Mode/BModeSoft/
Sector-Y-Res","512","pixels"
"B-Mode/BModeSoft/
Sector-Y-Start","0","pixels"
"B-Mode/BModeSoft/
Target-Field-Of-View","10.00","mm"
"B-Mode/BModeSoft/
V-Relative-Frame-Rate","4"
"B-Mode/Diag/Build-Version","17.0"
"B-Mode/Diag/ICB-FPGA-Revision","15"
"B-Mode/Diag/ICB-PCB-ID","1"
"B-Mode/Diag/ICB-PCB-Revision","3"
"B-Mode/Diag/MAX1137","1"
"B-Mode/Diag/
Monitor-15V","14.94","V"
"B-Mode/Diag/
Monitor-3point3V","0.23","V"
"B-Mode/Diag/
Monitor-5V","4.97","V"
"B-Mode/Diag/
Monitor-GDI-Objects","155"
"B-Mode/Diag/
Monitor-Neg15V","-14.96","V"
"B-Mode/Diag/
Monitor-Neg5V","-5.02","V"
"B-Mode/Diag/
Monitor-Temperature","27"
"B-Mode/Diag/
Monitor-USER-Objects","138"
"B-Mode/Diag/
Motor-FPGA-Revision","9"
"B-Mode/Diag/
Motor-PCB-ID","4"
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Motor-PCB-Revision","4"
"B-Mode/Diag/NE1619","1"
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"B-Mode/Diag/
Receive-FPGA-Revision","12"
"B-Mode/Diag/Receive-PCB-ID","2"
"B-Mode/Diag/
Receive-PCB-Revision","3"
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Software-Version","1.4.0"
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Switch-PCB-ID","5"
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Switch-PCB-Revision","1"
"B-Mode/Diag/
Transmit-PCB-ID","3"
"B-Mode/Diag/
Transmit-PCB-Revision","3"
"B-Mode/Diag/
Window-Time","2000.000000","ms"
"B-Mode/Display/
ECG-HP-Filter","100","Hz"
"B-Mode/Display/
ECG-Range","32768","mV"
"B-Mode/Display/
ECG-Frequency","8000","Hz"
"B-Mode/Display/
Heart-Period","0","ms"
"B-Mode/Display/
Pressure-Amplification","0.058"
“B-Mode/ECG/
Pressure-Calibration”, “100”, “mV/mmHg”
“B-Mode/ECG/
Pressure-Diastolic”, “40”, “ms”
“B-Mode/ECG/
Pressure-Range”, “6473”, “mmHg”
“B-Mode/ECG/Pressure-Show-Event”, “0”
“B-Mode/ECG/
Pressure-Systolic”, “40”, “ms”
“B-Mode/ECG/
Respiration-Beats-To-Average”, “4”, “Beats”
“B-Mode/ECG/
Respiration-Blank-Period”, “500”, “samples”
“B-Mode/ECG/
Respiration-Gate-Delay”, “1”, “ms”
“B-Mode/ECG/
Respiration-Minimal-Peak-2-Peak”, “200”
“B-Mode/ECG/
Respiration-Percent-Peak”, “85”, “%”
“B-Mode/ECG/
Respiration-Period”, “110”, “ms”
“B-Mode/ECG/
Respiration-Range”, “4144”, “mV”
“B-Mode/ECG/
Respiration-Show-Event”, “0”
“B-Mode/ECG/
Respiration-Subsample-Rate”, “100”, “samples”
“B-Mode/ECG/
Respiration-Threshold”, “35000”
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Respiration-Threshold-Change”, “50”, “%”
“B-Mode/ECG/
Respiration-Time-To-Average”, “5000”, “ms”
“B-Mode/ECG/
Respiration-Window-End”, “0.75”, “%”
“B-Mode/ECG/
RWave-Blank-Time”, “0.06”, “sec”
“B-Mode/ECG/
RWave-Default-Threshold”, “10000”
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RWave-Future-Search-Time”, “0.02”, “sec”
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RWave-Max-Change-Factor-Percent”, “25”, “%”
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RWave-Max-Change-Period”, “0.25”, “sec”
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RWave-Maxima-Block-Time”, “0.1”, “sec”
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RWave-Noise-Threshold”, “135”
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RWave-Threshold-Percent”, “60”, “%”
“B-Mode/ECG/
RWave-Threshold-Trigger-Percent”, “60”, “%”
“B-Mode/ECG/
RWave-Show-Filtered-Data”, “0”
“B-Mode/ECG/
RWave-Show-RWaves”, “90”
“B-Mode/ECG/
Temperature”, “-0.10974883984375”, “°C”
“B-Mode/ECG/
Temperature-Amplification”, “-0.0155”
“B-Mode/ECG/
Temperature-Calibration”, “100”, “mV/C”
“B-Mode/EKVModeSoft/EKV-Advanced”, “0”
“B-Mode/EKVModeSoft/EKV-Quality”, “1”, “%”
“B-Mode/EKVModeSoft/EKV-Save-Raw”, “0”
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“B-Mode/EKVModeSoft/EKV-Stop”, “1”, “mm”
“B-Mode/EKVModeSoft/EKV-Triggers”, “384”, “triggers”
“B-Mode/EKVModeSoft/EKV-Variance”, “10”, “%”
“B-Mode/MIS/
Blood-Pressure-Available”, “0”
“B-Mode/MIS/BP-Gain”, “4”
“B-Mode/MIS/Control”, “0”
“B-Mode/MIS/ECG-Available”, “1”
“B-Mode/MIS/ECG-Gain”, “4”
“B-Mode/MIS/
Respiration-Available”, “1”
“B-Mode/MIS/Respiration-Gating”, “0”
“B-Mode/MIS/
Temperature-Available”, “1”
“B-Mode/Motor/
Acceleration”, “42950”, “cnt/cyc2”
“B-Mode/Motor/
Acceleration-Stationary”, “42950”, “cnt/cyc2”
“B-Mode/Motor/
Actual-Position”, “-3566”
“B-Mode/Motor/Alarm-Clear”, “2”
“B-Mode/Motor/Axis-Out-Source”, “640”
“B-Mode/Motor/Breakpoint”, “2624”
“B-Mode/Motor/
Breakpoint-Value”, “4194304”
“B-Mode/Motor/Buffer-Length”, “512”
“B-Mode/Motor/Buffer-Read-Index”, “0”
“B-Mode/Motor/Buffer-Start”, “512”
“B-Mode/Motor/Buffer-Stop”, “0”
“B-Mode/Motor/Clear-Interrupt”, “1”
“B-Mode/Motor/Event-Status”, “769”
“B-Mode/Motor/
Integration-Limit”, “100000”
“B-Mode/Motor/Interrupt-Mask”, “1”
“B-Mode/Motor/Kd”, “25”
“B-Mode/Motor/Ki”, “5”
“B-Mode/Motor/Kp”, “8”
“B-Mode/Motor/Limit-Switch-Mode”, “1”
“B-Mode/Motor/
Motion-Complete-Mode”, “1”
“B-Mode/Motor/Motor-Mode”, “1”
“B-Mode/Motor/No-Operation”, “0”
“B-Mode/Motor/Output-Mode”, “0”
“B-Mode/Motor/Position”, “818”, “unit”
“B-Mode/Motor/Position2”, “3541”, “unit”
“B-Mode/Motor/Position-Forward”, “3541”, “unit”
“B-Mode/Motor/Position-Reverse”, “-3541”, “unit”
“B-Mode/Motor/Profile-Mode”, “0”
“B-Mode/Motor/Read-Buffer”, “0”
“B-Mode/Motor/Reset”, “1”

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"B-Mode/Motor/Reset-Event-Status","18686"
"B-Mode/Motor/R-Home","0"
"B-Mode/Motor/R-Initialize","0"
"B-Mode/Motor/R-Reset-Limit-Switch","0"
"B-Mode/Motor/R-Scan-Move","818","unit"
"B-Mode/Motor/R-Scan-Move2","0","unit"
"B-Mode/Motor/R-Scan-Move-No-Wait","0","unit"
"B-Mode/Motor/R-Setup","1"
"B-Mode/Motor/R-Setup-Abort","0"
"B-Mode/Motor/R-Setup-Trace","0"
"B-Mode/Motor/R-Wait-Finish-Scan-Move","0"
"B-Mode/Motor/Sample-Time","154"
"B-Mode/Motor/Scan-Move-Control","0"
"B-Mode/Motor/Serial-Port-Mode","69"
"B-Mode/Motor/Settle-Time","500"
"B-Mode/Motor/Settle-Time-3d","5"
"B-Mode/Motor/Settle-Window","25"
"B-Mode/Motor/Settle-Window-3d","200"
"B-Mode/Motor/Velocity","2889087","cnt/cyc"
"B-Mode/Motor/V-Switch-Limit","11093"
"B-Mode/RX/ADCA-Out","1"
"B-Mode/RX/ADCB-Out","0"
"B-Mode/RX/AD-Clock-Div","0"
"B-Mode/RX/AD-DCS","0"
"B-Mode/RX/AD-Gate-Width","496","samples"
"B-Mode/RX/AD-IF","0"
"B-Mode/RX/AD-In","0"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
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"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
"B-Mode/RX/AD-TestIn","0","V"
Chapter 2: Raw Data Export Format: Image Parameters / System Settings

"B-Mode/Sys/Company-Name","" 
"B-Mode/Sys/DDG-Control","273351489" 
"B-Mode/Sys/Feature","14230" 
"B-Mode/Sys/Interrupt-Clear","4" 
"B-Mode/Sys/Interrupt-Mask","4" 
"B-Mode/Sys/Interrupt-Status","15" 
"B-Mode/Sys/Mode","15" 
"B-Mode/Sys/Pipeline-Delay","155.3","ns" 
"B-Mode/Sys/Sound-Speed","1540","m/s" 
"B-Mode/Sys/SubMode","0" 
"B-Mode/TX/Attenuation","0","dB" 
"B-Mode/TX/Computer-Trigger","1" 
"B-Mode/TX/Frequency","40","MHz" 
"B-Mode/TX/Multi-Trigger","1" 
"B-Mode/TX/Multi-Trigger-Freq","23" 
"B-Mode/TX/Phase","1" 
"B-Mode/TX/Pulse-Rep-Frequency","0","kHz" 
"B-Mode/TX/RF-Amp","1" 
"B-Mode/TX/Trigger-Control","1" 
"B-Mode/TX/Trigger-Counter","0" 
"B-Mode/TX/Unblank-Cycles","14","cycles" 
"B-Mode/TX/Unblank-Time","350","ns" 
"B-Mode/TX/V-Frequency","40","MHz" 
"B-Mode/TX/V-Power","100","%" 
"B-Mode/TX/V-Pulse-Rep-Freq","8.000443","kHz" 
"B-Mode/TX/V-Transmit-Length","0.04","mm" 
"B-Mode/TX/V-Unblank-Time","354.4156725","ns" 
"B-Mode/TX/V-Width","1" 
"B-Mode/TX/Width","1" 

7062,7084,7105,7127,7148,7170,7192,7 
213,7235,7256,7278,7299,7321,7342,736 
4,7386,7407,7429,7450,7472,7493,7515, 
7537,7558,7580,7601,7623,7644,7666,76 
67,7709,7731,7752,7774,7795,7817,7838, 
7860,7881,7903,7925,7946,7968,7989,8 
011,8032,8054,8076,8097,8119,8140,816 
2,8183,8205,8226,8248,8270,8291,8313, 
8334,8356,8377,8399,8420,8442,8464,84 
85,8507,8528,8550,8571,8593,8615,8636, 
8658,8679,8701,8722,8744,8765,8787,8 
809,8830,8852,8873,8895,8916,8938,895 
7,8981,9003,9024,9046,9067,9089,9110, 
9132,9154,9175,9197,9218,9240,9261,92 
63,9304,9326,9348,9369,9391,9412,9434 
,9455,9477,9499,9520,9542,9563,9585,9 
606,9628,9649,9671,9693,9714,9736,97 
57,9779,9800,9822,9843,9865,9887,9906, 
9930,9951,9973,9994,10016,10038,10059 
7,10081,10102,10124,10145,10167,1018 
8,10210,10102,10123,10145,10166,10187,1 
0209,10230,10251" 
"B-Mode/TX/V-Power","100","%" 
"B-Mode/TX/Unblank-Cycles","14","cycles" 
"B-Mode/TX/V-Unblank-Time","350","ns" 
"B-Mode/TX/V-Width","1" 
"B-Mode/TX/Width","1"
Image Data Format

ROI Image Data Format

The raw acquired B-Mode data for the ROI is written to the binary data file as described by the following:

Let $S$ be the number of samples on each scan line (samples/line)

\[ S = \text{B-Mode/RX/AD-Gate-Width} \]

(from the Image Parameters section of the CSV text file)

Let $L$ be the number of triggered scan lines acquired (lines)

\[ L = \text{B-Mode/TX/Trig-Tbl-Trigs} \]

(from the Image Parameters section of the CSV text file)

Let $B$ be the total size of the block (in bytes) of raw acquired image data

\[ B = L \text{ lines} \times S \text{ samples/line} \times 2 \text{ bytes/sample} \]

The data block is then written to the binary data file as a contiguous stream of unsigned values, one data line at a time, from the earliest line acquired for the frame to the latest line acquired.

Each data line is output as a set of samples, two bytes per sample, in order from the sample closest to the ultrasound transducer to the sample furthest away.

(Line 1 : Sample 1) (Line 1 : Sample 2) \ldots (Line 1 : Sample $S$)

(Line 2 : Sample 1) (Line 2 : Sample 2) \ldots (Line 2 : Sample $S$)

\ldots

(Line $L$ : Sample 1) (Line $L$ : Sample 2) \ldots (Line $L$ : Sample $S$)

The value for each sample is written in Little Endian format, such that the least significant byte (LSB) precedes the most significant byte (MSB) in the binary data file.

The sample value 3754 (or 0x0EAA), for example, would appear in the binary data file as these two consecutive byte values:

0xAA 0x0E

ROI Saturation Data Format

The raw acquired saturation data for the ROI is written to the binary data file as described by the following:

Let $S$ be the number of samples on each scan line (samples/line)

\[ S = \text{B-Mode/RX/AD-Gate-Width} \]

(from the Image Parameters section of the CSV text file)

Let $L$ be the number of triggered scan lines acquired (lines)

\[ L = \text{B-Mode/TX/Trig-Tbl-Trigs} \]

(from the Image Parameters section of the CSV text file)

Let $B$ be the total size of the block (in bytes) of raw acquired image data

\[ B = L \text{ lines} \times S \text{ samples/line} \times 2 \text{ bytes/sample} \]

The data block is then written to the binary data file as a contiguous stream of unsigned values, one data line at a time, from the earliest line acquired for the frame to the latest line acquired.
Each data line is output as a set of samples, two bytes per sample, in order from the sample closest to the ultrasound transducer to the sample furthest away.

(Line 1 : Sample 1) (Line 1 : Sample 2) . . . (Line 1 : Sample S)
(Line 2 : Sample 1) (Line 2 : Sample 2) . . . (Line 2 : Sample S)

. . .
(Line L : Sample 1) (Line L : Sample 2) . . . (Line L : Sample S)

For each sample, a value of 0 indicates that the signal is not saturated and a value of 4095 indicates that the signal is saturated.

The value for each sample is written in Little Endian format, such that the least significant byte (LSB) precedes the most significant byte (MSB) in the binary data file.

The sample value 4095 (or 0x0FFF), for example, would appear in the binary data file as these two consecutive byte values:

0xFF 0x0F

RF Data Format

The raw acquired RF data for a line is written to the binary data file as described by the following:

Let $B$ be the total size of the block (in bytes) of raw acquired image data

$B = \text{Image Acquisition Size}$
(from the Image Info section of the CSV text file)

Let $S$ be the number of samples on each RF data acquisition

$S = B / (2 \text{ bytes/sample})$

The frame number, line number and acquisition number of the RF data line is provided in the entry name for each RF data offset in the Image Data section of the CSV text file.

The data line is then written to the binary data file as a contiguous stream of signed value representing the samples, two bytes per sample, in order from the sample closest to the ultrasound transducer to the sample furthest away.

(Sample 1) (Sample 2) . . . (Sample S)

The value for each sample has been multiplied by 16 to preserve the sign bit when the 12-bit data is represented in 16-bit format.

The value for each sample is written in Little Endian format, such that the least significant byte (LSB) precedes the most significant byte (MSB) in the binary data file.

The sample value 3754 (or 0x0EAA), for example, would appear in the binary data file as these two consecutive byte values:

0xAA 0x0E

If multiple acquisitions were collected for a given line, the average of those acquisitions is also stored in the data file.

The average RF data is written to the binary file in the same way as the raw acquired data for the RF line is.
The only exception is that the entry name for the average RF data offset in the Image Data section of the CSV file does not include an acquisition number.
## Chapter 3: Attenuation Characterization

Digital RF-Mode includes an analysis feature that calculates the attenuation characteristic of the RF signal within the subject.

### Fundamentals

When in the analysis state, the Digital RF-Mode window includes the following modifications and tools to set the parameters required for the attenuation characterization calculation:

- The Scout window is removed and replaced with Analysis Settings.
- The acquisition lines in ROI window are no longer selectable.
- The RF data graph is not available.
- Two selection control buttons are added.
- A Calculate button is added to generate the best-fit line on the normalized data within the specified frequency range.

---

Digital RF-Mode in data analysis state, calculation completed.

Create and Remove selection control buttons. For more information, see “Selecting the RF Data Region” on page 26.

Calculate button. For more information, see “Calculating The Attenuation Characterization” on page 30.
Entering RF-Mode Analysis

To analyze RF data:
1. Acquire RF Data.
2. Click Analyze.

Selecting RF Data

Selecting the Frame of Data

To select a specific frame within the data set:
Drag the "frame index indicator" to the desired frame or click on the "acquired frame indicator" at the location of the desired frame.

When RF data comprised of multiple frames is saved using Frame Store, the Frame Index Indicator identifies the frame index of the saved frame when the frame is reloaded. The Acquired Frame Indicator is disabled and a different frame index cannot be selected.

When a change is made in the frame index, the Normalized and FFT graph is cleared. To recalculate the Graph window with the latest settings, click Calculate.

Selecting the RF Data Region

In the analysis state, two selection control buttons appear below the ROI window. A selection is a region within the ROI where the attenuation characterization calculation is performed. If there no selection is defined, all RF data lines in the selected frame are used for the attenuation characterization calculation.

The size of the selection is restricted to a minimum size of 16x16 pixels.

To create a new selection:
1. Click Create. Create becomes highlighted and the cursor becomes a cross symbol when inside the ROI window. Any previously created selection is removed permanently.
2. Left click in the ROI window and position the cursor across the desired area. The selected area becomes yellow.
3. Left click again to complete the selection creation process. If any part of the created selection is outside of the ROI data area, the selection reduces its size to fit the ROI data.

To edit the selection:
1. Left click and move the trackball to start moving and/or resizing the selection.
2. Left click to commit the new position and/or size.

To remove the selection:
1. Click Remove. The selection is removed. No confirmation message is provided.
2. When changes are made in the selection, the Normalized and FFT graph is cleared. To recalculate the data within Graph window with the latest settings, click Calculate.
3. The saturation overlay is still available in the ROI window so areas of saturation can be avoided when selecting the RF data region for calculation.

**To toggle the saturation overlay:**
Click Overlay > Saturation, or press <Overlay>.

### Setting The Analysis Settings
Analysis Settings are used to configure the attenuation characterization calculation. The system includes four settings:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td>The RF data that the acquired data will be compared against.</td>
</tr>
<tr>
<td>Ref. Offset</td>
<td>The magnitude offset, in dB, for the reference data set for the calculation.</td>
</tr>
<tr>
<td>FFT Offset</td>
<td>The magnitude offset, in dB, for the FFT data set for the calculation.</td>
</tr>
<tr>
<td>Freq. Range</td>
<td>The frequency range over which the attenuation characterization calculation will be performed.</td>
</tr>
</tbody>
</table>

When the operator chooses a different reference data, the Normalized and FFT graph is cleared.

**Reference Data**

**To modify the default reference data folder:**
1. Click Edit > Operator Preferences.
2. Edit the Default Reference Data Folder. The reference data files are stored in the "D:\Vevo770\Data\RF-Reference" folder by default.

**To create and save a reference data file:**
1. Acquire Digital RF-Mode data. Typically this data is acquired using a bounce test setup.
2. Click an acquisition line in the ROI window that will be used as the reference data.
3. Click Study > Export Image... or press <Export>.
4. Click Reference Data as the file type. The default reference data folder will be selected automatically when Reference Data file type is selected.
5. Click OK.

**Reference Offset**

**To set the reference offset:**
1. In the Ref. Offset edit box, enter the reference offset value.
2. Click Set.

**FFT Offset**

**To set the FFT offset:**
1. In the FFT Offset edit box, enter the FFT offset value.
2. Click Set.
Chapter 3: Attenuation Characterization: Viewing The Calculation Results

**Frequency Range**

To select the frequency range based on transmit frequency:

1. In the Freq. Range list, select \((1 \pm r) \times \text{freq}\).

   ![Freq. Range](image)

2. In the \(r\) box, enter a frequency value between 0.1 and 1.
3. Click Set.

To select a specified frequency range:

1. In the Freq. Range list, select range.

   ![Freq. Range](image)

2. In the Min and Max frequency boxes, enter the appropriate frequency values in MHz.
3. Click Set.

**Viewing The Calculation Results**

**Graph Window**

The Graph window in the Digital RF-Mode window is used to plot the Reference graph, FFT graph, or Normalized graph.

As shown in the following illustration, the system layers the graph data over the background grid in the following default order, from top to bottom:

- Normalized
- FFT
- Reference
- Frequency Range
To zoom in/out any of the three axes:

1. Left click on the desired axis. The cursor will change into a double arrow in the direction that you can drag the axis.

2. Drag the axis to zoom in or out:
   - Drag the horizontal axis left to zoom out and right to zoom in.
   - Drag the vertical axis up to zoom in and down to zoom out.

3. Left click again to complete the zoom.

To pan the graph:

1. Left click inside the graph window on the desired graph.

2. Move the cursor and the graph will pan in the direction of movement.

3. Left click again to complete the action.
Chapter 3: Attenuation Characterization: Calculating The Attenuation Characterization

When the mouse pointer enters the Graph window, a vertical cursor line appears and follows the mouse movement. A coordinate indicator appears at the top right corner of the Graph window and displays the data value at the cursor line position. When the mouse pointer leaves the Graph window, the cursor line and the coordinate indicator disappear.

To return to review of the RF data:
Click Review.

To scan in the Scout window and acquire new RF data:
1. Ensure that the study is in Acquisition Mode.
2. Click Mode > Freeze, or press <Freeze/Unfreeze>.

Calculating The Attenuation Characterization

To perform the attenuation characterization calculation:
1. Select the desired RF data region.
2. Select the desired analysis settings.
3. Click Calculate.

The attenuation characterization includes four calculation steps:
1. Calculate the frequency power spectrum of the reference data.
2. Calculate the frequency power spectrum of the RF data.
3. Normalize the RF and reference frequency power spectrum.
4. Apply a linear regression on the normalized data.

Reference Power Spectrum

The frequency spectrum of the reference data is calculated by performing a forward FFT on the selected RF line with the windowing function the operator selected in the current analysis state. The frequency spectrum of the reference data is then resampled so that it has the same resolution as the frequency spectrum in the current review state.

The power spectrum in dB is calculated according to:

\[ P_{ref} = 10 \times \log_{10} \left( |S_{ref}(f)|^2 \right) + \text{offset}_{dB} \]

RF Data Power Spectrum

The frequency spectrum of the RF data is calculated by performing a forward FFT with the selected windowing function for each RF data line within the RF Data Region. If multiple acquisitions were acquired per line, the frequency spectrum on the averaged RF data (averaging in time domain) for the line is calculated. If no RF Data Region is defined, the entire frame is considered to be the RF Data Region.

\[ s_{ave}(t) = \frac{1}{N} \sum_{n=1}^{N} s_{n,m}(t) \]

where \( N \) is the number of acquisitions per line.
Chapter 3: Attenuation Characterization: Calculating The Attenuation Characterization

\[ S_{\text{ave}}(f) = F(s_{\text{ave}}(t)) \]

The frequency spectrum of the RF data on each line is then resampled to the same resolution as the frequency spectrum in the current review state.

The power spectrum in decibels is then calculated for each line:

\[ P_{\text{RF}} = 10 \times \log_{10} \left( |S_u(f)|^2 \right) + \text{offset}_{\text{dB}} \]

The final power spectrum is the average of all the RF lines' power:

\[ P_{\text{RF}} = \frac{\sum_{m=1}^{M} P_{\text{line}m}}{M} \]

where \( M \) is the number of lines.

**Normalized Data**

The normalized data is calculated by subtracting (in dB) the reference power spectrum from the RF power spectrum.

\[ P_{\text{normalized}} = P_{\text{RF}} - P_{\text{ref}} \]

**Linear Regression**

The linear regression is calculated using Least Squares Fitting method across the frequency range specified by the operator. Standard error of the regression line will also be calculated.

\[
\text{slope} : a = \frac{\sum_{i=1}^{n} x_i y_i - \left( \sum_{i=1}^{n} x_i \right) \left( \sum_{i=1}^{n} y_i \right)}{n \sum_{i=1}^{n} x_i^2 - \left( \sum_{i=1}^{n} x_i \right)^2} \\
\text{intercept} : b = \frac{\sum_{i=1}^{n} x_i^2 \sum_{i=1}^{n} y_i - \left( \sum_{i=1}^{n} x_i \right) \left( \sum_{i=1}^{n} x_i y_i \right)}{n \sum_{i=1}^{n} x_i^2 - \left( \sum_{i=1}^{n} x_i \right)^2} \\
\text{standard error} : se = \sqrt{ \frac{\sum_{i=1}^{n} y_i^2 - b \sum_{i=1}^{n} y_i - a \sum_{i=1}^{n} x_i y_i}{n-2} } 
\]
**Created Measurements**

The following measurements are created when the calculation is completed.

<table>
<thead>
<tr>
<th>Measurement Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF (Slope)</td>
<td>Slope of the regression line</td>
</tr>
<tr>
<td>RF (Y-Intercept)</td>
<td>Y-intercept of the regression line</td>
</tr>
<tr>
<td>RF (Standard error)</td>
<td>Standard error of the regression line</td>
</tr>
<tr>
<td>RF (Midband fit)</td>
<td>Middle y-value of the regression line between the frequency range</td>
</tr>
<tr>
<td>RF (Slope - standard deviation)</td>
<td>Standard deviation of the slope of the regression line across all scan lines in the selection</td>
</tr>
<tr>
<td>RF (Y-Intercept - standard deviation)</td>
<td>Standard deviation of the y-intercept of the regression line across all scan lines in the selection</td>
</tr>
<tr>
<td>RF (Standard error - standard deviation)</td>
<td>Standard deviation of the standard error of the regression line across all scan lines in the selection</td>
</tr>
<tr>
<td>RF (Midband fit - standard deviation)</td>
<td>Standard deviation of the midband fit of the regression line across all scan lines in the selection</td>
</tr>
</tbody>
</table>

**Save And Export**

When the operator clicks Calculate, the system automatically saves or resaves a Digital RF-Mode frame.

*To manually save/resave a Digital RF-Mode Frame:*

Click Study > Frame Store, or press <Frame Store>. To save a new copy of a Digital RF-Mode Frame, press <Ctrl> + <Frame Store>. 