SECTION 1 – BROADBAND AND NARROWBAND RF CABINET

This Service Manual does not contain PROBE Spectroscopy specific information. The term Spectro or Spectroscopy as used throughout this manual refers to Multi–Nuclear Spectroscopy unless otherwise noted.

The term **WRT** used means with respect to or with reference to.

The term **MNS** refers to Multi–Nuclear Spectroscopy. MNS is the same as **BroadBand (BB)** Spectroscopy. These terms will be used throughout this Service Manual.

M1040HT (5.X) includes a Spectro Option Key—this is required to perform PROBE and MNS Spectroscopy. The key is discussed in the Installation Section of this manual and is labeled 46–317350G1. Also included is the Spectroscopy EPROM.

M1090KT (4.X) includes a Spectro Option Key Tape—this is required to perform PROBE and MNS Spectroscopy. Also included is the Spectroscopy EPROM. The Key Tape is discussed in the Installation Section of this manual, Final Procedures.

This Section applies to M1040FF (4.X to 5.3 HARDWARE) and M1040FK (5.4 HARDWARE).

1–1 DESCRIPTION

- **Planned Maintenance: Perform RF and Power Monitor Checks when required.**

This section describes how to adjust (M1040FF/M1040FK Only):

- VERIFICATION OF RF INTERFACE BOARD JUMPERS
- SPECTRO ANALOG SENSE BOARD OFFSETS MEASURED—M1040FF ONLY
- SPECTRO ANALOG SENSE BOARD OFFSETS ADJUSTMENT PROCEDURE—M1040FF ONLY
- MULTI–NUCLEAR SPECTROSCOPY EXTREMITY COIL VERIFICATION
- MNS CABLE VERIFICATION / LABELING IN CARRIAGE ASSEMBLY
- DYNAMIC DISABLE/TR DRIVER BOARD (MR1A9A3) JUMPER LOCATIONS
- INITIAL (^{31}P) MULTI–NUCLEAR SPECTROSCOPY SCAN PREPARATION
- SPECTROSCOPY TR DRIVER CIRCUIT ADJUSTMENTS —– DYNAMIC STATE
- MULTI–NUCLEAR SPECTRO RF SIGNAL FROM THE EXCITER WITH BB MODULE
- NARROWBAND RF OUT OF SYSTEM CABINET—MEASUREMENT
- CALIBRATE NARROWBAND RF SIGNAL ROUTED THROUGH BROADBAND CABINET TO MR1
- ADJUSTMENT FOR 1.55 kW MULTI–NUCLEAR SPECTROSCOPY RF POWER OUTPUT
- MULTI–NUCLEAR SPECTRO POWER MONITOR VERIFICATION (M1040FF Only)
- MULTI–NUCLEAR SPECTRO POWER MONITOR ADJUSTMENT (M1040FK Only)
- RF CABINET–RESTORATION CHECK LIST

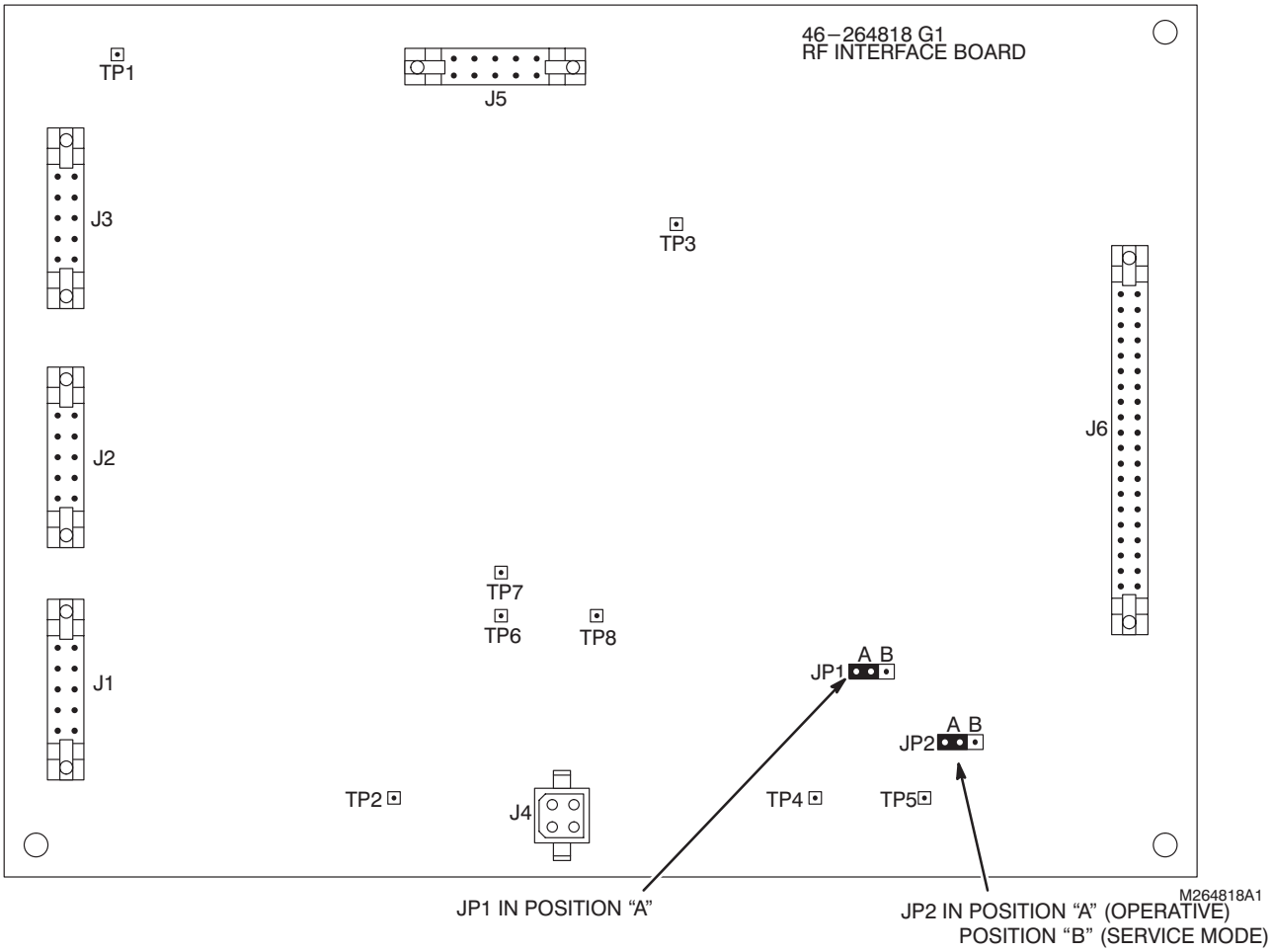
1–2 PRELIMINARY CHECKS

1–2–1 VERIFICATION OF RF INTERFACE BOARD JUMPERS

This procedure will:

- Verify RF Interface Board (MR6 A2 A4) jumper positions.

1. Remove eight screws from Power Monitor front panel. Place panel on top of the Power Monitor, Key Switch cables may be disconnected if necessary.
2. Remove eight screws and washers from RF I/F Assembly Cover (MR6 A2).
3. Verify RF Interface Board (MR6 A2 A4) jumper positions are a s follows (see Illustration 1–1):
   - JP1 – Position “A” (operative mode)
   - JP2 – Position “A” (operative mode)
4. Replace RF I/F Assembly Cover, but **DO NOT** re–install the screws and washers at this time.



RF INTERFACE BOARD (MR6 A2 A4)
ILLUSTRATION 1–1

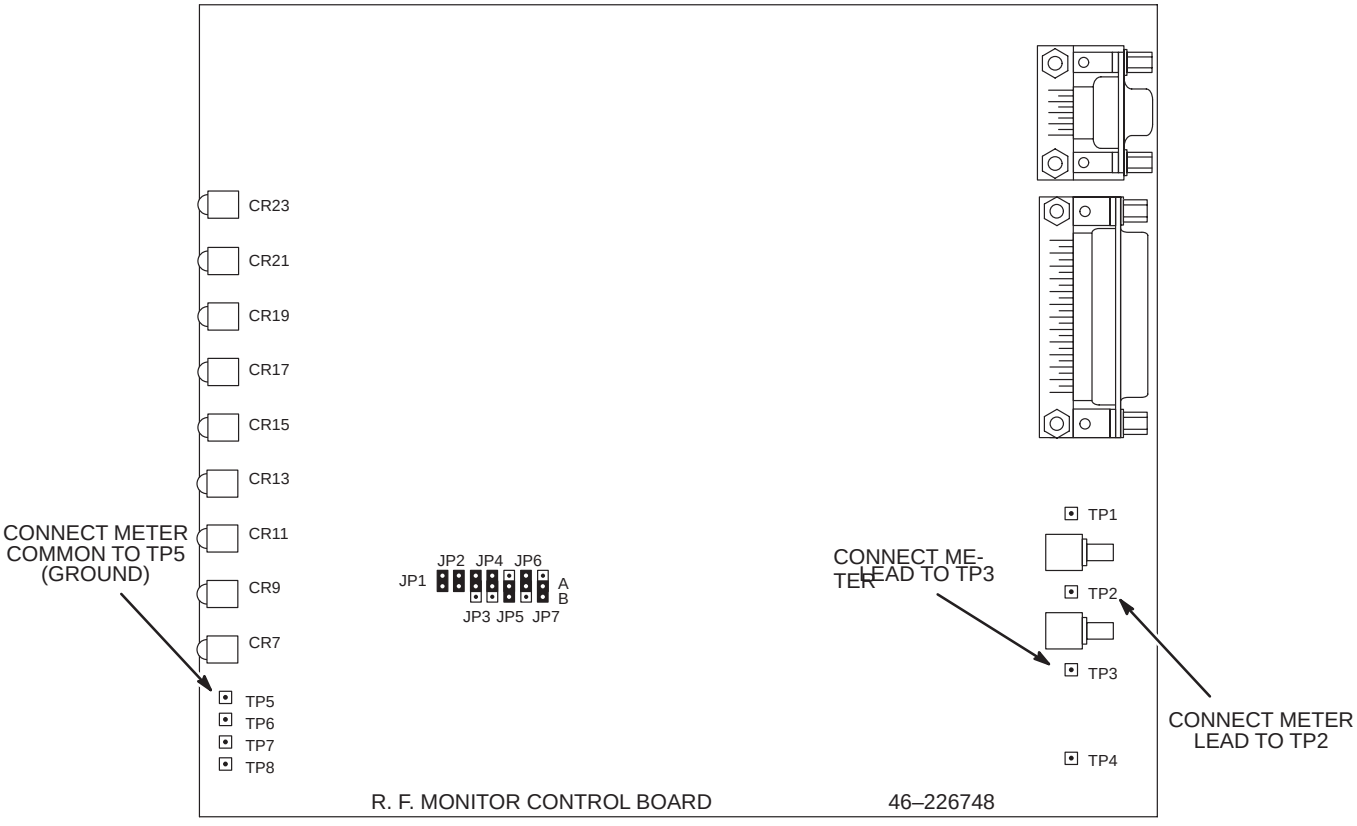
1–2–2 SPECTROSCOPY ANALOG SENSE BOARD OFFSETS MEASURED

This section applies to M1040FF only.

This procedure will verify that the offset voltages for Body, Spectro, and Head are as close to 0 mV_{DC} as possible:

- Measure the (steady state) offset voltage on the Power Monitor Control Boards (MR1 A3 A1/A2) for both Head Narrowband and Spectro BroadBand DC pickoffs at TP2 WRT TP5 [Power Monitor Control Boards #1 (MR1 A3 A1) and # 2 (MR1 A3 A2)].
- Measure the (steady state) offset voltage on the Power Monitor Control Boards (MR1 A3 A1/A2) for Body Narrowband DC pickoffs at TP3 WRT TP5 [Power Monitor Control Boards #1 (MR1 A3 A1) and # 2 (MR1 A3 A2)].
- If the offset voltage is out of tolerance an adjustment procedure will be required. The adjustment procedure must be done in sequence and will be performed on the Spectro Analog Sense Boards (MR1 A3 A3/A4). Only the offset voltages out of tolerance should be adjusted.

1. Make sure SIGNA System is up, not scanning (steady state), and BroadBand RF Cabinet (MR6) has been on > 30 minutes. The top or front cover of the Power Monitor must be removed to gain access to the circuit boards.
2. Connect a voltmeter at TP2 of Control Board #1 (MR1 A3 A1) WRT TP5 (ground reference). The offset voltage measured should be 0.0 $mV_{DC,}$ $\pm$ 5.0 mV_{DC}. Record TP2 #1 offset voltage for Head/Spectro _____. Refer to Illustration 1–2.



POWER MONITOR CONTROL BOARD #1 AND #2 (MR1 A3 A1 AND MR1 A3 A2)
ILLUSTRATION 1–2

1–2–2 SPECTROSCOPY ANALOG SENSE BOARD OFFSETS MEASURED (Continued)

3. Connect a voltmeter at TP2 of Control Board #2 (MR1 A3 A2) WRT TP5 (ground reference). The offset voltage measured should be 0.0 $mV_{DC,} \pm 5.0\ mV_{DC}$. Record TP2 #2 offset voltage for Head/Spectro _____. Refer to Illustration 1–2.
4. Connect a voltmeter at TP3 of Control Board #1 (MR1 A3 A1) WRT TP5 (ground reference). The offset voltage measured should be 0.0 $mV_{DC,} \pm 5.0\ mV_{DC}$. Record TP3 #1 offset voltage for Body _____. Refer to Illustration 1–2.
5. Connect a voltmeter at TP3 of Control Board #2 (MR1 A3 A2) WRT TP5 (ground reference). The offset voltage measured should be 0.0 $mV_{DC,} \pm 5.0\ mV_{DC}$. Record TP3 #2 offset voltage for Body _____. Refer to Illustration 1–2.
6. If any of the offset voltages recorded in Steps 2 through 5 are not within tolerance then go to Section 1–2–3, Spectro Analog Sense Board Adjustment Procedure.
7. ***If NOT proceeding*** to the applicable next section of this procedure ***proceed*** to the RESTORATION CHECK LIST to restore system hardware.

1–2–3 SPECTROSCOPY ANALOG SENSE BOARD OFFSETS ADJUSTMENT PROCEDURE

This section applies to M1040FF only.

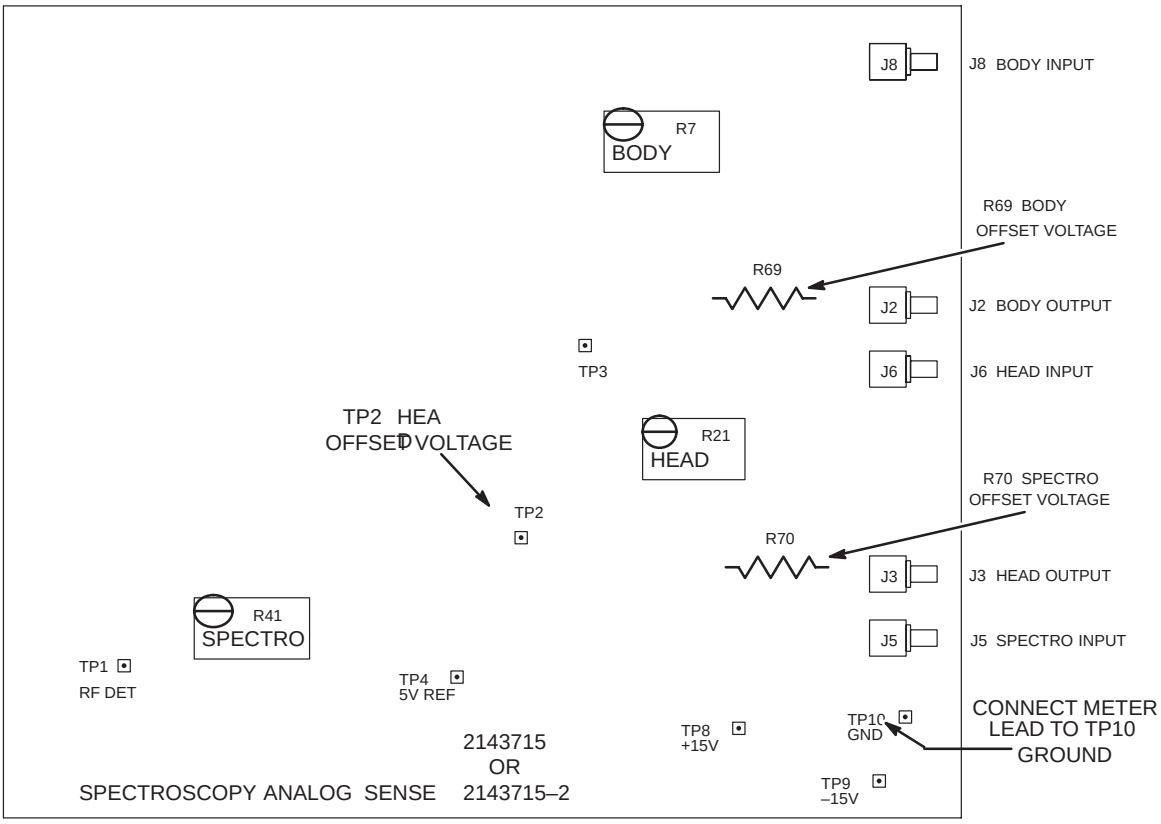
NOTE

Perform this procedure only if Section 1–2–2 SPECTROSCOPY ANALOG SENSE BOARD OFFSETS MEASURED, Steps 2 through 5 are not within tolerance.

This procedure will adjust the offset voltages for Body, Spectro, and Head as close to 0 mV_{DC} as possible:

1. Use a volt–meter to perform the following checks on the Power Monitor Spectro Analog Sense Boards.
2. At Spectro Analog Sense Board #1 adjust R7 until voltage at J2 (or at R69) with reference to common ground TP10 is 0.0 mVDC ± 5.0 mVDC. The TPS Cable Kit can be used to connect to J2 or use the EZ clip jumpers at R69. Refer to Illustration 1–3.
3. At Spectro Analog Sense Board #1 adjust R21 until voltage at TP2 with reference to common ground TP10 is 0.0 mVDC ± 5.0 mVDC. Use the EZ clip jumpers to connect to the TP2 referenced to TP10. Refer to Illustration 1–3.
4. At Spectro Analog Sense Board #1 adjust R41 until voltage at J3 (or at R70) with reference to common ground TP10 is 0.0 mVDC ± 5.0 mVDC. This step is affected by step 3. This step must be adjusted after step 3. The TPS Cable Kit can be used to connect to J3 or use the EZ clip jumpers at R70. Refer to Illustration 1–3.
5. Perform steps 2 through 4 for the Spectro Analog Sense Board #2.

The sequence of the Spectro and Head adjustment steps above is important.



POWER MONITOR SPECTRO ANALOG SENSE BOARD #1 AND #2 (MR1 A3 A3 AND MR1 A3 A4)
ILLUSTRATION 1–3

1–2–4 MULTI–NUCLEAR SPECTROSCOPY EXTREMITY COIL VERIFICATION

This procedure will:

- Verify using a multimeter the three diodes in the ^{31}P (Phosphorus) service coil are not damaged.

This procedure will not:

- Verify the ^{31}P (Phosphorus) service coil is properly tuned or damaged due to other components which can not be easily measured in the Field Environment.

The following checks cannot be performed on a Phosphorus Flex Coil.

1. Use ohmmeter on the diode scale.
2. Place either lead on transmit line shield (GND) and other lead on receive line side shield (GND). Should measure an open (high impedance). If your coil is not a product coil (without a visible diode in the receive line), this high impedance will not appear.
3. Forward Check —— Measure *receive* line side of coil. Red lead to center pin, black lead to shield (GND). Should measure ~0.7V (1 diode drop).
4. Reverse Check —— Measure *receive* line side of coil. Red lead to shield (GND), black lead to center pin. Should measure an open (high impedance).
5. Forward Check —— Measure *transmit* line side of coil. Red lead to center pin, black lead to shield (GND). Should measure ~0.7V (1 diode drop).
6. Reverse Check —— Measure *transmit* line side of coil. Red lead to shield (GND), black lead to center pin. Should measure an open (high impedance).

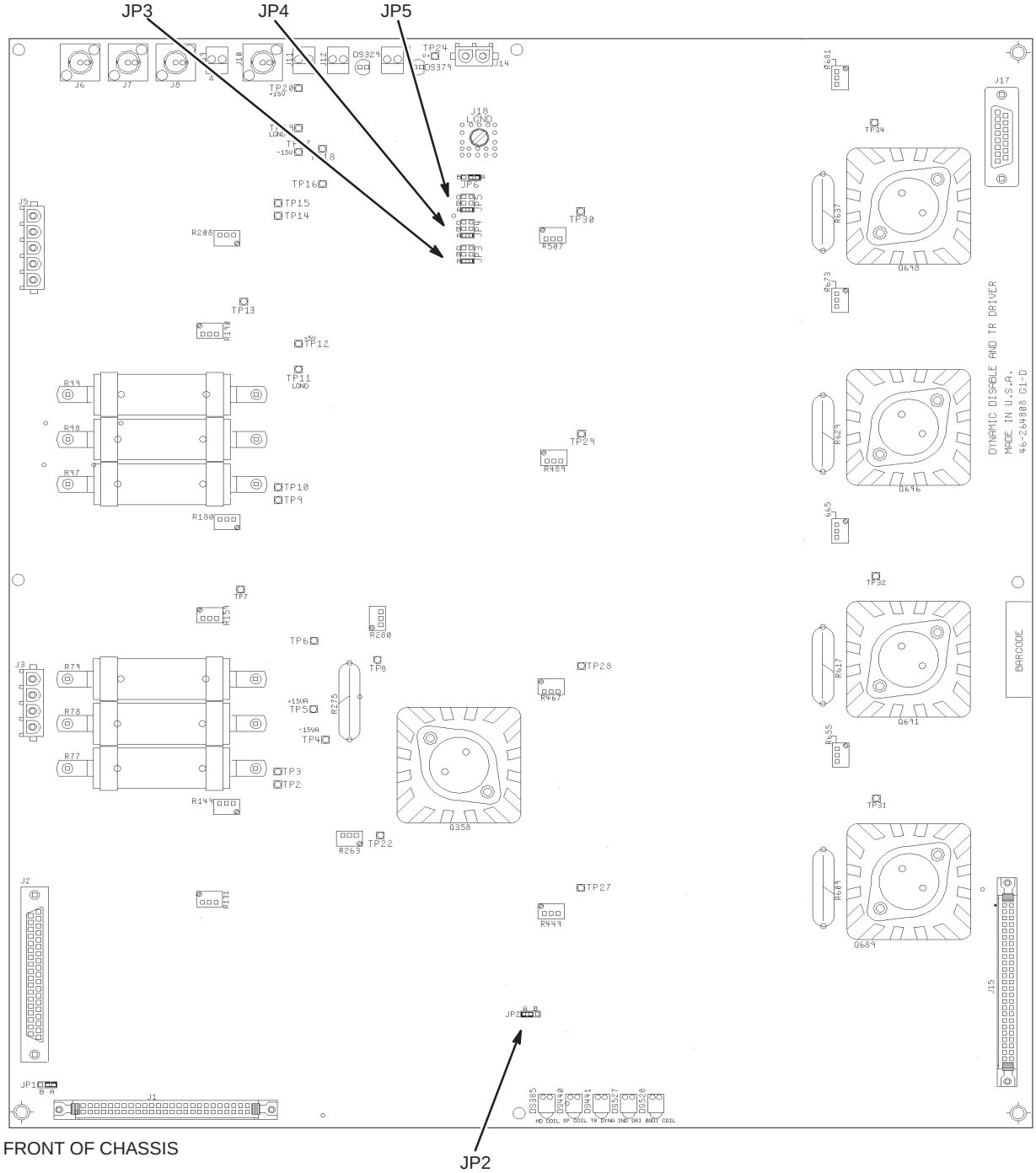
1–2–5 MNS CABLE VERIFICATION / LABELING IN CARRIAGE ASSEMBLY

- Procure cable label markers or tape to visually identify the 2 (two) separate cable take–up coaxial cables used for Multi–Nuclear Spectroscopy.

1. Visually verify that RUN 455 (MNS Receive Signal / Receive Bias) is connected to the right side of the Carriage Assembly as viewed from the rear of the magnet.
2. Place a piece of tape or cable marker on this cable identifying it as “MNS Receive Signal / Receive Bias” or **“RCV”**. This is for future reference and troubleshooting.
3. Visually verify that RUN 456 (MNS RF OUT + TR BIAS) is connected to the left side of the Carriage Assembly as viewed from the rear of the magnet.
4. Place a piece of tape or cable marker on this cable identifying it as “MNS RF OUT + TR BIAS” or **“XMIT”**. This is for future reference and troubleshooting.

1–3 DYNAMIC DISABLE/TR DRIVER BOARD (MR1A9A3) JUMPER LOCATIONS

The following procedure will require moving jumpers on the Dynamic Disable/TR Driver Board. Illustration 1–4 shows the locations of jumpers JP2, JP3, JP4, and JP5. Become familiar with these jumper locations.



DYNAMIC DISABLE/TR DRIVER BOARD (MR1A9A3)
ILLUSTRATION 1–4

1–4 INITIAL (^{31}P) MULTI–NUCLEAR SPECTROSCOPY SCAN PREPARATION

1. Install the Spectroscopy TR Module and connect to Carriage Assembly per Illustration 1–5.
   - **At the RF Cabinet:**
   - Verify JP3 located on Dynamic Disable/TR Driver Board to Position “Normal Mode A” (Software Control Mode).
   - Place the redundant JP4 Power Monitor Control Board jumpers into Position “B” (service/bypass mode).
   - Place JP2 located on the Dynamic Disable/TR Driver Board to Position “B” (service/bypass mode) which disables TR fault reporting .
2. Set up scan using protocol in Section 1–4.
3. Landmark on Head area of cradle (no coil or phantom needed at this time).
4. Set the TG to 0 (zero).

The MNS scan protocol must be **pulsed once** to activate the Multi–Nuclear Spectroscopy circuitry:
This activates the AUX Receive Bias to the 20 dB Gain Block and Spectro Preamp.
This selects the proper relay providing a transmit path to the Multi–Nuclear Spectro TR Module.

CAUTION

The Analogic Amplifier must have the POWER and READY LED’s located on the front panel illuminated.

The ENI Amplifier must have 60 VDC, this is the equivalent of a READY.

Look at the front of the ENI Amplifier in the BroadBand Cabinet. If the Gating Button LED is continuously ON, press button to toggle LED OFF. This LED should only light when RF pulses occur during scanning. If this Gating Button LED is always ON, the ENI Amplifier may be damaged and Spectroscopy BroadBand scanning can not occur.

1–4 INITIAL (^{31}P) MULTI–NUCLEAR SPECTROSCOPY SCAN PREPARATION (Continued)

TABLE 1–1
4.X SCAN PRESCRIPTION FOR 1.55 kW BROADBAND OUTPUT ADJUSTMENT

SCAN PRESCRIPTION (4.X)

MAIN MENU	**[SCAN MODES]**
SCAN MODES	**[Research Mode]**
	[EXECUTE]
MAIN MENU	**[NEW STUDY]**
PATIENT STUDY PARAMETERS	
ID:	**GESERVICE** See Note 1
Patient Weight:	**300 < IMPORTANT!!**
	[NEXT PAGE]
PATIENT POSITION	
Patient Entry	**[Head First]**
Patient Position	**[Supine]**
Coil Type	**[Other Coil]**
Axial/Sag. Landmark	**[Nasion]**
	[NEXT PAGE]
OTHER COILS	
	[EXTREM]
	[NEXT PAGE]
IMAGING PARAMETERS	
Image Mode	**[Single Scan]**
Scan Plane	**[Axial]**
Pulse Sequence	**[Multiple Echo]**
Imaging Option	**[Extra Options]**
Enter PSD Filename:	**SPECFID.PSD** *(4.7 Release)*
	BBCAL.PSD *(4.8 Release)*
	[NEXT PAGE]
	[Extended Dyn Rang]
	[NEXT PAGE]

PRESCAN PARAMETERS	
Spec Width	**32000.00**
Num_PTS	**256**
NUC	**31.00**
NAV	**16.0**
	[NEXT PAGE]
SCAN TIMING	
Number of Echoes	**[1]**
Echo Time (TE)	**[25 msec]**
Rep Time (TR)	**[600 msec]**
	[NEXT PAGE]
SCANNING RANGE	
Field of View	**[24 cm]**
Scan Thickness	**[10 mm]**
Scan Location	(I/S) **0**
FOV Center	(L/R) RO (P/A) A0
	[NEXT PAGE]
ACQUISITION TIME	
Acq. Matrix	**[256 x 128]**
Imaging Time	**[2 NEX 0:00]**
Frequency Direction	**[S/I]**
Table Delta:	0
	[NEXT PAGE]
AUTO CENTER FREQ.	
	[WATER]
REVIEW	**[NEXT PAGE]**
SCAN OPERATIONS	
See Box Below	**[MODIFY CVS]**
	[BACKUP]
	[SPECTROSCOPY]

Note 1: GESERVICE ID automatically activates the research mode.

[Modify CVs]

IA_RF1 = 32766 (sets 90_ pulse full–scale)
A_RF1 = 100 (amp of selective 90 _ pulse)
BBAMP_FILT=1 (Selects proper filter
for 24 MHz to 38 MHz

A software bug workaround for gradient and thickness too small messages is to initially set FOV to 48 cm and Scan Thickness at 30 mm. The FOV and scan thickness must be changed to 24 cm and 10 mm respectively when performing the SNR Functional Checks.

1–4 INITIAL (^{31}P) MULTI–NUCLEAR SPECTROSCOPY SCAN PREPARATION (Continued)

TABLE 1–2
5.X SCAN PRESCRIPTION FOR 1.55 kW BROADBAND OUTPUT ADJUSTMENT

SCAN PROTOCOL (5.X)

MAIN MENU
[New Series]

PATIENT/EXAM INFORMATION
Id: **geservice**
Name:
Patient Weight **300 < IMPORTANT!!**
[Patient Position]

PATIENT POSITION
Patient Entry **[Head First]**
Patient Position **[Supine]**
Axial/Sag. Landmark **[Nasion]**
Coil Type **[Other Coils]**
Other Coils Selection screen appears
[EXTREM]
[Backup]
Scan Plane **[Axial]**
[Imaging Params]

IMAGING PARAMETERS
Image Mode **[Spectro]**
*(*K *SAR must be "On"* K*)* **[Monitor SAR]**
Pulse Sequence **[Spin Echo]**
Imaging Options **[Extended Dyn Rang]**
or enter PSD Filename **fidcsi**
[Next Screen]

USER CVs
spectral width **2000**
number of points **1024**
nucleus **31**
Scan Mode **1**
Total # of Scans **16**
ap resolution for CSI scans **1**
rl resolution for CSI scans **1**
si resolution for CSI scans **1**
rfpulse **1** (selects soft/sinc pulse)
[Scan Timing]

SCAN TIMING
Rep Time (TR) **[Other] 600** msec
[Scan Set–Up]

SCAN SET–UP
Prescan Options None *if applicable*
Auto CF **[Water]**
[Scanning Range]

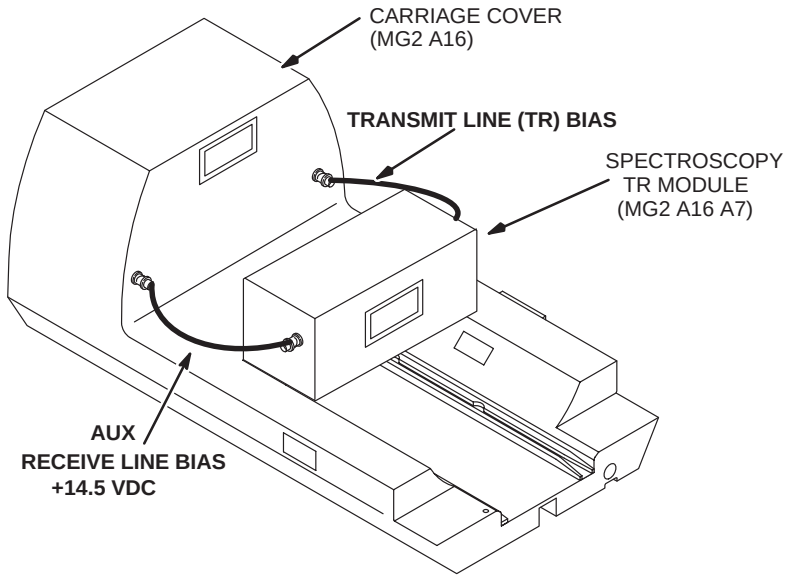
SCANNING RANGE
Field of View **[24 cm]**
Scan Thickness **[10 mm]**
Interscan Spacing **don't care**
Start Loc (I/S): **0**
End Loc (I/S): **0**
No. of Scan Locations: 1
FOV Center (L/R): 0 (P/A): 0
[Scan Ops]
[Spectro]

SPECTROSCOPY
Use AX to set the ^{31}P frequency,
Type **R1 7 R2 30 TG 25** press **ENTER**
[MODIFY CVs]
Change the following CVs:
dda New Value: **10**
ia_rf1 New Value: **32766**
pibbandfilt New Value: **1**
spec_cal New Value: **1**

[BACKUP]
Set Entry Point, type **ent** **SINGLE1**

A software bug workaround for gradient and thickness too small messages is to initially set FOV to 48 cm and Scan Thickness at 30 mm. The FOV and scan thickness must be changed to 24 cm and 10 mm respectively when performing the SNR Functional Checks.

1–4 INITIAL (^{31}P) MULTI–NUCLEAR SPECTROSCOPY SCAN PREPARATION (Continued)



MULTI–NUCLEAR SPECTROSCOPY HARDWARE SET–UP
ILLUSTRATION 1–5

1–5 SPECTROSCOPY TR DRIVER CIRCUIT ADJUSTMENTS ––– DYNAMIC STATE

This section calibrates the Spectroscopy TR Driver Circuits to eliminate Multi–Nuclear Spectroscopy TR errors which occur only during Multi–Nuclear Spectroscopy scanning. To complete this section, you will perform the following:

- Dynamic State TP2 (voltage), TP1 (current), TP3 (threshold) Adjustment and Verification.

1–5–1 INITIAL SET–UP

- Setup Initial Multi–Nuclear Spectroscopy Scan Preparation per Section 1–4.
- Set–up an oscilloscope to 1 Meg Ω termination when measuring TR and Power Monitor Signals. Set–up an oscilloscope to 50 Ω termination when measuring any RF Signal.

1–5–2 DYNAMIC STATE TP2, TP1, TP3 ADJUSTMENT AND VERIFICATION

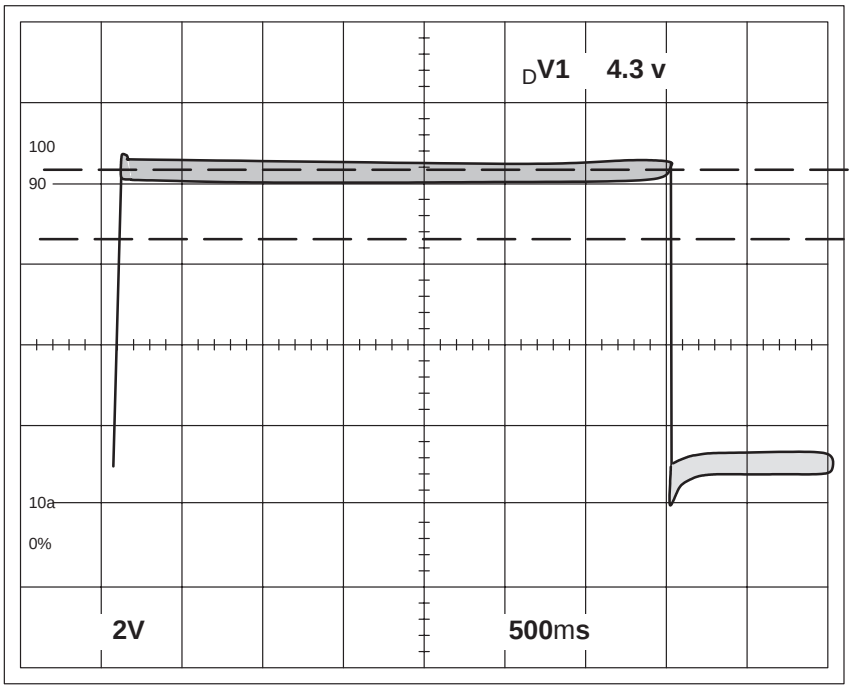
1. At “Scan Operation” screen, press **[Spectro Prescan]**.
2. Press **[Start]**.
3. Monitor the Spectro TR PIN Driver test points TP2, TP1, and TP3.
4. Set the positive output voltage level at TP2 by adjusting R131 to +4.3 VDC as shown in Illustration 1–6.
5. Verify TP1 (current output value) positive output level falls near the value in Illustration 1–7 (no specification).
6. Set the TP3 (threshold error detection value) by adjusting R149 to+1.2 VDC as shown in Illustration 1–8.

   When TP2 voltage setting is increased/decreased the current output value at TP1 will also increase/decrease.

   The waveforms shown are worst case and may not represent those displayed on your system. Waveforms should ideally be clean and square.

   The measurements should be taken in near the middle to the end of the positive transmit pulse.

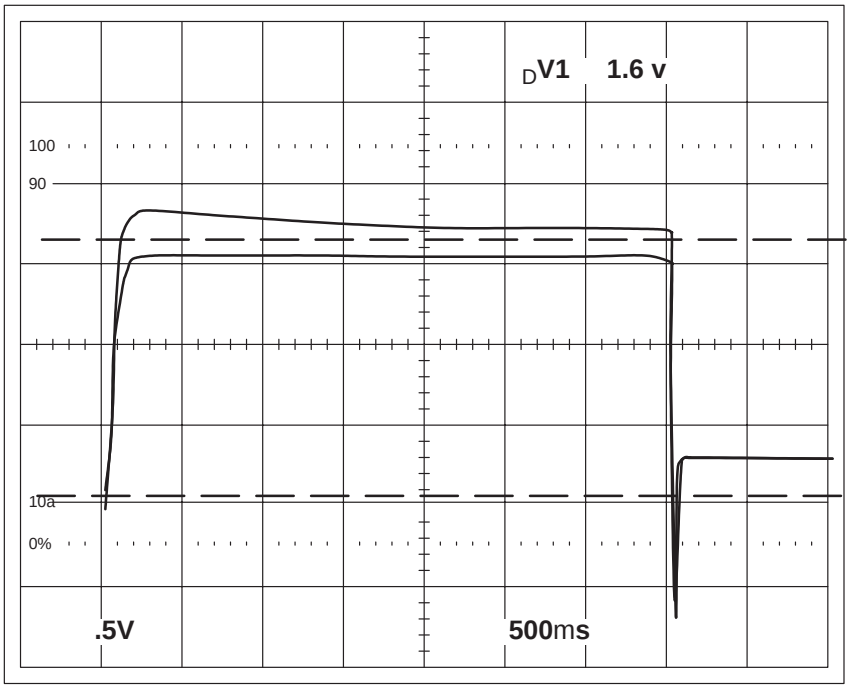
1–5–2 DYNAMIC STATE TP2, TP1, TP3 ADJUSTMENT AND VERIFICATION (Continued)



USE R131 TO ADJUST THE POSITIVE VOLTAGE LEVEL

GROUND REF

SPECTRO PIN DRIVER TR OUTPUT VOLTAGE (TP2)
ILLUSTRATION 1–6

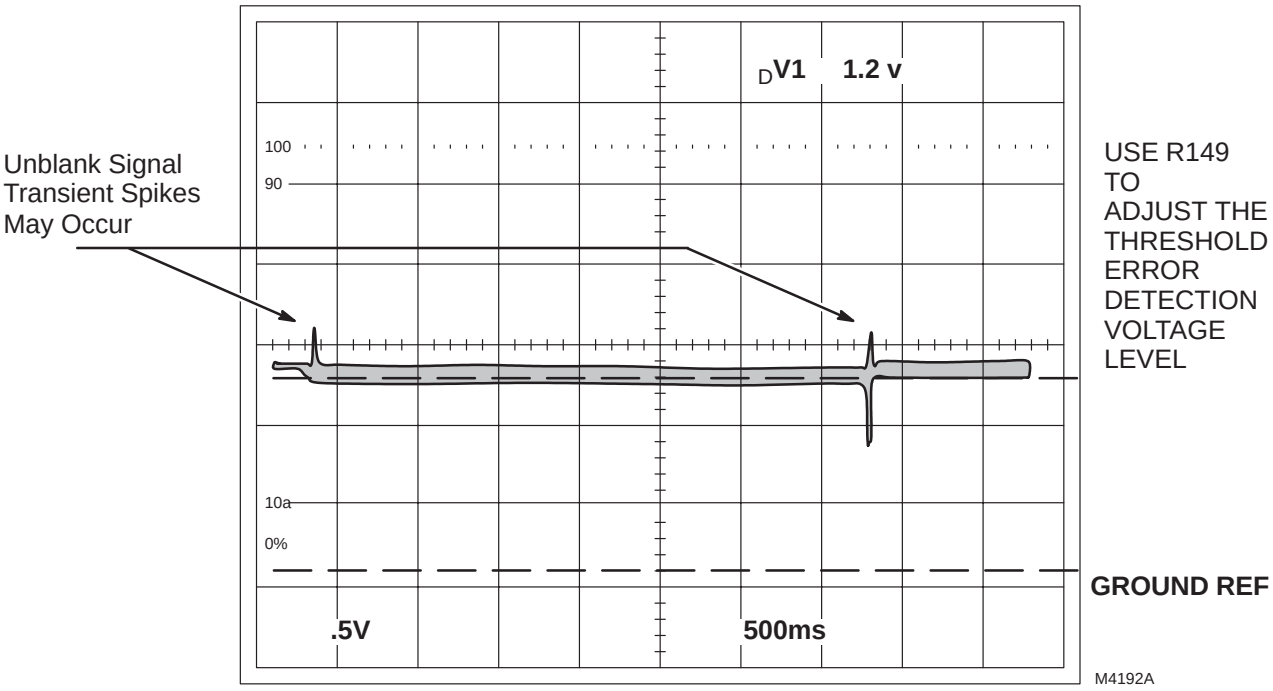


THE CURRENT WAVEFORM IS AFFECTED BY THE LOAD AND ADJUSTING R131

GROUND REF

SPECTRO TR DRIVER CURRENT EQUIVALENT VOLTAGE (TP1)
ILLUSTRATION 1–7

1–5–2 DYNAMIC STATE TP2, TP1, TP3 ADJUSTMENT AND VERIFICATION (Continued)



SPECTRO TR THRESHOLD ERROR DETECTION (TP3)
ILLUSTRATION 1–8

7. When adjustments are completed, press **[Stop]** to stop the Prescan.
8. Place JP2 located on the Dynamic Disable/TR Driver Board to Position "A" (normal mode) which enables fault reporting .
9. Press **[Start]**.

   If TR errors are reported check the Error Log to insure that they are related to Multi–Nuclear Spectroscopy Hardware (the Error Log will report if the problem is Head, Body or Spectro). Recheck connections to J2, J3, J4 at the rear of the DD Module. Verify they are not swapped and are all connected properly. If Spectro TR errors are reported re–verify the dynamic calibration procedure or turn to TROUBLESHOOTING Section.

10. When operation is satisfactory, press **[Stop]** to stop the Prescan.
11. Press **[Done]** to stop the exit the Spectro Prescan page.
12. ***If NOT proceeding*** to the applicable next section of this procedure ***proceed*** to the RESTORATION CHECK LIST to restore system hardware.

1–6 MULTI–NUCLEAR SPECTROSCOPY RF SIGNAL FROM THE EXCITER WITH BB MODULE

NOTE

This Sub–section is not required, but has been provided for as verification of the RF limits expected from the Exciter and Multi–Nuclear (BroadBand) Exciter Module combination.

- Setup Initial Multi–Nuclear Scan Prescription per Section 1–4.

1. Disconnect the System Cabinet Interface Panel coaxial cable at MR2 A11 J1.
2. Set the TG to 200.
3. Set–up an oscilloscope to 50 Ω termination.
4. Connect oscilloscope to the BNC panel mount connector at the System Cabinet I/F Panel, MR2 A11 J1.
5. At “Scan Operation” screen, press **[Spectro Prescan]**.
6. Select **[Start]**.
7. Measure the MNS RF OUT Signal and verify it meets specification at MR2 A11 J1:
   10 dBm, ±1 dBm **(**1.6 VP–P to 2.2 VP–P)
8. Set the TG to 0 (zero).
9. Select **[Stop]**.
10. Select **[Done]**.
11. Re–connect the System Cabinet Interface Panel coaxial cable at MR2 A11 J1.
12. ***If NOT proceeding*** to the applicable next section of this procedure ***proceed*** to the RESTORATION CHECK LIST to restore system hardware.

1–7 NARROWBAND RF ADJUSTMENTS

This procedure will:

NOTE

The purpose of this Section is to set the RF IN signal to a level that will allow for bypassing of the BroadBand Cabinet (MR6) in the case of a failure that affects normal Signa proton scanning.

- Measure normal Narrowband RF OUT Signal from the System Cabinet (MR2 A11 J1) as it enters the BroadBand Cabinet (MR6 A3 J3). This will be the reference value used to set the input of the Narrowband RF IN signal at the RF Cabinet (MR1 A7 J3).
- Use the above measured Narrowband RF value as the reference value. Adjust the Narrowband RF signal coming out of the BroadBand Cabinet (going to MR1 – RF Cabinet) by changing the attenuator (AT38) on the RF Input Board in the BroadBand Cabinet to match the measured RF reference value above.

CAUTION

Do not leave the Spectroscopy TR Module installed (connected / disconnected) during non–spectroscopy scanning. The Spectroscopy TR Module will be installed during Proton localizer scans per this document, this is acceptable. Once the BroadBand Spectroscopy scanning has been completed and Narrowband scanning is resumed the Spectroscopy TR Module should be removed from the bore of the magnet.

The Head and Body RF Calibrations must have been previously completed before continuing.

1–7–1 NARROWBAND RF OUT OF SYSTEM CABINET––MEASUREMENT

1. Move JP2 of Dynamic Disable/TR Driver Board (MR1 A9 A3) in the Dynamic Disable Module (A9) of RF Cabinet (MR1) into position “B” (service mode).
2. Disconnect Run 466 from MR6 A3 J3 at the BroadBand Cabinet (RF IN from the System Cabinet Exciter Board). Connect scope to monitor output of disconnected cable. Scope channel monitoring this signal should be terminated into 50 Ω when measuring any RF Signal.
3. Prepare system to scan using the scan parameters in Table 1–3 (4.x), Table 1–4 (5.x–EFB), or Table 1–5 (5.x–APB).
4. **[MANUAL PRESCAN]**.
5. **[SCAN TR]**.
6. Slowly increase TG=200. Record peak–to–peak level of RF IN from System Cabinet shown on scope.

   Record value: _____volts peak–to–peak (NB RF input to MR1)
7. Lower TG to 0 (zero).
8. Stop Manual Prescan.
9. Reconnect cable (Run 466) to MR6 A3 J3 (BroadBand Cabinet Interface Panel).

1–7–1 NARROWBAND RF OUT OF SYSTEM CABINET––MEASUREMENT (Continued)

TABLE 1–3
4.X SCAN PRESCRIPTION FOR NORMAL RF OUT MEASUREMENT

SCAN PRESCRIPTION (4.X)

MAIN MENU **[SCAN MODES]**

SCAN MODES **[Default Auto CF]**
[EXECUTE]

MAIN MENU **[NEW STUDY]**

PATIENT STUDY PARAMETERS
ID: **GESERVICE** See Note 1
Patient Weight: **300 < IMPORTANT!!**
[NEXT PAGE]

PATIENT POSITION
Patient Entry **[Head First]**
Patient Position **[Supine]**
Coil Type **[Body Coil]**
Axial/Sag. Landmark **[Sternal Notch]**
[NEXT PAGE]

IMAGING PARAMETERS
Image Mode **[Single Scan]**
Scan Plane **[Axial]**
Pulse Sequence **[Multiple Echo]**
Imaging Option **[None]**
Enter PSD Filename: **:STAGE:TOOL:CAL.PSD**
[NEXT PAGE]

SCAN TIMING
Number of Echoes **[1]**
Echo Time (TE) **[25 msec]**
Rep Time (TR) **Other [50 msec]**
[NEXT PAGE]

SCANNING RANGE
Field of View **[24 cm]**
Scan Thickness **[10 mm]**
Scan Location (I/S) **0**
FOV Center (L/R) RO (P/A) A0
[NEXT PAGE]

ACQUISITION TIME
Acq. Matrix **[256 x 128]**
Imaging Time **[2 NEX 0:13]**
Frequency Direction **[R/L]**
Table Delta: 0
[NEXT PAGE]

AUTO CENTER FREQ.
[WATER]

REVIEW **[NEXT PAGE]**

SCAN OPERATIONS

Note 1: GESERVICE ID automatically activates the research mode.

[Modify CVs]

CALMODE = 5 (Sinc Pulse)
IA_RF1 = 32766 (sets 90_ pulse full–scale)
IA_RF2 = 0 (turns off 180_ pulse)

1–7–1 NARROWBAND RF OUT OF SYSTEM CABINET––MEASUREMENT (Continued)

TABLE 1–4
5.X SCAN PRESCRIPTION FOR NORMAL RF OUT MEASUREMENT (EFB ASSEMBLY CONFIGURATION)

SCAN PROTOCOL (5.X)

MAIN MENU **[New Exam]**

PATIENT/EXAM INFORMATION

Id: **geservice**
Name: **body cal**
Patient Weight **300 < IMPORTANT!!**
[Patient Position]

PATIENT POSITION

Patient Entry **[Head First]**
Patient Position **[Supine]**
Axial/Sag. Landmark **[Sternal Notch]**
Coil Type **[Body Coil]**
Scan Plane **[Axial]**
[Image Params]

IMAGING PARAMETERS

Image Mode **[2D]**
*(*K *SAR must be "On"* K*)* **[Monitor SAR]**
Pulse Sequence **[Spin Echo]**
Imaging Options **[None]**
or enter PSD Filename **cal**
[Scan Timing] or [Next Screen]

SCAN TIMING

Number of Echoes **[1]**
Echo Time (TE) **[25 msec]**
Rep Time (TR) **[Other] 50** msec
[Scan Set–Up]

SCAN SET–UP

Prescan Options None *if applicable*
Auto CF **[Peak]**
[Scanning Range]

SCANNING RANGE

Field of View **[24 cm]**
Scan Thickness **[10 mm]**
Interscan Spacing **don't care**
Start Loc (I/S): **0**
End Loc (I/S): **0**
No. of Scan Locations: 1
FOV Center (L/R): 0 (P/A): 0
[#] [Acq Time]

ACQUISITION TIME

Acq. Matrix (freq.) **[256]**
Acq. Matrix (phase) **[128]**
Frequency Direction **[R/L]**
Phase FOV default
Imaging Time **[2 NEX 0:52]**
Contrast **[No]**
Table Delta: 0 mm
[Scan Ops]

SCAN OPERATIONS

[Modify CVs]

calmode = 5 (Sinc Pulse)
ia_rf1 = 32766 (sets 90_ pulse full–scale)
ia_rf2 = 0 (turns off 180_ pulse)

1–7–1 NARROWBAND RF OUT OF SYSTEM CABINET––MEASUREMENT (Continued)

TABLE 1–5
5.X SCAN PRESCRIPTION FOR NORMAL RF OUT MEASUREMENT (APB CONFIGURATION)

SCAN PROTOCOL (5.X)

MAIN MENU **[New Exam]**

PATIENT/EXAM INFORMATION

Id: **geservice**
Name: **body cal**
Patient Weight **300 < IMPORTANT!!**
[Patient Position]

PATIENT POSITION

Patient Entry **[Head First]**
Patient Position **[Supine]**
Axial/Sag. Landmark **[Sternal Notch]**
Coil Type **[Body Coil]**
Scan Plane **[Axial]**
[Image Params]

IMAGING PARAMETERS

Image Mode **[2D]**
*(*K *SAR must be "On"* K*)* **[Monitor SAR]**
Pulse Sequence **[Spin Echo]**
Imaging Options **[None]**
or enter PSD Filename **cal**
[Scan Timing] or [Next Screen]

SCAN TIMING

Number of Echoes **[1]**
Echo Time (TE) **[25 msec]**
Rep Time (TR) **[Other] 50** msec
[Scan Set–Up]

SCAN SET–UP

Prescan Options None *if applicable*
Auto CF **[Peak]**
[Scanning Range]

SCANNING RANGE

Field of View **[24 cm]**
Scan Thickness **[10 mm]**
Interscan Spacing **don't care**
Start Loc (I/S): **0**
End Loc (I/S): **0**
No. of Scan Locations: 1
FOV Center (L/R): 0 (P/A): 0
[#] [Acq Time]

ACQUISITION TIME

Acq. Matrix (freq.) **[256]**
Acq. Matrix (phase) **[128]**
Frequency Direction **[R/L]**
Phase FOV default
Imaging Time **[2 NEX 0:52]**
Contrast **[No]**
Table Delta: 0 mm
[Scan Ops]

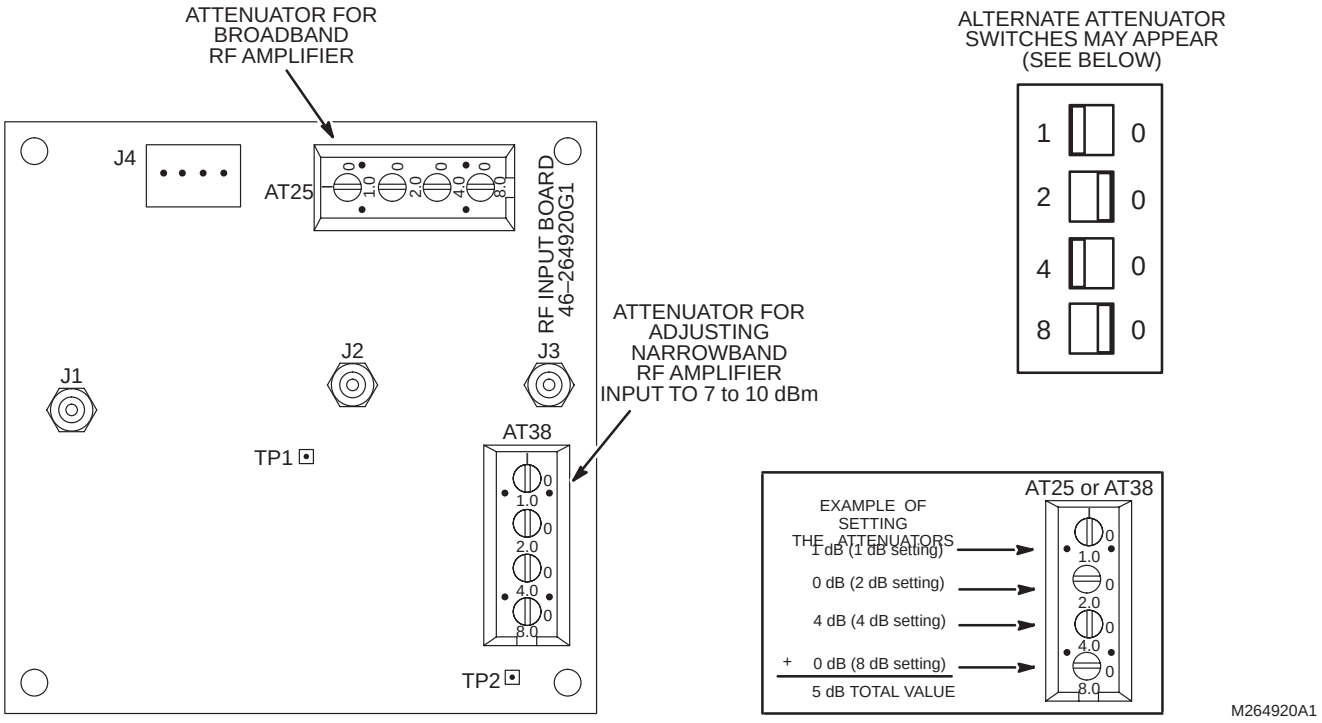
SCAN OPERATIONS

[Modify CVs]

calmode = 5 (Sinc Pulse)
ia_rf1 = 32766 (sets 90_ pulse full–scale)
ia_rf2 = 0 (turns off 180_ pulse)

1–7–2 CALIBRATE NARROWBAND RF SIGNAL ROUTED THROUGH BROADBAND CABINET TO MR1

1. Disconnect cable (Run 461) from MR1 A7 J3 (RF Cabinet Interface Panel).
2. Connect scope to monitor output of disconnected cable. Scope channel monitoring this signal should be terminated into 50 Ω.
3. **[MANUAL PRESCAN]**.
4. **[SCAN TR]**.
5. Slowly increase TG=200.
6. Adjust Attenuator AT38 of the RF Input Board (MR6 A2 A7) to obtain voltage value recorded in Step 6 of Section 1–7–1 NARROWBAND RF OUT OF SYSTEM CABINET—MEASUREMENT. Refer to Illustration 1–9.
7. Lower TG to 0 (zero).
8. Stop Manual Prescan.
9. Re–connect cable (Run 461) to MR1 A7 J3 (RF Cabinet Interface Panel).



RF INPUT BOARD (MR6–A2–A7)
ILLUSTRATION 1–9

1–8 1.55 kW MULTI–NUCLEAR SPECTROSCOPY RF POWER OUTPUT ADJUSTMENTS

This procedure will:

- Verify 1.55 kW maximum RF Output at TG=200 from the Multi–Nuclear Spectroscopy RF Amplifier using the scan protocol per Section 1–4.

A calculator may be necessary.

1–8–1 INITIAL SET–UP

- Setup Initial Multi–Nuclear Spectroscopy Scan Preparation per Section 1–4.
- Set–up an oscilloscope to 50 Ω termination to measure RF Signals.

1. Carefully set AT25 attenuator of RF Input Board (MR6 A2 A7) to maximum attenuation (15 dB). Refer to Illustration 1–9. Notice for maximum attenuation, all grooves on potentiometers are horizontal.

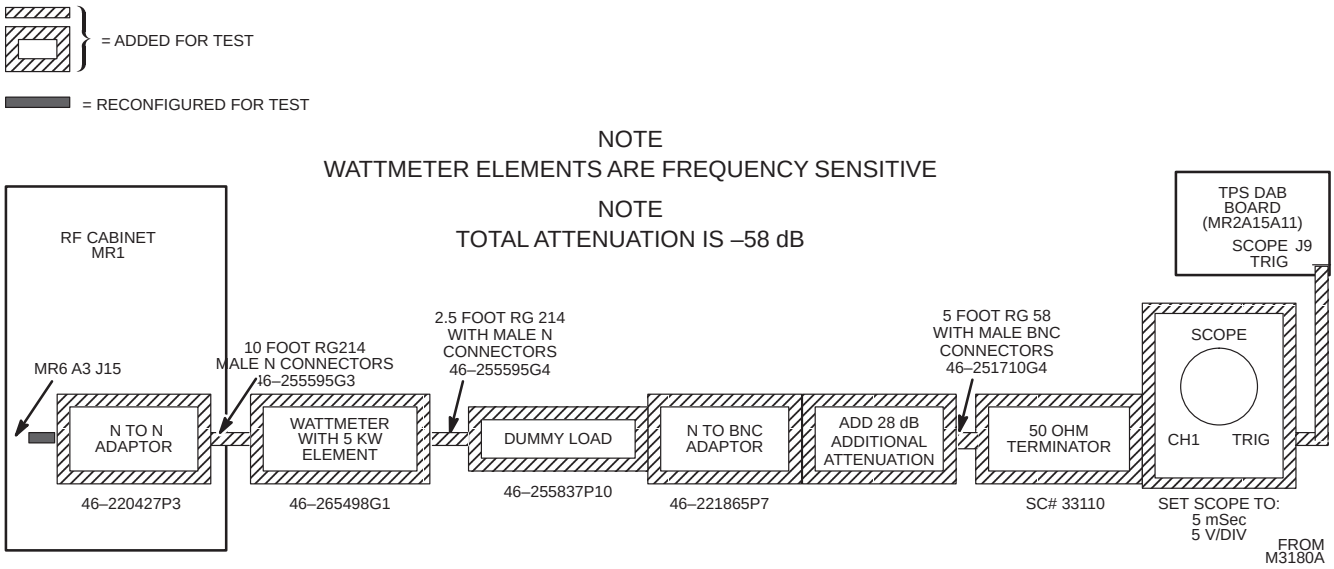
CAUTION

Look at the front of the ENI Amplifier in the BroadBand Cabinet. If the Gating Button LED is continuously ON, press button to toggle LED OFF. This LED should only light when RF pulses occur during scanning. If this Gating Button LED is always ON, the ENI Amplifier may be damaged and Spectroscopy BroadBand scanning can not occur.

2. Reconfigure system for Spectroscopy power measurements as shown. If using a Wattmeter, verify that the wattmeter element selected is correct for the frequency and power to be measured. The RF Power Measurement Kit is the preferred method, however, the wattmeter method is shown.

1–8–1 INITIAL SET–UP (Continued)

USING WATTMETER, ILLUSTRATION 1–10 ONLY:



RECONFIGURATION FOR WATTMETER SPECTROSCOPY POWER MEASUREMENTS
ILLUSTRATION 1–10

If an oscilloscope has a 50 Ω selectable termination there is no need to use the 50 Ω teminator shown in Illustration 1–10 unless selecting the oscilloscope's 1 Meg Ω selectable termination.

CAUTION

30 dB of ATTENUATION is the minimum amount required when measuring 1.55 kW into any oscilloscope. It is preferable to have a higher value of ATTENUATION to prevent damage to the oscilloscope. This procedure requests –58 dB total.

1–8–1 INITIAL SET–UP (Continued)

USING RF POWER MEASUREMENT KIT, ILLUSTRATION 1–11 ONLY:

The Quick Reference Card shown was created for Multi–Nuclear Spectroscopy RF Power Measurements (only frequencies below 50 MHz) and may not be available in the RF Power Measurement Kit.

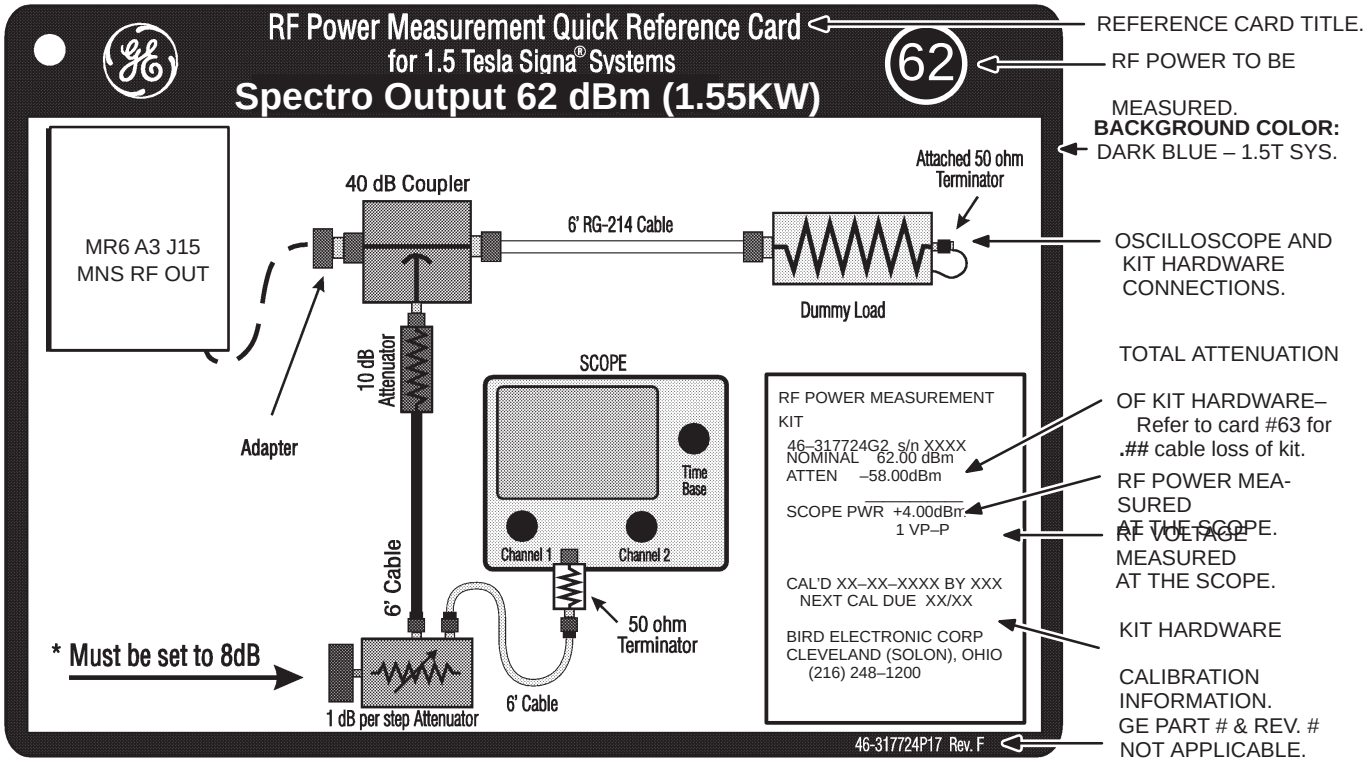
The Scope Calibrator is not to be used for frequencies below 50 MHz.

If an oscilloscope has a 50 Ω selectable termination there is no need to use the 50 Ω teminator shown in Illustration 1–11 unless selecting the oscilloscope's 1 Meg Ω selectable termination.

CAUTION

Ensure the output of the 30 dB attenuator is terminated with the 50 Ω terminator chained to the 30 dB attenuator to create a dummy load as illustrated on the reference cards. See Illustration 1–11. If the attenuator is not terminated, RF signal can be transmitted into the surrounding area and erroneous measurements will occur.

Each Power Measurement Kit has a unique cable loss value. Refer to 1.5T Head RF OUT card. Look at the **ATTEN** value (–59.##). Add the **.##** shown on this card to the –58 dB of the card shown below. For example: –58.00 + –.41 = ATTEN of –58.41 dB.



RF POWER MEASUREMENT QUICK REFERENCE CARD FOR FREQUENCIES UP TO 50 MHz
ILLUSTRATION 1–11

1–8–2 ADJUSTMENT FOR 1.55 kW MULTI–NUCLEAR SPECTROSCOPY RF POWER OUTPUT

1. Record the Total Attenuation per selected hardware set–up:
   (**Total Attenuation**) **– _____dB**.
   (Attenuation + **cable loss** shown on Head Card #63 as 59.##)
2. **[Spectro Prescan]**.
3. Set the TG to 0 (zero).
4. **[START SINGLE]**.
5. **[MOD ACQ PARAMS]** (4.x only).
6. Slowly increase TG setting to 200 using 20 unit increments.
   Output at BroadBand RF Amplifier (MR6 A1) should be below 1.55 kW.
7. Adjust Attenuator AT25 to obtain 1.55 kW. Final AT25 setting is _____ dB.
8. Monitor Spectro RF Output and record volts peak–to–peak (Spectro Out+TR BIAS).

   Record in appropriate space: _____ **VP–P** or _____ **mVP–P**

   EXAMPLE: –58.00 dB + –.41 (Kit Attenuation) = ATTEN of –58.41 dB
   62.00 dB – 58.41 dB = 3.59 dB

   Refer to Trouble–Shooting Section RF Calculation and Reference Tables to calculate proper voltage level
   3.59 dB = 0.95547 VP–P or 955 mVP–P into 50 Ω terminated oscilloscope.

9. Lower TG to 0 (zero).
10. **[STOP ACQUISIT].**
11. Press **[DONE].**

1–8–3 MULTI–NUCLEAR SPECTRO POWER MONITOR VERIFICATION (M1040FF Only)

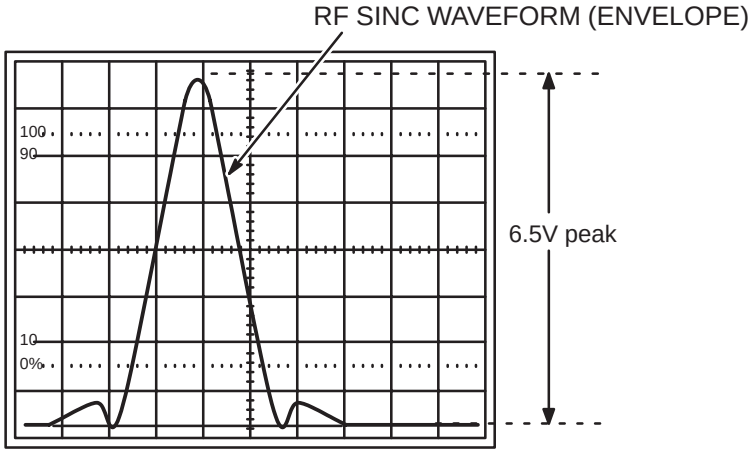
This procedure will:

- Verify the Multi–Nuclear Spectroscopy redundant Power Monitor waveforms are set to a pre–determined 6.5 Volts Peak value (oscilloscope terminated into 1 Meg Ω) at 1.55 kW.

  Always use 1 Meg Ω termination when not measuring RF.

  If the System faults due to the Power Monitor—place the appropriate jumpers on each Power Monitor Control Board into the Service/Bypass Mode (JP4, position B). In service/bypass mode only the power LED will be illuminated. These jumpers on the redundant Power Monitor Control Boards must be placed back to the normal monitoring mode (ready and power LED are both illuminated).

1. Leave hardware set up as in Section 1–8. ONLY disconnect the Channel 1 scope input.
2. Connect Channel 1 scope (Hi impedance input, 1 M Ω) to TP2 of Control Board #1 (MR1 A3 A1), with ground to chassis or TP5.
3. **[START SINGLE]**.
4. Slowly increase TG setting until output of the dummy load is within +/– 0.2 dB of **1.55 kW** BB Spectro RF output.
5. Monitor peak voltage of the waveform at TP2 of Control Board #1 (MR1 A3 A1) WRT chassis Ground (Hi impedance input, 1 M Ω). Signal should be approximately 6.5 Volts Peak. No adjustment. Verify the RF Sense LED is illuminated.
6. Move scope probe to Control Board #2 (MR1 A3 A2), with ground to chassis or TP5.
7. Monitor peak voltage of the waveform at TP2 of Control Board #2 (MR1 A3 A2) WRT chassis Ground (Hi impedance input, 1 M Ω). Signal should be approximately 6.5 Volts Peak. No adjustment. Verify the RF Sense LED is illuminated.



WAVEFORM FOR POWER MONITOR VERIFICATION
ILLUSTRATION 1–12

8. Lower TG to 0 (zero).
9. Select **[STOP]**.
10. Select **[DONE]**.
11. ***Proceed*** to the RESTORATION CHECK LIST to restore system hardware.

1–8–4 MULTI–NUCLEAR SPECTRO POWER MONITOR ADJUSTMENT (M1040FK Only)

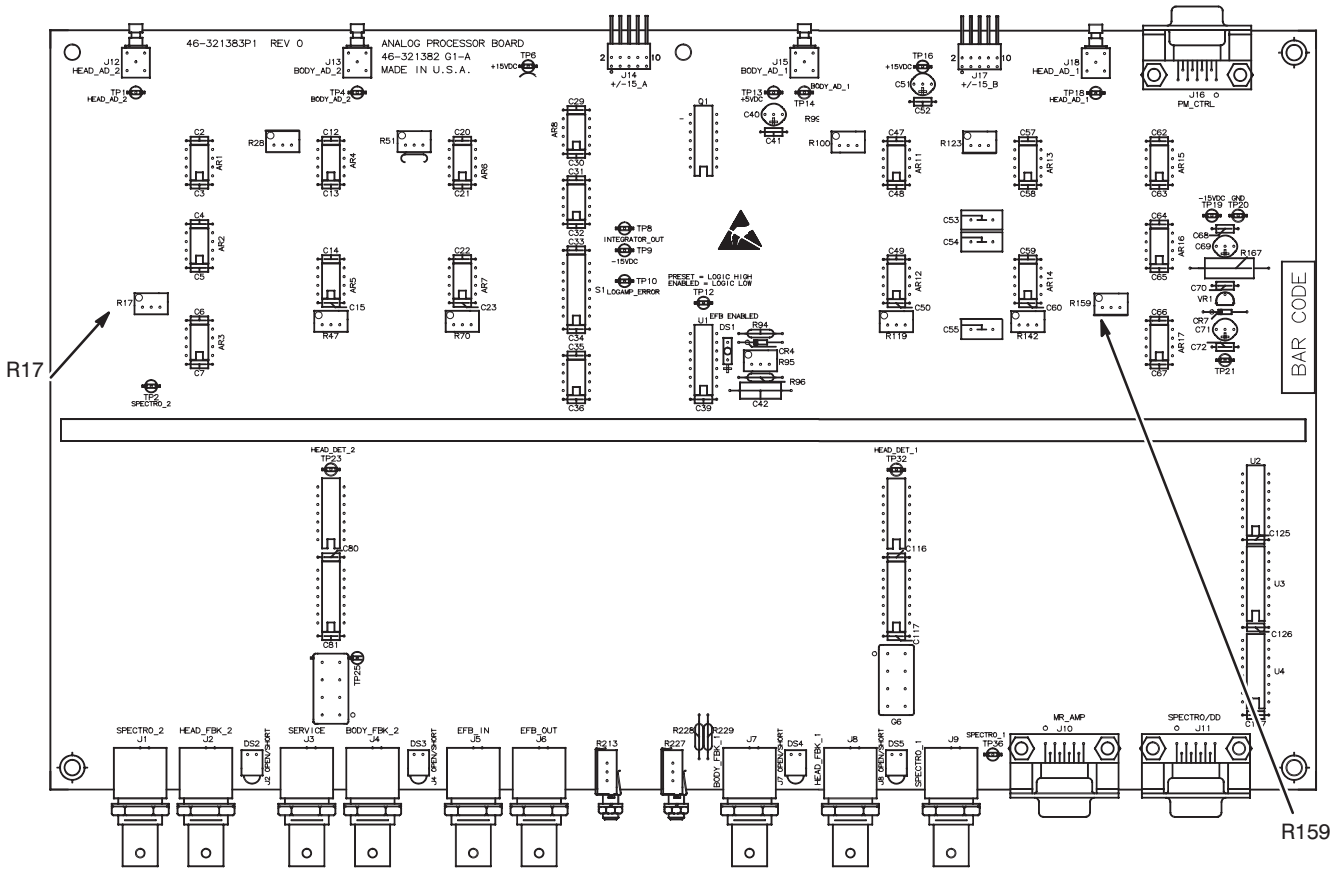
This procedure will:

- Set the Multi–Nuclear Spectroscopy redundant Power Monitor waveforms to a pre–determined 6.5 Volts Peak value (oscilloscope terminated into 1 Meg Ω) at 1.55 kW.

  Always use 1 Meg Ω termination when not measuring RF.

  If the System faults due to the Power Monitor—place the appropriate jumpers on each Power Monitor Control Board into the Service/Bypass Mode (JP4, position B). In service/bypass mode only the power LED will be illuminated. These jumpers on the redundant Power Monitor Control Boards must be placed back to the normal monitoring mode (ready and power LED are both illuminated).

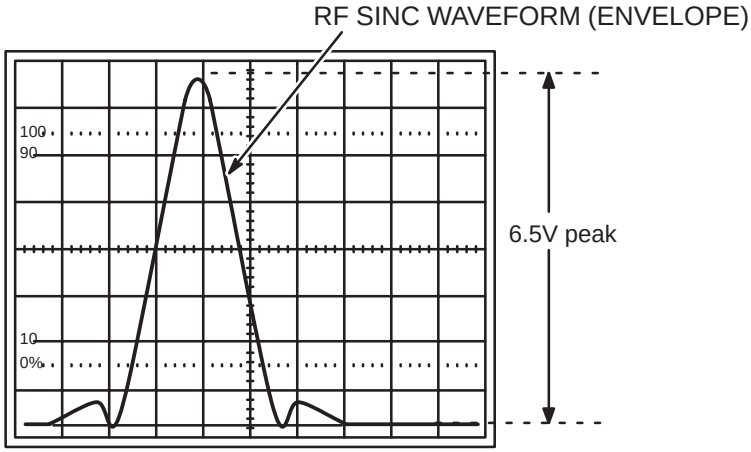
1. Leave hardware set up as in Section 1–8. ONLY disconnect the Channel 1 scope input.
2. Connect Channel 1 scope (Hi impedance input, 1 M Ω) to TP2 of Control Board #1 (MR1 A3 A1), with ground to chassis.



ANALOG PROCESSOR BOARD (MR1 A3 A8)
ILLUSTRATION 1–13

1–8–4 MULTI–NUCLEAR SPECTRO POWER MONITOR ADJUSTMENT (M1040FK Only) (Continued)

3. **[START SINGLE]**.
4. Slowly increase TG setting until output of the dummy load is within +/– 0.2 dB of **1.55 kW** BB Spectro RF output.
5. Monitor peak voltage of the waveform at TP2 of Control Board #1 (MR1 A3 A1) WRT chassis Ground (Hi impedance input, 1 M Ω) and adjust R159 on Analog Processor Board (MR1 A3 A8) to obtain 6.5 ¿0.1V peak (1.55 kW equivalent). See Illustration 1–13. [TP18 of APB = TP2 on the Control Board]. Verify the RF Sense LED is illuminated.
6. Monitor peak voltage of the waveform at TP2 of Control Board #2 (MR1 A3 A2) WRT chassis Ground (Hi impedance input, 1 M Ω) and adjust R17 on Analog Processor Board (MR1 A3 A8) to obtain 6.5 ¿0.1V peak (1.55 kW equivalent). See Illustration 1–13. [TP1 of APB = TP2 on the Control Board]. Verify the RF Sense LED is illuminated.
7. Lower TG to 0 (zero).
8. Select **[STOP]**.
9. Select **[DONE]**.



WAVEFORM FOR POWER MONITOR ADJUSTMENT
ILLUSTRATION 1–14

10. ***Proceed*** to the RESTORATION CHECK LIST to restore system hardware.

1–9 RF CABINET–RESTORATION CHECK LIST

1. Perform the following:
   - Disconnect all scope probes.
   - Remove all test hardware.
   - Verify the Spectroscopy TR Module, lemo cables, and associated MNS hardware is removed from Magnet Bore.
   - Verify the redundant Power Monitor jumpers are placed back to the normal monitoring mode (JP4, position A).
   - Replace the Power Monitor covers and tighten screws.
   - Slide the Power Monitor in place and replace screws.
   - Verify JP3 located on the DD Module DD/TR Driver Board is in Position “Normal Mode A**”** (Software Control Mode).
   - Verify JP2 located on the DD/TR Driver Board is in Position Enable “A” error reporting (normal mode).
   - Verify all the TR Bias cables at MR1 A9 (J2, J3, J4) are connected correctly. TR Faults will occur if there is a miscabling issue. The Error Log will report on the specific TR paths that are failing when pulsing MNS protocols.
   - Close the DD Module cover and tighten screws.
   - Slide the DD Module in place and replace screws.
   - Verify the RF Cabinet I/F Panel coaxial cable at MR1 A7 J3 is connected.
   - Replace all MR1 RF Cabinet covers and tighten all screws.
   - Verify the System Cabinet I/F Panel coaxial cable at MR2 A11 J1 is connected.
   - Replace all MR6 BroadBand Cabinet covers and tighten all screws.
   - Verify the BroadBand Cabinet I/F Panel Heliax Cable at MR6 A3 J15, MNS RF Out + Bias is connected.
   - Verify the BroadBand Cabinet I/F Panel coaxial cable at MR26A3 J3 is connected.

Do not leave the Spectroscopy TR Module installed (connected / disconnected) during non–spectroscopy scanning. The Spectroscopy TR Module will be installed during Proton localizer and Functional Test scans per this manual using the MNS ^{31}P Coil and MNS Q. D. Adaptor Box, this is acceptable. Once the Multi–Nuclear Spectroscopy scanning has been completed and Narrowband scanning is resumed the Spectroscopy TR Module and associated hardware should be removed from the bore of the magnet.