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Description - This test verifies the presence of RF noise in either the screen room, or the TPS subsystem.

Note

Perform Standard Correlated Noise Check on all systems. If the multi-coil option has been installed, also perform procedure in Section 2- Multicoil Correlated Noise Check.

1- STANDARD CORRELATED NOISE CHECK

1-1 Overview

Correlated noise is phase and frequency coherent noise sources that correlate to clocks and other digital signals generated internal to the MRI system. These noise sources cause undesirable constant frequency lines (noise "zippers"), or bright spot ("hot" pixel cluster) type artifact in MR images. These problems are usually caused by poor screen room integrity, or grounding problems on the TPS chassis or backplane. Refer to Table 1-1 for procedure step summary.

TABLE 1-1
STANDARD CORRELATED NOISE TEST PROCEDURE SUMMARY

<p>The test consists of the following:</p> <ul style="list-style-type: none">• The Head Coil is placed in the bore with the Head TLT Sphere and Loader.• The CERD RF Output Disable mode is selected (toggle switch) to disable the transmit RF.• 1.5T: Nine scans are taken between 63,710,000 and 63,910,000 Hz with R1=11, 256matrix. 1.0T: 13 scans are taken between 42,530,000 and 42,830,000 Hz with R1=11, 256matrix.• 1.5T: Nine more scans are taken between 63,710,000 and 63,910,000 Hz with R1=7. 1.0T: 13 more scans are taken between 42,530,000 and 42,830,000 Hz with R1=7.• For all systems (1.5T and 1.0T): One scan is taken at magnet frequency with R1=11, 512 matrix. Then, one more scan is taken at magnet frequency with R1=7, 512 matrix.• All images are analyzed for artifacts.

1-2 Tools Required

- Head TLT Sphere, 46-265826G6
- Head Loader, 46-287899G1
- Tuning Ring for Head Coil, 46-287416G1 (1.5T systems **only**)

1-3 SYSTEM HARDWARE PREPARATION

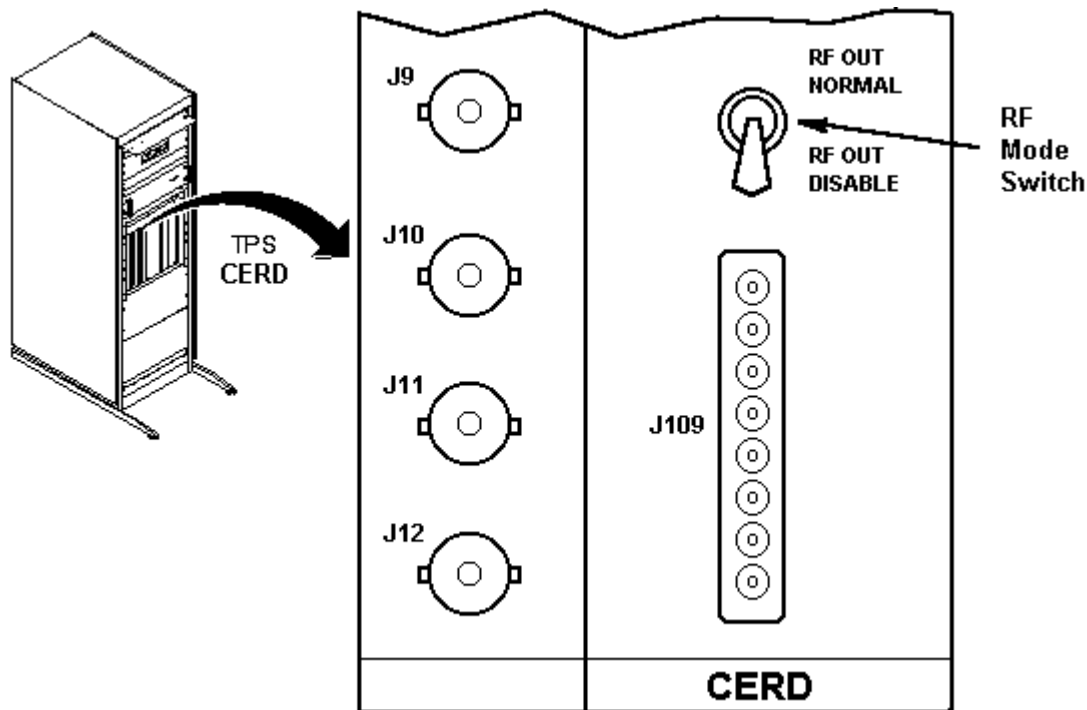
WARNING!

POISON HAZARD! THE PHANTOM CONTAINS NICKEL, A SUSPECT CARCINOGEN. DO NOT INGEST. DISPOSE OF AS A HAZARDOUS WASTE ACCORDING TO STATE AND FEDERAL REGULATIONS.

1. Remove front panel from Systems Cabinet.
2. Disable the CERD RF Output, by setting the RF Output mode toggle switch (located on the front panel of the CERD), to the RF Out Disable position (see Illustration 1-1).

Note

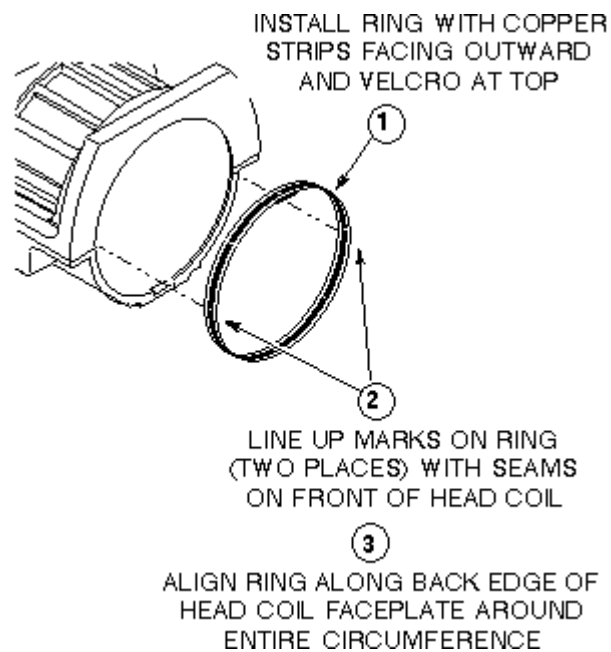
Be sure that the receiver(s) are tightly installed, and that ground screws are in place and tight. A missing or loose grounding screw produces correlated noise.



RF DISABLED FOR CORRELATED NOISE SCAN
ILLUSTRATION 1-1

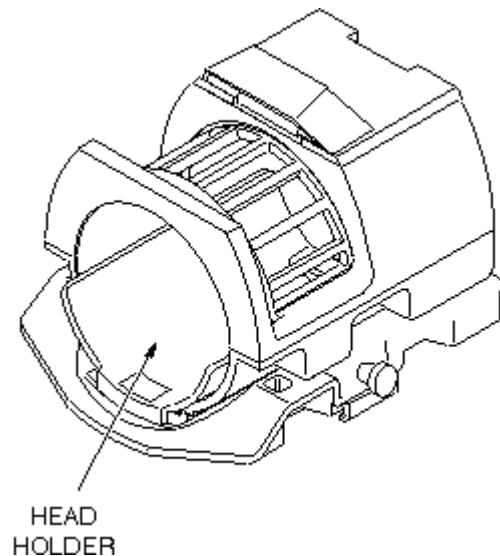
1-4 Scan Preparation

1. **1.5T systems:** Install tuning ring in head coil, as Illustration 1-2 shows.



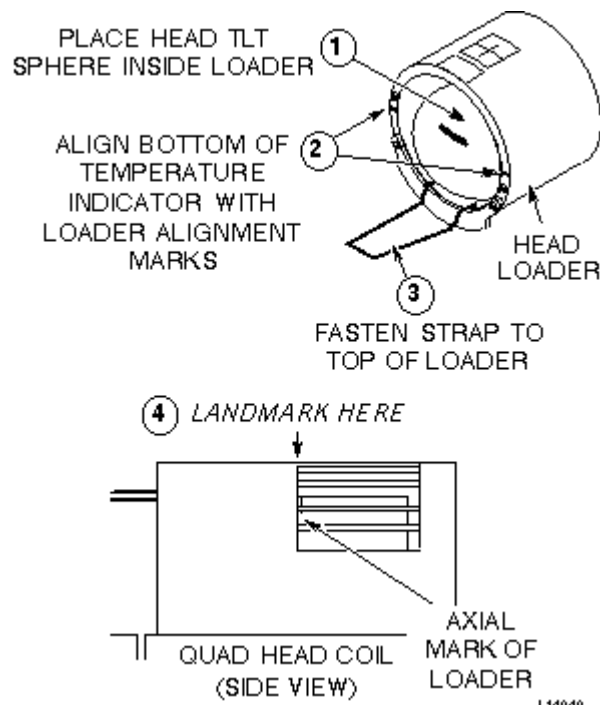
TUNING RING INSTALLATION (1.5T ONLY)
ILLUSTRATION 1-2

2. (All systems:) Install the head coil and holder. See Illustration 1-3.



HEAD HOLDER PLACEMENT IN HEAD COIL
ILLUSTRATION 1-3

3. Place the Head TLT Sphere in the Head Loader and landmark per Illustration 1-4 . At the front of the magnet enclosure, press LANDMARK, then MOVE TO SCAN.



HEAD TLT PHANTOM SETUP
ILLUSTRATION 1-4

- At the operator work space, prepare the system for a Correlated Noise (256 matrix) scan using the "Service Protocols" procedure located under **[Software Utilities]** menu on the service methods CD-ROM, or for the proprietary procedure, see below.

This proprietary procedure is only available for GE use, and to sites with a valid Advanced Service Package Limited License.

- Click on **[New Pt]**, and enter
Id: **geservice**
Name: **corr noise**
Weight (Lb): **111**
Set Patient Protocols to **Service**.
 - In the Protocol field, type **o.36.1** (o=Other, 1=series number) to load the protocol.
 - [Save Series]**, then **[Prepare to Scan]**.
 - Right click on **[Research Operations]**, select Setup Params, and enter settings:
R1=**11**, R2=**15**, TG=**0**, **[Done]**
- Select **[Manual Prescan]**, record current system frequency, and set system frequency as follows: AX = **63710000** (1.5T), or AX = **42530000** (1.0T).
 - Click on **[Done]**, then **[Scan]**.
 - After scan is complete, click on **[Manual Prescan]** and increment the system frequency by +25,000 Hz using AX.

Note

The DX parameter is limited to delta frequency changes of 200 Hz at a time. Therefore, use the AX command to change the value by +25,000 Hz for each new frequency thereafter.

Click on **[Done]**, then **[Scan]**. Repeat this step eight times (1.5T), or twelve times (1.0T), incrementing the system frequency by +25,000 Hz each time.

Refer to Data Sheet 1 (1.5T), or Data Sheet 2 (1.0T), Correlated Noise Scan Data.

After completing the ninth scan (1.5T), or thirteenth scan (1.0T), go to the next step.

8. Click on the **Active** series, from the Rx Manager list, and right click to select **Copy**, then **Paste**, then click on **[View Edit]**. Click on **[Save Series]**.
9. Right click on **[Research Options]**, select **Setup Params**, and set R1 = 7, **[Done]**.
10. Click on **[Manual Prescan]**, then set system frequency back to AX = **63710000** (1.5T), or AX = **42530000** (1.0T). Click on **[Done]**, then **[Scan]**.
11. After the scan is complete, click **[Manual Prescan]** and increment the system frequency by +25,000 Hz. Select **[Done]**, then **[Scan]**. Repeat this step eight times (1.5T), or twelve times (1.0T), incrementing the system frequency by +25,000 Hz each time (all at R1 = 7).

After completing the ninth scan (1.5T), or thirteenth scan (1.0T), go to the next step.

12. At the operator work space, prepare the system for a Correlated Noise (512 matrix) scan using the *Service Protocols* procedure located on the service methods CD-ROM, or for the the proprietary procedure, see below.

This proprietary procedure is only available for GE use, and to sites with a valid Advanced Service Package Limited License.

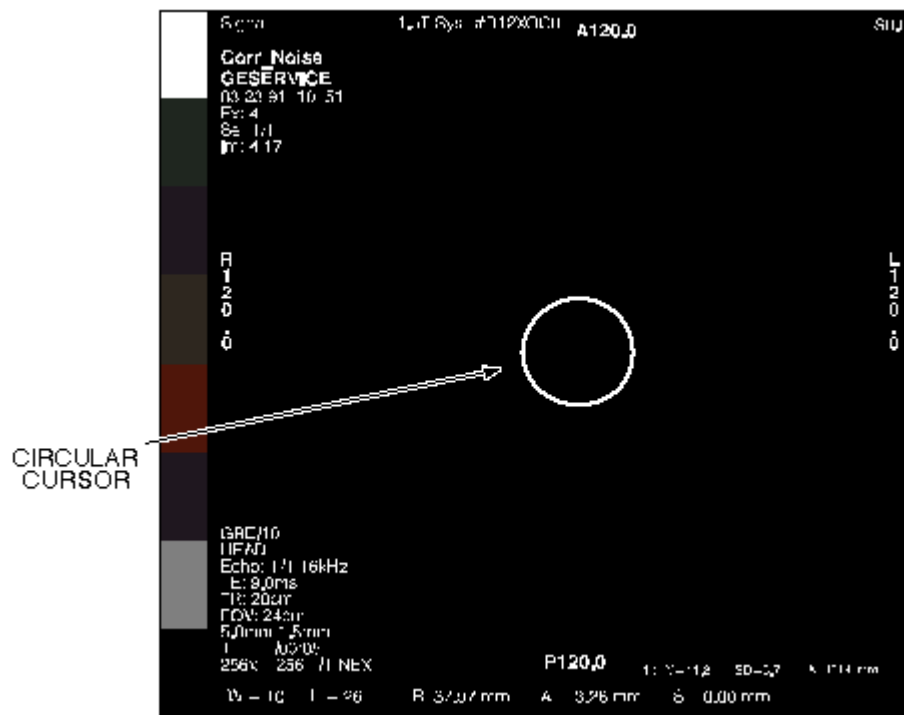
- a. Click on **[New Series]**, and enter
Id: **geservice**
Name: **corr noise**
Weight (Lb): **111**
Set Patient Protocols to **Service**.
 - b. In the Protocol field, type **o.36.2** (o=Other, 2=series number) to load the protocol.
 - c. **[Save Series]**, then **[Prepare to Scan]**.
13. Right click on **[Research Operations]**, select **Setup Params**, set R1 = 11, then select **[Done]**.
 14. Click on **[Manual Prescan]**, set system frequency to magnet frequency (recorded in step 5). Select **[Done]**, then **[Scan]**.
 16. After the scan is complete, right click on **[Research Operations]**, select **Setup Params**, and set R1 = 7. Click on **[Done]**, then **[Scan]**. After completing this second scan at magnet frequency is completed, continue to next section.

1-5 Correlated Noise Data Analysis

Note

Images must be viewed in an unmagnified format. Ensure that zoom factor is set to 2; otherwise, the images may look different between manual and auto paging modes since different interpolation methods are used for each mode.

1. **Background Mean and Standard Deviation.** Using the Image Browser, measure and record the Mean and Standard Deviation for the first R1=11 image and the first R1=7 image of each image set (both 256 matrix and 512 matrix scans), per the following steps. If you wish, record Mean and Standard Deviation values for the other images.
 - a. Position a circular cursor from **[Measure]** so that it is in the center of the image area. Using the size/shape handle, set the circular size for an area of approximately 1200 mm² (see Illustration 1-5).



CORRELATED NOISE IMAGE
ILLUSTRATION 1-5

- b. Ensure that zipper and/or bright pixels do not fall within circle.
- c. Record mean value (\bar{X}) and standard deviation value (SD) displayed on screen in Data Sheet 1 (1.5T), or Data Sheet 2 (1.0T).
- d. Calculate pixel acceptance spec value: $(P_i) \text{ limit} = \bar{X} + 8 (SD)$, for first R1=11 and R1=7 256 matrix scans, and for both 512 matrix scans. Record these four values in the Acceptance Specifications - Pixels (P_i) column in the appropriate data sheet.

2. **Review all images for any bright spots.** View all the images (20 for 1.5T systems, or 28 for 1.0T systems) on the screen.
 - a. Adjust window width to 1 and level to pixel acceptance spec value recorded in data sheet from step 1.
 - b. The image will be flat black; any "hot" pixel clusters will appear white. If the bright spot is a single pixel (temporarily increase the window level a bit to determine this), then it's a random noise value, which can be ignored. If, however, the bright spot is part of a "hot" pixel cluster, then:
 - **First scan "hot" pixels:** Make sure that all system cabinet circuit boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans and repeat analysis steps 1 and 2.
 - **Second scan "hot" pixels:** Set window width to 1, and increase window level until brightest pixel (P_i), in cluster of interest goes black. Record window level value (P_i) and pixel location (L, P) in appropriate data sheet. Repeat the "hot" pixel check/recording for all images.
3. **Review all images for zippers.** View all the images (20 for 1.5T systems or 24 for 1.0T systems) on the screen. Adjust window level so that any zippers are displayed, but normal noise is not displayed (start at a level setting of 60). Review all images for zippers. If any are detected:
 - **First scan zippers:** Be sure that all system cabinet circuit boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans.
 - **Second scan zippers:** If the zippers still exist, continue with next step.
4. **Zipper Peak Pixel** (Perform if zipper is present in image.)
 - a. Set window width to 1.
 - b. Increase window level until brightest pixel (P_Z), in zipper of interest goes black. Record window level value (P_Z) in Data Sheet 1 (1.5T), or Data Sheet 2 (1.0T).
 - c. Calculate using measured (\bar{X}) and (SD) data from appropriate data sheet: $\bar{X} + 6$ (SD). Record result in appropriate data sheet, Acceptance Spec, P_Z column. Verify that measured Zipper Peak Pixel (P_Z) is \leq calculated spec.
 - d. Calculate using measured (\bar{X}) and (SD) data from appropriate data sheet: $\bar{X} - 6$ (SD). Record result in appropriate data sheet, Acceptance Spec, P_Z column. Verify that measured Zipper Peak Pixel (P_Z) is \geq calculated spec.
5. **Zipper Mean** (Perform if zipper is present in image.)

- a. Position a rectangular box from **[Measure]** so that it covers only the area (and not beyond) of a zipper (or section of a segmented zipper).
- b. Record mean value (\bar{X}_Z) of zipper in data sheet.
- c. Calculate using measured (\bar{X}) data from appropriate data sheet: $\bar{X} + 3$. Record in appropriate data sheet, Acceptance Spec, \bar{X}_Z column. Verify that Zipper Mean (\bar{X}_Z) is \leq calculated spec.
- d. Calculate using measured (\bar{X}) data from appropriate Data Sheet: $\bar{X} - 3$. Record in appropriate data sheet, Acceptance Spec, \bar{X}_Z column. Verify that Zipper Mean (\bar{X}_Z) is \geq calculated spec.

Note

If the results of the data for "hot" pixels and zippers do not meet the Acceptance Specifications in the applicable Data Sheet 1 or 2, use appropriate procedures to troubleshoot the system.

6. Store completed data sheets on floppy disk for future reference.

1-6 System Restoration

- Reset the CERD RF Output mode switch to the **Normal** position (located on the CERD front panel).
- Install front panel on System Cabinet.

2- MULTICOIL CORRELATED NOISE CHECK

Note

This procedure is to be performed on 1.5T and 1.0T systems with the Multi-coil option installed. If the CTL Coil is not available, use the Pelvic Coil and Pelvic Coil Phantom Assembly to perform this procedure.

2-1 Overview

This test verifies the presence of RF noise in either the screen room or the TPS subsystem (including all multicoil receivers). Refer to Table 2-1 for procedure step summary.

TABLE 2-1
MULTICOIL CORRELATED NOISE TEST PROCEDURE SUMMARY

The test consists of the following:

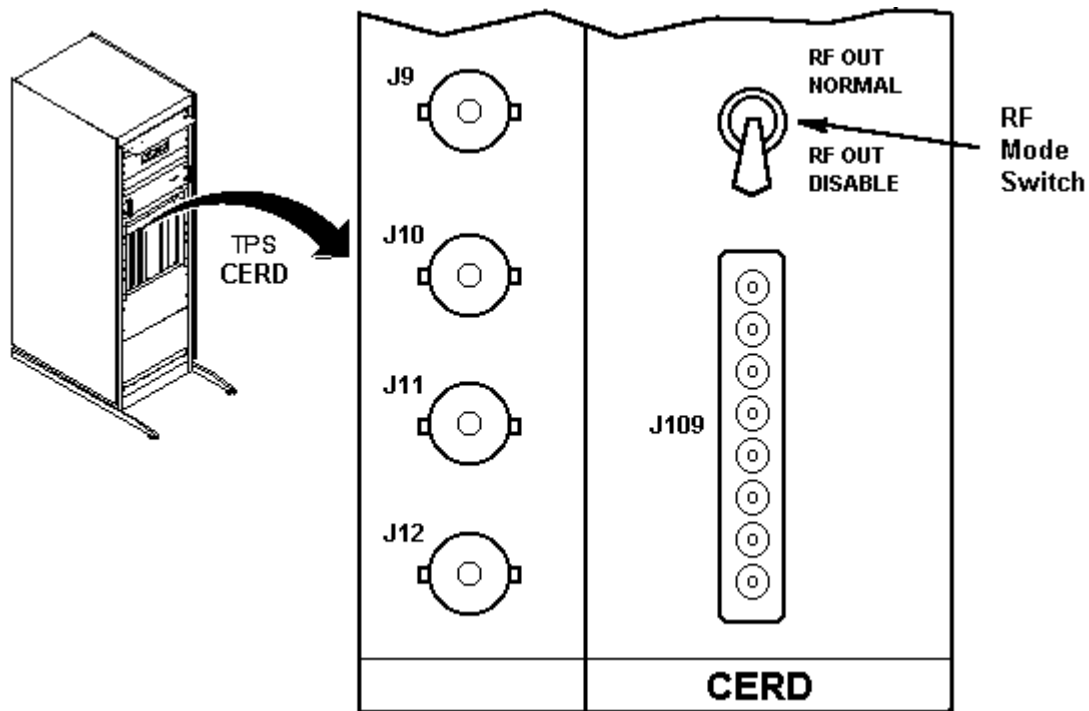
- The CTL Phased Array Coil is placed in the bore with CTL phantoms.
- The CERD RF Output Disable mode is selected (toggle switch) to disable the transmit RF.
- 1.5T: Five scans are taken between 63,710,000 and 63,910,000 Hz with R1=11 and R1=7.
1.0T: Seven scans are taken between 42,530,000 and 42,830,000 Hz with R1=11 and R1=7.
- All images are analyzed for artifacts.

2-2 Tools Required

- CTL Coil Phantom Assembly, 46-317605G1 or
- Pelvic Coil Phantom Assembly, 46-317626G1

2-3 System Hardware Preparation

1. Remove front panel from Systems Cabinet.
2. Disable the CERD RF Output, by setting the RF Output mode toggle switch (located on the front panel of the CERD), to the RF Out Disable position (see Illustration 2-1).



RF DISABLED FOR CORRELATED NOISE SCAN
ILLUSTRATION 2-1

Note

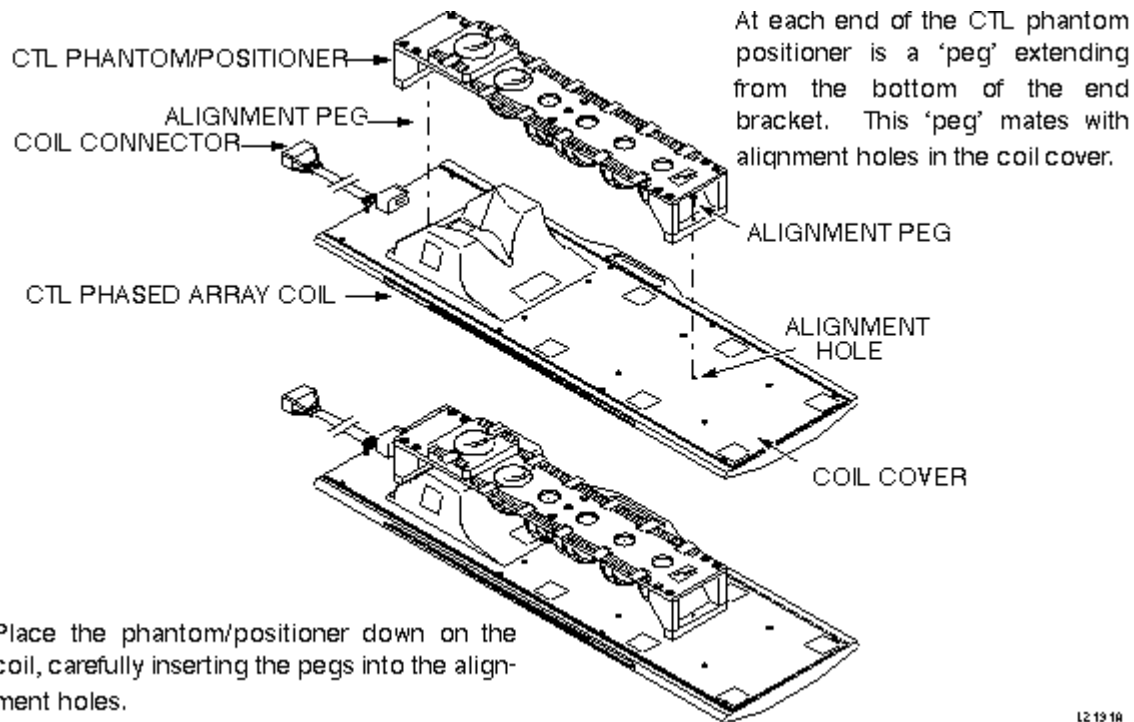
Be sure that the receiver(s) are tightly installed, and that ground screws are in place and tight. A missing or loose grounding screw produces correlated noise.

2-4 Multicoil Scan Preparation



Equipment damage possibility. Completely remove the quad head coil from the cradle before performing any body scans. Failure to do so may damage the head coil T/R network.

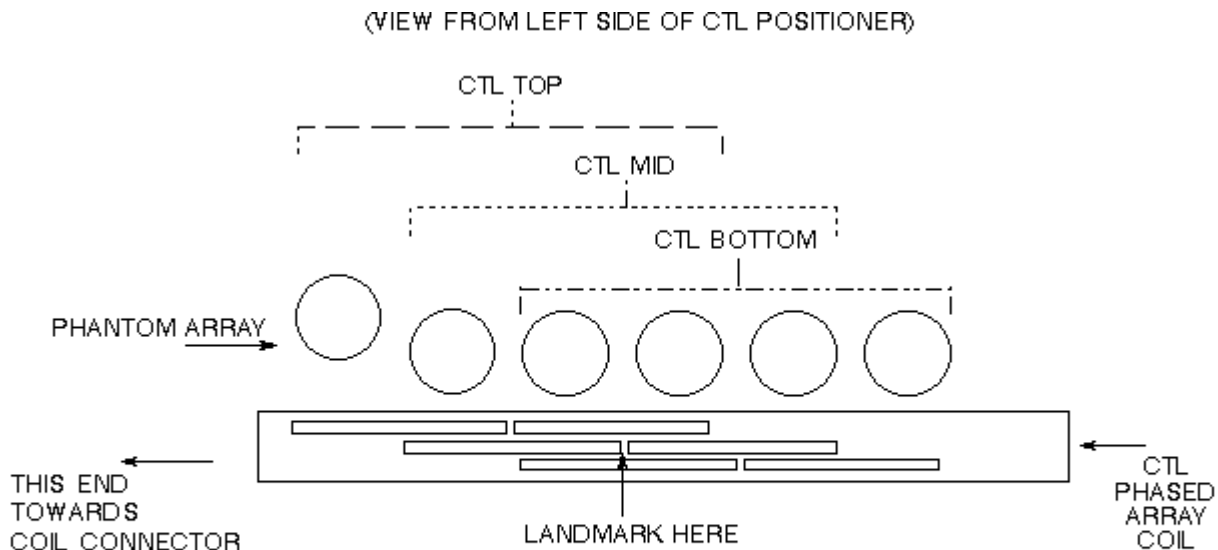
1. Remove quad head coil (if present) from cradle.
2. Place coil array to be tested on table. The CTL coil array and positioner fit together. Two pegs on the bottom of the positioner mate with two positioning holes on the top cover of the array. Connect them as described in Illustration 2-2 .



L2 19 1A

CTL PHASE ARRAY COIL PHANTOM SETUP
ILLUSTRATION 2-2

- See Illustration 2-3 for landmarking phantom. Press LANDMARK, then MOVE TO SCAN.



Note: The CTL array contains six coils (only four are used at one time). Three regions are designated (landmarks for each region are marked on the side of the array). The CTLTOP array uses coils 1 through 4 (counting from the head end). CTLMID uses coils 2 through 5. CTLBOT uses coils 3 through 6.

L2 19 2A

CTL PHANTOM/POSITIONER LANDMARK SETUP
ILLUSTRATION 2-3

4. At the operator work space, prepare the system for a Multicoil Correlated Noise scan using the *Service Protocols* procedure located on the service methods CD-ROM, or for the proprietary procedure, see below.

This proprietary procedure is only available for GE use, and to sites with a valid Advanced Service Package Limited License.

- a. Click on **[New Pt]**, and enter
Id: **geservice**
Name: **mc corr noise**
Weight (Lb): **111**
Set Patient Protocols to **Service**.
- b. In the Protocol field, type **o.36.3** (o=Other, 3=series number) to load the protocol.
- c. **[Save Series]**, then **[Prepare to Scan]**.
- d. Right click on **[Research Operations]**, select Setup Params, and enter settings:
R1=**11**, R2=**15**, TG=**0**, **[Done]**.
- e. Right click on **[Research Operations]**, select Display CVs, set saveinter = **1** (Note 1).

Note 1

Setting this CV to 1 generates five images for each single multi-coil scan. Images 1 to 4 will correspond to data from Receivers 0 to 3. Therefore, Image 1 is reconstructed from Receiver 0 data. Image 5 is the combined and processed data from all 4 Receivers. This is the same image normally observed when saveinter = **0**.

5. Select **[Manual Prescan]**, record current system frequency. Set system frequency AX = **63,710,000** (1.5T), or **42,530,000** (1.0T).

Note

Record all data from Receivers 1-4 and the combined image in Data Sheet 3 (1.5T), or Sheet 4 (1.0T), respectively.

6. Click on **[Done]**, then **[Scan]**.

Note

Make sure the system doesn't "timeout" during the scan. If a timeout occurs, rescan before changing the system frequency.

7. After scan is complete, click on **[Manual Prescan]** and change system frequency by +50,000 Hz using **AX**. Click on **[Done]**, then **[Scan]**.

Note

The DX parameter is limited to delta frequency changes of 200 Hz at a time. Therefore, use the AX command to change the value by +25,000 Hz for each new frequency thereafter.

(Perform this step four times for a total of five scans for 1.5T systems, or six times for a total of seven scans for 1.0T systems. Increment the system frequency +50,000 Hz each time. Refer to Data Sheet 3 (1.5T), or Data Sheet 4 (1.0T). After completing the last scan, go to next step.)

8. Click on the **Active** series, from the RX Manager list, and right click to select **Copy**, then **Paste**, then click on **[View Edit]**. Click on **[Save Series]**.
9. Right click on **[Research Operations]**, select **Setup Params**, and set R1 = 7, **[Done]**.
10. Select **[Manual Prescan]**, set system frequency to 63,710,000 Hz for 1.5T system, or 42,530,000 for 1.0T system. Click on **[Done]**, then **[Scan]**.
11. After scan is complete, select **[Manual Prescan]** and increment the system frequency +50,000 Hz. Click on **[Done]**, then **[Scan]**.

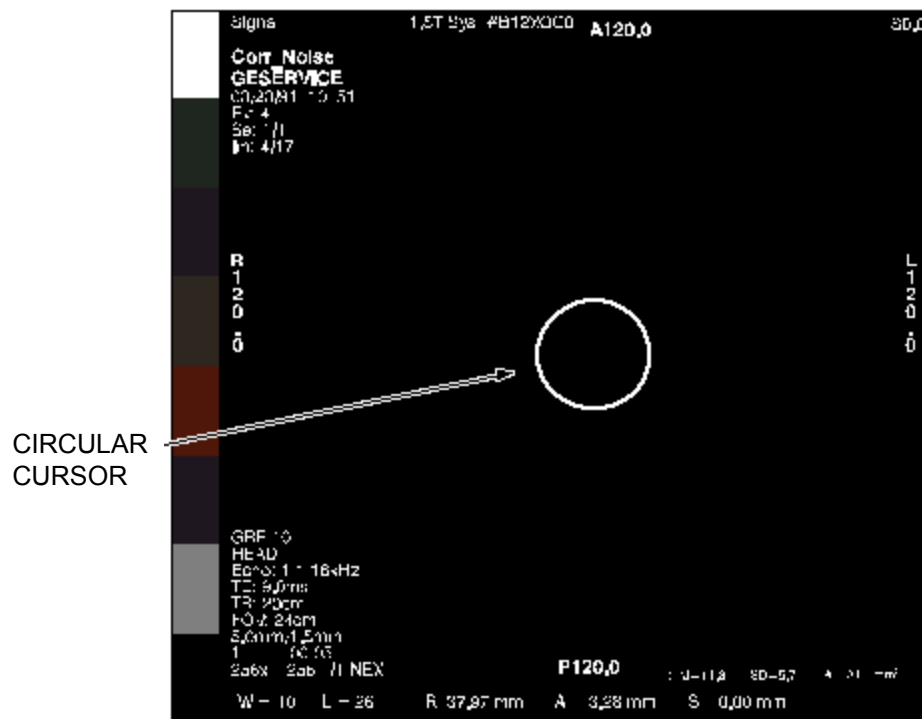
Perform this step four times for a total of five scans for a 1.5T system, or six times for a total of seven scans for a 1.0T system. Increment the system frequency by +50,000 Hz each time. Refer to Data Sheet 3 (1.5T) or Data Sheet 4 (1.0T). After completing the last scan, go to the next section.

2-5 Correlated Noise Data Analysis

Note

Images must be viewed in an unmagnified format. Ensure that zoom factor is set to 2; otherwise, the images may look different between manual and auto paging modes since different interpolation methods are used for each mode.

- Background Mean and Standard Deviation.** Using the Image Browser, measure and record Mean and Standard Deviation for first R1=11 and first R1=7 images, per the following steps. If you wish, record Mean and Standard Deviation values for the other images.
 - Position a circular cursor from **[Cursors and Measuring]** so that it is in the center of the image area. Using the size/shape handle, set the circular size for an area of approximately 1200 mm² (see Illustration 2-4).



CORRELATED NOISE IMAGE
ILLUSTRATION 2-4

- Ensure that zipper and/or bright pixels do not fall within circle.
 - Record mean value (\bar{X}) and standard deviation value (SD) displayed on screen in the appropriate data sheet.
- Review all images for bright spots.** View all the images (50 for 1.5T systems, or 70 for 1.0T systems) on the screen.
 - Adjust window width to 1 and level to pixel acceptance spec value (refer to Data Sheet 3 (1.5T), or Data Sheet 4 (1.0T) for spec calculation).

- b. The image will be flat black; any "hot" pixel clusters will appear white. If the bright spot is a single pixel (temporarily increase the window level a bit to determine this), then it's a random noise value which can be ignored. If, however, the bright spot is part of a hot pixel cluster, then:
- **First scan hot pixels:** Be sure that all system cabinet circuit boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans, and repeat analysis steps 1 and 2.
 - **Second scan hot pixels:** Set window width to 1 and increase window level until brightest pixel (P_i), in cluster of interest goes black. Record window level value and pixel location in appropriate data sheet. Repeat the "hot" pixel check/recording for all images.
3. **Review all images for any zippers.** View all the images (50 for 1.5T systems, or 70 for 1.0T systems) on the screen. Adjust window level so that any zippers are displayed, but normal noise is not displayed (start at a level setting of 60). Review all images for zippers. If any are detected:
- **First scan zippers:** Be sure that all system cabinet circuit boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans.
 - **Second scan zippers:** If the zippers still exist, continue with next step.
4. **Zipper Peak Pixel** (Perform if zipper is present in image.)
- a. Set window width to 1.
 - b. Increase window level until brightest pixel (P_Z), in zipper of interest goes black. Record window level value in appropriate data sheet.
 - c. Calculate using measured (\bar{X}) and (SD) data from appropriate data sheet: $\bar{X} + 6$ (SD). Record result in appropriate data sheet, Acceptance Spec, P_Z column. Verify that measured Zipper Peak Pixel (P_Z) is \leq calculated spec.
 - d. Calculate using measured (\bar{X}) and (SD) data from appropriate data sheet: $\bar{X} - 6$ (SD). Record result in appropriate data sheet, Acceptance Spec, P_Z column. Verify that measured Zipper Peak Pixel (P_Z) is \geq calculated spec.
5. **Zipper Mean:** (Perform if zipper is present in image.)
- a. Position a rectangular box from the **[Cursor and Measuring]** so that it covers only the area (and not beyond) of a zipper (or section of a segmented zipper).
 - b. Record mean value (\bar{X}_Z) of zipper in data sheet.

- c. Calculate using measured (\bar{X}) data from appropriate data sheet: $\bar{X} + 3$. Record in appropriate data sheet, Acceptance Spec, $\bar{X}Z$ column. Verify that Zipper Mean ($\bar{X}Z$) is \leq calculated spec.
- d. Calculate using measured (\bar{X}) data in appropriate data sheet: $\bar{X} - 3$. Record in appropriate data sheet, Acceptance Spec, $\bar{X}Z$ column. Verify that Zipper Mean ($\bar{X}Z$) is \geq calculated spec.

Note

If the results of the data for "hot" pixels and zippers do not meet the Acceptance Specifications in the applicable Data Sheet 3 or 4, use appropriate procedures to troubleshoot the system.

6. Store completed data sheets on floppy disk for future reference.

2-6 System Restoration

- Reset the CERD RF Output mode switch to the **Normal** position (located on the CERD front panel).
- Install front panel on System Cabinet.
- Restore original system frequency.

3- FAST RECEIVER CORRELATED NOISE CHECK

The following procedure applies only to Signa Horizon EchoSpeed systems.

3-1 Overview

This check verifies that the correct low-pass analog filters on the Fast Receiver are selected. It also checks for any correlated noise that may be induced by the TPS subsystem, Fast Receiver, or external noise sources. Refer to Table 3-1 for procedure step summary.

TABLE 3-1
FAST RECEIVER CORRELATED NOISE TEST PROCEDURE SUMMARY

The test consists of the following:

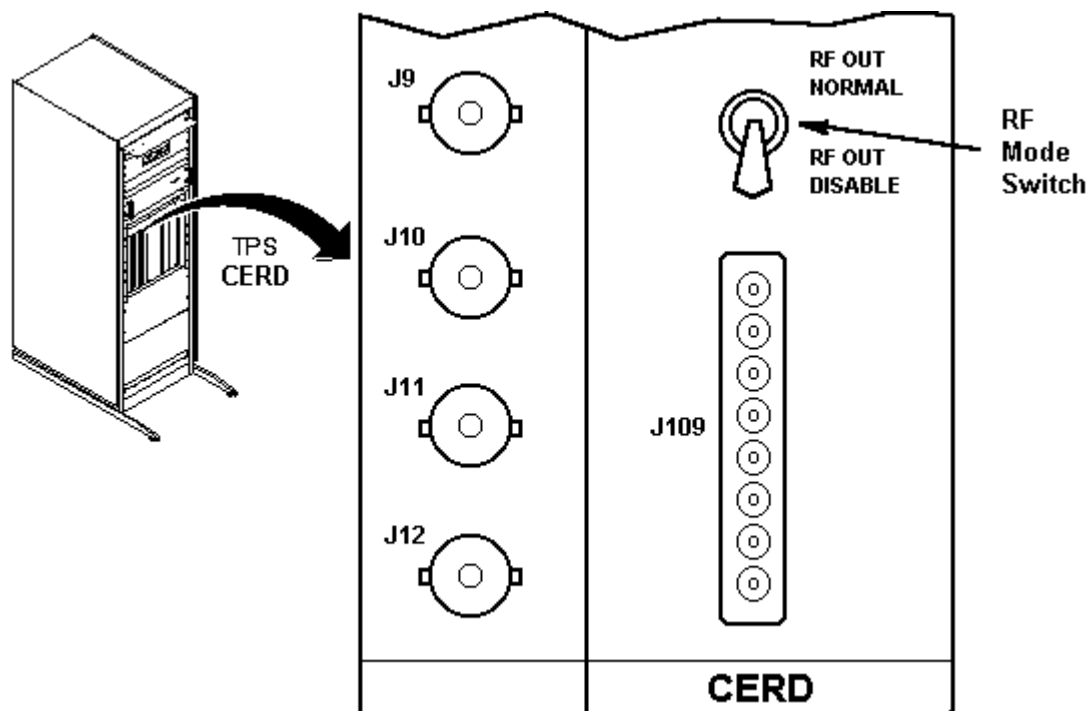
- SPT phantom is placed in the bore.
- The CERD RF Output Disable mode is selected (toggle switch) to disable the transmit RF.
- A total of six scans are taken (at default center frequency) using five different low pass filters with R1=11 & one scan with R1=7.
- All images are analyzed for artifacts.

3-2 Tools Required

- SPT Short Loader Sphere, 2135650
- SPT Short Loader Cylinder, 2135652

3-3 System Hardware Preparation

1. Remove front panel from Systems Cabinet.
2. Disable the CERD RF Output, by setting the RF Output mode toggle switch (located on the front panel of the CERD), to the **RF Out Disable** position. (see Illustration 3-1).



RF DISABLED FOR CORRELATED NOISE SCAN
ILLUSTRATION 3-1

Note

Be sure that the receiver(s) are tightly installed, and that ground screws are in place and tight. A missing or loose grounding screw produces correlated noise.

3-4 Fast Receiver Scan Preparation

CAUTION

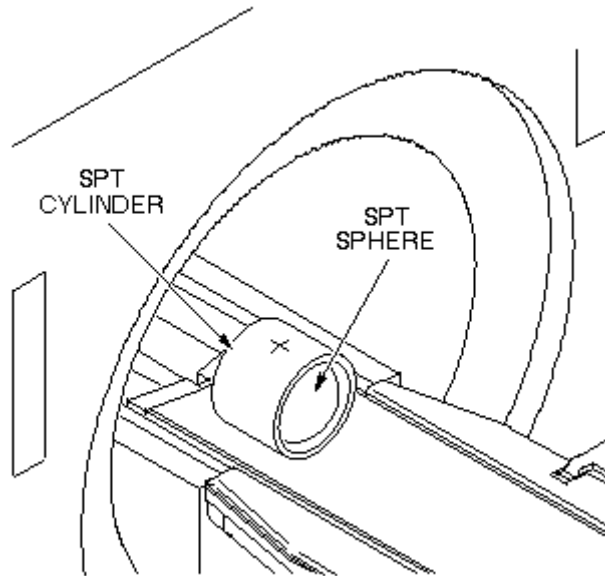
Equipment damage possibility. Completely remove the quad head coil from the cradle before performing any body scans. Failure to do so may damage the head coil T/R network.

1. Remove quad head coil (if present) from cradle.

WARNING!

POISON HAZARD! THE PHANTOM CONTAINS NICKEL, A SUSPECT CARCINOGEN. DO NOT INGEST. DISPOSE OF AS A HAZARDOUS WASTE ACCORDING TO STATE AND FEDERAL REGULATIONS.

2. Position SPT Phantom as shown in Illustration 3-2 and landmark. At keypad on front magnet enclosure, press LANDMARK, then MOVE TO SCAN.



SPT PHANTOM ON PATIENT TABLE
ILLUSTRATION 3-2

3. At the operator work space, prepare the system for a EPI Correlated Noise scan using the *Service Protocols* procedure located on the service methods CD-ROM, or for the proprietary procedure, see below.

This proprietary procedure is only available for GE use, and to sites with a valid Advanced Service Package Limited License.

- a. Click on **[New Pt]**, and enter
Id: **geservice**
Name: **fast rcvr corr noise**
Weight (Lb): **111**
Set Patient Protocols to **Service**.
- b. In the Protocol field, type **o.36.4** (o=Other, 4=series number) to load the protocol.
- c. Locate the **[User CVs Screen]** button under Additional Parameters. Verify that the CVs Ramp Sampling and Burst Scan Time are both set to **0**. Verify that bandwidth is set to **455**, and that Autoshim and Phase Correct are turned **off**. Remember to press **<Enter>** after each CV parameter that is entered.
- d. **[Save Series]**, then **[Prepare to Scan]**.

In steps 4-9, scans 1–5 are taken at R1=11 and five different low-pass filters.

Note

When you run Correlated Noise Test, it is typical to satisfy prescan by simply starting and stopping manual prescan. If the Fast Receiver has been selected by manually setting the CVs $rh\text{dab}0s = 4$ and $rh\text{db}0e = 4$, a data acquisition error will occur because the drivers required to initialize the Fast Receiver do not recognize the hardware. Simply ignore this error and proceed with the "ref" scan (which should reset the data acquisition board appropriately).

4. Click on **[Manual Prescan]**, **[Scan TR]**, **[Done]**, then **[Ref Scan]**.
5. When scan is done, perform scan #1 by:
 - a. Right click on **[Research Operations]**, select **Setup Params**, set R1 = 11, **[Done]**
 - b. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify the following CVs:

```
nograd = 1 <Enter>  
rhpccon = 0 <Enter>  
rhpcclin = 0 <Enter>  
cfdbdtper =100 <Enter>  
fast_rec_lpf = 5 <Enter>
```

Remember to press <Enter> after each CV parameter that is entered.

- c. **[Accept]**, **[Download]**, then **[Scan]**.
6. When scan is done, perform scan #2 by:
 - a. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify the following CVs:

```
nograd = 1<Enter>  
rhpccon = 0<Enter>  
rhpcclin = 0<Enter>  
cfdbdtper =100<Enter>  
fast_rec_lpf = 4<Enter>
```

b. **[Accept]**, **[Download]**, then **[Scan]**.

7. When scan is done, perform scan #3 by:
 - a. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify the following CVs:

```
nograd = 1<Enter>  
rhpccon = 0<Enter>  
rhpcclin = 0<Enter>  
cfdbdtper =100<Enter>  
fast_rec_lpf =3<Enter>
```

b. **[Accept]**, **[Download]**, then **[Scan]**.

8. When scan is done, perform scan #4 by:
 - a. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify the following CVs:

nograd = 1<Enter>
rhpccon = 0<Enter>
rhpcclin = 0<Enter>
cfdbdtper =100<Enter>
fast_rec_lpf =2<Enter>

b. **[Accept]**, **[Download]**, then **[Scan]**.

9. When scan is done, perform scan #5 by:

a. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify the following CVs:

nograd = 1<Enter>
rhpccon = 0<Enter>
rhpcclin = 0<Enter>
cfdbdtper =100<Enter>
fast_rec_lpf =1<Enter>

b. **[Accept]**, **[Download]**, then **[Scan]**.

In step 10, a scan is taken at R1=7 and a low-pass filter of 5.

10. Perform scan #6 by:

a. Right click on **[Research Operations]**, select **Setup Params**, set R1 = 7, **[Done]**

b. Right click on **[Research Operations]**, select **[Display CVs]**.

Modify CVs as follows:

nograd = 1 <Enter>
rhpccon = 0 <Enter>
rhpcclin = 0 <Enter>
cfdbdtper =100 <Enter>
fast_rec_lpf = 5 <Enter>

Remember to press <Enter> after each CV entry.

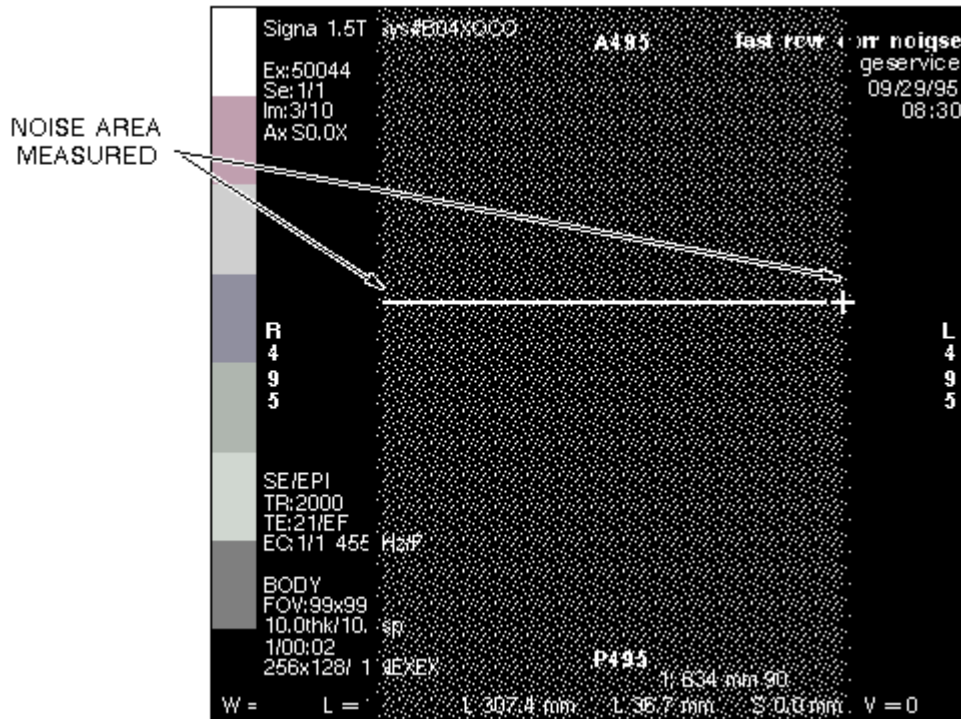
c. **[Accept]**, **[Download]**, then **[Scan]**.

3-5 Correlated Noise Data Analysis

Note

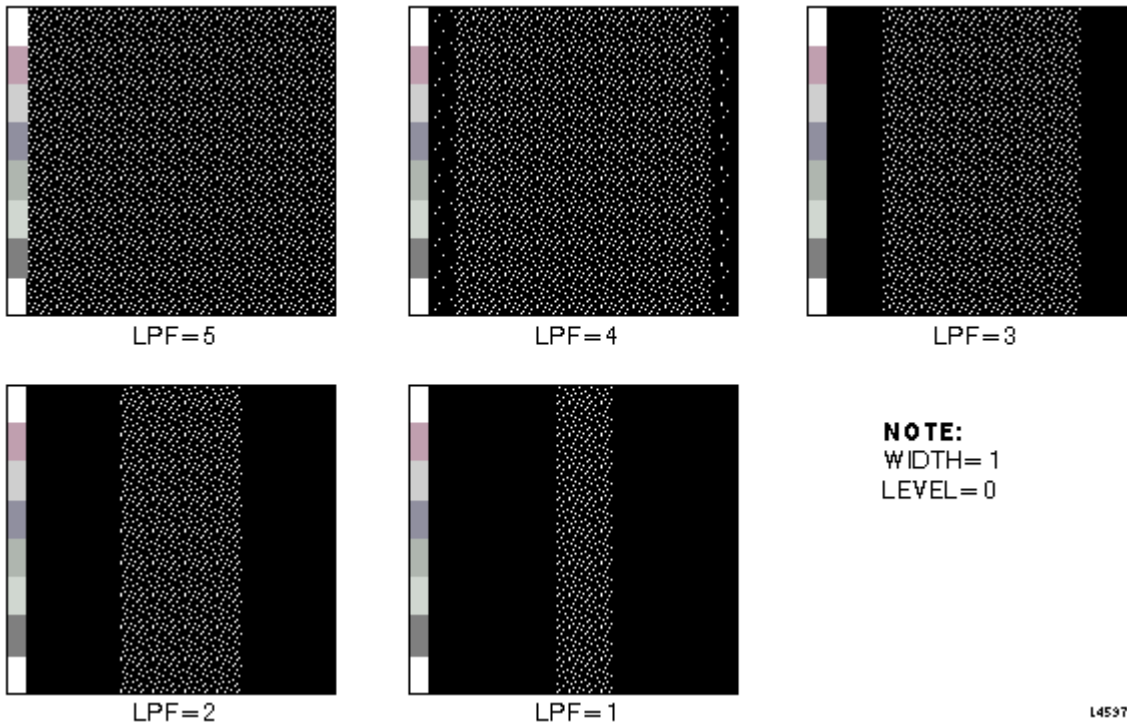
Images must be viewed in an unmagnified format. Ensure that zoom factor is set to 2; otherwise, the images may look different between manual and auto paging modes since different interpolation methods are used for each mode.

1. **Verify Correct Filter Roll-offs.** This check verifies that the low-pass analog filters on the Fast Receiver are performing correctly. Use the Distance Measuring cursor to make a rough measurement of the noise area in each image per the steps below (see Illustration 3-3 for example). This measurement is only done for the first 5 images (i.e. R1=11).



MEASURED NOISE WIDTH CHECK (LPF=3 SHOWN)
ILLUSTRATION 3-3

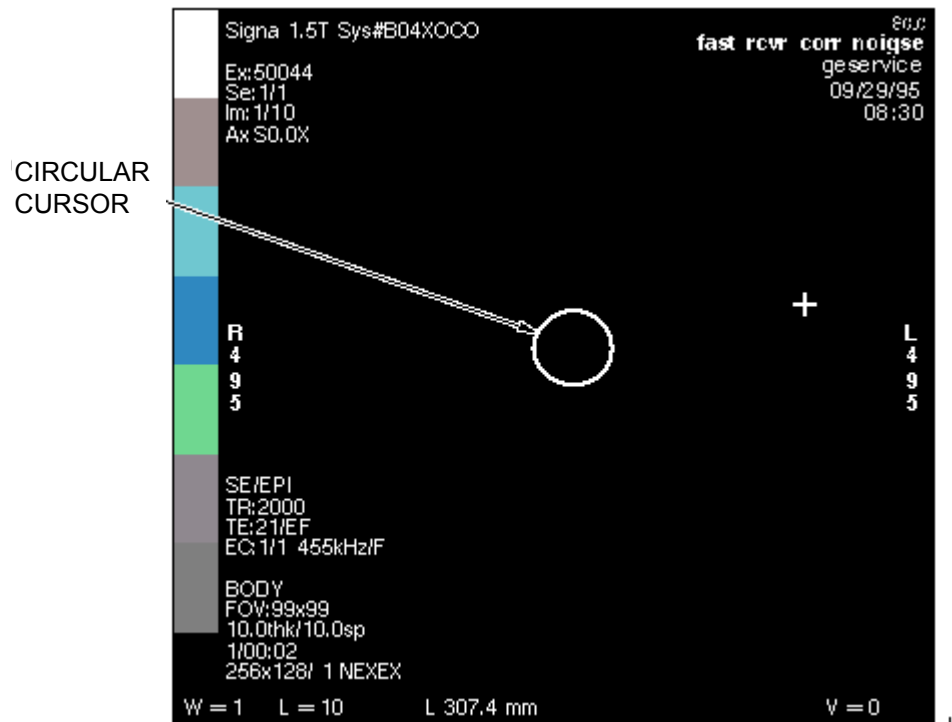
- a. Set window width to 1 and level > 0.
- b. Select the line cursor from **[Measure]** and position its left-hand handle at the left-hand edge of the image where noise density begins decreasing.
- c. Drag the right-hand handle of the cursor to the right-hand edge of image, where noise density begins to decrease. Try to maintain the line horizontally.
- d. Read the distance value (mm) from the screen.
- e. Approximate distances of the filter passband should be as follows (see Illustration 3-4 for example image at each filter setting):



FAST RECEIVER NOISE WIDTH CHECK (LPF = 5 TO 1)
ILLUSTRATION 3-4

fast_rec_lpf	Distance
5	~990 mm (fills screen)
4	~870 mm + 10%
3	~650 mm + 10%
2	~435 mm + 10%
1	~220 mm + 10%

2. Background Mean and Standard Deviation. Using the Image Browser, measure and record Mean and Standard Deviation for first R1=11 and first R1=7 images, per the following steps. If you wish, record Mean and Standard Deviation values for the other images.
 - a. Position a circular cursor so that it is in the center of the image area. Set the circular size for an area of approximately 4950 mm² (see Illustration 3-5).



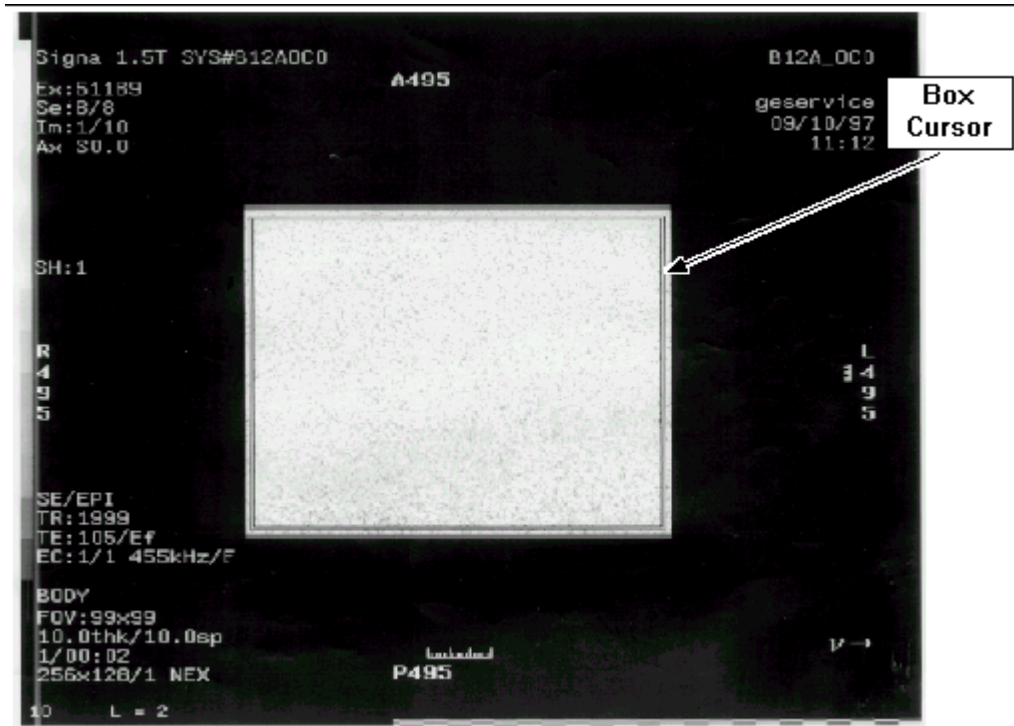
FAST RECEIVER CORRELATED NOISE IMAGE
ILLUSTRATION 3-5

- b. Ensure that zipper and/or bright pixels do not fall within circle.
 - c. Record mean value (\bar{X}) and standard deviation value (SD) from screen in Data Sheet 5.
3. Review all six images for any bright spots.
- a. Adjust Window Width to 1 and Level to 0.

Note

Window width and window level can be set from the command line in advantage windows by using the **ww** and **wl** commands (i.e., **ww 1** or **wl 0**).

- b. Position a box cursor over the center of the noise image. Adjust the size so it is slightly smaller than the noise image (see Illustration 3-6). Touch **[ROI]** and verify the size is approximately 854200 mm².



BOXED CURSOR OVER CENTER OF NOISE IMAGE
ILLUSTRATION 3-6

- c. Adjust the window width to 1 and level to pixel acceptance spec value (refer to Data Sheet 5 for spec calculation).
 - d. The image will be flat black; any hot pixel "clusters" will appear white. If any of the hot pixels appear outside of the box cursor, they are outside of the normal imaging field and can be ignored. If the bright spot is a single pixel and appears within the region outlined by the box cursor (temporarily increase the Window Level some to determine this), then it's a random noise value, which can be ignored. If however, the bright spot is part of a "hot" pixel cluster, then:
 - **First scan hot pixels:** Be sure that all system cabinet boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans, and repeat analysis steps 1 and 2.
 - **Second scan hot pixels:** Set window width to 1, and increase window level until brightest pixel (Pi) in cluster of interest goes black. Record window level value and pixel location in Data Sheet 5. Repeat the hot pixel check/recording for all images.
4. Review all images for zippers. View all six images on the screen. Adjust window level so that any zippers are displayed, but normal noise is not displayed (start at a level setting of 60). Review all images for zippers. If any are detected:
- **First scan zippers:** Be sure that all system cabinet boards are properly seated, and that all circuit board mounting screws are securely tightened (to assure proper grounding), then rerun all scans.

- **Second scan zippers:** If the zippers still exist, continue with next step.

5. Zipper Peak Pixel: (perform if zipper is present in image.)

- a. Set window width to 1.
- b. Increase window level until brightest pixel (Pz), in zipper of interest goes black. Record window level value in Data Sheet 5.
- c. Calculate using measured (\bar{X}) and (SD) data from Data Sheet 5: $\bar{X} + 6$ (SD). Verify that measured Zipper Peak Pixel (Pz) is \leq calculated spec. Record result in Data Sheet 5.
- d. Calculate using measured (\bar{X}) and (SD) data from Data Sheet 5: $\bar{X} - 6$ (SD) Verify measured Zipper Peak Pixel (Pz) is \geq calculated spec. Record result in Data Sheet 5.

6. Zipper Mean: (Perform if zipper is present in image.)

- a. Position a rectangular box so that it covers only the area (and not beyond) of a zipper (or section of a segmented zipper).
- b. Record mean value (\bar{X}_z) of zipper in Data Sheet 5.
- c. Calculate using measured (\bar{X}) data from Data Sheet 5: $\bar{X} + 3$. Verify that Zipper Mean (\bar{X}_z) is \leq calculated spec. Record in Data Sheet 5.
- d. Calculate using measured (\bar{X}) data from Data Sheet 5: $\bar{X} - 3$. Verify that Zipper Mean (\bar{X}_z) is \geq calculated spec. Record in Data Sheet 5.

Note

If the results of the data for "hot" pixels and zippers do not meet the Acceptance Specifications in the applicable Data Sheet 1, 2, or 3, use appropriate procedures to troubleshoot the system.

3-6 System Restoration

- Reset the CERD RF Output mode switch to the Normal position (located on the CERD front panel).
- Install front panel on System Cabinet.

APPENDIX A - CORRELATED NOISE DATA SHEETS

DATA SHEET 1 1.5T SYSTEM CORRELATED NOISE

		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE R1=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PBKEL	HOT PBKEL LOCATION	ZIPPER PEAK PBKEL	ZIPPER MEAN	PKELS (P)	ZIPPERS (Pz) or (Xz)	
		(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	$Pz \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq Pz \leq [(X) + 6(SD)]$	$[(X) - 3] \leq Xz \leq [(X) + 3]$
1	63,710,000									
2	63,735,000									
3	63,760,000									
4	63,785,000									
5	63,810,000									
6	63,835,000									
7	63,860,000									
8	63,885,000									
9	63,910,000									
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)	
10	63,710,000									
11	63,735,000									
12	63,760,000									
13	63,785,000									
14	63,810,000									
15	63,835,000									
16	63,860,000									
17	63,885,000									
18	63,910,000									
R1	FREQ (Note)	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)	
6	↔									
4	↔									

Note: System frequency is set to magnet frequency for the 512 matrix scans.

DATA SHEET 2
1.0T SYSTEM CORRELATED NOISE

		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
SCAN Ri=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PIXEL	HOT PIXEL LOCATION	ZIPPER PEAK PIXEL	ZIPPER MEAN	PIXELS (Pj)	ZIPPERS (Pz) or (Xz)	
		(X)	(SD)	(Pj)	(L, P)	(Pz)	(Xz)	$P_j \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_z \leq [(X) + 6(SD)]$	$[(X) - 3] \leq X_z \leq [(X) + 3]$
1	42,530,000									
2	42,555,000									
3	42,580,000									
4	42,605,000									
5	42,630,000									
6	42,655,000									
7	42,680,000									
8	42,705,000									
9	42,730,000									
10	42,755,000									
11	42,780,000									
12	42,805,000									
13	42,830,000									
Ri=4	FREQUENCY	(X)	(SD)	(Pj)	(L, P)	(Pz)	(Xz)	PIXELS (Pj)	ZIPPERS (Pz) or (Xz)	
14	42,530,000									
15	42,555,000									
16	42,580,000									
17	42,605,000									
18	42,630,000									
19	42,655,000									
20	42,680,000									
21	42,705,000									
22	42,730,000									
23	42,755,000									
24	42,780,000									
25	42,805,000									
26	42,830,000									
Ri	FREQ (Note)	(X)	(SD)	(Pj)	(L, P)	(Pz)	(Xz)	PIXELS (Pj)	ZIPPERS (Pz) or (Xz)	
6	↳									
4	↳									

Note: System frequency is set to magnet frequency for the 512 matrix scans.

DATA SHEET 3
1.5T SYSTEM MULTI-COIL CORRELATED NOISE

RECEIVER 0		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (X)	STD DEV (SD)	HOT PBKEL (P)	HOT PBKEL LOCATION (L, P)	ZIPPER PEAK PBKEL (Pz)	ZIPPER MEAN (Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)
								$P_f \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_z \leq [(X) + 6(SD)]$ $[(X) - 3] \leq X_z \leq [(X) + 3]$
1	63,710,000								
6	63,760,000								
11	63,810,000								
16	63,860,000								
21	63,910,000								
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)
26	63,710,000								
31	63,760,000								
36	63,810,000								
41	63,860,000								
46	63,910,000								
RECEIVER 1		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (X)	STD DEV (SD)	HOT PBKEL (P)	HOT PBKEL LOCATION (L, P)	ZIPPER PEAK PBKEL (Pz)	ZIPPER MEAN (Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)
								$P_f \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_z \leq [(X) + 6(SD)]$ $[(X) - 3] \leq X_z \leq [(X) + 3]$
2	63,710,000								
7	63,760,000								
12	63,810,000								
17	63,860,000								
22	63,910,000								
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PKELS (P)	ZIPPERS (Pz) or (Xz)
27	63,710,000								
32	63,760,000								
37	63,810,000								
42	63,860,000								
47	63,910,000								

DATA SHEET 3 (CONTINUED)
1.5T SYSTEM MULTI-COIL CORRELATED NOISE

RECEIVER 2		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (X)	STD DEV (SD)	HOT PBXEL (P)	HOT PBXEL LOCATION (L, P)	ZIPPER PEAK PBXEL (Pz)	ZIPPER MEAN (Xz)	PBXELS (P)	ZIPPERS (Pz) or (Xz)
								$P_1 \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_z \leq [(X) + 6(SD)]$ $[(X) - 3] \leq X_z \leq [(X) + 3]$
3	63,710,000								
8	63,760,000								
13	63,810,000								
18	63,860,000								
23	63,910,000								
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PBXELS (P)	ZIPPERS (Pz) or (Xz)
28	63,710,000								
33	63,760,000								
38	63,810,000								
43	63,860,000								
48	63,910,000								
RECEIVER 3		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (X)	STD DEV (SD)	HOT PBXEL (P)	HOT PBXEL LOCATION (L, P)	ZIPPER PEAK PBXEL (Pz)	ZIPPER MEAN (Xz)	PBXELS (P)	ZIPPERS (Pz) or (Xz)
								$P_1 \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_z \leq [(X) + 6(SD)]$ $[(X) - 3] \leq X_z \leq [(X) + 3]$
4	63,710,000								
9	63,760,000								
14	63,810,000								
19	63,860,000								
24	63,910,000								
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(Pz)	(Xz)	PBXELS (P)	ZIPPERS (Pz) or (Xz)
29	63,710,000								
34	63,760,000								
39	63,810,000								
44	63,860,000								
49	63,910,000								

DATA SHEET 3 (CONTINUED)
1.5T SYSTEM MULTI-COIL CORRELATED NOISE

COMBINED IMAGES		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE R1=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PBXEL	HOT PBXEL LOCATION	ZIPPER PEAK PBXEL	ZIPPER MEAN	PBXELS (P ₁)	ZIPPERS (P ₂) or (X _z)	
		(X)	(SD)	(P)	(L, P)	(P _z)	(X _z)	$P_1 \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_2 \leq [(X) + 6(SD)]$	$[(X) - 3] \leq X_z \leq [(X) + 3]$
5	63,710,000									
10	63,760,000									
15	63,810,000									
20	63,860,000									
25	63,910,000									
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(P _z)	(X _z)	PBXELS (P ₁)	ZIPPERS (P ₂) or (X _z)	
30	63,710,000									
35	63,760,000									
40	63,810,000									
45	63,860,000									
50	63,910,000									

DATA SHEET 4
1.0T SYSTEM MULTI-COIL CORRELATED NOISE

RECEIVER 0		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (\bar{X})	STD DEV (SD)	HOT PIXEL (P_i)	HOT PIXEL LOCATION (L, P)	ZIPPER PEAK PIXEL (P_z)	ZIPPER MEAN (\bar{X}_z)	PIXELS (P_i) $P_i \leq [(\bar{X}) + 8(SD)]$	ZIPPERS (P_z) or (\bar{X}_z) $[(\bar{X}) - 6(SD)] \leq P_z \leq [(\bar{X}) + 6(SD)]$ $[(\bar{X}) - 3] \leq \bar{X}_z \leq [(\bar{X}) + 3]$
1	42,530,000								
6	42,580,000								
11	42,630,000								
16	42,680,000								
21	42,730,000								
26	42,780,000								
31	42,830,000								
R1=4	FREQUENCY	(\bar{X})	(SD)	(P_i)	(L, P)	(P_z)	(\bar{X}_z)	PIXELS (P_i)	ZIPPERS (P_z) or (\bar{X}_z)
36	42,530,000								
41	42,580,000								
46	42,630,000								
51	42,680,000								
56	42,730,000								
61	42,780,000								
66	42,830,000								
RECEIVER 1		IMAGE DATA						ACCEPTANCE SPECIFICATIONS	
IMAGE R1=6	SYSTEM FREQUENCY	MEAN (\bar{X})	STD DEV (SD)	HOT PIXEL (P_i)	HOT PIXEL LOCATION (L, P)	ZIPPER PEAK PIXEL (P_z)	ZIPPER MEAN (\bar{X}_z)	PIXELS (P_i) $P_i \leq [(\bar{X}) + 8(SD)]$	ZIPPERS (P_z) or (\bar{X}_z) $[(\bar{X}) - 6(SD)] \leq P_z \leq [(\bar{X}) + 6(SD)]$ $[(\bar{X}) - 3] \leq \bar{X}_z \leq [(\bar{X}) + 3]$
2	42,530,000								
7	42,580,000								
12	42,630,000								
17	42,680,000								
22	42,730,000								
27	42,780,000								
32	42,830,000								
R1=4	FREQUENCY	(\bar{X})	(SD)	(P_i)	(L, P)	(P_z)	(\bar{X}_z)	PIXELS (P_i)	ZIPPERS (P_z) or (\bar{X}_z)
37	42,530,000								
42	42,580,000								
47	42,630,000								
52	42,680,000								
57	42,730,000								
62	42,780,000								
67	42,830,000								

DATA SHEET 4 (CONTINUED)
1.0T SYSTEM MULTI-COIL CORRELATED NOISE

RECEIVER 2		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE R1=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PIXEL	HOT PIXEL LOCATION	ZIPPER PEAK PIXEL	ZIPPER MEAN	PIXELS (P _i)	ZIPPERS (P _z) or (X _z)	
		(X̄)	(SD)	(P _i)	(L, P)	(P _z)	(X _z)	$P_i \leq [(\bar{X}) + 6(SD)]$	$[(\bar{X}) - 6(SD)] \leq P_z \leq [(\bar{X}) + 6(SD)]$	$[(\bar{X}) - 3] \leq \bar{X}_z \leq [(\bar{X}) + 3]$
3	42,530,000									
8	42,580,000									
13	42,630,000									
18	42,680,000									
23	42,730,000									
28	42,780,000									
33	42,830,000									
R1=4	FREQUENCY	(X̄)	(SD)	(P _i)	(L, P)	(P _z)	(X _z)	PIXELS (P _i)	ZIPPERS (P _z) or (X _z)	
38	42,530,000									
43	42,580,000									
48	42,630,000									
53	42,680,000									
58	42,730,000									
63	42,780,000									
68	42,830,000									
RECEIVER 3		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE R1=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PIXEL	HOT PIXEL LOCATION	ZIPPER PEAK PIXEL	ZIPPER MEAN	PIXELS (P _i)	ZIPPERS (P _z) or (X _z)	
		(X̄)	(SD)	(P _i)	(L, P)	(P _z)	(X _z)	$P_i \leq [(\bar{X}) + 6(SD)]$	$[(\bar{X}) - 6(SD)] \leq P_z \leq [(\bar{X}) + 6(SD)]$	$[(\bar{X}) - 3] \leq \bar{X}_z \leq [(\bar{X}) + 3]$
4	42,530,000									
9	42,580,000									
14	42,630,000									
19	42,680,000									
24	42,730,000									
29	42,780,000									
34	42,830,000									
R1=4	FREQUENCY	(X̄)	(SD)	(P _i)	(L, P)	(P _z)	(X _z)	PIXELS (P _i)	ZIPPERS (P _z) or (X _z)	
39	42,530,000									
44	42,580,000									
49	42,630,000									
54	42,680,000									
59	42,730,000									
64	42,780,000									
69	42,830,000									

DATA SHEET 4 (CONTINUED)
 1.0T SYSTEM MULTI-COIL CORRELATED NOISE

COMBINED IMAGES		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE R1=6	SYSTEM FREQUENCY	MEAN	STD DEV	HOT PBKEL	HOT PBKEL LOCATION	ZIPPER PEAK PBKEL	ZIPPER MEAN	PKELS (P ₁)	ZIPPERS (P ₂) or (X _z)	
		(X)	(SD)	(P)	(L, P)	(P _z)	(X _z)	$P_1 \leq [(X) + 8(SD)]$	$[(X) - 6(SD)] \leq P_2 \leq [(X) + 6(SD)]$	$[(X) - 3] \leq X_z \leq [(X) + 3]$
5	42,530,000									
10	42,580,000									
15	42,630,000									
20	42,680,000									
25	42,730,000									
30	42,780,000									
35	42,830,000									
R1=4	FREQUENCY	(X)	(SD)	(P)	(L, P)	(P _z)	(X _z)	PKELS (P ₁)	ZIPPERS (P ₂) or (X _z)	
40	42,530,000									
45	42,580,000									
50	42,630,000									
55	42,680,000									
60	42,730,000									
65	42,780,000									
70	42,830,000									

DATA SHEET 5
EPI CORRELATED NOISE

COMBINED IMAGES		IMAGE DATA						ACCEPTANCE SPECIFICATIONS		
IMAGE	LOW PASS FILTER #	MEAN	STD DEV	HOT PIXEL	HOT PIXEL LOCATION	ZIPPER PEAK PIXEL	ZIPPER MEAN	PIXELS (P _i)	ZIPPERS (P _z) or (\bar{x}_z)	
R1=11		\bar{x}	(SD)	(P _i)	(L, P)	(P _z)	(\bar{x}_z)	P _i ≤ [(\bar{x} + 8(SD))]	[(\bar{x}) - 6(SD)] ≤ P _z ≤ [(\bar{x}) + 6(SD)] [(\bar{x}) - 3] ≤ \bar{x}_z ≤ [(\bar{x}) + 3]	
1	5									
2	4									
3	3									
4	2									
5	1									
R1=7	FILTER #	(\bar{x})	(SD)	(P _i)	(L, P)	(P _z)	(\bar{x}_z)	PIXELS (P _i)	ZIPPERS (P _z) or (\bar{x}_z)	
6	5									

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	Aug 19, 1998	R. Hawthorne	Initial conversion to Word
1	Nov 10, 1998	M. Keber	Removed obsolete 8.1 information, added data sheets, misc. style guide cleanup.
2	May 20, 1999	S.M.Atladottir	Updated Procedure References for New GUI
3	Jun 10, 1999	R. Kaufman	Removed scans 7-10 for R1=7 due to UCERD filter issue.
4	Oct. 18, 1999	G. Boerner	Minor corrections per 8.3 verification.