USA Instruments, Inc.

GE Signa® 1.5T

FLOW 7000
PHASED ARRAY PERIPHERAL VASCULAR COIL

Service Manual

Part No. 780006 (Rev. G)

TABLE OF CONTENTS

INTRODUCTION

1. How the Coil Operates

- The coil package is a flexible two-piece design. The coil also has a ramp pad that is positioned underneath the lower coil piece. The purpose of the ramp pad is to facilitate the positioning of the body vasculature in a horizontal plane. The coil contains 12 elements which are physically arranged into six pairs. A block diagram showing individual coil elements of the Phased Array Peripheral Vascular Coil is shown in *Figure 1*. A maximum of four RF inputs, representing either the upper (PVUPPER), middle (PVMIDDLE) or lower (PVLOWER) four coils can be selected at a time *(see Figures 2, 3 and 4)*.

- The Flow 7000 Phased Array Peripheral Vascular Coil is a receive-only coil. The coil is decoupled from the transmit coil during transmit by means of a RF choking circuit. These RF chokes can be switched on actively or passively. Each loop coil has six decoupling RF chokes (one active and five passive) and each saddle has eight decoupling chokes (one active and seven passive). Passive decoupling is achieved when small signal diodes are turned on by the induced RF voltage, in the chokes, coupled from the transmit field. Each small signal diode is turned on when the induced RF voltage reaches 0.5 volt. Active decoupling is achieved by PIN diodes which are turned on by a biasing DC current source (200mA) from the MR scanner. When either the small signal diodes or PIN diodes are turned on the RF choking circuits become very high impedance (typically above 2 kilo-ohm) blocks, compared to the other circuit elements (less than 25 Ohm). These high impedance elements segregate the coil circuitry into several electrical segments.

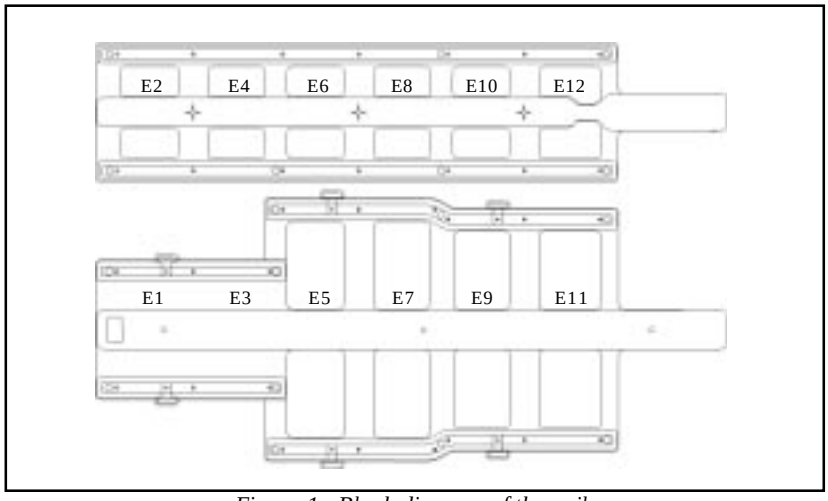

Figure 1: Block diagram of the coil.

INTRODUCTION (continued)

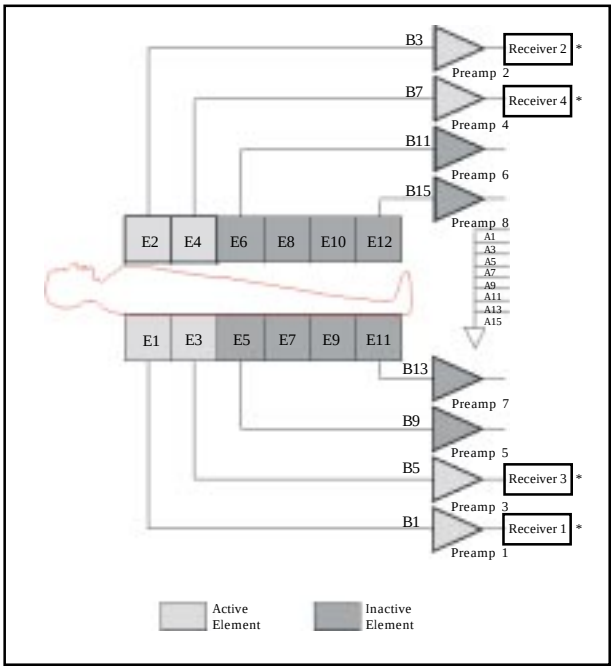

Figure 2: "PVUPPER" signal path (port mask 3).
**see note on the following page*

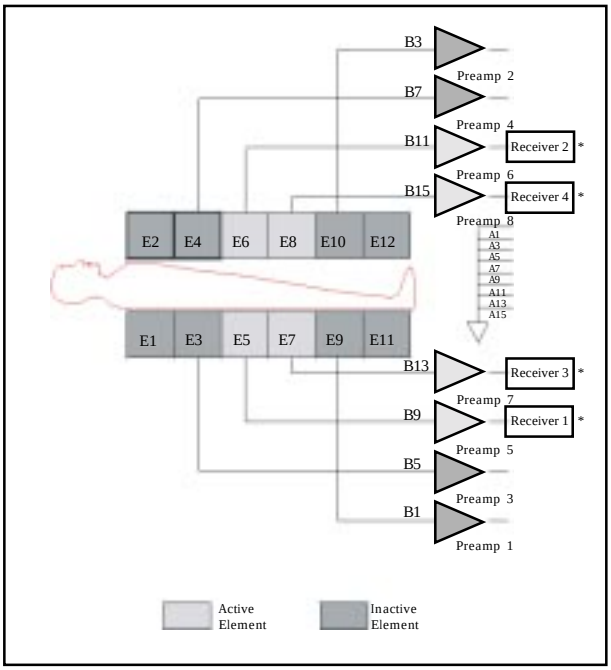

Figure 3: "PVMIDDLE" signal path (port mask 12).
**see note on the following page*

INTRODUCTION (continued)

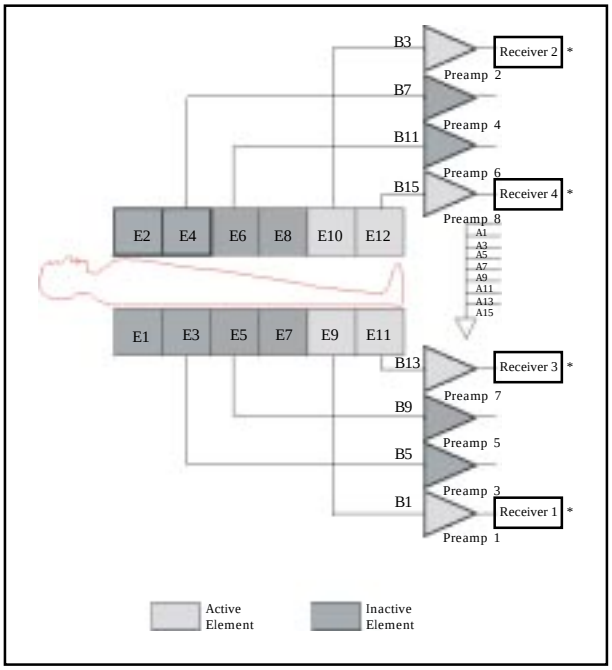

Figure 4: "PVLOWER" signal path (port mask 9).
**see note below*

**Note: The following relates receiver numbering in LX and Genesis systems.*

System	*Receiver Numbers*			
LX User Interface	*1*	*2*	*3*	*4*
LX Hardware Docs	*0*	*1*	*2*	*3*
Genesis User Interface	*0*	*1*	*2*	*3*
Genesis Hardware Docs	*0*	*1*	*2*	*3*

2. Compatibility

- The Flow 7000 Phased Array Peripheral Vascular Coil (GE Catalog # M1087PW) is compatible with the Signa Horizon™ 1.5T system.

3. Coil Specification

Parameter	**Characteristics**
Coil Design	12-element phased array, receive-only coil
Tuned Frequency	63.86 MHz (factory set)
Optimum Field of View	each four-element array provides a 44cm FOV
Operation/Storage Environment	operate and store the coil in the scanner room

Table 1: Coil specification.

4. Related Documents

- Operator's Guide (USAI Part # 770007).
- MR System Guide (GE Part # 2124201-3 for Signa 5.X Service Methods, GE Part # 2160623-3 for Signa 8.X Service Methods).

SETUP AND CALIBRATION

1. Shipping List

Part Name	GE Part #	USAI Part #	Qty
Coil	2192406-12	100079	1
Ramp Pad	E8800ZT	150040	1
Patient Comfort Pad	E880ZW	150075	1
Foam Spacer Block	E8800ZY	150041	1
Coil Velcro Strap Set *(attached to coil)*	E8800ZZ	150042	1
SNR Phantom	2192406-6	150034	3
Loading Phantom	2192406-7	150035	2
Phantom Positioner Set	2192406-9	150036	1
Phantom Velcro Strap	2285178-4	150171	1
Operator's Guide	2192406-10	770007	1
Service Manual	2192406-1	780006	1

Table 2: Peripheral Vascular Coil shipping list.

2. Installing the Preamplifier

- The Phased Array Peripheral Vascular Coil requires all eight (8) phased array preamplifiers to be installed in the system. Refer to the system manuals for information on installing the preamplifiers (Direction 2238944: Signa 8 Channel Preamp Installation). Also, refer to instructions in the preamplifier kit (GE Part Number M1087CY).

3. Installing the Coil

- At the console, install a new coil. After this, the operator will be able to select PVUPPER, PVMIDDLE and PVLOWER. Refer to the system manuals for information on installing coils (use the coil configuration parameters shown below).

- The coil is ready for clinical use after proper installation of the coil. Refer to the Operator's Guide for instructions on how to use the coil.

SETUP AND CALIBRATION (continued)

coilName	PVUPPER	PVMIDDLE	PVLOWER
numRec	4	4	4
startRec	0	0	0
endRec	3	3	3
numFastRec	0	0	0
startFastRec	4	4	4
endFastRec	4	4	4
fastTGstartRG	12	12	12
fastTGstartTA	90	90	90
mcErrorEnable	3	12	9
mcPortEnable	3	12	9
mcReconEnable	0	0	0
coilType	3	3	3
extremity	no	no	no
linearQuad	1	1	1
multiCoil	yes	yes	yes
xmitAtten	0	0	0
cableLoss	1.05 (BRM)	1.05 (BRM)	1.05 (BRM)
coilLoss	1.72 (BRM)	1.72 (BRM)	1.72 (BRM)
reconScale	1.00	1.00	1.00

Table 3: Coil configuration parameters for Signa Horizon 1.5T.

SETUP AND CALIBRATION (continued)

4. Quality Assurance

- Tuning -- The Flow 7000 Phased Array Peripheral Vascular Coil does not require matching or tuning on a per patient basis. The coil is initially tuned to the system frequency by USA Instruments' service engineers and requires no additional tuning.

- QA Check -- It is recommended that the clinical user conduct a QA check on the Flow 7000 Phased Array Peripheral Vascular Coil on a weekly basis. The QA check consists of a QA scan, a calculation of the signal-to-noise ratio (SNR) and a visual inspection of the coil phantom image.

- QA Setup -- Select [New Study], [New Exam] or [New Pt] to set a new landmark. Remove any other surface coil (if present) from the cradle. Place the ramp pad and posterior array coil at the top of the cradle *(see Figure 5)*.

Figure 5: Placing the ramp pad and posterior array coil onto the cradle.

- Assemble the phantom set as follows: (1) place a loading phantom on the posterior array coil near the top *(see Step 1 of Figure 7)*; (2) place the lower section of the phantom positioner on the posterior array coil *(see Step 2 of Figure 7)*; (3) place the SNR phantoms onto the lower section of the phantom positioner *(see Step 3 of Figure 7)*; (4) place and align the upper section of the phantom positioner over the SNR phantoms; (5) place a loading phantom onto the upper section of the phantom positioner *(see Step 4 of Figure 7)*; (6) place the anterior array coil on top of the coil phantom set and fasten the velcro straps *as shown in Step 5 of Figure 7* (be sure the anterior array coil is aligned with the posterior array coil).

- Connect the Phased Array Peripheral Vascular Coil connector to the phased array port.

SETUP AND CALIBRATION (continued)

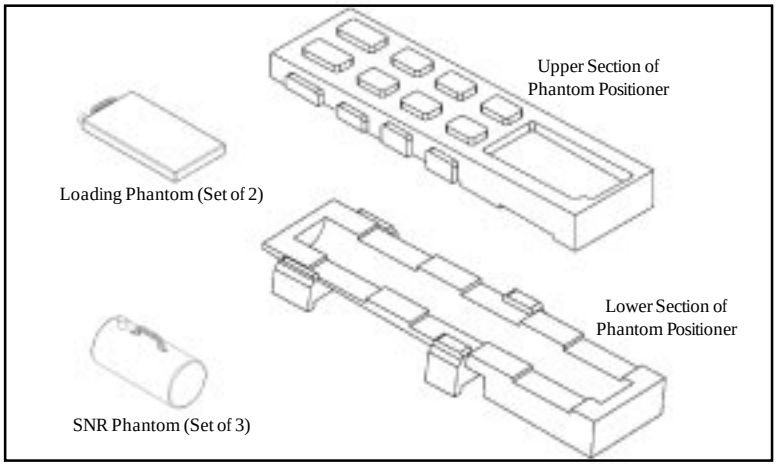

Figure 6: Parts of the coil phantom set.

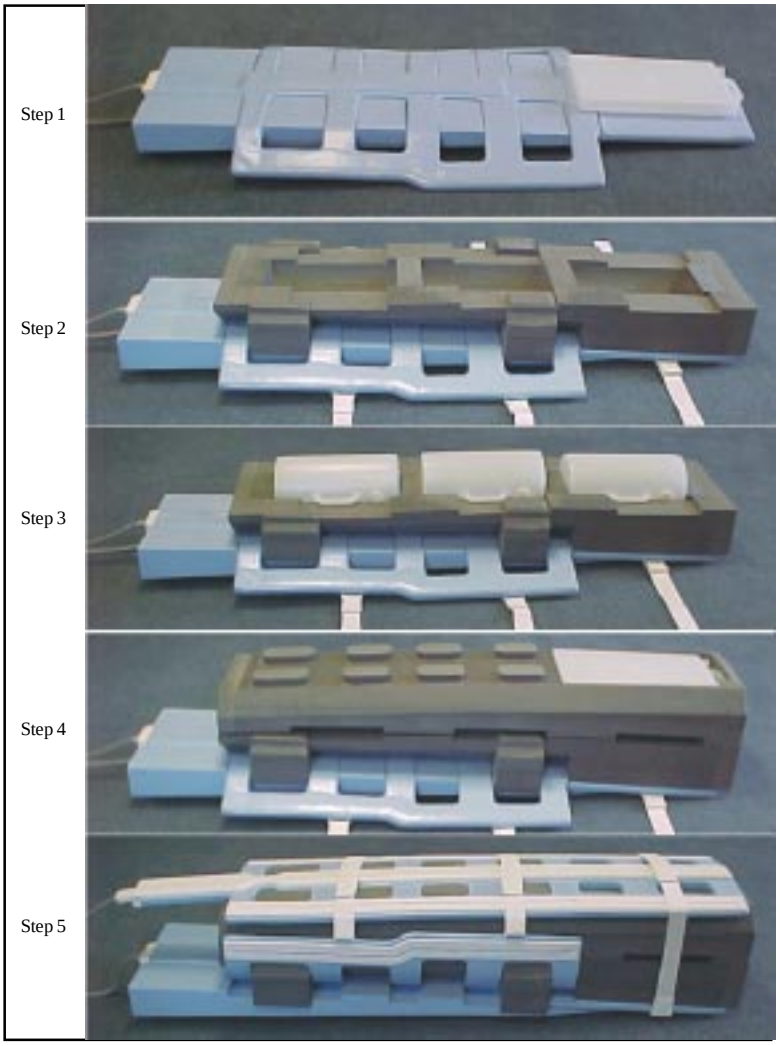

Figure 7: Positioning the coil phantom set.

SETUP AND CALIBRATION (continued)

- The QA check for the coil requires three scans. The array consists of three stations, each employing four individual coil elements. The first scan measures SNR of the most inferior station (coil mode PVLOWER) and should be landmarked at the crosshair on top of the anterior array of the PVLOWER station (the end of the array that enters the magnet first). The second scan measures SNR of the middle station (coil mode PVMIDDLE) and should be landmarked at the crosshair on top of the anterior array of the PVMIDDLE station. The third scan measures SNR of the most superior station (coil mode PVUPPER) and should be landmarked at the crosshair on top of the anterior array of the PVUPPER station (the end of the array that enters the magnet last). Parameters for the QA scan protocol are:

Patient/Exam Information			
ID	geservice		
Name	PV Array		
Patient Weight	111 lbs / 50 kg		
Patient Position			
Patient Position	Supine		
Patient Entry	Feet First		
Coil	PVLOWER, PVMIDDLE, or PVUPPER		
Series Description	*leave blank*		
Imaging Parameters			
Plane	Sagittal		
Mode	2D		
Pulse Sequence	FSE		
Imaging Options	Variable Bandwidth, No Phase Wrap		
PSD Name	*leave blank*		
Protocol	*leave blank*		
Scan Timing			
Number of Echoes	1		
Echo Time (TE)	17		
Rep Time (TR)	500		
Echo Train Length (ETL)	8		
Bandwidth	15.63		
Additional Parameters			
no entries required in this area			
Acquisition Time			
Freq	256		
Phase	256		
NEX	2		
Phase FOV	1.00		
Freq DIR	A/P		
Auto Center Freq	Peak		
Autoshim	On		
Phase Correct	On		
Contrast	Off		
# of Reps B4 Pause	0		
Scanning Range			
FOV	38		
Slice Thickness	3		
Spacing	1.5		
	R/L	**P/A Center**	**I/S Center**
Start	0.0	0.0	0.0
End	0.0		
# Slices	1	Table Delta:	0.00

Table 4: QA scan parameters.

SETUP AND CALIBRATION (continued)

- After the series is saved and prepared, right click on Research Options and select Display CVs (on Genesis System touch [Modify CVs] button). Type in **saveinter** and change the value from 0 to 1. This will enable intermediate images to be saved to the database along with the composite image. This will cause each scan to produce five images even though only one slice is prescribed.

- Autoprescan and scan.

- When the scan is done, view the images to verify that a bright region is visible in a different portion of each intermediate image and that the composite image is reasonably uniform. Images from the anterior section of the coil will not be as bright as those from the posterior section. The scan will yield 5 images. Images 1 through 4 correspond to images from receivers 0 through 3, respectively. Image 5 is the composite of the first four.

- Copy and paste the series. Change landmark and coil selection and repeat for each additional station in the array.

- Review Images -- The images from each station should resemble those in *Figures 8 through 10*. Note particularly that each intermediate image has a bright region in one corner, corresponding to the coil element which made it. A normal composite image will be slightly darker in the center than in the corners. If one or more corners of the composite image is noticeably darker than the others, it may indicate that one or more elements or receive channels is not working properly. Images from the PVUPPER station of the coil will be somewhat less bright than those from the PVMIDDLE and PVLOWER stations. This is normal due to coil geometry and the presence of loaders for the PVUPPER station in the phantom set.

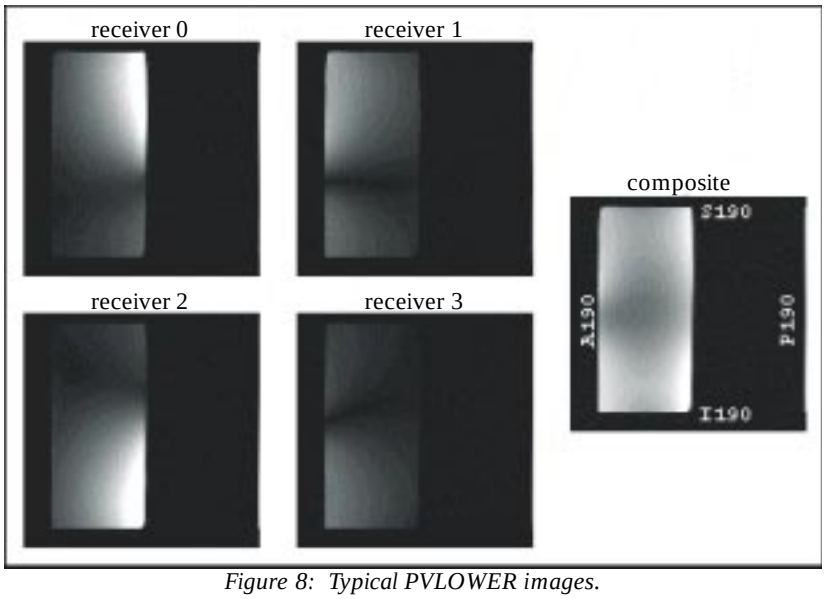

Figure 8: Typical PVLOWER images.

SETUP AND CALIBRATION (continued)

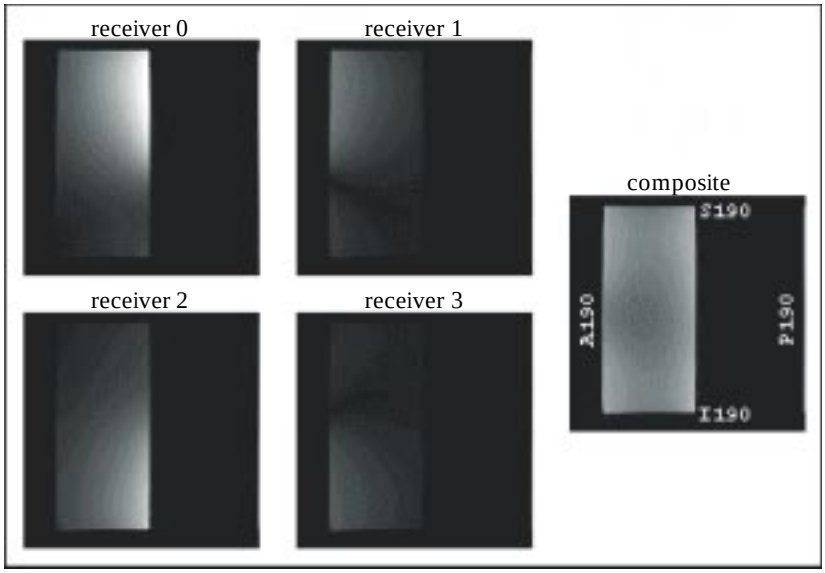

Figure 9: Typical PVMIDDLE images.

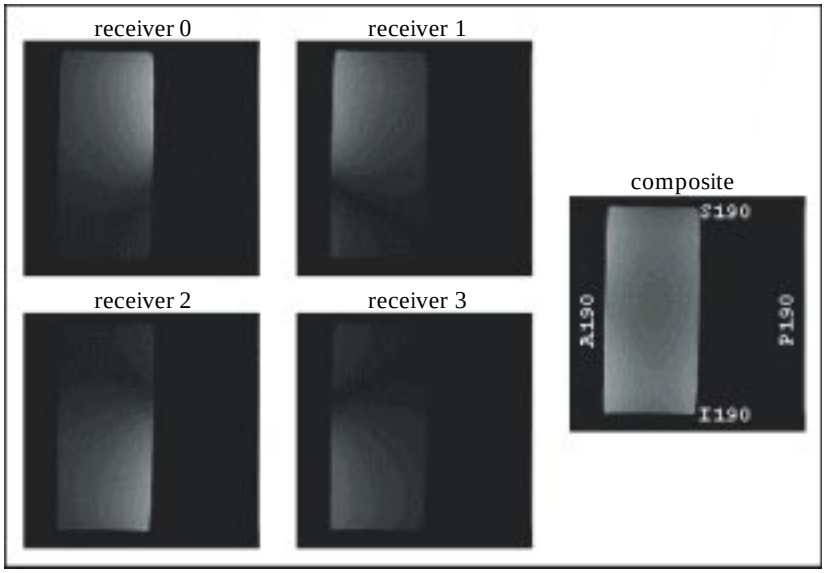

Figure 10: Typical PVUPPER images.

- Signal-to-Noise Ratio Analysis -- In this section, you will be asked to position several “measure distance” lines on the image to facilitate location and sizing of the signal and noise regions of interest. Average signal will be divided by average background noise to obtain a signal-to-noise ratio (SNR) value for each station in the PV array. Perform the following steps for each of the three stations:

SETUP AND CALIBRATION (continued)

- Step 1 -- Display image 5 from the PVLOWER, PVMIDDLE or PVUPPER series.

- Step 2 -- Use the measure distance feature to place four lines, each 5mm long at the approximate center of each edge of the phantom as shown in *Figure 11*. Note that the lines extend from the edge of the phantom toward the interior. LX systems: ends of lines are at the center of the little boxes used to adjust line size. Genesis systems: ends of lines are at the center of the crosshair cursor.

- Step 3 -- Place a rectangular region of interest (ROI) on the phantom so the four sides just touch the inside ends of the four 5mm lines that were created in step 2 *(see Figure 12)*.

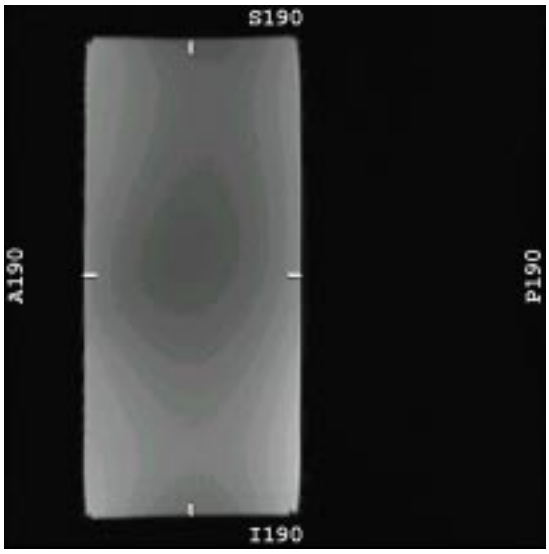

Figure 11: Preparation for signal region of interest.

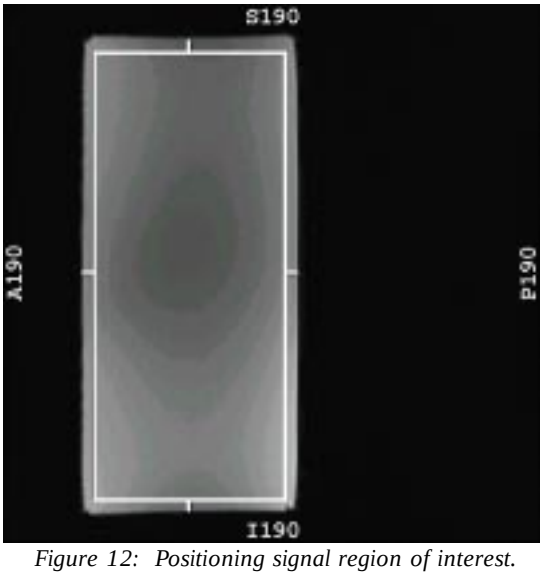

Figure 12: Positioning signal region of interest.

SETUP AND CALIBRATION (continued)

- Step 4 -- Record the mean signal value in a copy of the worksheet in *Appendix A or B*.
- Step 5 -- Use the measure distance feature to place a new 5mm line at the posterior edge of the phantom as shown in *Figure 13*. This new line should be slightly inferior or superior to the poster mark made earlier.
- Step 6 -- Create a 100mm line from near the posterior end of the new 5mm line toward the posterior edge of the image as shown in *Figure 13*.
- Step 7 -- Create a rectangular ROI that touches the ends of the 100mm line and is about the same inferior-to-superior length as the signal ROI as shown in *Figure 14*.
- Step 8 -- Record the mean noise value in the worksheet.
- Step 9 -- Divide mean signal by mean noise and enter SNR in the worksheet.
- Step 10 -- Repeat steps 2 through 9 for PVMIDDLE and PVUPPER stations.

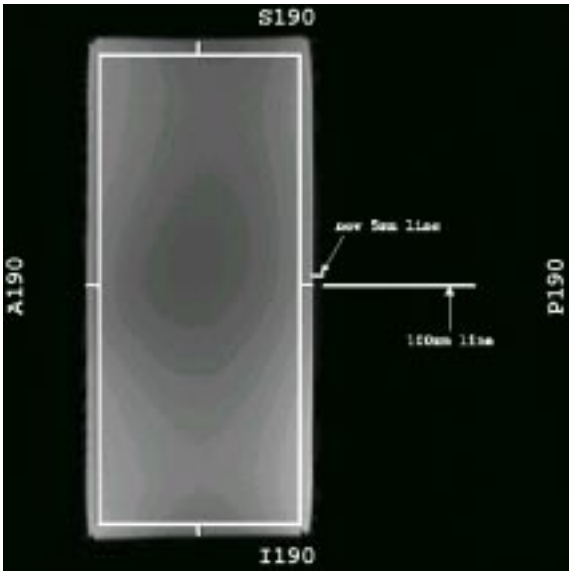

Figure 13: Preparation for noise region of interest.

SETUP AND CALIBRATION (continued)

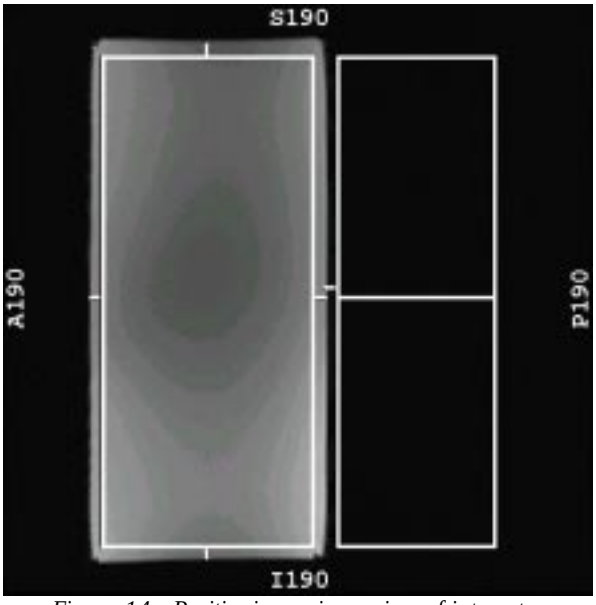

Figure 14: Positioning noise region of interest.

REPLACEMENT AND MAINTENANCE

1. Field Replaceable Units

Part Name	GE Part #	USAI Part #
Coil	2192406-12	100079
Cable Assembly	2192406-2	110035
SNR Phantom	2192406-6	150034
Loading Phantom	2192406-7	150035
Phantom Positioner Set	2192406-9	150036
Phantom Velcro Strap	2285178-4	150171
Pin Diodes Set (set of 4)	2192406-5	150077

Table 5: Field replaceable units.

2. Replaceable Accessories

Part Name	GE Part #	USAI Part #
Extension Cable		110143
Ramp Pad	E8800ZT	150040
Patient Comfort Pad	E8800ZW	150075
Foam Spacer Block	E8800ZY	150041
Coil Velcro Strap Set	E8800ZZ	150042
Coil Storage Rack	E8801WA	150086
Coil Shipping Container Set		150078
Phantom Shipping Container Set		150106

Table 6: Replaceable accessories.

REPLACEMENT AND MAINTENANCE (continued)

3. Coil Care

- Warning! Detach the coil connector from the scanner before attempting to clean the coil. Do not touch the connectors with bare fingers. Never press a sharp object against the surface of the connector. Do not reattach the connector after cleaning the coil until the coil has dried completely. Electric shock may result if the coil is attached to the system during cleaning or when it is wet,

- Caution! Do not pour or spray cleaning liquid directly on the coil. Do not submerge the coil in the solution. The coil contains sensitive electronic components that could be damaged by the solution The coil cannot be sterilized and should be cleaned only according to the procedure outlined in this section.

- Cleaning -- The following cleaning solutions are recommended for the coil and pad surfaces: (1) a ten percent bleach solution (some discoloration may occur), (2) one ounce commercial dish-washing liquid mixed with one gallon water or (3) warm water. Apply cleaning solution to a soft cotton cloth and proceed to clean. To prevent soiling of the coil, the user should place a clean cotton sheet over the coil before positioning the patient . If the coil is soiled, clean the coil as described above.

- Carrying the Coil -- The coil should be supported from underneath using both hands.

- Coil Storage -- Lay the ramp pad and posterior array coil completely flat *(see Figure 15).* Place a sheet on top of the posterior array coil *(see Figure 15).* The sheet separates the posterior array coil and anterior array coil to prevent them from sticking. Place the anterior array coil on top of the sheet and loosely fasten the Velcro straps *(see Figure 15).* Please note that although the straps are fastened together, the coil is not bent. **Note: The coil should be handled with care. Gently bend the coil when necessary -- never fold/crease the coil sharply. Avoid excessive folding of the coil.**

4. Special Care Requirements

- Prior to returning a coil for service, use a ten percent bleach solution (as described above) to eliminate risk of exposure to potentially infectious materials.

REPLACEMENT AND MAINTENANCE (continued)

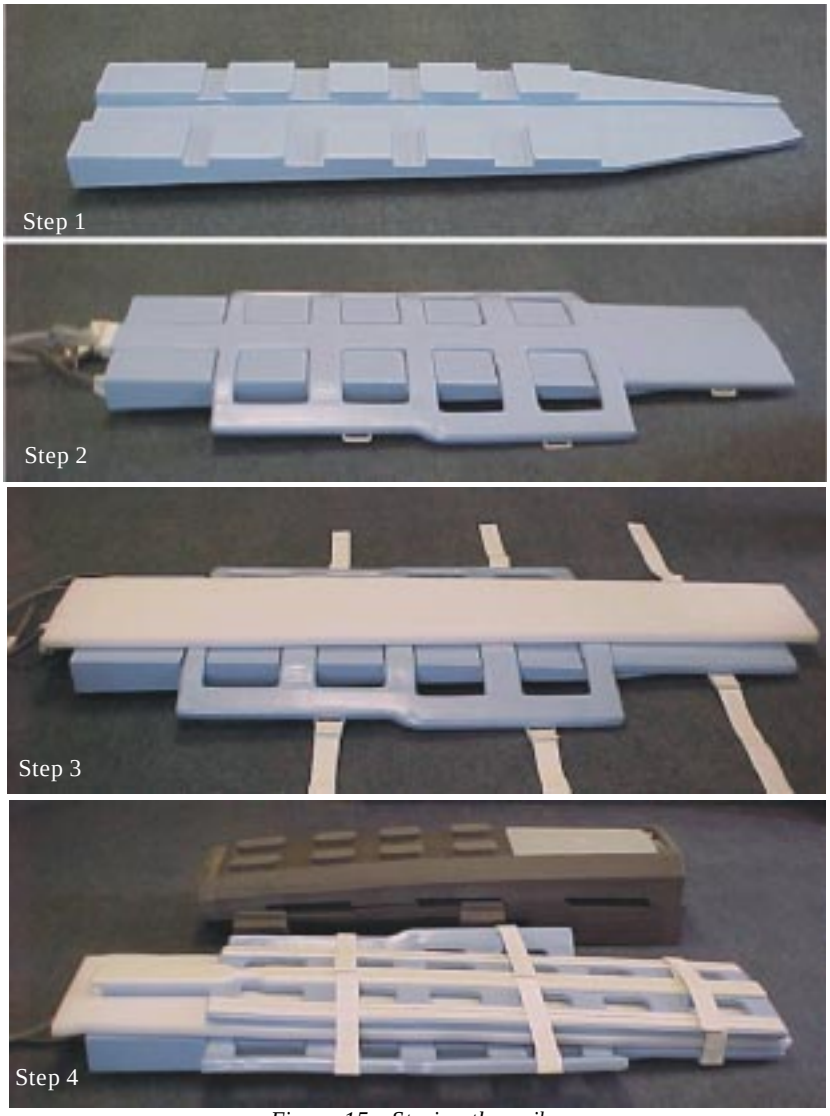

Figure 15: Storing the coil.

REPLACEMENT AND MAINTENANCE (continued)

- Storage of the Phantoms -- The phantoms may be stored next to the coil as shown in *Figure 15* or in the shipping box as shown in *Figure 16*.

Figure 16: Storing the phantoms in the shipping box.

- Coil Dimensions -- see below.

Part	Length	Width	Height
Ramp Pad	65.48"	15.50"	3.65"
Posterior Coil	65.60"	27.87"	1.57"
Anterior Coil	65.34"	14.50"	1.62"

REPLACEMENT AND MAINTENANCE (continued)

5. Troubleshooting

System Transmit/Receive Fault

- Check to make sure the coil cable is plugged into the system.
- Check to make sure the cable is plugged into both the anterior and posterior array coils.
- Check for continuity in the output cable. Use a Digital Volt Meter (DVM). Separate the output cable from the anterior coil by pushing the buttons located on the sides of the cable housing and gently pulling the connector out of the socket. Follow the same procedure for the posterior coil. Make sure there is continuity between the appropriate pin at the 30-pin connector which plugs into the system and the connectors that plug into the anterior and posterior coils *(see Figure 19 and Table 11 for the correct pins).*
- Note that the following T/R fault troubleshooting will require removing the middle covers from the anterior and posterior coils. Gently pry up the four white screw covers located down the middle of the anterior cover and the three white screw covers located down the middle of the posterior cover. Remove all the screws found under the covers. Remove the center covers from both the anterior and posterior coils.
- Check the red hookup wires located between each of the coil elements for continuity using a DVM.
- Make sure the SMB jacks located on the white internal cables are securely seated on the appropriate jack.
- Check the pin diodes located on the feed boards of the individual coil elements with a DVM. Every coil element has one diode *(see Figure 20 for the location of the diodes).* If a diode is found to be either open or shorted: (1) take note of the diode's cathode-anode orientation; (2) carefully de-solder the surface mounted diodes from the feed board; (3) cut the leads of a new diode to 1/8"; (4) place the new diode into the hole on the PCB. Align the leads of the diode with the surface mount pads. The cathode pad is designated with a dot near the pad *(see Figure 21 for diode mounting).*

REPLACEMENT AND MAINTENANCE (continued)

Coil Fails System QA Check (SNR Test or No Signal from One or More Elements)

- Check for proper phantom placement. Refer to the Set and Calibration procedure in this manual.
- Make sure the landmark is matched to the proper coil station.
- Check white, internal cable connections (see T/R fault troubleshooting).
- Check internal pin diodes (see T/R fault troubleshooting).
- Call your GE representative for further assistance.
- Note that there are no field serviceable parts in the outer arms of the coil.

Connector to Coil Pins	30-Pin Connector to Cradle
Anterior, Center Pin 1	Pin B11
Anterior, Ground 1	Pin A11
Anterior, Center Pin 2	Pin B15
Anterior, Ground 2	Pin A15
Anterior, Center Pin 3	Pin B3
Anterior, Ground 3	Pin A3
Anterior, Center Pin 4	Pin B7
Anterior, Ground 4	Pin A7
Posterior, Center Pin 1	Pin B5
Posterior, Ground 1	Pin A5
Posterior, Center Pin 2	Pin B1
Posterior, Ground 2	Pin A1
Posterior, Center Pin 3	Pin B13
Posterior, Ground 3	Pin A13
Posterior, Center Pin 4	Pin B9
Posterior, Ground 4	Pin A9

Table 7: Center pin and ground connections.

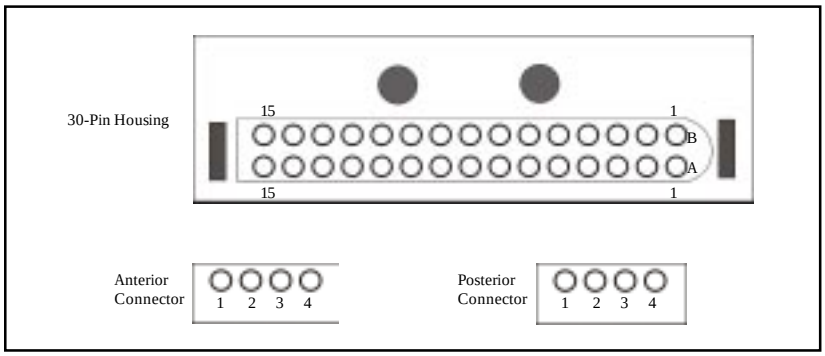

Figure 19: Pin layouts of 30-pin housing, anterior, and posterior connectors.

REPLACEMENT AND MAINTENANCE (continued)

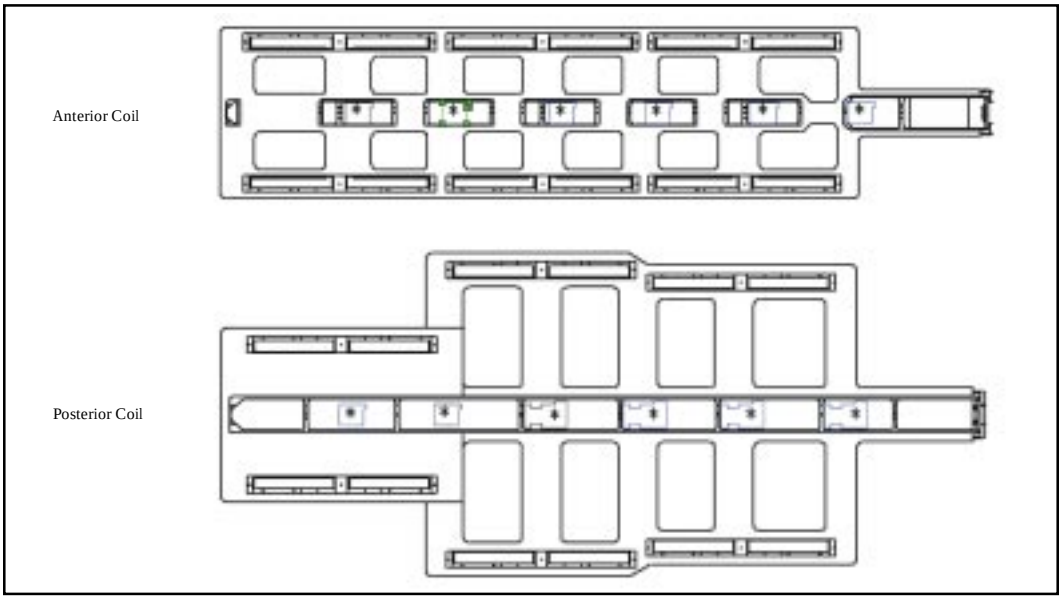

Figure 20: Pin diode placement for both the anterior and posterior coils (represents pin diode location).*

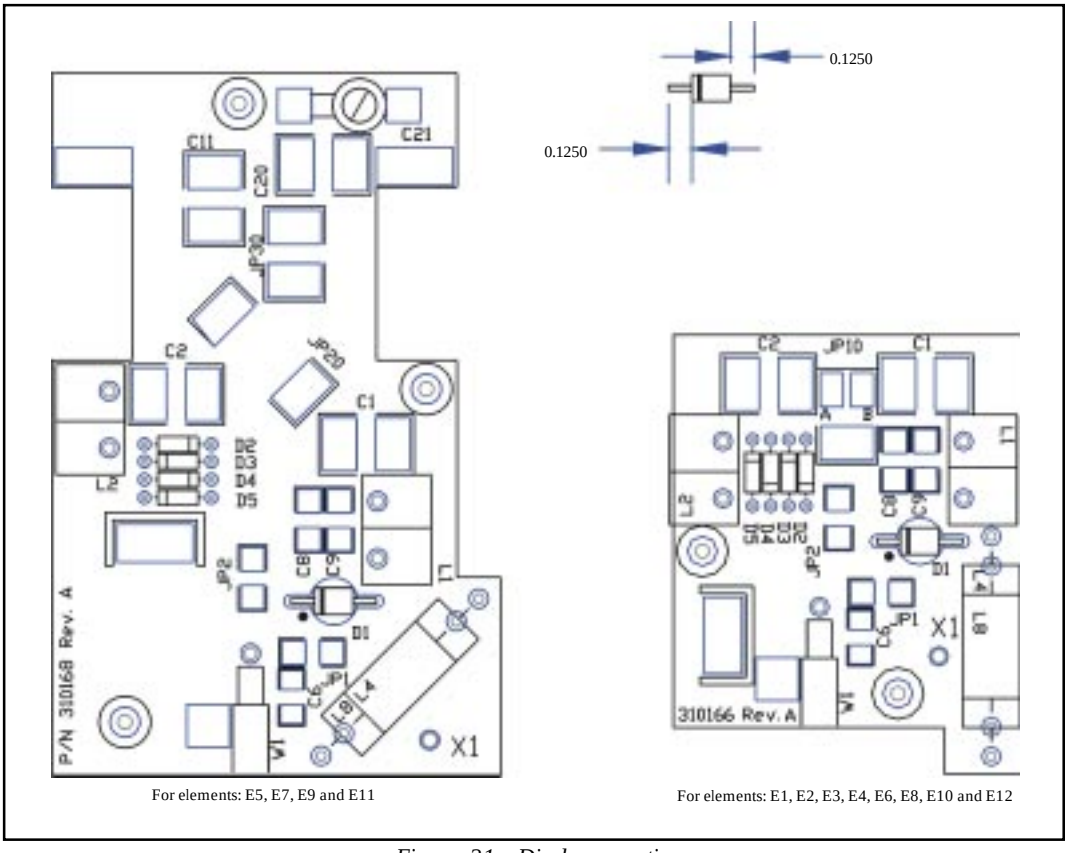

Figure 21: Diode mounting.

APPENDIX A -- SNR WORKSHEET

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments

Date Tested

Station	Mean Signal	Mean Noise	SNR	Limit
PVLOWER				≥ 45
PVMIDDLE				≥ 45
PVUPPER				≥ 35

Comments