10161 Harwin Dr., Suite 150
Houston, TX 77036
Tel: 713-667-8747
Fax: 713-667-3180
info@tecmag.com
www.tecmag.com

Tecmag Redstone HF2 1RX
MRI System

Serial #37863

University of Utah
Salt Lake City, Utah USA

TECHNOLOGY FOR MAGNETIC RESONANCE

Redstone Installation

Introduction

Verify that the shipment is complete. See **Parts Lists**, below, and any shipping documents. Check for any notices or instructions attached to the units.

Parts List *

- Redstone 8U Console Chassis
- 2U Gradient DAC Chassis
- USB interface cable to PC
- DB25 to BNC pigtail adapters
- TNMR software CD-ROM

* Note: Consult packing list for exact list of items in your shipment

Installation Procedure

> *Note: if TNMR is pre-installed on the spectrometer computer at the factory - you do not need to run the TNMR Installer from the CD! Skip the TNMR Installation Procedure! The TNMR CD contains additional material as well as an installer for re-installing TNMR if necessary. Otherwise, please follow the TNMR Installation.*

TNMR Installation

1. Do not connect the Redstone USB cables to the computer. Turn on the computer running Windows7 and insert the TNMR CD.
2. Follow the steps in the more detailed "TNMR Installation Instructions" found after this guide for the installation of TNMR, USB drivers including 64-bit drivers, and registering the software for the first time.
3. Restart the computer.
4. To prevent the interruption of long-duration experiments, it is recommended that Hibernation and Sleep be disabled in the Windows Power Options.

Hardware installation

All connections are on the rear of the Redstone console cabinet.

1. **General Setup:** Find a convenient location for the Redstone chassis and the computer. Be sure to leave the air vents on the consoles (front and back) unobstructed.

2. **AC Power:** Check that the power switch is off (lower left of rear panel). Connect AC mains power of proper voltage to the rear panel AC socket. NOTE: The power supply is auto-switching between 100 and 240 VAC.

3. **Redstone/Computer Interface Connections:** Using the provided labeled USB cable, connect Redstone (USB IN) to a free USB port on computer. Once the power of Redstone is on, check the Device Manager to verify the computer load the USB drivers. Look for Tecmag NMR Interface (SA-USB) **with** Firmware (tecsa.sys) and Tecmag NMR Interface (SI-III) **with** Firmware (tecsi3.sys) drivers. The actual number of drivers loaded will depend on the system configuration.

   - If "Found new hardware" wizard appears, chose "No, not at this time." when asked if Windows may connect to Windows Update. Click "Next"
   - Choose "Install the software automatically (Recommended)" and click "Next"
   - Choose "Continue Anyway" at the Logo verification disclaimer.

4. **Transmitter/Receiver/Blanking Connections:** Connect the following signals to the appropriate points in the NMR system using 50 ohm coaxial cable and BNC connectors (not supplied):

   - **F1-F4**. Approximately 1 V_{PP} modulated radiofrequency (RF) source for the F1 transmitter channel. Connect to the input of your RF amplifier. Use a fixed attenuator if required (not supplied).
   - **RX1 - RX4**. Low-level RF signal from your RF preamplifier. A preamp with a gain of 20-30dB is recommended, depending on the application. The internal amplifier has a gain of about 70dB, and the input may be damaged by excessive signal.
   - **10 MHz out**. >1 V_{PP} 10 MHz sine wave is available for synchronizing external devices (if required).
   - **Ext Trig in**. Apply a TTL (5V) pulse here to synchronize pulse sequences with external events (as required).
   - **BP1, BP2, etc. outputs.** DB25 to BNC pigtail adapters are provided for convenient access to the pre-assigned output signals for blanking of

RF power amplifiers and/or triggering external devices (such as an oscilloscope). Connect the adapters and connect the appropriate BNC outputs to the amplifier(s), scope, etc. Observe the labeling on the BNC connectors as the lines have been pre-assigned for specific functions.

- **EXT IN inputs**. DB25 connector for conditional branching. Pins 1-4 (bits 0-3) may be connected to external devices to receive a TTL level input signal which can be tested by the pulse sequence for conditional branch logic determination. Pin 25 is ground.

> *Additional TTL level lines appear on the provided DB25 connectors that may be used to control external devices. For use of spare LP lines, refer to TNMR documentation and consult the chart included for output assignments, or contact technical support. Note that Tecmag reserves the right to assign any one or more of these lines to specific purposes in future hardware/software releases.*

Optional Gradient Subsystem Installation Procedure.

1. Find a convenient location near the gradient amplifiers for the 2U DAC-20 subsystem chassis.

2. Connect the subsystem to the console using three RJ-45 serial cables. Note that the outputs of the gradient board in the console are X, Y, and Z in order from bottom to top. One serial cable goes to each channel. If you have ordered a B_0 compensation unit, you will need to install and additional cable.

3. Connect the DAC-20 boards to their respective gradient amplifier inputs using short cables. BNC or Twin-ax connectors for these cables are supplied if ordered. If the B_0 compensation is included, connect the B_0 DAC output to the B_0 amplifier input.

Once the system has been tested, you may wish to mount the individual DAC-20 boards directly inside the respective gradient amplifiers, using the +/- 15V from the amplifier power supply to power them. This should significantly reduce any mains-frequency signal pickup by reducing ground loops.

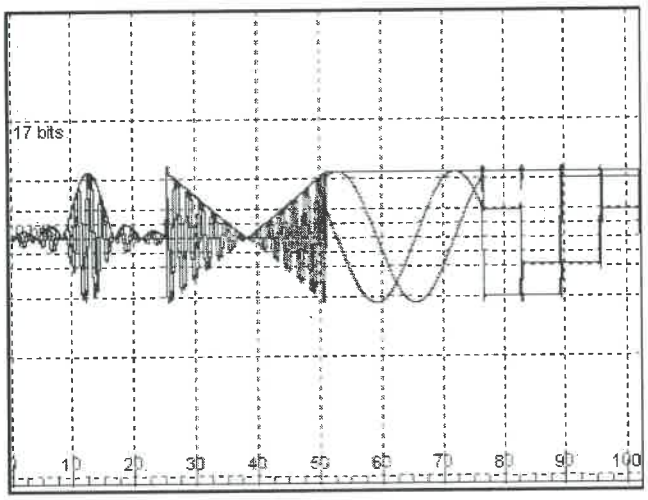
Preliminary Test - Loopback

Disconnect **F1** TX output and **RX1** input from the console. Connect **F1** to **RX1** via a 50 ohm coaxial cable and a 20dB attenuator.

Turn on the power. The LED on the front panel should light up. Turn on and boot up the computer.

Double-click the TNMR icon on the desktop. TNMR will start, and after a brief delay a "beep" will sound signifying that the console has been initialized.

Open the file \Data\Test\Loopbacks\Loopback_F1.tnt. Click the "ZG" button on the toolbar. A waveform should appear on the screen consisting of a sinc and "bow-tie" amplitude modulation function followed by discrete and continuous phase modulation.



If this test fails, contact Tecmag technical support immediately.

If this test passes, reconnect the cables to **F1** and **RX1** and repeat the test with the additional transmitter channels and appropriate loopback file if applicable (e.g. **F2** with Loopback_F2.tnt)

You're ready to go!

Additional Documentation

Other than the documentation in this folder (i.e. Installation Notes, last minute documentation changes, etc.), all documentation is online in Adobe Acrobat format. The Adobe Acrobat Reader software package is pre-installed on the computer at Tecmag.

The online documentation consists of:

- TNMR Reference Manual
- Hardware Reference Manual
- System Specific documentation

Other items contained on the TNMR CD include TNMR File Format documentation, Visual Basic and Visual C++ automation examples.

Contacting Tecmag

Tecmag, Inc.
10161 Harwin Dr., Suite 150
Houston, TX 77036

Phone: 713-667-8747
Fax: 713-667-3180

www.tecmag.com
Sales inquires: info@tecmag.com
Support inquires: support@tecmag.com

Rev. 110125

Figure 1: 8U Back Panel Layouts

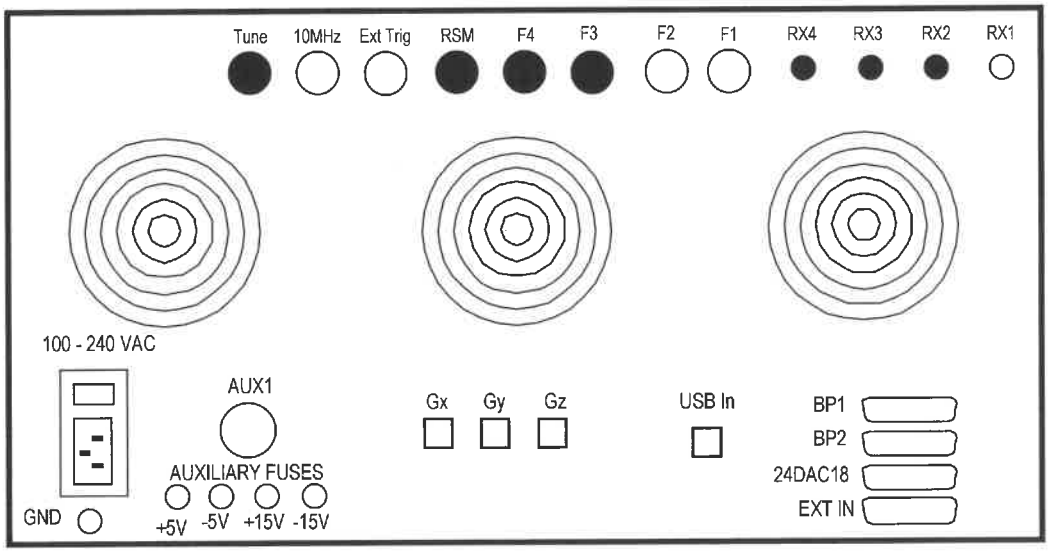
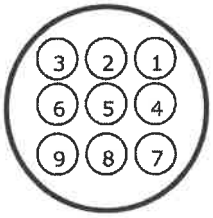
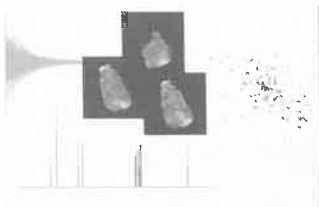


Figure 2: DC Power Pin Outs—Redstone 8U

AUX 1



1. +5V
2. 5V GND
3. -5V
4. +15V
5. 15V GND
6. -15V
7-9. N\C



Installing TNMR

Table of Contents

Introduction

These instructions will guide you in the installation of Tecmag's latest data processing and hardware control software—TNMR! Supporting Microsoft's Win7 Professional 32-bit and 64-bit operating systems, this software provides all the updates needed for controlling Tecmag's USB 2.0 products. Older PCI-based products are not supported by TNMR.

NOTE: If you recently purchased hardware with a computer from Tecmag, you may not need to install the software as it may have already been installed for you at the factory.

Installing and Upgrading to TNMR

1. Close all Tecmag applications including NTNMR or TNMR
2. If installing from a TNMR installation CD, place it in the PC's CD-ROM drive and choose setup_tnmr.exe if prompted (see Figure 1). If installing from a web download package, launch the executable and allow it to auto-extract. (Figure 2).

Figure 1

Figure 2

3. Click Next at the InstallShield Wizard Welcome screen (Figure 3)

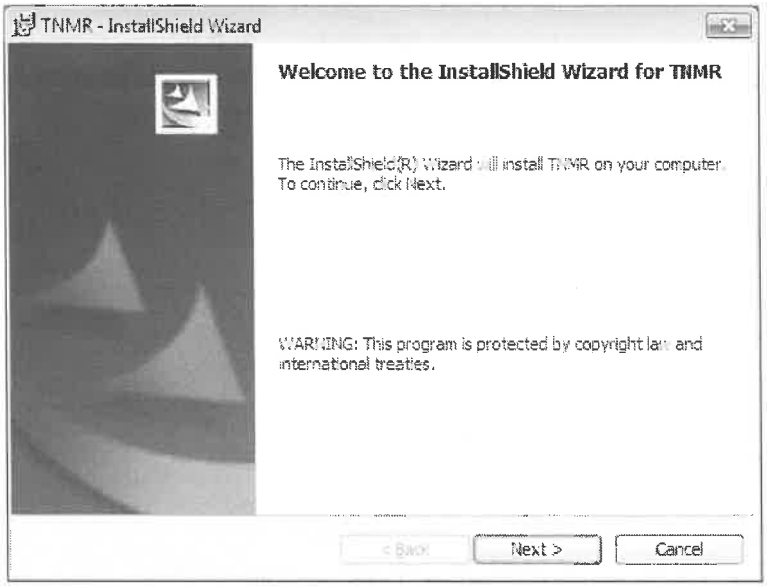


Figure 3

4. Read and accept the terms of the License Agreement, and click Next. (See Figure 4)

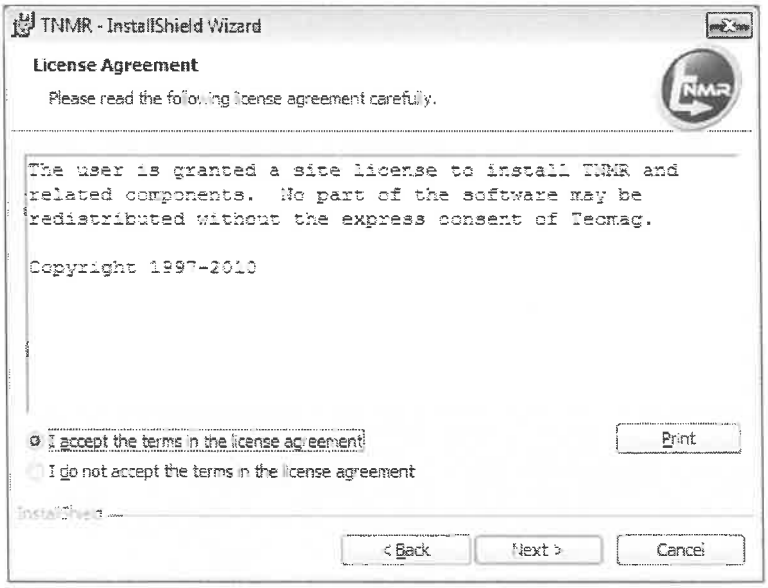


Figure 4

5. Enter user name and organization info; choose whether the application should be installed for all users of the computer or only the active user's account. Click Next (See Figure 5)

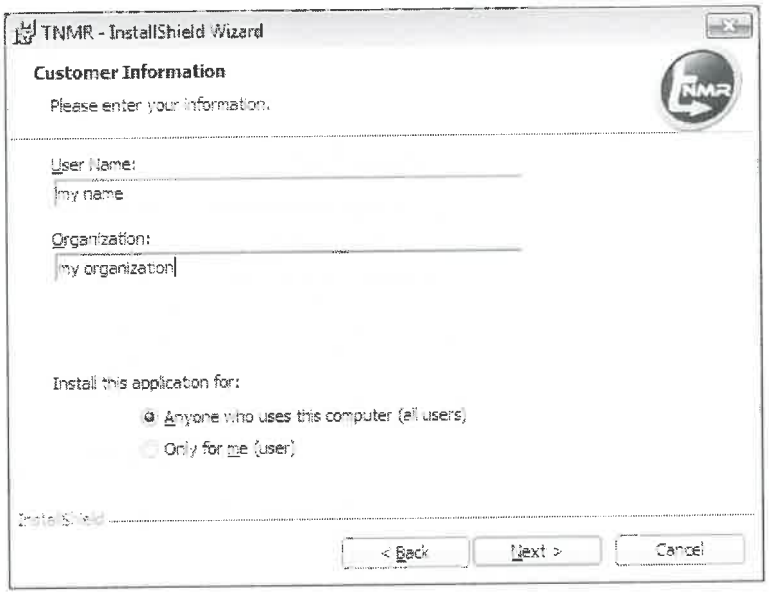


Figure 5

6. Select the Destination Folder for the installation and click Next. If the computer has multiple disks or partitions, InstallShield defaults to the root of the drive with the most available space. **It is highly recommended that the default folder be used.** (See Figure 6)

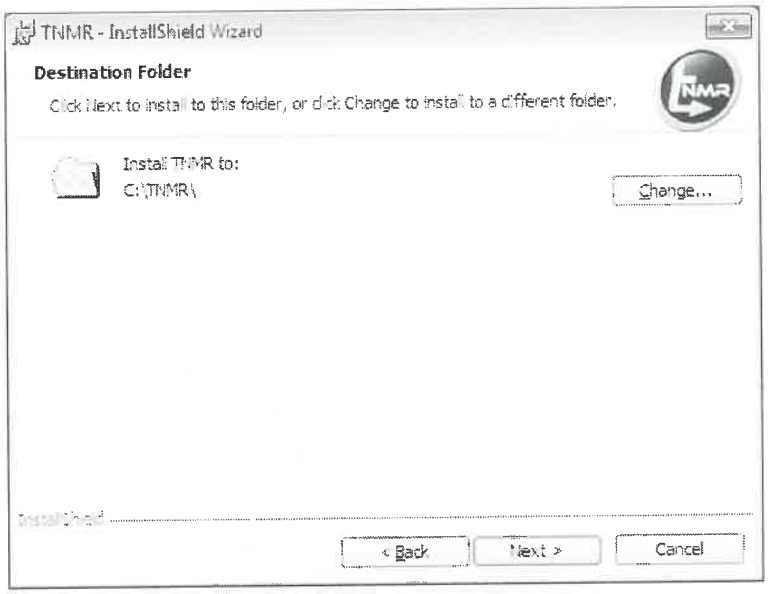


Figure 6

7. At the Program Mode screen, select Hardware Control Mode if the software will be used to control Tecmag hardware. If the software is being installed for data processing only, select Processing Only Mode. Click Next (See Figure 7)

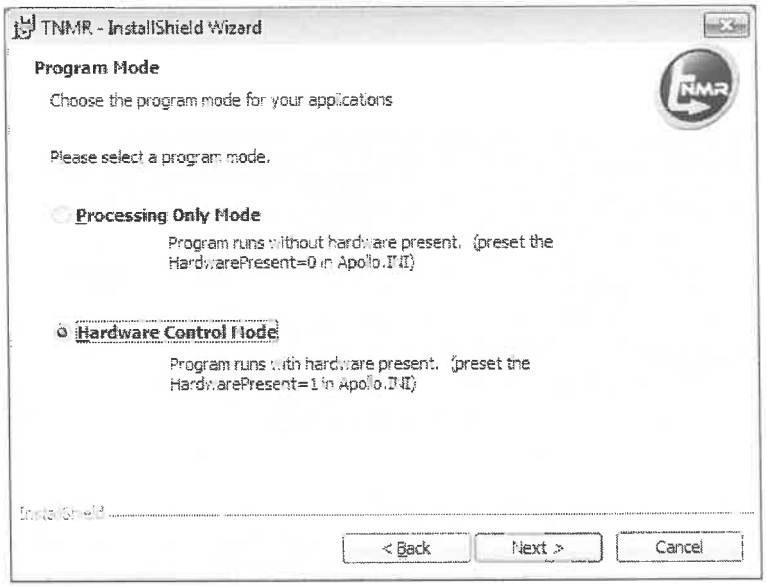


Figure 7

8. At the Configuration Mode screen, choose *Software Update Only* when upgrading from NTNMR or previous TNMR installations on computers with an existing installation. The following will be preserved from the previous installation:

   - NTNMR/TNMR data folder contents
   - NTNMR/TNMR sequences folder contents
   - NTNMR/TNMR configuration "config" folder contents
   - Gradient pre-emphasis values
   - Dashboard configurations
   - Print templates

   Or, choose *Hardware Update or New Computer* for a complete installation in which previous hardware configuration files will be replaced by those on the CD. Click Next (See Figure 8)

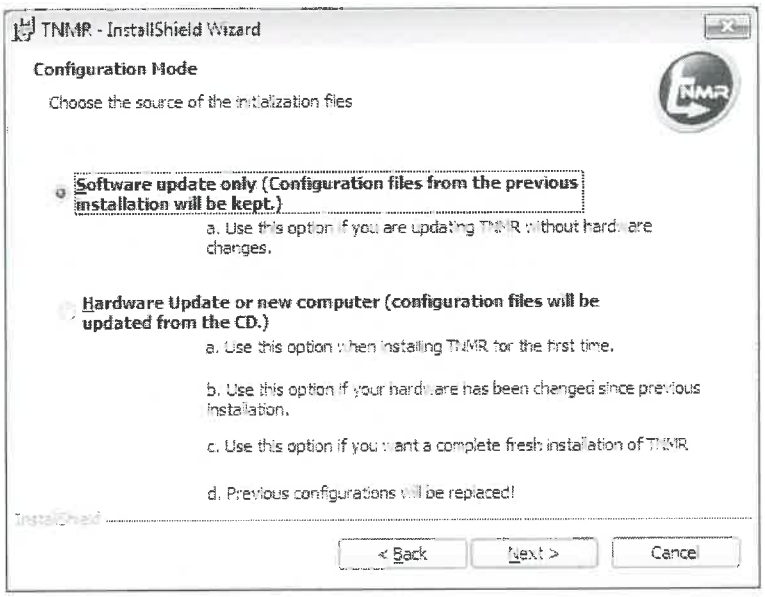


Figure 8

9. At the Setup Type screen, choose between a *Default* or *Custom* installation. A default installation will include data files and sequences selected at the factory according to the hardware type as well as the applications specified by the user at the time of hardware ordering; the default option also installs TecmagVNC (remote desktop software for customer support). Choosing *Custom* allows the user to select from additional libraries of example data files and sequences for other Tecmag products as well as select to install the full UltraVNC remote desktop software and Adobe Acrobat. ***Default* is recommended.** Click next. (See Figure 9)

10. If *Custom* was the chosen Setup Type, then configure the installation on the Custom Setup window and click Next. (See Figure 10)

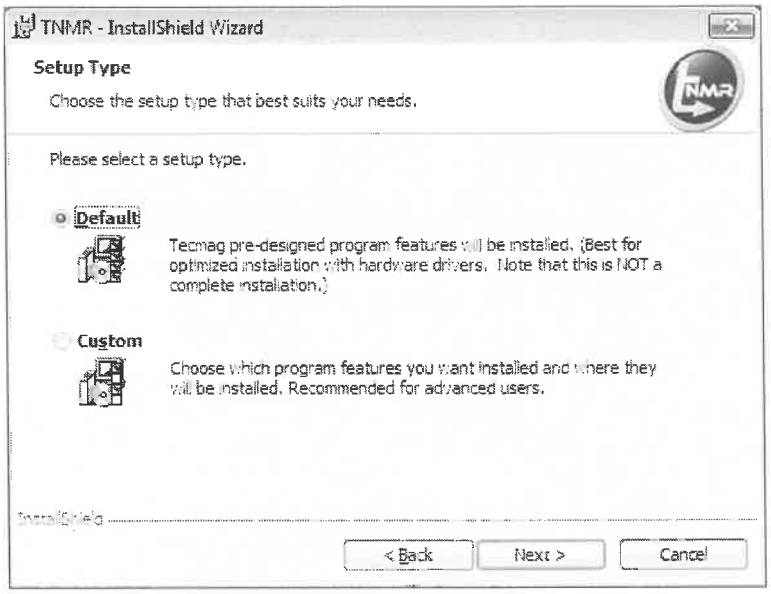


Figure 9

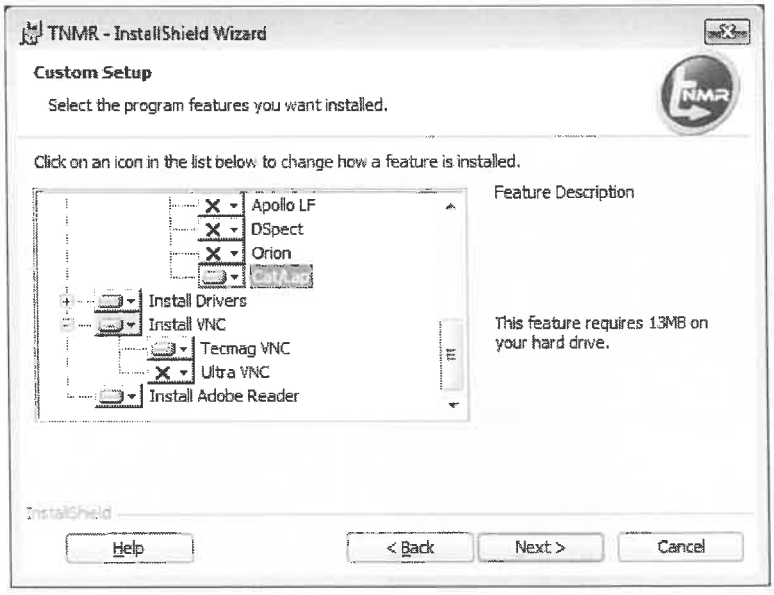


Figure 10

11. TNMR is now ready to be installed. At the *Ready to Install the Program* screen, select Add Tecmag Wallpaper to change the desktop background to the embossed Tecmag "T" logo. Click Install to begin the installation. (See Figure 11)

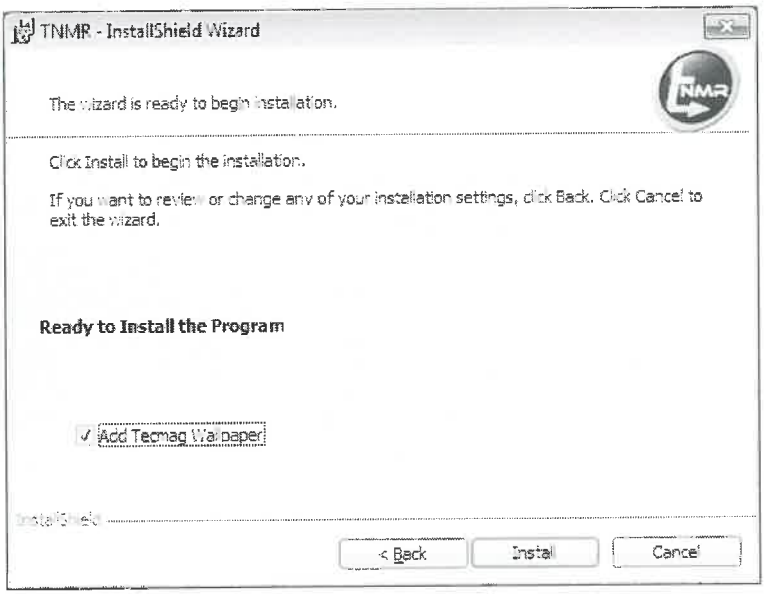


Figure 11

12. During the installation process, if applicable, previous installations of NTNMR or TNMR will be uninstalled including device drivers. The driver uninstallation notification window may appear **behind** the "Installing TNMR" window. If it appears that the setup process has stalled, try moving the top window to look for the driver window. (See Figure 12)

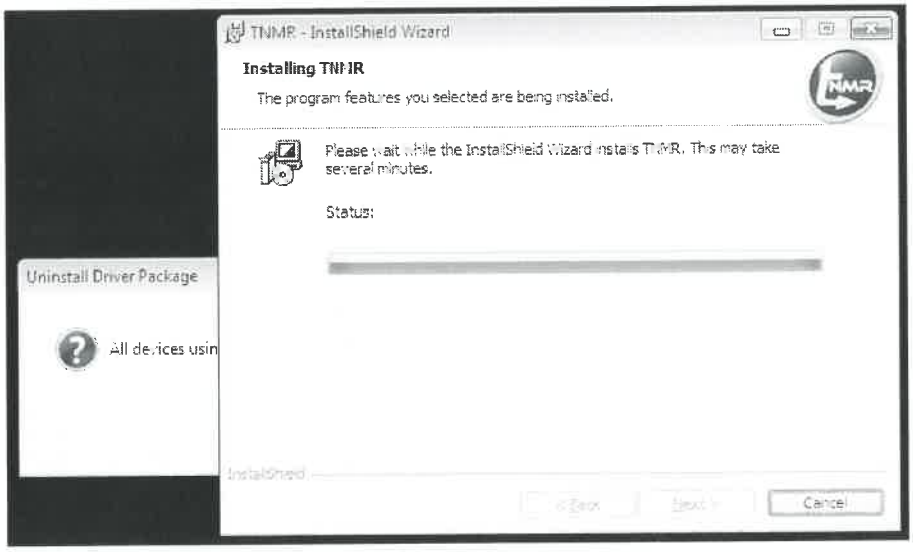


Figure 12

13. If prompted to uninstall previous driver packages, click YES for all prompts. (See Figure 13)

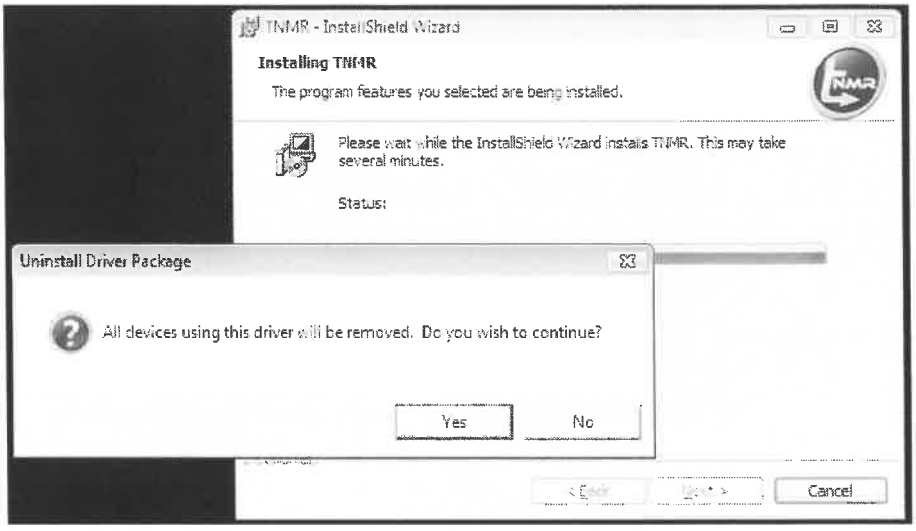


Figure 13

14. When TNMR installation resumes, it will be necessary to install new hardware drivers. Click Next on the Device Driver Installation Welcome window. (See Figure 14) *

Figure 14

* When installing TNMR on Win7 64-bit OS, skip to the section below titled "Installing 64-bit drivers."

15. At the Windows Security prompt, click Install to allow the installation of the Tecmag drivers. (See Figure 15)

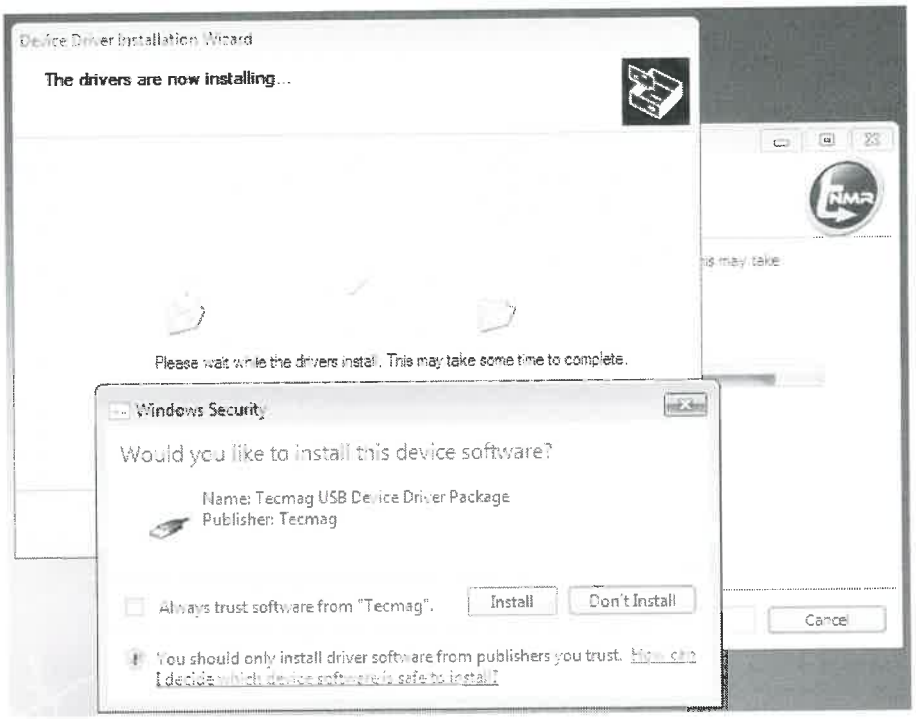


Figure 15

16. Click Finish when Device Driver Installation is complete. (See Figure 16)

Figure 16

17. **Click Finish when TNMR Installation is complete. (See** Figure 17)

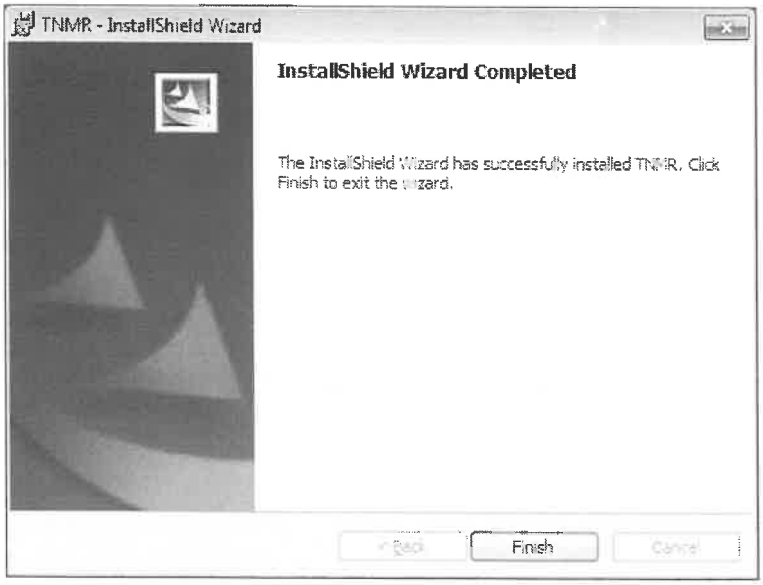


Figure 17

18. Connect your Tecmag hardware USB cable(s) to the PC and power on the device. The 32-bit device drivers will configure automatically and progress notification will appear in the taskbar.

See the section below for instructions on launching TNMR for the first time.

Installing 64-bit drivers

When installing TNMR on Win7 64-bit OS an error message will appear behind the TNMR InstallShield Wizard window on Step 14 above as InstallShield attempts to install 32-bit drivers. To continue installing TNMR with 64-bit drivers after completing Steps 1-14 above, proceed with the steps below.

1. Locate the Device Driver Installation Wizard window behind TNMR Installshield Wizard and click OK. (See Figure 18)

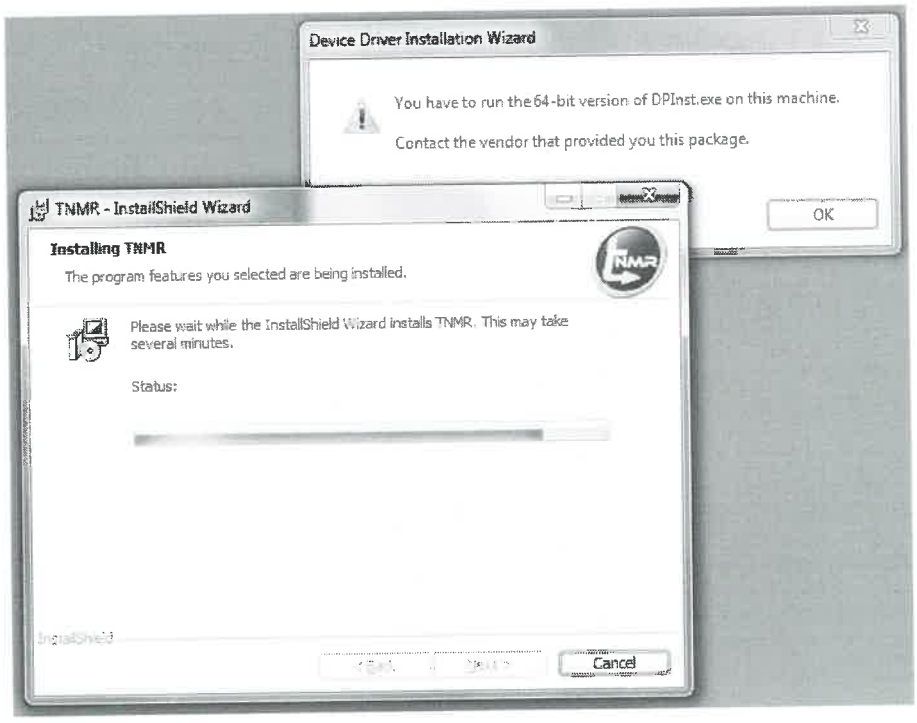


Figure 18

19. Click Finish when TNMR Installation is complete. (See Figure 19)

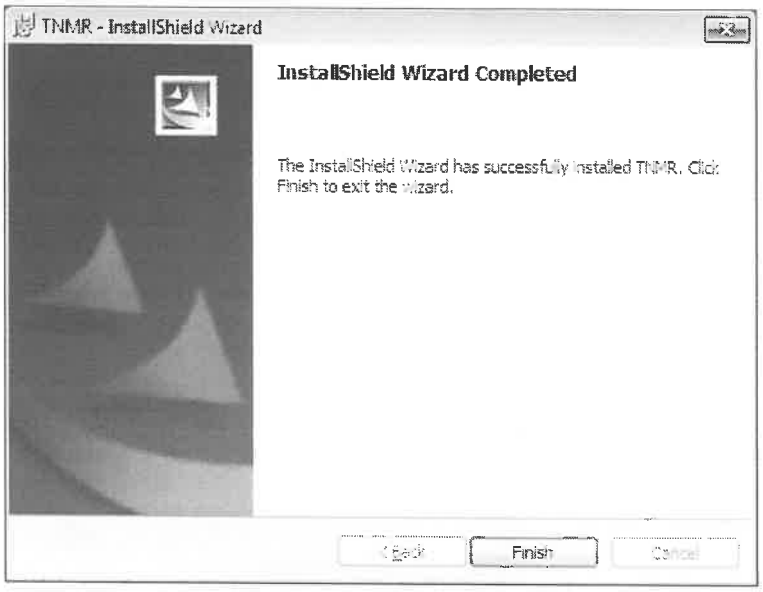


Figure 19

2. From the \TNMR\USBDrivers\64-bit folder, right click on 64bitUpgrade.exe and click Run as administrator. (See Figure 20)

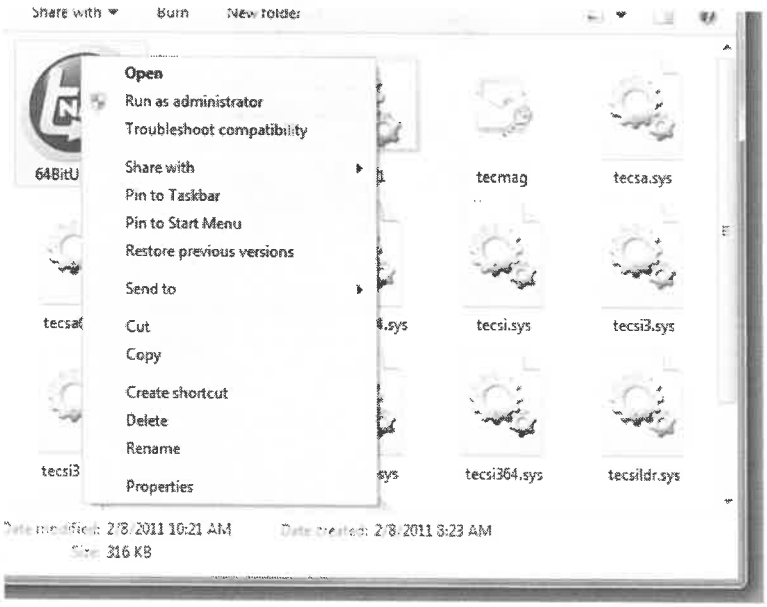


Figure 20

3. When the User Account Control Window pops up and asks "Do you want to allow…" click Yes.

4. On the Tecmag 64Bit Driver Upgrade Patch window, click Start Driver Installation. (See Figure 21)

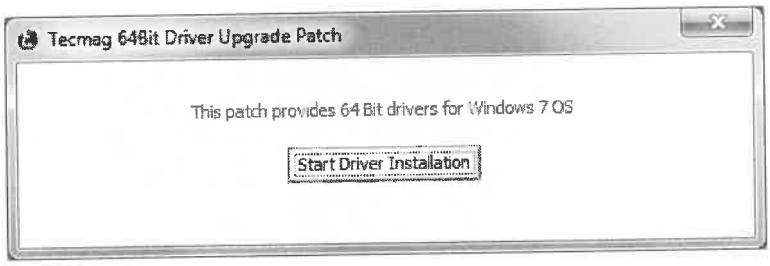


Figure 21

5. On the Device Driver Installation Wizard window click Next to proceed with 64-bit USB driver installation. (See Figure 22)

Figure 22

6. When prompted "Would you like to install this device software?" by Windows Security, click Install. (See Figure 23)

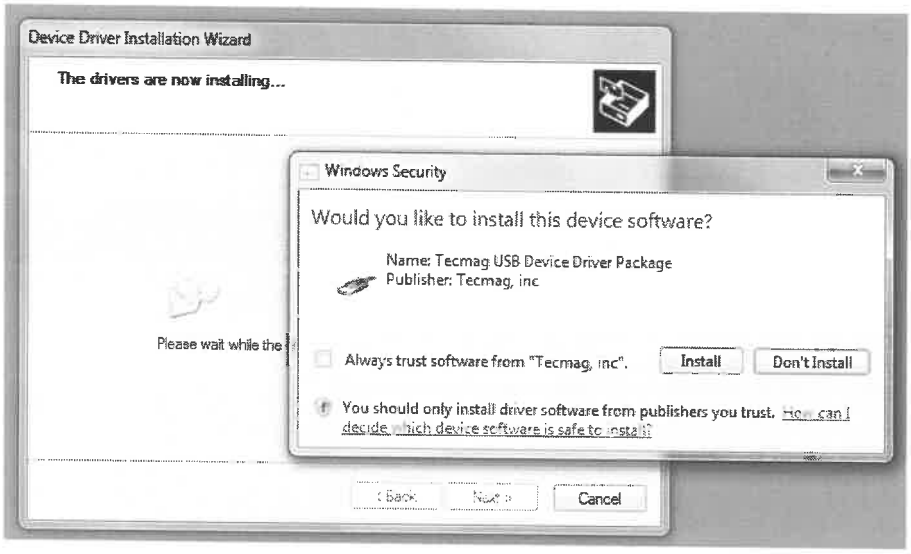


Figure 23

7. Close the Device Driver Installation Wizard by clicking Finish to complete the installation. (See Figure 24)

Figure 24

8. Finally, connect your Tecmag hardware USB cable(s) to the PC and power on the device. The 64-bit device drivers will configure automatically, and progress notification will appear in the taskbar. (See Figure 25)

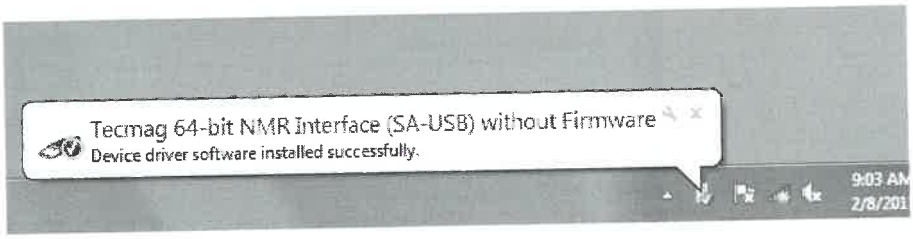


Figure 25

Launching TNMR and Utilities for the First Time

Due to Microsoft Win7's elevated registry security measures, it is necessary to launch TNMR and its components with Administrator privileges when first run. The following steps should be taken for every user account on the PC.

1. Right click on the TNMR desktop icon.
2. Select *Run as administrator*. TNMR will now start.

Each Tecmag utility that will be used for the user's hardware also needs to be *Run as Administrator* in order to establish proper registry connections. Use the list below to determine which utilities need to be launched. NOTE: Not all are applicable to your hardware configuration, and configuration files from the factory may be required in order to use some utilities.

Hardware or Application	Software Utility	Configuration File
Probe Interface & Tuning	RFControl.exe	RFControl.ini
Air Control / VT	SampleInterface.exe	SampleInterface.ini
Lock	TecmagLock.exe	Lock.ini
Sample Changer	TecmagSampleChanger.exe	TecmagSampleChanger.ini
Automation -- Setup	NMRWizard.exe	NMRWizard.ini
Automation – Scheduling	NMRQueue.exe	NMRQueue.ini

3. Using Windows Explorer, browse to the \TNMR\bin folder on the computer's hard drive.
4. From the \TNMR\bin folder, right click on each application executable (.exe) and choose *Run as Administrator*.
5. If prompted for configuration files, navigate to the \TNMR\config folder and select the appropriate .ini file.
6. After the application starts, exit the utility.

The Windows Registry should now be updated. TNMR may now be launched from the desktop or Start Menu without *Run as administrator*. Its utilities may now be launched from the Start Menu or from within TNMR.

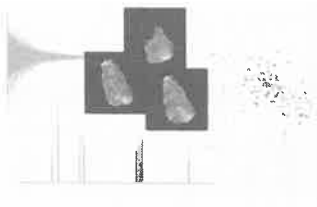
7. Restart TNMR *without* Administrator privileges.

Launching Scripts

Once the steps above have been taken to establish TNMR registry connections, automation scripts should connect to TNMR and its utility applications without problem.

Custom user scripts can be launched in a couple of ways. Compiled .exe scripts (e.g. Visual Basic) as well as non-compiled .vbs files can be launched directly from the desktop or hard drive. Alternatively, the files can be placed in the \TNMR\Scripts folder and launched within TNMR from the Scripts menu after first refreshing the menu by clicking Scripts | Update Menu.

NOTE: Compiled scripts should be launched using the same privileges as TNMR. If TNMR is still running in Administrator mode, the script will also need to be run as Administrator. Furthermore, non-compiled .vbs scripts cannot be launched directly from the hard drive or desktop if TNMR is in Administrator mode. Launching the scripts from within TNMR avoids this problem since scripts assume TNMR's privileges.



System Specific Information

The table below lists configuration information about the system which may be system specific. This table should be used as a reference when reviewing system specifications and capabilities found in the "Hardware Reference Manual".

Consult the "Hardware Reference Manual" for all system specifications.

General	
System	Redstone HF-2 MRI
Serial Number	37863
Hardware	
F1 & F2 Channels	
Freq Range	0.5 MHz - 500 MHz*
Phase/Amplitude Mod Type	EM-III
Freq Control Type	EM-III
Gradients	
Gradient Type	EM-III
Rotation Option	Yes
B_0 Compensation	No

Phase Reset

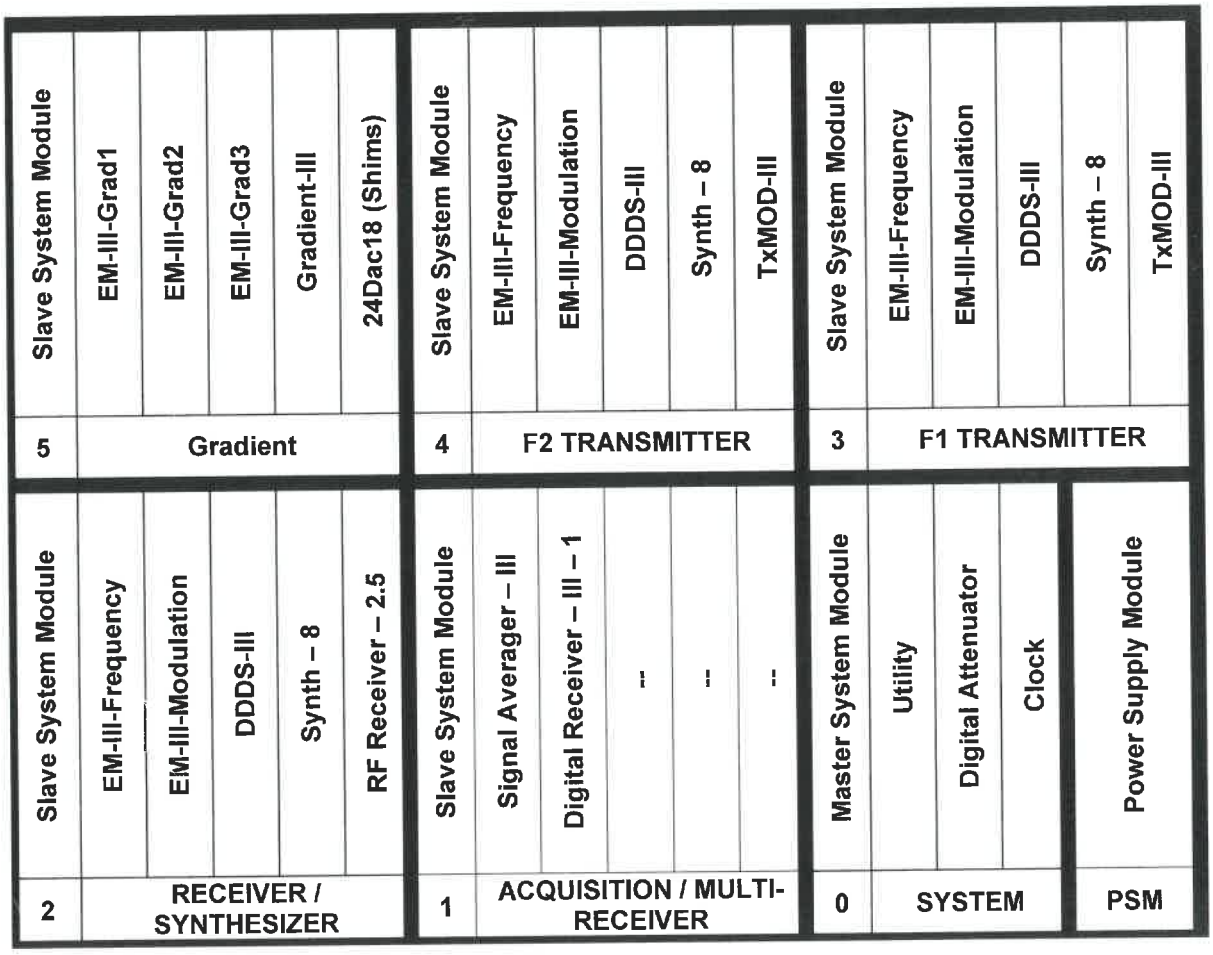
In order to ensure phase synchronization between all transmitters and receivers, all pulse sequences need to begin with a recommended 5 μs event (minimum duration) for the following sequence lines:

F0_PhRst F1_PhRst

RX_PhRst F2_PhRst

* Lower frequency operation is possible in a Direct Digital Detection configuration.

Chassis Layout Diagram:



Converting to Direct Digital Detection (DDD) Configuration:

Redstone S/N 37863 is shipped in a "High Frequency" configuration in which both transmitters are capable of 0.5 to 500 MHz output, and an analog receiver is used over this range. It is possible, however, to reconfigure the Redstone to allow "Low Frequency" F1 transmitter output while bypassing the analog receiver for Direct Digital Detection (DDD). This low-frequency DDD mode is recommended for operation below 500 kHz; the F2 transmitter and analog receiver are not used in DDD mode.

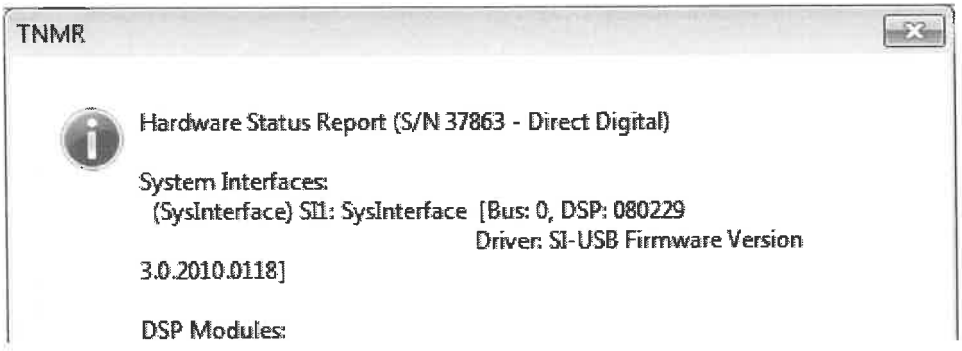
To switch between configurations, it is necessary to make (a) hardware changes in the form of changing the cabling within the Redstone, (b) software changes in the form of modifying the /tnmr/config configuration files, and (c) TNMR preference changes.

(a) **Hardware:** The diagrams on the following two pages will guide you in making the necessary cabling changes. Changes are indicated by bolder lines. An 8mm wrench can be used when working with the SMA connectors. It is recommended that the power to the unit be turned OFF while making the changes. To access the cables, remove the top cover by removing the screws along the sides and top of the cover.

(b) **Software:** The software changes are performed by simply copying the appropriate files from the /tnmr/config subfolders to the root /tnmr/config folder. Restart TNMR after changing configuration files.
- For direct digital detection (DDD) mode, use the Apollo.ini and config.con files in the /tnmr/config/DDD subfolder.
- For high frequency mode, use the Apollo.ini and config.con files in the /tnmr/config/HF subfolder.

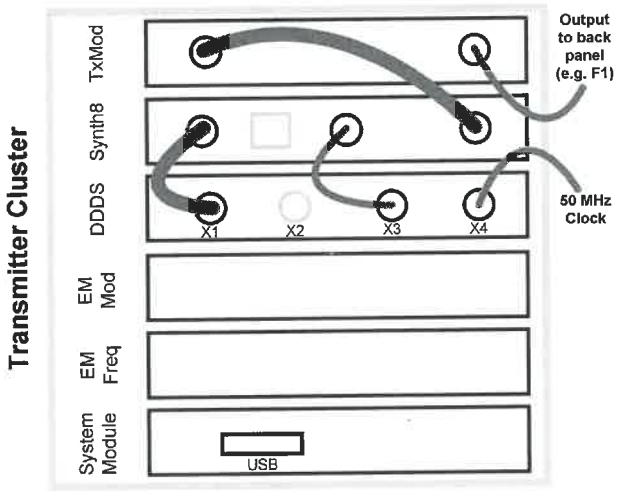
(c) **Prefereneces:** A simple preference change is necessary when switching between high frequency and DDD mode. In TNMR open the Edit Menu and click Preferences. On the Acquisition / Console tab, locate the "Reverse Direct Dimension" option box. Set the preference as follows:
- DDD Mode: Checked
- HF Mode: Unchecked

You can verify the software configuration by choosing Commands | Configuration Commands | Hardware Status. The Serial Number field at the top of the message box will report the serial number and configuration (See screenshot below).

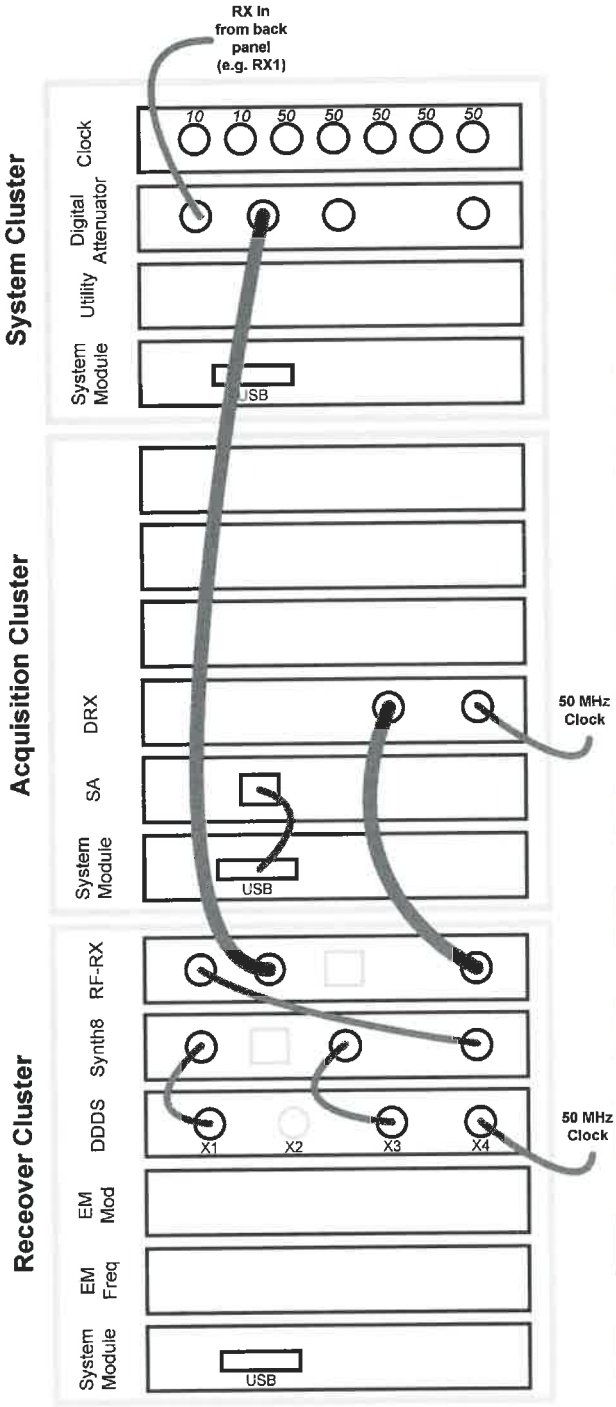


High Frequency (default) Cabling

Transmitter (High Frequency)

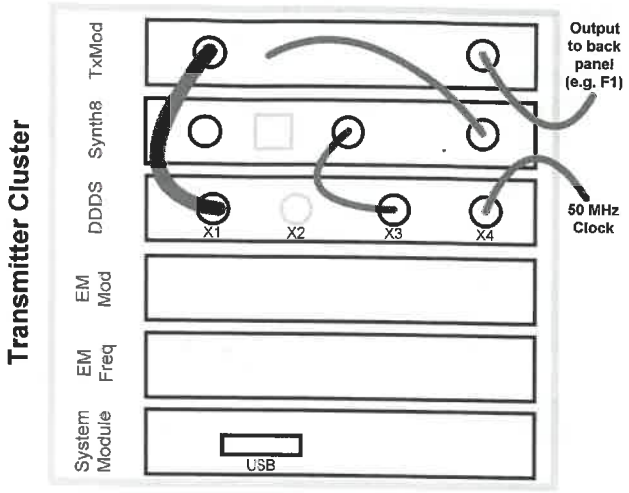


Receiver (High Frequency)

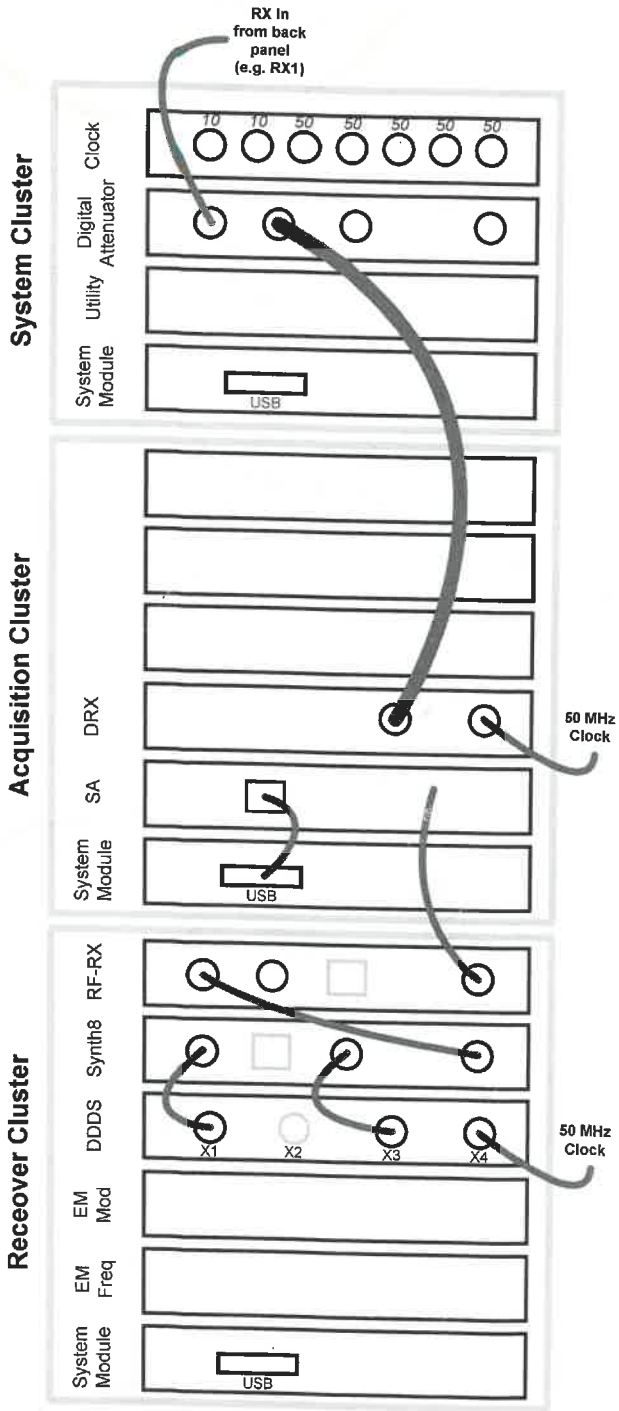


Direct Digital Detection Cabling

Transmitter (Low Frequency)
***Bypass Synth8**



Receiver (Direct Digital Detection)



1 V_{p-p} → 1.5 V_{p-p}

High + Low F

Change transmitter 1 cable (cabling)

Change .ini file

F2 → high freq.

ZM 10/16

Two Channel 5-bit Digital Attenuator

Introduction:

This Redstone incorporates a two channel digital attenuator module which incorporates two Hittite Microwave Corp. HMC470LP3 digital attenuators. Five-bit control is provided via the System Cluster backplane. The software interface is accomplished using the Ext_Gain line of the TNMR pulse sequence editor.

The attenuator allows 1.0 dB incremental attenuation from 0 dB to 31 dB (5-bits). However, due to the logic of the device, software control is presented as a "Gain" since a value of 31 (all 5 bits high logic) delivered to the device corresponds to 0 dB attenuation while a value of 0 (all 5 bits low) results in maximum attenuation. *NOTE: The two channels are controlled together using the same sequence editor control.*

Hardware Installation:

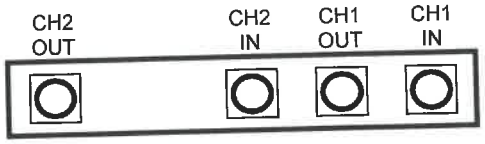
The attenuator hardware is factory installed as an internal component of the Redstone. It is installed in the System Cluster, and inserted in the cable path between the RX1 input on the Redstone back panel and the RX1 analog receiver input. All cabling has been installed in the factory; no additional installation is required. *NOTE: The SMA Port Assignments are illustrated below.*

Software Installation:

The /tnmr/config/config.con file has already been modified at the factory to incorporate the Ext_Gain control line for the pulse sequence.

Operating Instructions:

1. Add a "Gain" value or variable on the Ext_Gain line during every acquisition event in the TNMR pulse sequences.
2. For maximum signal, enter a value of 31. For minimum signal, use a variable set to zero. For 10 dB attenuation, enter 31 – 10 = 21.



Tecmag Two Channel Digital Attenuator
SMA Port Assignments

New Features with EM-III

The Tecmag Redstone system is based on the latest Event Module—the EM-III. Below are detailed a few of the new features made possible with the EM-III including *Extended Tables, Conditional Branching,* and *Simultaneous Tables.*

Extended Tables:

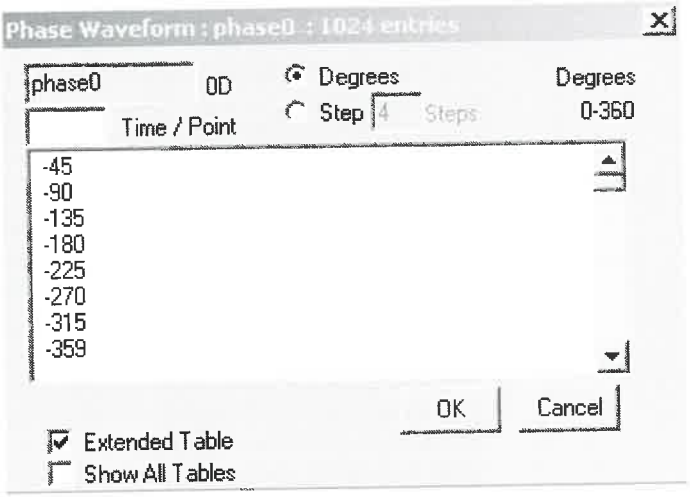
Certain table types may now be "extended". This means that the table pointer is no longer reset along with the associated scan counter. Thus, (depending upon the number of entries) the table entries can become "asynchronous" from the scan counter. For example, suppose it is desired to apply a pseudo-random phase to the transmitter and receiver on each excitation, to accomplish so-called "rf-spoiling" of the transverse magnetization. In such a case, it would be undesirable for this phase pattern to repeat itself synchronously with the phase encoding in a 2D experiment (e.g., every 4th record). If we use an extended table, we can accomplish this, as illustrated in the chart below, which compares the phase from the following tables:

- Standard 1D table (0°, 180°)
- Standard 2D table (0°, 90°, 180°, 270°)

  vs.
- Extended 1D table (117°, 234°, 351°, 108°, 225°, 342°, 99°, 216°, 333°, 90°, 207°, 324°, 81°)

1D scan #	2D scan #	Phase from standard 1D table	Phase from standard 2D table	Net phase from standard tables	Phase from 1D extended table
1	1	0	0	**0**	**117**
2	1	180	0	**180**	**234**
1	2	0	90	**90**	**351**
2	2	180	90	**270**	**108**
1	3	0	180	**180**	**225**
2	3	180	180	**0**	**342**
1	4	0	270	**270**	**99**
2	4	180	270	**90**	**216**
1	5	0	0	**0**	**333**
2	5	180	0	**180**	**90**
1	6	0	90	**90**	**207**
2	6	180	90	**270**	**324**
1	7	0	180	**180**	**81**
2	7	180	180	**0**	**117**
1	8	0	270	**270**	**234**
2	8	180	270	**90**	**351**

In this example, 2D records 1, 5, and so on have the same phase with the standard tables. The 1D extended table repeats on the second scan of the 7th record, resulting in far less correlation with record number. Note that because this table is a **1D extended table**, the pointer increments with the **1D scan counter**.



To specify extended table behavior, check the box in the table editor, as shown above. This feature is available for "Icon types" A3, E3, G3, P3, R3, and W3.

Other notes:

- All tables in the same dimension, on the same event, and on the same module (e.g. amplitude and phase), must have the same setting of the "extended" flag. The compiler creates a composite table for this event, and uses the flag value from the last table it processes.
- The number of table entries should be different from the corresponding Scans nD or Points nD, in order to be useful.

New Features with EM-III (continued)

Conditional Branching:

Conditional branching allows the execution of events in a pulse sequence in a different order, depending upon some **condition**. Such conditions might include:

- Scan count values
- Presence or absence of an external (hardware) signal (future)

The changed order of events results from a **branch**, from a branch event to a target event (The target is normally some event other than the next one in the sequence).

To allow the increased flexibility in pulse programming that results from conditional branches, some hardware and software features have been added to the Redstone system:

- A hardware state or condition input distributed to every EM-III (implemented with PCB rev C)
- A **CTest** sequence line to specify when the condition input is to be tested or detected, and what sort of test to perform. A CT event specified on this line will set an internal flag bit = 1 if the condition is true. The flag state is stored and persists until the next CT event occurs.
- A **CBranch** sequence line to specify the branch destinations. Tables on this line indicate the target event(s) for a branch. A branch occurs if the flag (from CTest) is true when the branch event is executed.

Some rules:

- Conditional branches apply only to Redstone/EM-III systems.
- Minimum time for CB/CT events is 1μs
- The condition must be tested BEFORE the branch event.
- The branch event and its target are always executed.
- Branches are always specified in tables. All branches are specified by the target event number as shown in the sequence editor. (If the number of events in the sequence is changed, the sequence editor will attempt to update the target event numbers, and warn the user if this is not possible).
- No branching INTO or OUT OF a loop (an entire loop may be skipped, however).
- No branching into another scan: i.e. beyond the START or END-OF-SCAN events for the current scan.
- No branch can skip any slow-io event (frequency hop, gradient rotation, or acquisition).
- nD tables: the highest dimension overrides any lower dimension branches (tables replace rather than add).
- A branch may not have a waveform table on the same event. However, the branch's target may have a waveform.
- A branch may not occur in the same event as an external trigger event.
- There is no protection against infinite loops

Limitations:

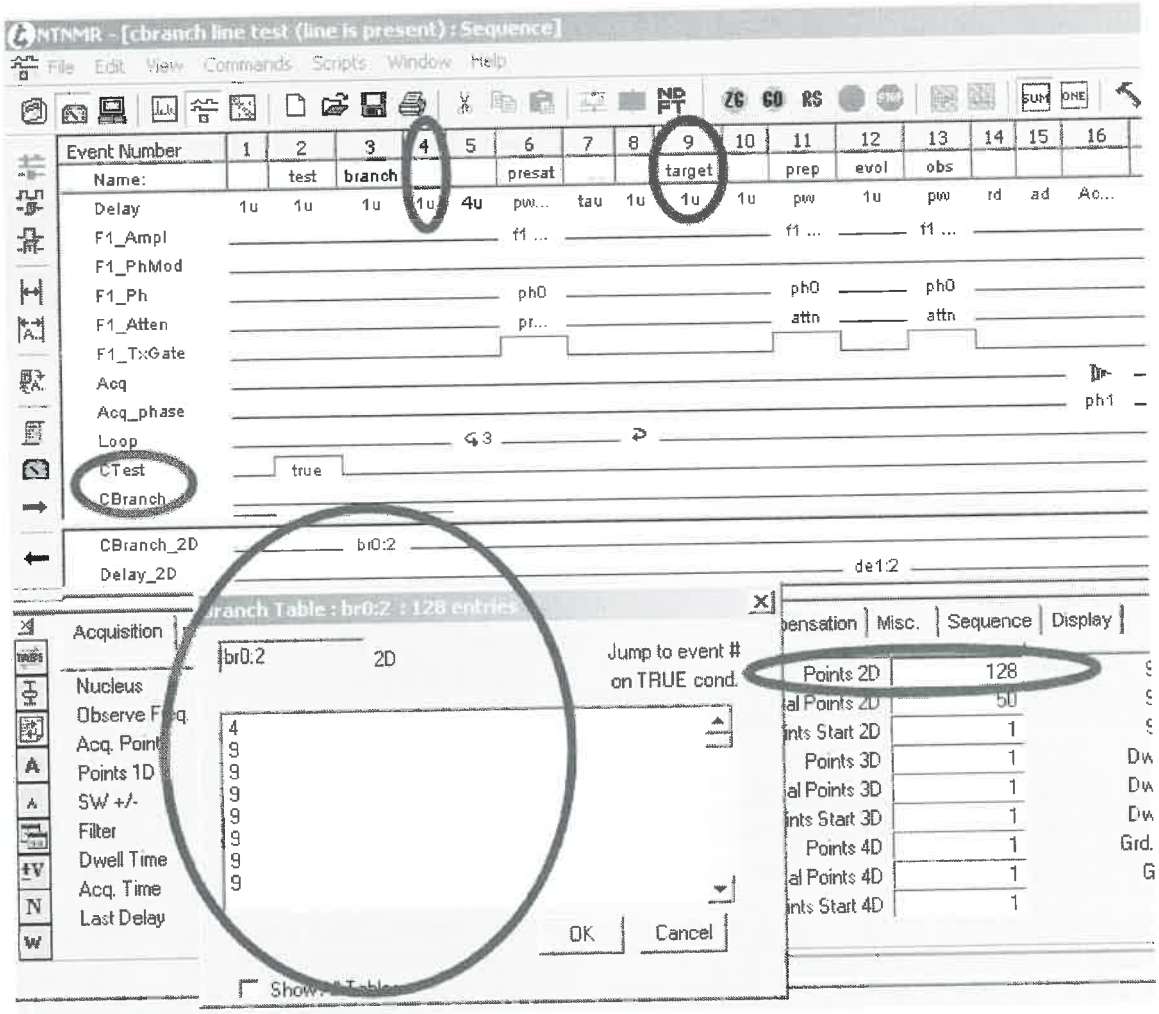
There are presently no software protections against illegal branches, infinite loops, or other problems that might cause the pulse programmer to lock up. Users must test their sequence under safe conditions (e.g. with the power amplifiers disabled).

Example 1: 2D Preparation Sequence

The following example performs the presaturation loop (events 5-7) only once for each 2D plane. On the first scan, events 4-8 are executed (the branch is from event 3 to 4). On all subsequent scans, a branch from event 3 to 9 causes events 4-8 to be skipped. Note the extra event (#4) inserted before the loop start to provide a target for the first jump.

Pulse Programming procedure:

In event 2, place "Always True" on the CTest line.
In event 3, place a 2D table on the CBranch line.
Put the following entries in the table: 4, 9, 9, 9.... (the target event numbers, total 128 entries)



Example 2: Conditional ("Gated") Acquisition

The following example shows how to maintain a steady-state magnetization while acquiring signals only when an external hardware condition is satisfied. This is useful, for example, in respiratory gating, where data are only acquired during a restricted phase of the subject's breathing cycle.

In the example, events 8-13 and 14-19 have exactly the same time duration. Depending upon the state of the external hardware, the sequence will either:

- execute events 8-13, then branch to event 1 (branch2 – target2, in red), without incrementing the counters, and then repeat the same scan, or
- branch from 8 to 14 (branch1 – target1, in blue), then execute events 14-19, then increment the 1D/nD counters and advance to the next scan.

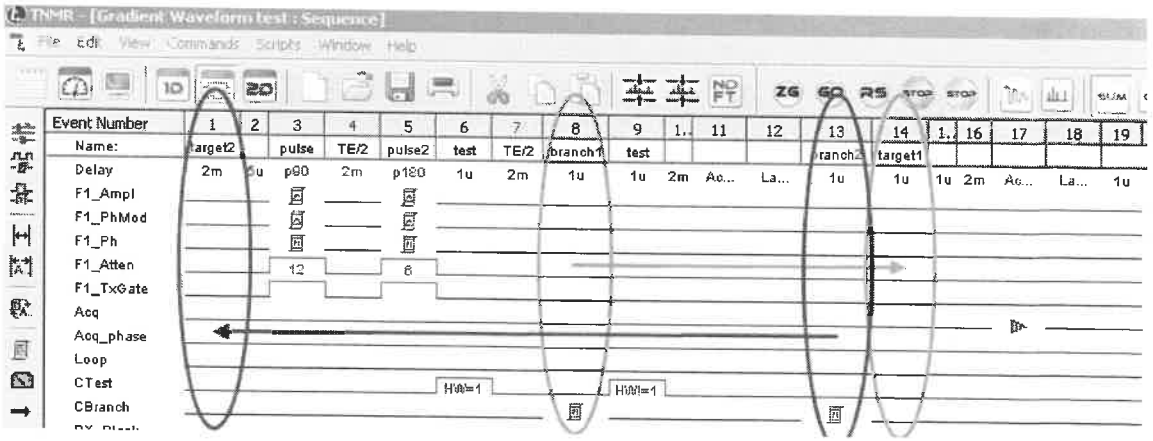
Pulse Programming notes:

There are two condition tests, in events 6, and 9, with opposite logic. The test in event 6 is true if hardware bit 0 is high (logic "1"), while the test in event 9 is false.

The CBranch table in event 8 has one entry, "14". The table in event 13, likewise has one entry, "1".

Be sure to count the events executed along each path and set the durations equal in order to maintain constant timing of the sequence.

(Note that this example assumes that the external condition bit is constant for the duration of the scan. This can be achieved, for example, by using an LP output in event 18 to latch in a new value).



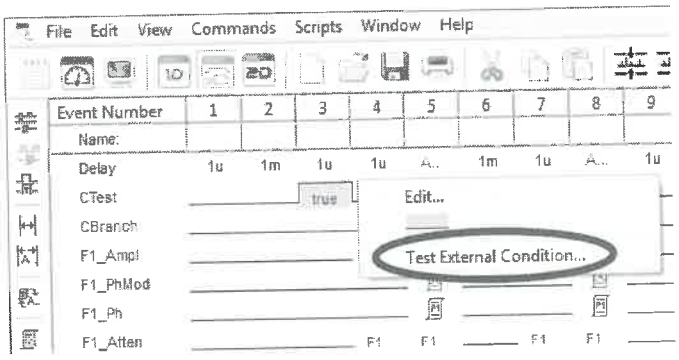
Hardware Interface for Conditional Branching:

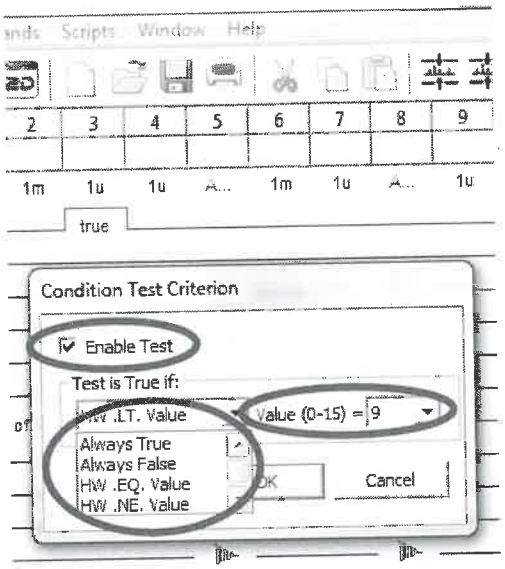
A DB-25 connector labeled "EXT IN" is provided on the Redstone back panel to interface external hardware signals for conditional branch control. Currently four bits are tested allowing 16 values ("conditions").

EXT IN	
Bit	**Pin**
0	1
1	2
2	3
3	4
GND	25

CTest Logic Conditions:

The TNMR Sequence Editor provides a number of logic options for conditional branch testing.





"Test is True if:"	**Expression**
Always True	True for all Values
Always False	False for all Values
HW .EQ. Value	=
HW .NE. Value	≠
HW .GT. Value	>
HW .LT. Value	<
HW .GE. Value	≥
HW .LE. Value	≤

BP1 LP Outputs*

DB-25 pin	Signal	Config.con Assignment	Event Module
1	LP20	Scope_Trig	EM_Sys_0
2	LP21		
3	LP22		
4	LP23		
14	GND	GND	
15	GND	GND	
16	LP22 inv	N/A	
17	LP23 inv	N/A	
5	LP20		EM_Sys_1
6	LP21		
7	LP22		
8	LP23		
18	GND	GND	
19	GND	GND	
20	LP22 inv	N/A	
21	LP23 inv	N/A	
9	LP20		EM_Sys_2
10	LP21		
11	LP22		
12	LP23		
22	GND	GND	
23	GND	GND	
24	LP22 inv	N/A	
25	LP23 inv	N/A	
13	GND	GND	

* Pins / Signal addresses with no Config.con assignment, N/A, or GND are available for use. Contact Tecmag Support for assistance with enabling these signals.

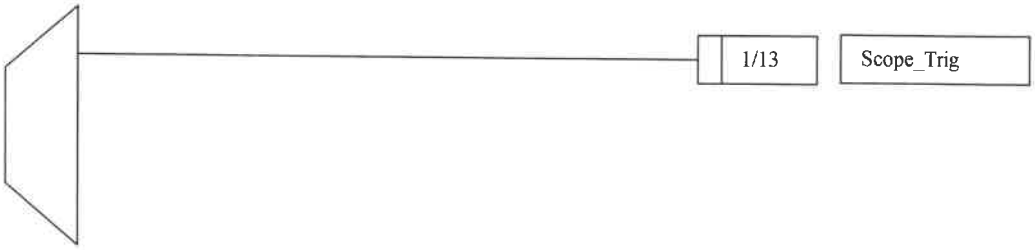
BP2 LP Outputs*

DB-25 pin	Signal	Config.con Assignment	Event Module
1	LP20		EM_Sys_3
2	LP21		
3	LP22		
4	LP23	F1_UnBlank	
14	GND	GND	
15	GND	GND	
16	LP22 inv	N/A	
17	LP23 inv	N/A	
5	LP20		EM_Sys_4
6	LP21		
7	LP22		
8	LP23	F2_UnBlank	
18	GND	GND	
19	GND	GND	
20	LP22 inv	N/A	
21	LP23 inv	N/A	
9	LP20		EM_Sys_5
10	LP21		
11	LP22		
12	LP23		
22	GND	GND	
23	GND	GND	
24	LP22 inv	N/A	
25	LP23 inv	N/A	
13	GND	GND	

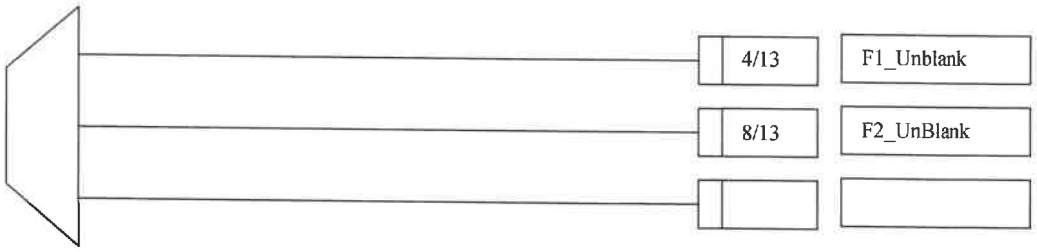
* Pins / Signal addresses with no Config.con assignment, N/A, or GND are available for use. Contact Tecmag Support for assistance with enabling these signals.

S/N 37863 DB25 LP Connectors

BP1



BP2



Remote Control Setup

Introduction

Using a third party software package called VNC (Virtual Network Computing) your system can be controlled remotely. Computer platforms supported for remote control clients are Windows, Linux, Macintosh, and various versions of UNIX. Tecmag is not the author of this software package and Tecmag does not assume any responsibility for the VNC software or any potential problems associated with its use. If you would like more information regarding the VNC software please see the VNC homepage at http://www.ultravnc.com.

The following steps are recommended to setup the computer for remote control.

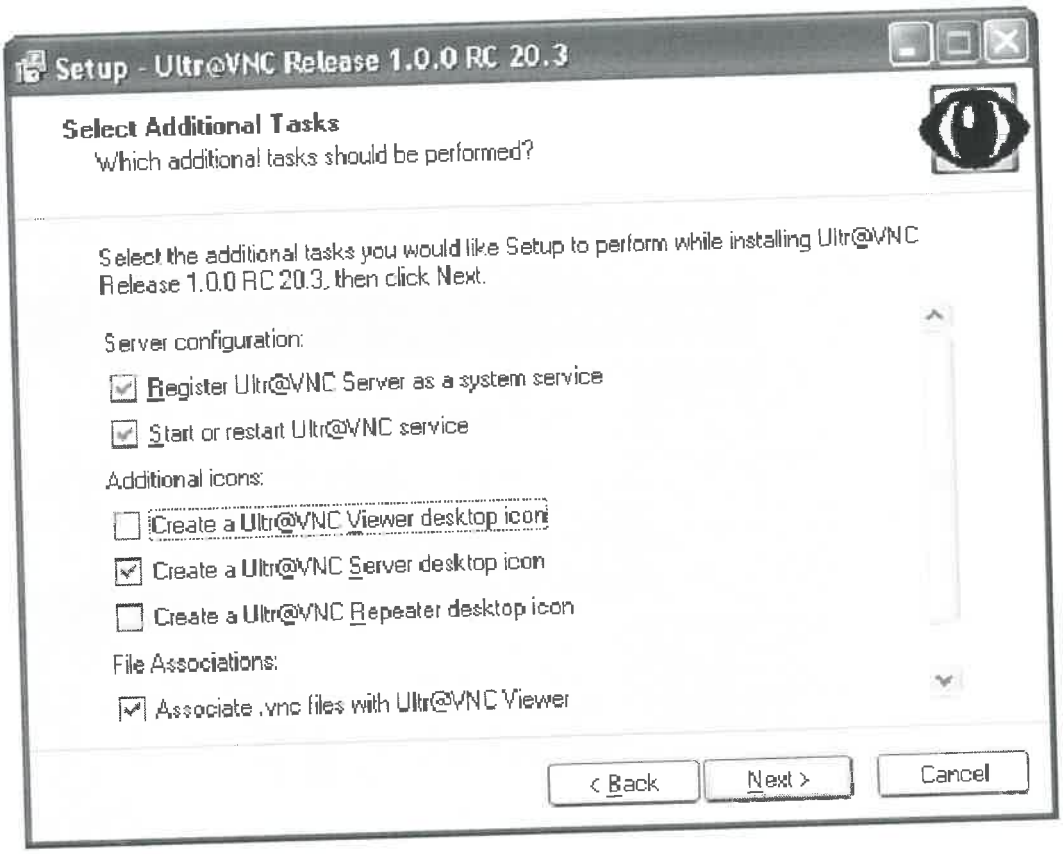
- Assign a static IP address to the computer
- Connect the computer to the network with a permanent connection
- Install and activate the VNC software (see below)

> *Tecmag will never connect to the spectrometer computer without prior consent and arrangement by an authorized end-user of the system. The VNC software provides password protection and the end-user has full control and responsibility of the remote control software, including password assignment and allowing/disallowing connections.*

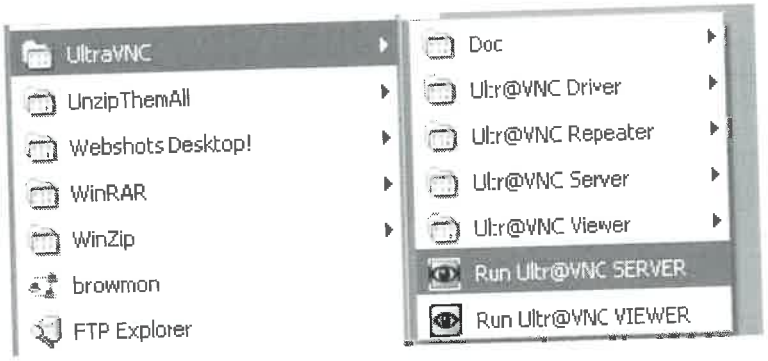
The latest release of the VNC software package for Windows and other platforms is included on the TNMR CD. The package includes three files: TecmagVNC.exe, UltraVNC-100-RC203-Setup.exe, and VNC setup.pdf.

- TecmagVNC.exe is based on UltraVNC for a reverse VNC connection. (Installed by default, recommended to use)
- UltraVNC-100-RC203-Setup.exe is a full VNC program including server and viewer, which is also downloadable from http://www.ultravnc.com. (Optional with custom installation)

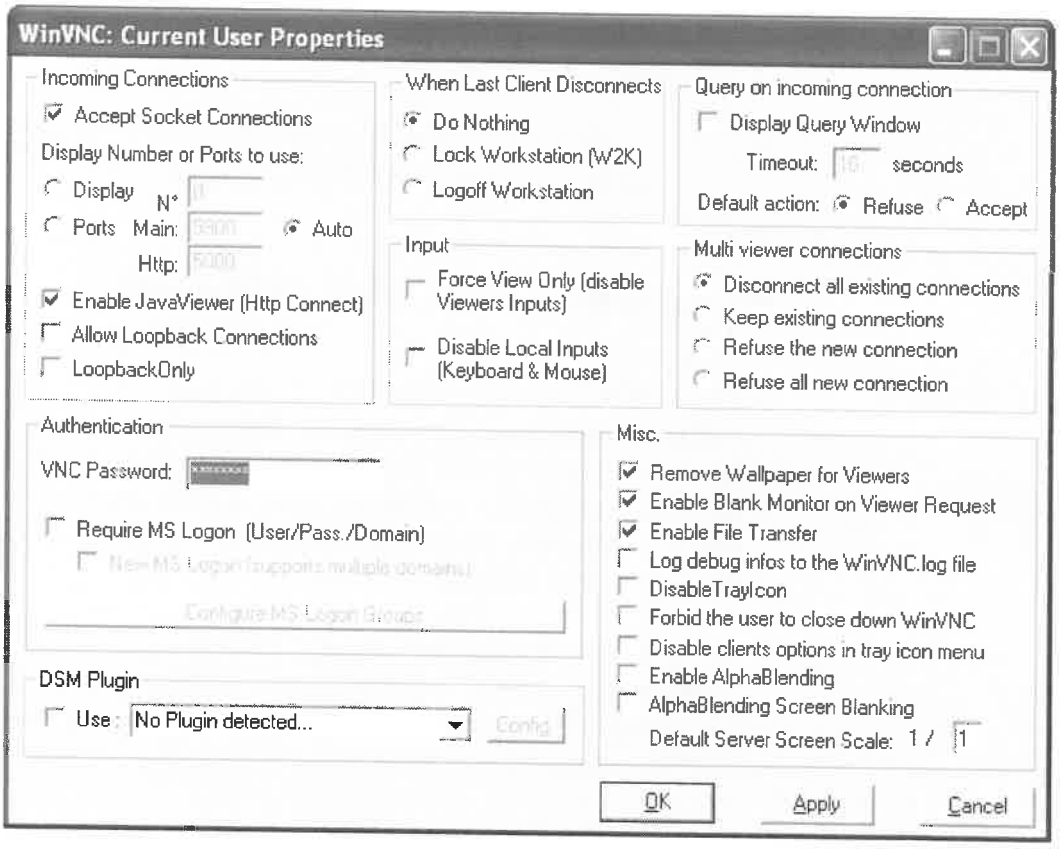
To install the programs, insert the TNMR CD and follow the installation wizard to select either or both of TecmagVNC (default, recommended) and UltraVNC (optional) programs. Tecmag customers might install and run both programs on their computers simultaneously, but **only one of them should be used** at a given time to establish a VNC connection.



2. Once the installation is complete, the server icon is added in the system tray.
   If not, go to the START menu to *Install WinVNC Service* first, then run the *UltraVNC Server*.
   The UltraVNC Server will start automatically every time the machine restarts unless you execute *Remove WinVNC Service* from the START menu.



3. Double click the server icon in the system tray to bring up the properties window. Type a password in the VNC Password textbox.



> *If the VNC icon is not visible in the Taskbar this indicates that the VNC server is not running. VNC will not allow connections to the computer unless the VNC server is running.*
>
> *Inform your network administrator to setup port forwarding of 5900(start port)-5900(end port, same as start port) to your local PC's IP address with TCP protocol.*

4. Provide Tecmag your internet IP (public IP) and your VNC server password.

   Now, the standard UltraVNC connection is ready to go.

> *Note that to use the VNC server in your local computer, your user account inside the PC has to have a password.* ***No blank user account password is allowed****. And to allow VNC Viewer to reboot your PC during a VNC session, you have to provide Tecmag with your user login account name and password of the PC.*
>
> *To ensure a reliable connection, it is recommended that you have a permanent TCP/IP network connection (not a dial-up connection) and a static IP address.*

5. To close VNC right-click on the VNC icon in the taskbar and select Close VNC from the right click menu.

Frequently Asked Questions

Which TCP/IP port does the VNC server use?
A VNC server listens on two ports. The exact port numbers depend on the VNC display number, because a single machine may run multiple servers. The most important one is 59xx, where xx is the display number. The VNC protocol itself runs over this port. So for most PC servers, the port will be 5900, because they use display 0 by default.

My University/Institution/Company has a firewall, what can I do?
In many cases your IT department will be able to create a very restricted hole in the firewall that you can use to allow connections. Contact your IT department for more information.

We use a DHCP server to dynamically assign IP addresses. Will this cause VNC to fail?
VNC uses the IP address assigned to the machine running the server. As long as you have some method for determining the IP address currently in use by the computer running VNC, there should not be any problems. Your IT department should be able to help you determine the current IP address.

Where can I find more information about VNC?
The VNC documentation is installed on the TNMR CD in the VNC directory along with the VNC programs for various computer platforms. You can also connect to http://www.ultravnc.com for more information

dBm - Voltage Chart

dBm	mV (p-p)	mWatts
-30	20.0	0.0010
-29	22.4	0.0013
-28	25.2	0.0016
-27	28.3	0.0020
-26	31.7	0.0025
-25	35.6	0.0032
-24	39.9	0.0040
-23	44.8	0.0050
-22	50.2	0.0063
-21	56.4	0.0079
-20	63.2	0.0100
-19	71.0	0.0126
-18	79.6	0.0158
-17	89.3	0.0200
-16	100	0.0251
-15	112	0.0316
-14	126	0.0398
-13	142	0.0501
-12	159	0.0631
-11	178	0.0794
-10	200	0.100
-9	224	0.126
-8	252	0.158
-7	283	0.200
-6	317	0.251
-5	356	0.316
-4	399	0.398
-3	448	0.501
-2	502	0.631
-1	564	0.794
0	632	1.00
1	710	1.26
2	796	1.58
3	893	2.00

dBm	V (p-p)	mWatts
0	0.632	1.00
1	0.710	1.26
2	0.796	1.58
3	0.893	2.00
4	1.00	2.51
5	1.12	3.16
6	1.26	3.98
7	1.42	5.01
8	1.59	6.31
9	1.78	7.94
10	2.00	10
11	2.24	12.6
12	2.52	15.8
13	2.83	20.0
14	3.17	25.1
15	3.56	31.6
16	3.99	39.8
17	4.48	50.1
18	5.02	63.1
19	5.64	79.4
20	6.32	100
21	7.10	126
22	7.96	158
23	8.93	200
24	10.02	25.1
25	11.25	316
26	12.62	398
27	14.16	501
28	15.89	631
29	17.83	794
30	20.00	1000
31	22.44	1259
32	25.18	1585
33	28.25	1995

dBm	V (p-p)	Watts
30	20.0	1.00
31	22.4	1.26
32	25.2	1.58
33	28.3	2.00
34	31.7	2.51
35	35.6	3.16
36	39.9	3.98
37	44.8	5.01
38	50.2	6.31
39	56.4	7.94
40	63.2	10.00
41	71.0	12.59
42	79.6	15.85
43	89.3	19.95
44	100	25.12
45	112	31.62
46	126	39.81
47	142	50.12
48	159	63.10
49	178	79.43
50	200	100.0
51	224	125.9
52	252	158.5
53	283	199.5
54	317	251.2
55	356	316.2
56	399	398.1
57	448	501.2
58	502	631.0
59	564	794.3
60	632	1000
61	710	1259
62	796	1585
63	893	1995

Tecmag, Inc.
10161 Harwin Dr., Suite 150 | Houston, TX 77036 | USA
ph 713-667-8747 | fx 713-667-3180 | www.tecmag.com

tecmag
TECHNOLOGY FOR MAGNETIC RESONANCE